CUTE

Clean Urban Transport for Europe
General Introduction Brochure

Goals of CUTE

Developing a role for hydrogen and fuel cells in public transport is probably one of the most ambitious actions in energy and transport today. This project, which is currently the world's largest in fuel cell technology, enjoys Community financial support because not only it is technologically innovative, but also it complements the Commission's current actions on alternative fuels. It demonstrates the feasibility of zero emission public transport, where the fuel - hydrogen - is produced from different energy sources. This technology development is a significant support to the Commission's policies and actions to promote a more rational use of energy, to promote new and renewable energies and to reduce oil dependence.

Attractive public transport has a key role to play in sustainable transport. Clean vehicles and clean fuels contribute to a high-quality public transport service. Clean urban transport has to combine energy-efficient, cost-effective and clean public and private vehicle fleets with innovative approaches to transport demand management, high-quality public transport services, intelligent traveller services and other soft measures.

CUTE will demonstrate an emission-free and low-noise transport system, including the accompanying alternative fuels infrastructure. This has great potential for reducing the global greenhouse effect according to the Kyoto protocol, improving the quality of the atmosphere and life in densely populated areas and conserving fossil resources. For this purpose the application of the innovative hydrogen-based fuel cell technology is to be established by using fuel cell powered buses in an urban environment together with novel hydrogen production and support systems as part of a European Union wide demonstration scheme.

The project will serve to strengthen the competitiveness of European industry in the strategically important areas of hydrogen processing and fuel cell technology. The project demonstrates also to European Society the closeness of such innovative technology to their every day concerns like improved local air quality, human health, environmental protection and quality of life.

The major objectives are as follows:

- Demonstration of 27 fuel cell powered regular service buses over a period of two years in 9 European inner city areas to illustrate the large spectrum of different operating conditions to be found in Europe.

- Design, construction and operation of the necessary infrastructure for hydrogen production and refuelling stations.

- Collection of findings concerning safety, standardisation and operating behaviour of production for mobile and stationary use, and exchange of experiences including bus operation under differing conditions among the numerous participating companies for replication.

- Ecological, technical and economical analysis of the entire life cycle and comparison with conventional alternatives. Quantification of the abatement of CO_2 at European level and contribution to commitments of Kyoto.

Genesis and description of the CUTE project

Genesis

Greenhouse gas emissions from transport are rising at an alarming speed and noise is increasing as a source of complaint from European citizens. For this reason 9 European cities: Amsterdam (Netherlands), Barcelona (Spain), Hamburg (Germany), London (United Kingdom), Luxembourg, Madrid (Spain), Porto (Portugal), Stockholm (Sweden) and Stuttgart (Germany), have committed to the CUTE (Clean Urban Transport for Europe) demonstration project, in introducing fuel cell powered city buses with hydrogen as fuel into their public transport system. These 9 European cities are convinced that the combination of hydrogen and fuel cells will lead towards the most sustainable urban transport system and address all these important problems simultaneously.

During the last few years a number of organisations have been actively engaged in the development of fuel cell technology for mobile applications. With this in mind, a wide range of vehicle prototypes were presented to the public and demonstrated in the course of individual test runs.

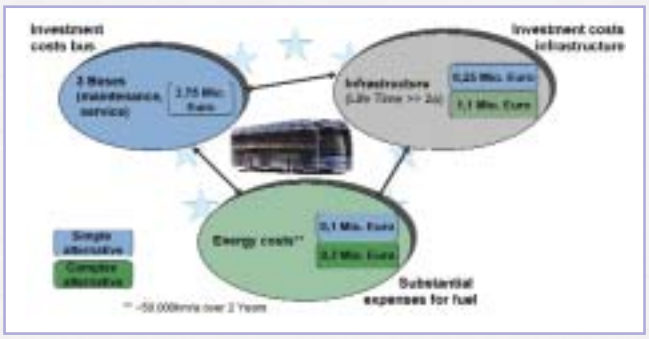
In order to gather particular practical experience in the operation of fuel cell vehicles, the establishment and operation of the necessary hydrogen infrastructure, as well as investigating the acceptance of these vehicles by the public, the 9 innovative cities as well as a vehicle manufacturer decided in 2000 to apply to the EU research programme.

In view of the high total costs (each fuel cell bus costs € 1.25 Mio), this project can only be viable when, for the first time in the history of this technology, the vehicles are bought by the customers and when the public bears a share of the financing, in this case the EU research funds.
The public private partnership, established around the ambitious targets of CUTE, started to work by the end of year 2001.

Description of the project

The public transport companies, committed to assume the necessary infrastructure (supply of hydrogen, garages etc.), just as DaimlerChyrsler and EvoBus agreed to guarantee the operation of these vehicles for the whole 2 year period of testing, to train the drivers and technical personnel and to offer technical advice for the creation of the infrastructure.
Apart from the particularly innovative and highly public character of this project (it is at present the largest project of its type throughout the world), the particular attraction for the public transport companies is the possibility of drastically reducing local particle and nitrogen emissions, accomplishing significant energy savings, as well as achieving, at least in part, additional future benefit from the production of hydrogen.

Figure: Total cost FC-Bus
(incl. infrastructure and operation)



Compared to a conventional diesel bus system, the project also offers the potential of reducing in excess of 40% in carbon dioxide emission as well as being able to use another approx. 40% of renewable energy carriers.
Zero emission systems are being installed for individual locations, i.e. there will be no emission during the complete project life, including the period of hydrogen production.

The fuel cell Citaro will ensure a drastic improvement in the emission situation, particularly in cities, where a constant battle is being fought with extremely high particle emission and high noise levels in city centres. Now, at the end of 2002, after almost one year into the official project , the first prototype is being tested in Mannheim under operating conditions.

According to the present evaluation, the first vehicle will be handed over in May 2003 to the transport company of Madrid. Phase 2 of the project foresees the delivery of the other 26 buses by the end of 2003. As a service life of 2 years has been guaranteed for each vehicle, the project will be terminated at the end of 2005 / beginning of 2006.

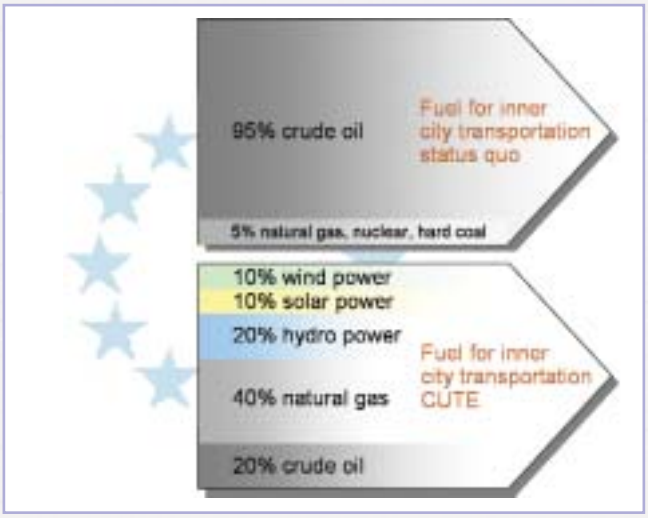
Genesis and description of the CUTE project

All cities are at present engaged in a planning- or realisation phase to create the infrastructure. In order to produce hydrogen in the most environmentally friendly way, electrolysis installations will be set-up in Amsterdam, Barcelona, Hamburg and Stockholm, which will use electricity produced by means of solar, wind and / or water power or from waste incineration for the fission of water into hydrogen and oxygen. Three further locations will be supplied with hydrogen by trailer. Stuttgart, Porto and Madrid, as individual locations, will install a steam reformer, which will extract the hydrogen from the water reformation of natural gas (this plant also represents new technology, as no other small plant of this type exists anywhere in the world).

The vehicles, which are being built especially for this fleet trial, have the benefit of the latest fuel cell and hydrogen storage technology. Each vehicle will have a total of approx. 250 kW of fuel cell output (gross) installed and the gas cylinders used have an initial storage pressure of 350 bar. The fuel cell system, the associated supply components, the coolers as well as gas cylinders are located on the roof of the MB Citaro, which therefore retains the complete low floor and accessibility of the vehicle. Depending on the number of passengers (up to approx. 70 passengers) as well as the topography, the bus can travel more than 200 km and it is well worth pointing out that the distances the bus can travel are hardly less, if at all, than those of a comparable diesel vehicle.

Apart from the investigation of the central and local hydrogen production via electrolysis installations as well as natural gas steam reformers, the CUTE project also includes the preparation of a report for the construction of high pressure refuelling stations at the 9 locations. In addition to that, the situation relating to certification of the vehicles in the 7 European countries will be investigated and a safety concept for the operation, maintenance and repair of the vehicles designed. The greatest interest from the participating public financial backers will focus on the publication of the project results. The main feature of the work, in the opinion of the fuel cell and vehicle manufacturers and vehicle operators, will centre on gaining and collecting operating experience. This is particularly important, as many stakeholders are already thinking about the next generation of fuel cell buses.

Figure: The energy mix outlines the potential for diversification of the used energy resources within the transportation sector



A major point during the creation of the project was invariably the widest possible involvement of all relevant players, such as politicians, hydrogen and plant manufacturers, suppliers, transport organisations and universities. More than 40 organisations throughout Europe and the rest of the world are now involved in the project.

Through this exciting pilot project the participating cities, the public transport operators, the hydrogen producers and the bus manufacturers will be world-wide pioneers and have the opportunity to generate valuable experience with this innovative technology at an early stage.

The Energy and Transport Directorate General of the European Commission has committed to provide support to such a project, as it will contribute significantly to the European transport and energy policy. The project particularly contributes to the alternative fuel strategy for road transport, which aims at 20% use of alternative fuels by 2020, and to the European transport policy, which aims at placing the user at the heart of the system promoting Clean Urban Transport.

Amsterdam

Mayor of Amsterdam.

Mr. Job Cohen´s statement on the Integration of Amsterdam City to CUTE: "Amsterdam is a very busy city with a lot of traffic. The city of Amsterdam has a policy to contribute to a better environment and we want to make traffic in the city as light as possible. We stimulate cycling, park and ride solutions and the use of public transport. For public transport we looked for and found, together with the City Public Transport Company (GVB), an environmentally friendly solution. We use sustainable energy, produced by green electricity, to operate the trams and the metro system. The buses of the GVB run on sulphur free petrol and are equipped with CRT-filters to eliminate emission. The fuel cell bus project fits in this policy of Amsterdam. It is to be a major step in fuel cell technology, which uses hydrogen, in the future, an important and potentially 'green' source of energy.
It is essential to learn from the testing period. To find out whether the whole chain of production, distribution and use of hydrogen lives up to our expectations. We cannot go on using fossil fuels forever. We have the obligation to look for effective alternatives, especially as a responsible government. We are glad we have found partners in Europe and in our own country who think alike. The importance of the fuel cell project is great; it may be one of the most interesting technologies for vehicle propulsion in the future.
The Dutch - and certainly the people of Amsterdam - are known as innovators, explorers and early adopters. This is why we are very proud that the Amsterdam public transport system is part of this European project. We are aware that this project has to be tailored to local needs, and circumstances all over Europe, and this will not be an easy task. Nevertheless, our expectations of the coming experiment are high.
I wish all participating cities and companies good luck with the fuel cell bus project."

Amsterdam has nearly 750.000 inhabitants, originating from 140 countries. It is the biggest city in the Netherlands. Good connections are absolutely essential in this densely populated, highly constructed area, thus public transport is an indispensable asset to mobility. The size and nature of the Amsterdam region are ideal for public transport and offer a range of opportunities for the Amsterdam city transport company GVB.
GVB is the public transport company of the Dutch capital.

GVB transports about 1.000.000 people within the greater Amsterdam area every day, offering transport by tram, bus, metro and ferries. GVB transport company services are not only in the city of Amsterdam, but also in a number of nearby towns. The intricate network of public transport by road, water and railway, both at street level and underground, is linked to the Dutch Railway stations and regional transport systems.

The main remit of the Environmental Service Department ('Milieudienst Amsterdam') of the City of Amsterdam is to improve the quality of the environment in the city. They realise their aim by collecting as much relevant knowledge as possible and

by implementing the appropriate regulations and legislation (such as the Environmental Protection Act and the Noise Nuisance Act). It is their task to monitor the environment in Amsterdam and to find ways of improving it. Therefore they provide advice (requested and unrequested) on the most wide-ranging environmental topics.

The City of Amsterdam has found a number of industrial partners willing to realise the infrastructure for the production, the storage and the fuelling of the hydrogen.

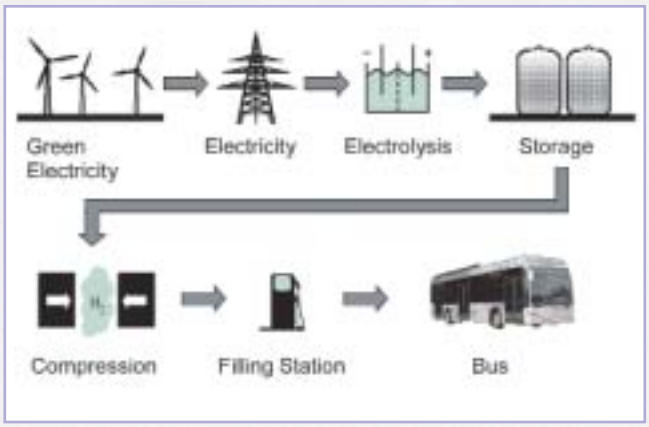
Shell Hydrogen is a global business of the Royal Dutch/Shell Group of companies with the head quarters in Amsterdam, the Netherlands, and regional bases in Houston, Hamburg and Tokyo. Shell Hydrogen was set up in 1999 to pursue and develop business opportunities related to hydrogen and fuel cells. Shell Hydrogen will provide energy solutions by bringing fuel cells to the market promoting a hydrogen reliant fuel economy.

Nuon is a leading, independent corporation, active in energy, water and related products, serving 2.7 million customers in the Netherlands and abroad. Nuon is a forerunner in renewable energy with revenues totalling € 4,5 billion (2001) and employs almost 10.000 people. For this project Nuon will supply renewable energy which is needed to produce the sustainable hydrogen fuel for the fuelcell buses.
Being a Linde company, a worldwide leader in industrial gases, plant design and construction for process industry, Hoek Loos closely works together with its partners. In both the Benelux and the United States Hoek Loos is a leading supplier of industrial and medical gases. A recent project of the business unit Tonnage and On-site Production (TOP) is the delivery of a hydrogen production plant at the Royal Glass Factory at Leerdam in the Netherlands. Hoek Loos will provide on turn-key bases an on-site hydrogen production plant and a filling station at the bus depot of GVB.

Hydrogen and fuelling infrastructure

Using renewable energy, which together with water is the basis for hydrogen production on-site, a pressurised electrolyser produces high quality hydrogen and is stored in on-site storage tank. The next step is to fill up the buses to 350 bar with a compressor connected to a high-pressure storage system at 420 bar. The filling time will be about 10 minutes.

The Demonstration of the Fuel Cell Buses will take place in the normal city bus system. They will run on bus routes in the city of Amsterdam, thus the FC bus will be integrated into the everyday traffic.



Barcelona

Mayor of Barcelona

Integration of CUTE in city policy
Mayor of Barcelona, Joan Clos i Matheu: "Barcelona has always been a pioneering city in the adoption of all the technical and scientific advances which contribute to improving the citizens´ quality of life.
The City Council has always considered collective public transport the principal resource for attending to the needs of urban mobility, both for the people of Barcelona themselves and for those who have to travel into the city from the great metropolitan urban area, that surrounds it. The 500 million annual journeys made on its integrated metro and bus network belonging to TMB give us an idea of its dimension and importance.
The Office of the Mayor of Barcelona assumes the pressing need to endow this reality with the perspective of a suitable and environmentally friendly future.
It is for this reason that, jointly with the adoption of alternative fuels such as GNC, the City Council has promoted and explicitly welcomes the CUTE project, designed to demonstrate the possibilities of use of hydrogen as a fuel of the future for urban buses, and wishes it all the success it deserves.
I am convinced that the demonstration of the new buses powered by hydrogen batteries, which will take place at the end or the year 2003, will be able to be fully integrated into the Universal Forum of Cultures in 2004, reinforcing the great importance that sustainability and ecology have in this event, on the basis of concrete, everyday realities. "

Barcelona is the second city of Spain, after the capital Madrid. With more than a million and a half inhabitants, Barcelona is the centre of an extensive metropolitan region (MRB -The Metropolitan Region of Barcelona) that covers 3.236 km^2 and where 4,3 million inhabitants live. 500 million passengers use TMB´s transport service a year, 40 % by bus.

Transports Metropolitans de Barcelona (TMB) is the management unit of the companies Ferrocarril Metropolità de Barcelona, S.A. and Transports de Barcelona, S.A. These companies provide their public passenger transport services to the city of Barcelona and various municipalities in its area of influence through two transport networks (surface and underground) that complement each other and the other transport company that operates in this area.

BP is one of the world's largest petroleum and petrochemicals companies. The main activities are: exploration and production of crude oil and natural gas, oil refining, gas marketing and power generation, retailing and transportation, as well as the production and marketing of petrochemicals. There is a growing activity in power generation using natural gas, and in solar-power generation. As BP develops and provides ever-cleaner forms of energy, it is actively exploring

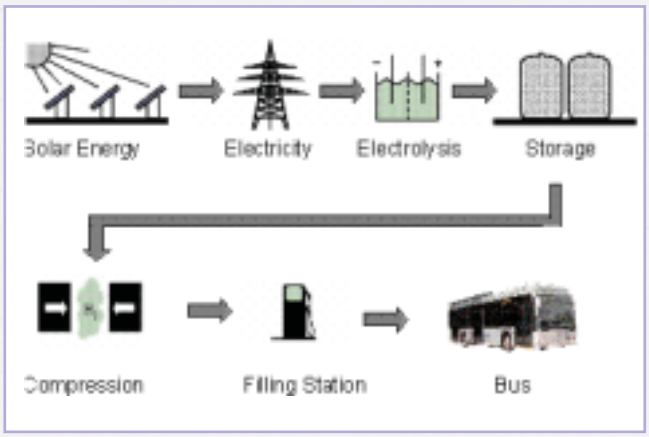
the role of hydrogen in a sustainable energy future. Offering the possibility of a non-polluting fuel with both stationary and transport applications, hydrogen has the potential to rewrite the world's energy economy. BP is one of the major suppliers of hydrogen for demonstration projects around the world.
BP will be responsible for the supply of the hydrogen refuelling infrastructure in London, Barcelona, and Porto and will be partnering, with other companies, in refuelling these vehicles in Hamburg and Stuttgart. In these different cities BP will evaluate various options for the production and supply of the hydrogen to the buses in a way that best suits the local conditions.
Specifically, the refuelling site in Barcelona, Spain, will be constructed in such a way that hydrogen will be produced from water using an electrolyser unit. Since Spain enjoys a high number of sunshine hours, this process will be partly powered by renewable electricity generated by solar panels.

Hydrogen and fuelling infrastructure

In Barcelona, hydrogen will be produced by means of an electrolytical process. Besides from the grid, electrical power will be partly obtained through solar panels, some of them installed in the depot where the buses will be maintained, so that a renewable process of hydrogen production and utilization will be shown and demonstrated.
Hydrogen will be stored on board of the buses in gaseous form, and a compression station will be installed in the depot that will allow filling the buses during their idle period at night. Safety checks will be carried out on a daily basis.

The amount of gas, and the pressure under which it is stored, will give the buses enough daily running range to cover the scheduled routes.

A demonstration plan of the FC Bus route will be set to have the buses used by the largest amount of passengers and in a variety of locations and routes across the city. Due to the hilly topography and climatic conditions Barcelona has one of the most challenging environments to the fuel cell technology of all the participating cities. Some exceptional events, such as the Forum of the Cultures, taking place in Barcelona, during the demonstration period, will also impact on the setting of possible bus routes.



Hamburg

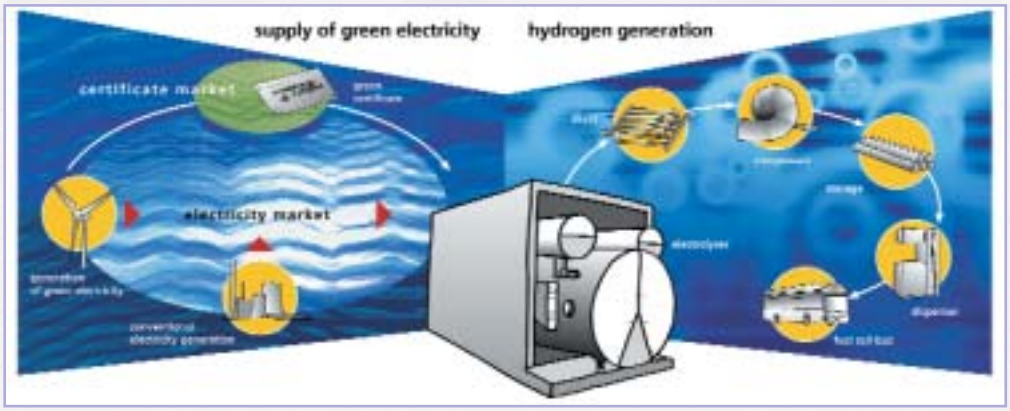
Mayor of Hamburg

The motivation of Hamburg cities involvement in CUTE is documented by the statement given by the Mayor of Hamburg, Mr. Ole von Beust: "The Clean Urban Transport for Europe project CUTE clearly supports our goals of the traffic development policy of the region of Hamburg:
-the preservation of the natural bases of life in the region,
-the decrease of the traffic-dependent pollutants and
-the traffic noise and the decrease of energy consumption.
In order to demonstrate the effectiveness of the new fuel cell bus technology for further exploitation, the Free and Hanseatic City of Hamburg together with the major public transport enterprise Hamburger Hochbahn AG is committed to the CUTE project. The reduction of bus operation caused emissions, in particular the CO_2 emissions, to zero is a big step towards fulfilling the objectives of Kyoto. Furthermore, the use of fuel cell buses will support ongoing inner city urban waterfront developments such as the HafenCity."

Hamburg is the biggest port in Northern Germany. With almost 2 million inhabitants, it is a major centre of trade and tourism which draws visitors from all over the globe. Hamburg is increasingly turning into an international hub of information, a role founded on a centuries-old tradition in the city.

The metropolis on the River Elbe was always ahead of its time when it came to trading goods and ideas. As a point of departure and springboard for Europe's markets, Hamburg is a business location for firms from many countries. Right now, some 3,500 international firms are estimated to be represented in Hamburg and with goods worth over € 60 bn handled annually, Hamburg is Germany's foreign-trade capital.

Hamburger Hochbahn AG (HHA), established in 1912, is one of the world's most advanced public transport operators. Throughout the century Hochbahn has played a fundamental role in the city's growth by helping people to come round as quickly and efficiently as possible. Hochbahn provides Metro and Bus Services in the metropolitan region of Hamburg: 3 metro lines with 82 stations, 112 bus lines with 1287 bus stops. Yearly carriage is approximately 360 million passengers.
It is Hochbahn's goal to strive towards a sustainable ecological solution for a clean transport system in Hamburg. Electric power from renewable sources for hydrogen production by means of electrolysis and the use of hydrogen in fuel cell buses will provide low noise and zero emission bus services. Environmentally friendly fuel cell buses as means of public transit supports urban developments, such as the transition from old harbour areas to the city's new urban waterfront "HafenCity".



Hamburgische Electricitäts-Werke AG (HEW) is part of the third largest German energy-group "Vattenfall Europe". HEW supplies industry and businesses in Germany and Europe and around 900.000 households in Hamburg. The approximately 6,800 employees of HEW AG produce an annual turnover of € 2.5 billion (2001). The group has interests in the field of power, gas, district heating, waste management, telecommunications, contracting and consultancy. As a potential user of electrolysers, HEW is concerned with the use of hydrogen in a wide variety of systems.

For details on BP see City description of "Barcelona". Deutsche BP will be partnering with HEW in refuelling the vehicles in Hamburg and will also be evaluating various options for the supply of the hydrogen to the buses in a way that best suits the local conditions.

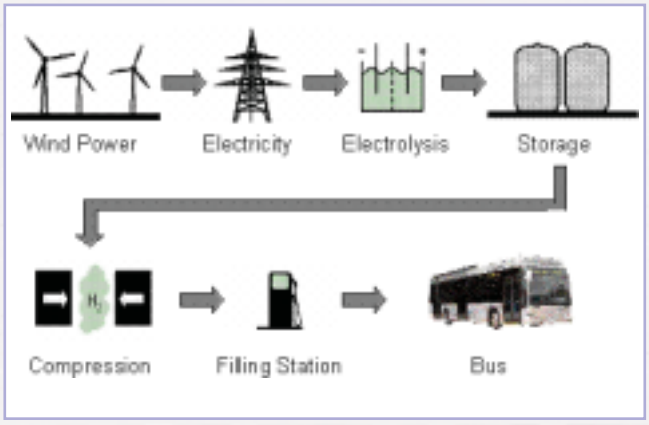
Hydrogen and fuelling infrastructure

Filling station and production facilities will be located at Hochbahn's bus depot site in Hamburg Hummelsbüttel.

A showroom, located at this site, is planned to spread further the ecological approach of the partnering firms as well as the overall CUTE project ideas. The operation of all facilities will be managed and supported jointly by Hamburger Hochbahn AG, Hamburgische Electricitäts-Werke AG and Deutsche BP.

Using electricity from the grid and combining this with green certificates, and guaranteeing the production of green electricity for the hydrogen production on-site, is fulfilling all goals of ecology and sustainability. A pressurised electrolyser produces high quality hydrogen with high efficiency which is then compressed to 450 bar and stored in on-site storage tanks. Busses can be filled up with 40 kg of hydrogen in 10 minutes which enables them to operate up to a range more than 200 km.

Fuel cell buses will operate in normal passenger services on different bus routes in order to gain various operational experiences under different topographic and traffic conditions (traffic flow, separate bus lanes etc.). Fuel Cell Bus services will focus on City Centre and HafenCity (the new urban waterfront development) routes.



London

Mayor of London

Statement of Mr. Ken Livingstone, Mayor of London:
"London's air quality needs to improve and my Transport and Air Quality Strategies make it clear that we need to promote clean, environmentally-friendly vehicle technology to tackle pollution problems. I am delighted that Daimler Chrysler is leading the way with the fuel cell bus project and that Transport for London is taking delivery of three zero emission hydrogen fuel cell buses during 2003."

London is a huge, multi-cultural, cosmopolitan city with a population of 7,5 million people. As the city extends over 600 square miles, London is the largest city in the U.K. and also the largest city in the Fuel Cell Bus trial.
London and its Transport authority are keen to trial alternative and zero emission vehicles in the UK's capital. The FC bus trial supports its continuing efforts to clean up the existing conventional diesel fleet through the introduction of more modern buses and the installation of exhaust after treatments to existing buses.

London Buses is working with bus operator First London and energy provider BP to deliver the Hydrogen fuel cell project in London.

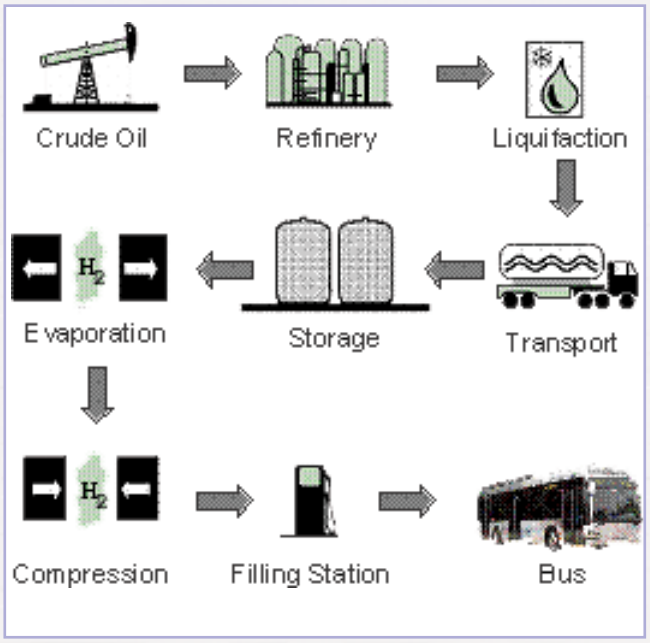
London Buses is part of Transport for London and is responsible for the planning, procurement and marketing of London's 6,500 buses. Although all buses are operated by private operators under contract, London Buses remains responsible for achieving the environment targets and standards for the bus fleet as required by the Mayor's Air Quality Strategy.
In addition to continuing to clean up the existing conventional diesel fleet through the introduction of more modern buses and the installation of exhaust after treatments to existing buses, the organisation is also keen to trial alternative and zero emission vehicles.

With a fleet of some 10,000 vehicles and over 23 % market share of the UK bus market FirstGroup is the UK's largest bus operator. First London operates just under 20% of the London bus network under contract to London Buses. FirstGroup has three core operations, which comprise of UK buses, UK passenger rail franchises and US school buses and transit management. BP will provide the hydrogen refueling site for the FC buses in London. In addition to the support from the EU, the project will also receive support from the Energy Saving Trust, the UK agency responsible for distributing environmental grants from central Government.

Hydrogen and fuelling infrastructure

London Buses and BP are planning to provide fuelling infrastructure on a stand-alone site away from the bus garage, in order that access can be made available to other potential users.
For the London site, liquid hydrogen will be transported directly to the site through a third party supplier. The hydrogen will be stored in liquid form and dispensed in a gaseous state at the refuelling site. This aims to demonstrate that the direct-to-site liquid hydrogen supply route is also a technically viable supply method.

The operation of the three vehicles will take place primarily on a central London bus route serving the busy shopping area of Oxford Street and will run alongside double decker buses. Due to the congested traffic in London and the very low average speed, London plays a major role in the field trial, as there is currently very little experience how the fuel cell propulsion system will work under these conditions.



Luxembourg

Mayor of Luxembourg
Paul Helminger

Integration of CUTE in city policy. The government statement of August 12th 1999 was based on a coalition agreement that implied among others the promotion of new alternative fuels. The city government's statement of January 2000 was aimed at promoting projects within the framework of sustainable development. These projects are meant to improve the quality of life of the citizen, and to further environment-friendly technologies.

Mr. Henri Grethen, minister for economy and transport, Mr. Paul Helminger, mayor of the City of Luxembourg, and Mr. Jos Sales, chairman of FLEAA (the federation of Luxembourg bus companies) signed on July 17th 2001 the purchase agreement with DaimlerChrysler for three fuel cell buses. By supporting this project, the three partners intend to gather experience concerning this innovative vehicle technology.
The fuel cell has all the prerequisites - physical as well as technological - to become the predominant drive technology of the new millennium. No other drive technology has so few emissions and is as quiet as the fuel cell. The citizen will profit from this highly advanced technology by getting a far better quality of public transport, a much-improved environment, and an increase in the quality of life.

Luxembourg, the smallest country of the European Union, is situated in the heart of Europe. The capital, Luxembourg City with 80.000 inhabitants, is an important regional centre and the world's seventh financial centre. The City of Luxembourg runs 45 rape methyl ester driven buses, which contribute a great deal to the reduction of emissions in the city. From 1996 to 2000 three hybrid petrol-electric midi buses have been operated on the city network. Putting into service fuel cell buses fits into all these actions that have been undertaken over the last years in order to reduce the inconveniences of the emissions caused by public transport.

Autobus de la ville de Luxembourg

The public transport in and around the city of Luxembourg is under the organisational responsibility of the municipal bus service. The service has 130 buses, 81 standard, 35 articulated, 8 mini and 6 special vehicles, with a capacity of 5.200 seats and standing room for 8.200 persons. This city department operates 22 bus routes with a total route length of over 130 km, carrying 23.500.000 passengers per year, which corresponds to some 235 passengers per inhabitant per year. The vehicles running on this network are operated both by public and private companies.

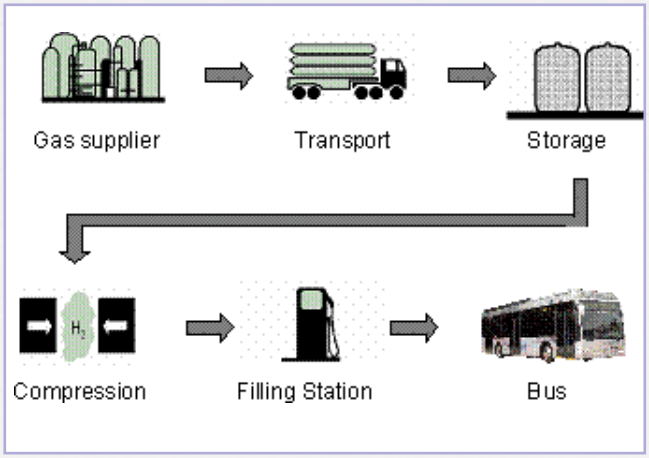
Fédération Luxembourgeoise des Exploitants d'Autobus et d'Autocars FLEAA

FLEAA currently has 27 member businesses which have a fleet of 800 buses and coaches, and employ around 1.150 persons. It is a non-profit association.

FLEAA is affiliated to Confédération du Commerce luxembourgeoise, and is an effective member of International Road Transport Union (IRU). Given that FLEAA's statutes have been lodged with the Trade Register, the association has a legal personality.

Hydrogen production and filling infrastructure

The design of the filling station and the technical characteristics of the compressor unit allow for a connection to an electrolyser. The trailer will be connected to the filling station. To fill the hydrogen into the buses, first of all a pressure compensation between the pressure in the trailers and that in the buses will be made. The second step is to fill up the buses to 350 bar with a compressor connected to a high-pressure storage system at 420 bar. The filling time will be about 10 minutes.
The fuel cell buses will be integrated in the daily roster of the city bus department and they will run on existing bus routes. Owing to the more stringent topographical conditions of the city of Luxembourg, these buses will prove that the fuel cell technology is reliable and able to work safely, even under difficult conditions.



Madrid

Mayor of Madrid

The statement of José María Alvarez del Manzano y Lopez del Hierro, Mayor of Madrid, on the integration of CUTE in city policy: “One of my biggest challenges, when I assumed the Madrid Council, was to utilize and improve, both, the urban public transport and the city environment. All these with the purpose to facilitate mobility of citizens and to get best air quality we breathe”.
Concerning alternative energy for decreasing the pollution level emissions, EMT was one of the first enterprises employing natural gas as fuel. At present we have one of the most important NGV fleets in Europe.
Finally I tell you, I have great satisfaction, the same as I hope the citizens will have, for EMT participation in the CUTE project. In this context, Madrid will be the first city putting in operation electric buses propelled by hydrogen. A system that, for its zero emissions, and once its technical viability is verified, will be called the fuel for the urban transport of the future. With this participation, we put Madrid at the top of the companies using new technologies to obtain clean urban transport."

Madrid, a cosmopolitan city with 3 million inhabitants is the capital of Spain. Regarding the over-ground urban public transport, the intensive renovation of the buses during the last years, introducing a multitude of technological improvements, had positive repercussions on the environment. That allowed Madrid to have one of the most modern, comfortable and ecological fleets in the world.

Empresa Municipal de Transportes de Madrid (EMT) is a Municipal Transport Company. It was founded in 1949 and has, on behalf of the Council, the responsibility for the over-ground urban transport. EMT has lines which cover the entire city. With its 1770 Diesel buses, 110 NGV buses and 20 Diesel-electric buses, that cover distance of around 100 million kilometres/year EMT has transported 544.664.521 passengers in 2001. It has 6.575 workers.

Technical partners in the project, Air Liquide, Gas Natural and Repsol-YPF are responsible for the hydrogen fuel station technology and engineering and also assess EMT on quality and safety issues. EMT will be responsible for utilities, construction and global operation as well as workshops.

Air Liquide is a global provider of industrial and medical gases and related services. By staying at the vanguard of technological leadership, Air Liquide provides its customers all over the world with new products, services and solutions that improve industrial performance and help protect the environment. Founded in 1902, Air Liquide has 130 subsidiaries in more than 65 countries and employs around 30,800 people.

For decades, Air Liquide has learned how to produce, liquefy, purify, transport, store and distribute hydrogen. This specific knowledge has enabled Air Liquide to be the Arianne aerospatial project's partner for the design, development and supply of cryogenic oxygen and hydrogen conveyors and gases. Air Liquide's DTA R&D Center has developped an hydrogen dispenser to be used in CUTE's Madrid hydrogen filling station.

The Gas Natural Group is an energy services multi-national focusing its activity on the supply, commercialisation and distribution of natural gas in Spain and Latin America, where it has over 7.5 million customers. Since December 2000, the Group has been commercialising electricity in the liberalised market, in which it has a 4% share, and since March 2002 it produces electricity at combined cycle plants.
With regards to environmental preservation, the group sponsors activities which are intended to sensitise public opinion to the future of our planet, and maintains agreements with universities and other educational institutions in order to contribute to the training of engineers and other professionals. Gas Natural Foundation contributes to these goals.

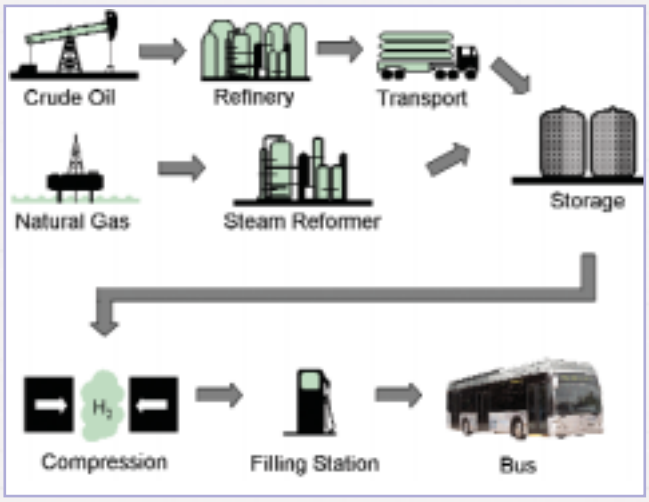
Repsol YPF is an international oil and gas company, engaged in all aspects of the petroleum business, including exploration, development and production of crude oil and natural gas, transportation of petroleum products, liquefied petroleum gas (LPG) and natural gas, petroleum refining, production of a wide range of petrochemicals and marketing of petroleum products, petroleum derivatives, petrochemicals, LPG and natural gas.
As a result of the acquisition of the Argentinean YPF, Repsol YPF is Spain's largest company, the largest private sector company in Latin America and one of the world's ten largest oil companies.

Hydrogen and fuelling infrastructure

Hydrogen is produced on-site through a compact methane steam reformer with a rated capacity slightly below the maximum demand. Complementary and back-up supply are provided by trucked hydrogen from a central production plant, mainly as a by-product from an industrial process.

Gas Natural and Repsol-YPF are responsible for the hydrogen on-site production with technology developed by Carbotech Anlagenbau. Air Liquide is responsible for the filling station including hydrogen storage, compression and vehicle filling dispenser; it will truck complementary and back-up supply as well.

Madrid will operate the three fuel cell buses as the other cities on different lines in the inner-city area. Due to the high temperatures in summer and also due to the highly congested traffic, Madrid will challenge the technical performance of the fuel cell drive train working under these conditions.



Porto

Mayor of Porto

Statement by the Mayor of Porto Rui Rio for the CUTE project. Nowadays, the importance of quality public transport in the drawing up of urban policies and their influence on the organisation of public space is widely recognised. The city of Porto is presently a living example of the importance that many different means of transport will have in the restructuring program of its commercial downtown area.

Even though the city has two light metropolitan railway lines under construction, and in spite of the importance being given to the reinstallation of a modern network of trams inside the city, these being projects able to counter the stagnation of the people mobility indicators and the growing traffic congestion in extensive central and residential areas, the role of the bus is obviously not in question. Porto City Council has closely followed the work of STCP in readapting the fundamental role of the bus to the new circumstances of the near future. It will carry on supporting improvements in operating conditions, namely with the extension in the future of the trial bus-exclusive corridor between Campo Alegre and Foz.

On the other hand, the Municipal Master Plan of the city is undergoing a revision whose principal intention is the creation of a complete road network that would be able to serve as the basis for a fully operational and efficient network of buses. The city's interest in the continuous effort by STCP to improve the environmental performance of its fleet is, thus, unquestionable. It is with satisfaction that we see the major public transport company of the Porto metropolitan area taking part in a European-wide project testing new technological solutions for engines, which will have a strong effect on the quality of the air we breathe and on urban noise pollution.

At the end of 2003, the streets of Porto will have the opportunity to serve as a testing ground for 3 new "completely green" buses powered by fuel cells; this experiment, which will form part of a campaign in this sense, will certainly assist in raising public awareness of the importance of public transport and the use of clean vehicles to improve the urban environment.

The Porto metropolitan area is located on the northern seacoast of Portugal. With its 1.200.000 inhabitants and total area of 817 km^2, Porto metropolitan area is made up of 9 municipalities (Espinho, Gondomar, Maia, Matosinhos, Porto, Povoa de Varzim, Valongo, Vila do Conde and Vila Nova de Gaia).

As a trading centre at the mouth of the Rio Douro it is the second largest city after Lisbon. The place has a number of distinctive atmospheres and this is very evident when comparing the various parts of the city.

Sociedade de Transportes Colectivos do Porto SA (STCP) is a Public Passenger Transport Company with more than 100 years (founded in 1872) employing about 2400 workers from which about 100 are experts level or highly educated. It is the sole passenger urban transport in the city of Porto operating in the bordering districts on a competitive basis. It serves a population of around 800.000 inhabitants carrying annually around 234 million passengers. It has a radial network about 400 km long with 69 routes operating virtually round the clock. In 1998 its profits were around € 49.000.000.

It has 125 CNG buses and 502 diesel buses with an annual energy consumption of about 14 million litres of fuel. The company has its own workshops where all mechanical and electrical parts of the fleet are repaired, and which have various test banks specially for engines and gear boxes. The company owns a Diagnosis Centre with an oil laboratory where some foreseeable maintenance is carried out. STCP is the authority responsible for the urban mass transportation in the greater area of Porto, now awaiting the arrival of a new tram operator, Metro do Porto, SA. It was founded in today's form in 1994, after being put under government management in 1975 (which still is the exclusive shareholder).

From 1946 until 1975 STCP was under city council management and was then named the Serviços de Transportes Colectivos do Porto (Porto Public Transport Service), following the redemption of the public transport concession granted by the Porto City Council to a group of entrepreneurs. This concession had lasted for 40 years.

Hydrogen and fuelling infrastructure

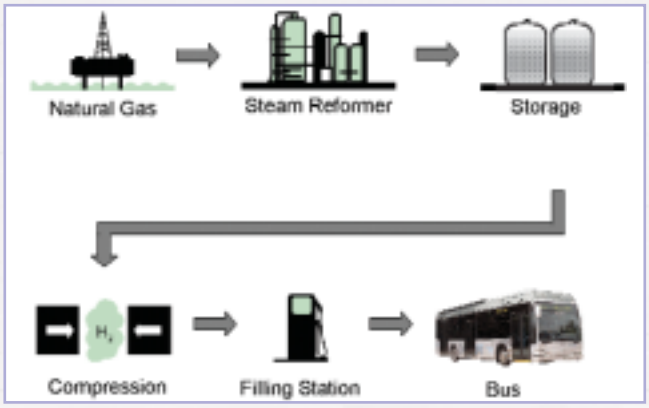
The BP CUTE installation in Porto will be part of a site that is used to park, maintain and refuel buses

operated by STCP working in Porto's metropolitan area. The initial concept design was to receive GH_2 by truck, store it at low pressure, increase the pressure to the buses and dispense at night to all 3 units, in sequence. However, the source of H_2 at the correct purity is located at a considerable distance from the site, therefore alternative options were sourced. Finally an on-site steam reformer based on natural gas as fuel has been chosen. The compression station will be designed to produce the high pressure GH_2 quantities needed for 3 buses, along with a backup high pressure storage, in order not to compromise the filling times specifications, with back-to-back filling operations.

STCP is responsible for the bus operation and BP for the hydrogen infrastructure and the hydrogen supply.

The demonstration of the Fuel Cell Buses in this city will take place under extreme geographical conditions. The operation on hilly topography and in hot climate allows the project to exploit the influence of concerned operation boundaries.

The buses will operate in a circular line crossing the city centre and with high rotation of passengers.



Stockholm

Vice Mayor of Stockholm

Integration of CUTE in city policy is expressed by the statement of Alf T Samuelsson (vice mayor of Stockholm): "The introduction of zero and low emission vehicles is important. Stockholm has come far in this field and we will continue our work. I am very happy that Stockholm, with the CUTE-project, can demonstrate the fuel cell technology."

The city of Stockholm, with 700.000 inhabitants, is the economic heart of Sweden and the most expansive region of the Nordic countries. Stockholm city has an extensive traffic policy to improve the environmental and living quality of the city. The introduction of zero and low emission vehicles (electric, biogas and ethanol) have been part of this policy since 1994. There are now 600 clean vehicles in use within the city administration fleet. An infrastructure for renewable fuels is in operation in co-operation with existing fuelling companies. The introduction of fuel-cell buses in Stockholm is the next important step in the development of sustainable transport systems.

Stockholm Transport (SL) supplies the country of Stockholm with public passenger transport. Approximately 2.2 million trips are made within the SL system every day. SL has the largest ethanol bus fleet in the world, with 250 buses operating in the inner city.

Busslink i Sverige AB is the second largest bus company in Sweden, mainly with public transport, school buses and special services for elderly and handicapped people. The number of employees is about 5.000 and the number of buses is about 1500, including a fleet of 260 ethanol buses. 250 of the ethanol buses are in operation in Stockholm. Busslink operates about 65 % of the bus traffic in Stockholm, including all ethanol buses.

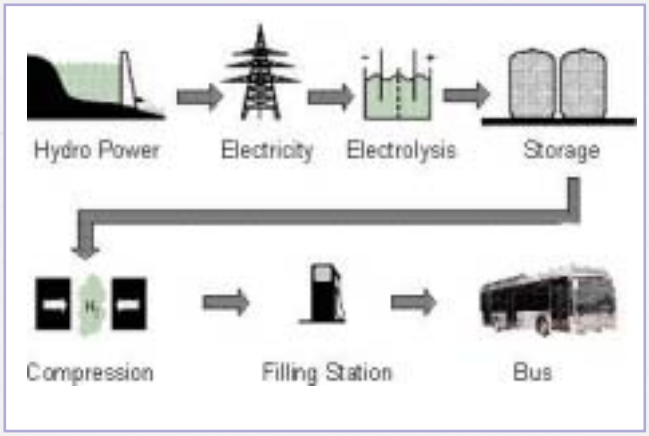
The Environment and Health Administration of the City of Stockholm is the responsible authority in Stockholm for issues relating to the environment. The Administration aims at promoting a sustainable development that will result in a good environment, both for the present and future generations. With a history dating back to 1863, the Administration has had much experience in dealing with environmental issues. In recent days the staff has grown to about 160, most of these being highly specialized.

Birka Energi (Fortum Corporation) is Sweden´s leading energy company in terms of number of customers and the third largest in terms of production capacity. In addition to electricity sales, electricity distribution and power production, the Group includes the biggest heating business in the Nordic area. In 2000, the average number of employees was 3.300. The Group´s products and services are today marketed chiefly under the Birka Energi and HemEl brand names. In February 2002 Birka Energi became part of the Fortum Group. Fortum is one of the Nordic countries' leading energy companies.

Hydrogen and fuelling infrastructure

The Energy company Birka Energi (Fortum Corporation) will produce the hydrogen and supply the fuelling station within the Stockholm project. The hydrogen will be produced using water electrolysis, with eco-labelled electricity from hydro power. One advantage with the method using electrolysis, is that electricity can be supplied anywhere, so a production unit can be set up anywhere when needed in the future. In CUTE, a small unit is planned in connection with the bus depot, where the three fuel cell buses will be stationed.

The demonstration of the three FC vehicles will take place in regular traffic in the city centre of Stockholm during a two years period, thus enabling the evaluation of the bus operation in a cold climate.



Stuttgart

Mayor of Stuttgart

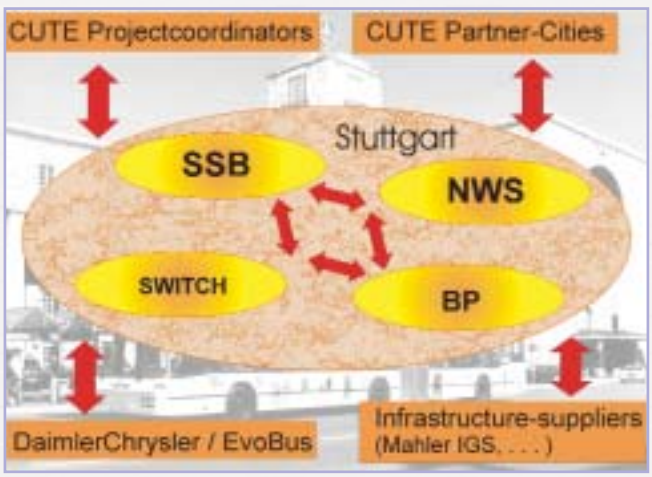
The statement of Dr. Wolfgang Schuster, Mayor of Stuttgart, on the Integration of the Cute project: "The testing of 30 fuel-cell-buses in an European-wide experiment is a step that is challenging and necessary at the same time. It is an important contribution in order to lead this sustainable propulsion-technology for motor vehicles to implementation.

Stuttgart is not only the cradle of the automobile industry, but also the state-capital of Baden-Württemberg and is one of the worldwide centres of innovation in the field of mobility. Consequently, the SSB as proficient public-transport-company of the state-capital applied for participation in this challenging experiment.
The experts of SSB are experienced in working with new technologies. I am convinced that the competence of the SSB will help to push forward the development of fuel-cell-propulsion. Sustainable mobility means for engine-powered traffic primarily to become independent of fossil fuels. In order to lower the emissions and noise exposure for the environment effectively, the fuel-cell-propulsion will play a key role in this development."

Stuttgart is the economic, cultural, sporting and social hub of a region in the heart of Europe with more than 2,5 million inhabitants. When visitors arrive at Stuttgart International Airport, they will be impressed by a fascinating landscape consisting of mountains, woods, vineyards, gardens, meadows and fields. The state capital of Baden-Württemberg is a cultural attraction that extends beyond regional borders.
Beside all the cultural and scenic values of the region, Stuttgart has developed into a main economical and scientific centre with a global attitude. Well known companies like DaimlerChrysler, Porsche, Bosch as well as a wide range of small firms are based in Stuttgart, whereby the strong involvement in the high technology sector is a result of the consequent cooperation between science and research at the universities and the economy.

The city of Stuttgart is involved in the CUTE project with several partners. In cooperation with the local power-supplier of Stuttgart 'Neckarwerke Stuttgart' (NWS) and with advice from BP, the 'Stuttgarter Straßenbahnen AG' (SSB) will build and operate a steam-reformer and a hydrogen filling station. With the facility, the partners produce hydrogen, store the product and supply three fuel-cell-buses for the project-period of two years.

Since 1868 - Stuttgarter Straßenbahnen AG (SSB) has been the leading provider of public transport services in the Stuttgart region and one of the largest and most modern local transport authorities in Germany. The SSB operates buses, tramways and light rail trains in an area of 550 km^2 with a population of approximately 900.000 inhabitants. With a team of around 2750 members, the SSB transports more than



500.000 passengers per day and offers 70 routes (55 bus routes, 17 rail routes) with a total route length of over 850 km.

The consulting company SWITCH Transit Consult GmbH is an independent subsidiary of SSB. SWITCH aims at making the competence of our parent company useful to others. SWITCH works in the fields of system-, operational- and infrastructure-planning, system engineering, organisational consulting and economic studies.

The Neckarwerke Stuttgart (NWS) produces electricity, provides gas, water and district heat. Additionally, they set up and operate telecommunication networks. The employees of the Neckarwerke Stuttgart (NWS) ensure that lights stay on, machines continue running, heaters give off warmth, and that high quality drinking water flows from the taps. The NWS supply region extends over 2.500 km^2. Over 3 million people are connected to the Neckarwerke Stuttgart networks.

But the company, with an annual turnover of approximately 3 billion marks, does more than just ensuring supplies. In its information centres, customers can find out about the newest domestic technology.
British Petroleum plc. (BP) is involved in the Stuttgart project team in order to give advice in terms of safety aspects and to ensure an exchange of information between the different sites.

Hydrogen and fuelling infrastructure

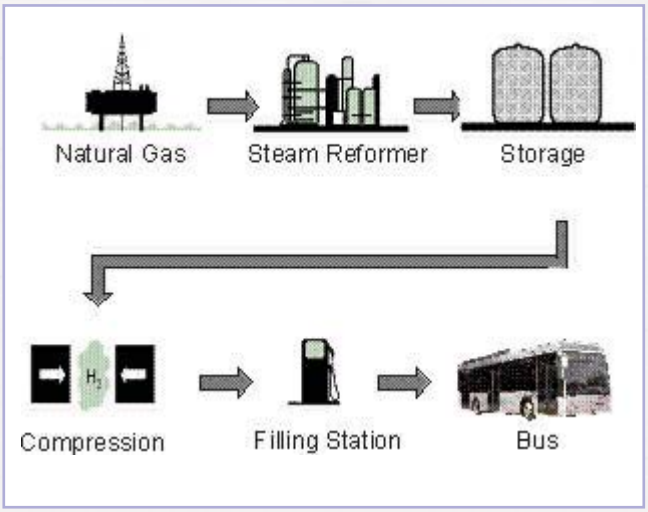
The steam-reformer is designed for small production-quantities and can be operated flexibly from 40 to 100 % of its power. This kind of technology and design of a compact-steam-reformer that is built on skids paves the way for a decentralised hydrogen-supply-concept in the future.

The produced hydrogen is stored in a tank-system in order to provide enough hydrogen to fill up the buses at the filling station. However, in it's natural state, hydrogen is not dense, so it requires compression for storage. In Stuttgart, the tank system is designed as a set of high-pressure-tanks with maximum pressures up to 350 bar.

In case the steam-reformer is not in use there is a connection available for external hydrogen supplies by trailer.

The operational concept of the Project in Stuttgart is structured into three parts: generating the hydrogen via a steam-reformer, operating the fuel-cell buses and providing information for the project partners.

The bus department of SSB will run the fuel cell buses. The buses will be used in normal daily schedules on various routes in order to receive a realistic stress-pattern. Of special interest is the topography of Stuttgart. Valuable information by operating fuel cell buses on routes with slopes and inclines of more than 10 % is expected. Due to the widespread population structure of Stuttgart and its challenging topography the buses will also have to run long distances beside all other every-day-conditions of public transport.



More than 80 companies around the world are currently working on fuel cell technology, including eight of the world's 10 biggest revenue earners and almost all car companies. For quite some time now, work on the fuel cell has no longer been motivated exclusively by technological and environmental considerations, but has become a genuine competitive factor. It is a competitive factor that will determine the number of high-tech jobs available in the future, the degree of success enjoyed by economies around the world and the face of future mobility. This is why the fuel cell has to be regarded as an economic opportunity and explains much of DaimlerChrysler's and EvoBus´ motivating forces to remain the frontrunner in this field.

Fuel cells offer the potential to meet the criteria for a genuinely eco-friendly vehicle propulsion system of the future. First of all, in the form under discussion today, fuel cells emit no pollutants, in particular no pollutants which constitute a health hazard. Secondly, it is distinctly possible that fuel cells will be able to operate without the use or consumption of fossil fuels, although this has not yet been realised on a large scale. Moreover, the fuel cell also offers a number of other advantages such as low noise, high energy efficiency, etc.

Within many cities in Europe the emission levels are still increasing and as a consequence a lot of the locally based transport companies try to introduce environmentally friendly busses with as low emissions as possible. Many trials with battery driven busses have been performed more or less with modest success. The only technology remaining in the field of zero-emission vehicles is the hydrogen based fuel cell technology.

CUTE has been developed in order to gain experience on how this technology really works on the day-to-day operation in a very challenging environment such as very hot and very cold climate, very hilly and flat geographical conditions and dense traffic. CUTE is also the first attempt to produce fuel cell buses on a scale of series production which is up to now unique in the world. Overall the main activities of DaimlerChrysler AG and Evobus GmbH within CUTE are:

- vehicle development
- preparation of small series production
- vehicle safety concept and vehicle approval initiative
- communication of the required infrastructure preparations to the project co-ordinator
- development of a service and training concept.

Bus development

The fuel cell buses are based on an innovative and novel concept, which is unique in Europe at the moment. In order to have maximum reliability, standard series components will be used as much as possible like the automatic transmission or some auxiliary components. The fuel cells and their related auxiliaries like compressors, cooling equipment, humidifiers etc. are at the highest level of development in order to get the best results for the project.

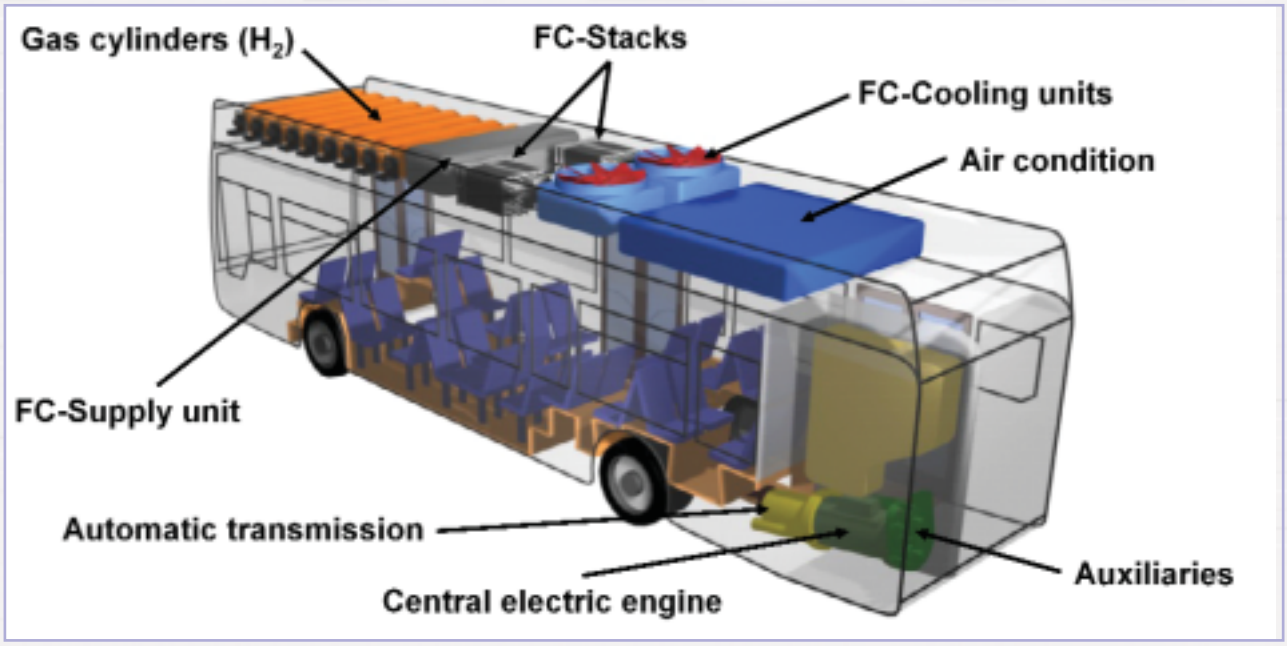
The buses will be equipped with a central traction system which will be located at the left hand side in the rear of the bus. All major auxiliary components are driven by a so called "gear box", which has been especially designed for these fuel cell buses and which is located next to the central engine. The vehicle is based on a low floor bus concept and equipped with three doors for optimised passenger movement.

The fuel cell will provide more than 200 kW of electrical power and will thus deliver performance levels in terms of acceleration that are comparable to standard diesel engines. The fuel cell system and additional aggregates are located on top of the roof of the bus. Gaseous hydrogen serves as the fuel. It is stored in compressed gas bottles, the number of which is decisive for the maximum range but also confines passenger capacity.

Concept of Mercedes-Benz Citaro fuel cell bus

The basis of the fuel cell bus is similar to a standard diesel Citaro. This city transit bus offers 3 doors for optimum passenger boarding. Similar to a standard diesel bus the rear left end of the vehicle houses the engine compartment.

Figure: Technical drawing of fuel cell Citaro bus



To allow for a vehicle that follows a series design as close as possible, modifications to this bus are limited to adaptations which are specific fuel cell requirements. This is intended to ensure the avoidance of design problems within the bus itself that are likely if an entirely new base is designed.

Vehicle design and packaging

As the drawing above shows, the passenger compartment will not be restricted by the inclusion of the innovative new drive train, i.e. the interior compartment appears equivalent to a conventional diesel bus.

Due to the fact that the passenger compartment is almost unchanged and due to the inclusion of the usual comfort systems, e.g. air conditioning, the bus will provide a comparable level of driving comfort to a conventional diesel bus - both to the driver and the passengers.

Hydrogen storage system

To store hydrogen on board, the vehicle new generation hydrogen storage vessels are used. These vessels operate at an increased pressure of 350 bar. Experiences collected with high pressure storage modules by Evobus during the design of natural gas buses contributed to the structural layout of the hydrogen bus.

Compressed hydrogen is used as a fuel due to the possibility to locally produce hydrogen by a variety of means and moreover due to the fact that fleet vehicles that return to their base daily can be served by a single refuelling station. Thus, the requirements for a refuelling infrastructure are significantly relaxed as compared to the needs for the introduction of private cars.

The storage module consists of 9 cylinders each containing 205 litres of geometrical volume. These carbon fibre-wrapped aluminium-liner tanks can contain a total of 44 kg of hydrogen at a nominal pressure of 350 bar. The quantity of hydrogen fuel that can be stored in the cylinders at one time is deemed sufficient for the typical daily range requirements of city transit buses.

Fuel Cell System

A novelty in the design of the Citaro fuel cell bus is the exclusive placement of hydrogen components on the roof of the bus. Whereas, in all former prototypes the gas cylinders, and in some instances the cooling system, have been located on the roof, the improvements in fuel cell stack size and weight now also allow the integration of these components on the bus roof.

The main reasons to opt for this design have been:

- Maximum safety in terms of city transit traffic accidents. Generally it is known that city transit buses hardly ever experience damages on the roof of the bus. Instead it is more likely to have collision damages along the circumference of the bus at standard vehicle height, i.e. significantly lower than 2 meters from street level.

- An intrusion of hydrogen into the passenger compartment can be safely avoided in all possible integration locations of the hydrogen components by a proper design and thus fuel cells can be safely integrated into the standard engine compartment. However, the chosen location for the hydrogen components on the roof intrinsically avoids any possibility of hydrogen leakage into the bus compartment. This is due to the fact that hydrogen will - in the event of a leakage - quickly vent almost all properties, i.e. hydrogen has a significantly lower density than air.

- In terms of serviceability an easy access to the components on the bus roof is favourable as compared to the time consuming disassembly of components in a normally tightly packed engine compartment. Since the new technology will require significantly more servicing and repair efforts, that issue will be the most important one during the actual demonstration period.

The fuel cell stack modules transform the chemical energy contained in the hydrogen fuel into electrical energy used to power the bus. The direct current from the fuel cells is regulated by an electrical inverter which creates the alternating current to power the central traction engine. This engine is designed for a maximum power of 205 kW which is sufficient to give the fuel cell bus a similar driving and acceleration behaviour as a diesel bus. All other components required for the operation of the bus. e.g. 24 volts supply, air condition compressor, air compressor or steering wheel pump are driven by this central engine.

Traction system

The traction system itself is integrated in the rear left end of the bus. The area used is the same as the one which is used in a conventional diesel Citaro with a so-called standing engine.

To minimise reliability problems with the traction system itself, many standard components which are also employed in diesel buses have been used. The use of high volume components which experience small adaptations for the use with the fuel cell system, allows for the choice of approved systems.

As an example, the drivetrain uses the reliable low-floor series rear axle of the diesel Citaro. Only the actual gear ratio has been adapted for the specific use. It will be road tested on the prototype vehicle which is currently in use within a broad test program.

The automatic transmission system which will ensure maximum comfort and operability for the driver is taken from the standard series program. Again an adaptation in terms of torque characteristics and shift profile required for the electrical traction motor will be made and road tested.

A hydraulic retarder is integrated which ensures the availability of an extra independent brake which is a necessity for series transit buses today.

The CUTE assessment frame

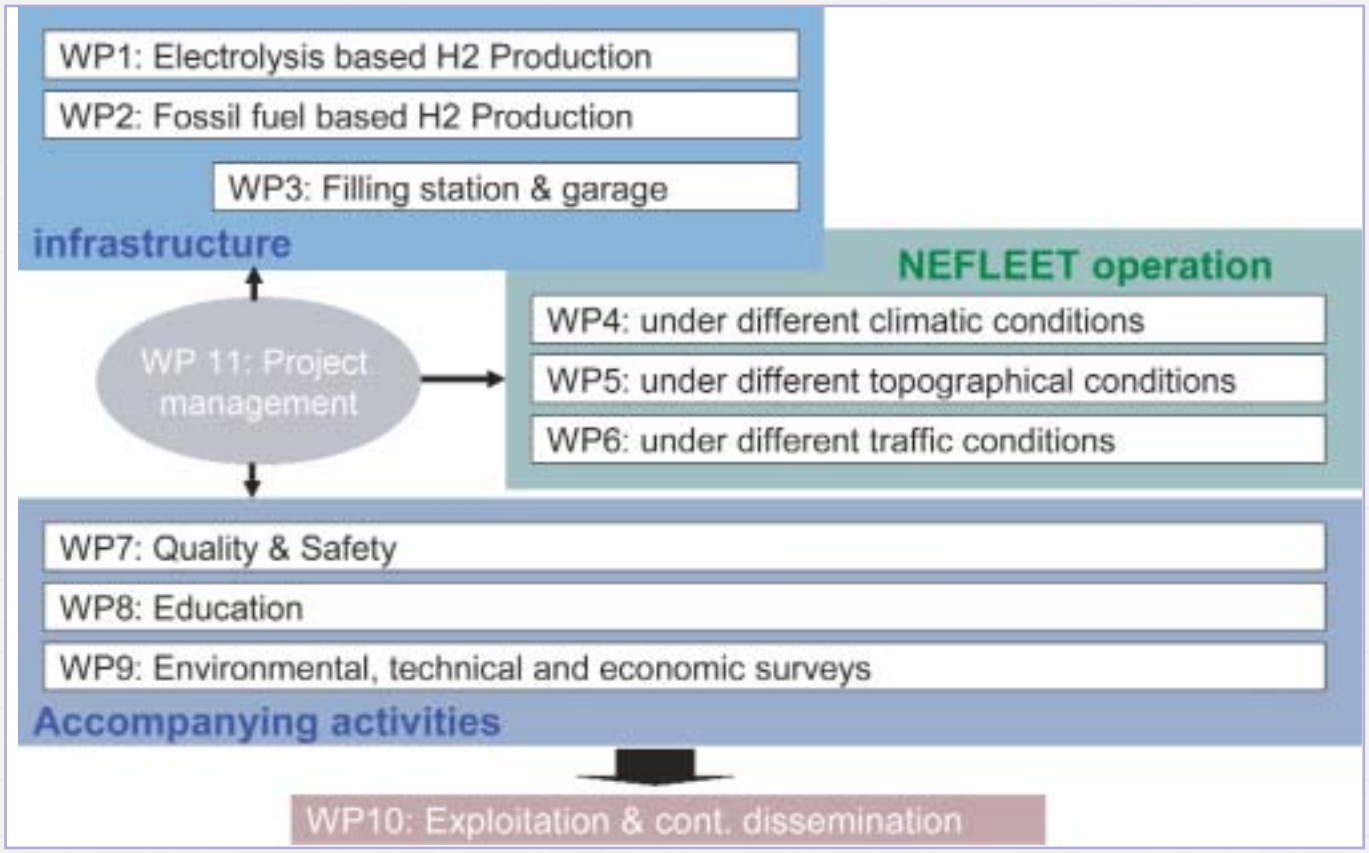
Today's European urban transport is primarily based on transport systems using either fossil based fuels like diesel and natural gas or the transport systems utilizing electricity which is also predominantly produced from fossil fuels. Public transport using mainly urban diesel buses, with vehicles being possibly 10 or more years in operation, contributes to the air pollution in inner city areas. The European legislation achieved major improvements in reducing traffic related emissions by implementing emission limits for heavy duty vehicles, now moving to its 5th stage with the introduction of EU IV regulation in 2005. However, the reduction of CO_2 emissions can only be achieved by using alternative technologies and non-fossil based fuels. Hydrogen, with its possibility to be produced CO_2 free from a multitude of sources, and the FC technology with its increased energy efficiency, present a promising solution to the dilemma of fossil fuel dependence and traffic related CO_2 emissions contributing to the global warming.

Therefore, the European Commission decided to take an unprecedented step in promoting the hydrogen utilizing fuel cell technology by initiating and funding the world's largest fuel cell demonstration fleet for transport applications.

In order to have an unbiased ecological evaluation of the new technology and to address issues such as safety and education related to the new technology, an overall assessment frame is an integral part of the CUTE project.

The assessment frame is set up to give recommendations to policy makers on how to promote the FC technology and how to prepare the next steps for a broader market introduction of the technology in the transportation sector. These recommendations are based on the comprehensive knowledge gained during the project and will contribute to maintaining Europe's competitiveness in a key technology. By making the results and findings of the project accessible to the public, the studies will also help to ensure the complete social acceptance of the new technology.

Work Package structure of the CUTE project



The goals of the assessment frame are:

- the visualisation of the recorded environmental effects of the new technology in comparison to ordinary propulsion systems in order to quantify their contribution to the EC's reduction objectives of all harmful emissions. Presented are the possible effects on air quality in congested urban areas using the new propulsion systems on a broad permanent basis;

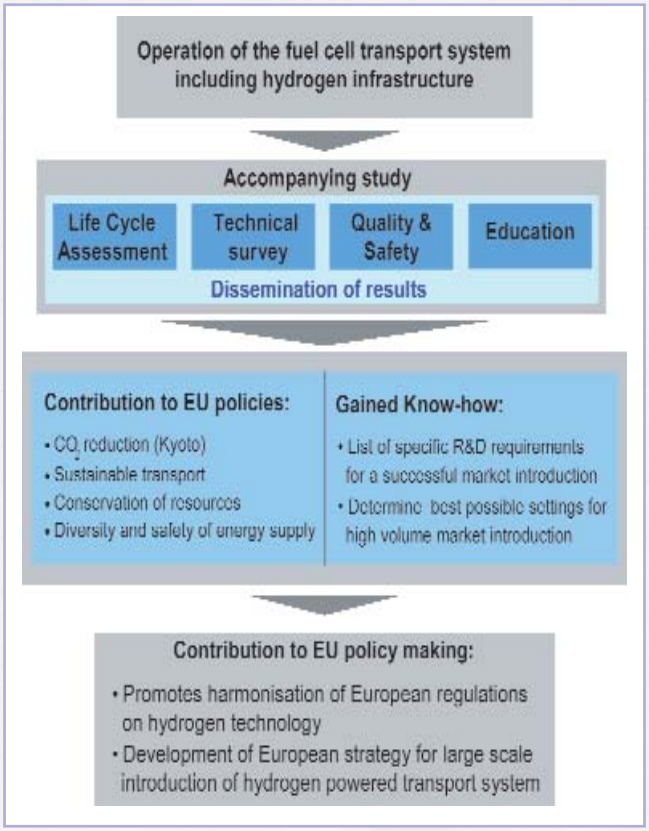
- an overview on existing safety codes & standards for the permission, the manufacturing, and the usage of the fuel cell and hydrogen technology in Europe. Based on the overview, a proposal for the harmonisation of these standards will be made.

The environmental, technical and economic assessment

In the environmental assessment, methods are being developed as part of Life Cycle Assessment (LCA) to draw comparisons between different drive technologies (e.g. diesel and natural gas engines, trolley vehicles). The results of the LCA study will illustrate the improvement on the quality of life. The inclusion of all upstream stages like the different production routes for the fuels will give a comprehensive decision support for securing sustainable urban transportation in the 21st century considering the different regional boundary conditions of each European city.

The extensive registration of data in all the participating cities and companies will provide the database for the comparison which also enables the modeling of CO_2 reduction on European level and the impact of the Kyoto commitments, based on different scenarios of penetration of the fuel cell bus in 9 European cities.

In tandem to the environmental survey, a technical and economical analysis of the infrastructure will be undertaken to get a more comprehensive knowledge of the infrastructure and the chance for a holistic discussion support for future implementation in the energy and transport sector. The costs for the bus depot, filling station and the different hydrogen production routes will be analyzed in order to define a baseline, which represents the state of the art. To give an outlook on future infrastructure costs, scenarios for varying market penetration will be developed and interpreted, incorporating economies of scale and the technology learning curve. Involved parties are the University of Stuttgart, PE Europe, University of Lisbon, Statkraft, Sydkraft, along with the other 23 participating organizations.



Education

In addition, an educational programme is set up to ensure the necessary qualification of the technical staff for secure handling of the new technology. The know-how is used for further training as well as for the higher qualification of directly involved staff, and for the creation of adequate training and education.

The Fuel Cell Bus Club

In March 2001 the Fuel Cell Bus Club was founded in Amsterdam in order to transfer the knowledge gained.

These founders (most of them are partners in the CUTE project) are firmly convinced that the fuel cell will form the basis for the drive technology of the future, enabling to provide public transport systems that are environmentally friendly and sustainable. Thus, the fuel cell technology will play an important part in improving the quality of life in major urban centres.

The vision of the Fuel Cell Bus Club members is to achieve a sustainable transport solution based on renewable fuels. In order to release this full potential of the fuel cell technology in the future, the Fuel Cell Bus Club will support activities in order to extend the commercial use of the technology.

The vehicle manufacturers, vehicle operators, energy/fuel suppliers and the political parties of the Fuel Cell Bus Club have set the following goals:

- To do everything within their power to achieve a comparable level of performance from fuel cell drive technology in practice as is obtained with conventional technology today
- To develop and put in place the necessary infrastructure
- To take all measures necessary to ensure the creation of the necessary political framework that would allow a genuine market launch of fuel cell drive technology
- To continue to develop fuel cell technology in such a way that it will provide a boost for both industry and employment in Europe.

Web Site: http://www.fuel-cell-bus-club.com