

EDS: AN EUROPEAN STUDY FOR NEW DEVELOPMENTS IN AUTOMOTIVE TECHNOLOGY TO REDUCE POLLUTION

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Abstract

The study "Advanced Electric Drive Systems for Buses, Vans and Passenger Cars to Reduce Pollution" (abbreviated EDS) was set up on initiative of the European Parliament with the aim of studying new technologies for road transport leading to energy economy and reduction of pollution without using an exhaust gas catalyst. These new propulsion systems could involve "electric traction".

A number of contracts, granted to specialist companies, universities and research centres all over the European Community were launched during beginning of 1990 and will allow the exchange of knowledge in the frame of a trade-off study comparing different solutions for the electric traction problem. The paper reports on the current state of the action and incorporates new developments.

Introduction

The Commission of the European Communities, on initiative of the European Parliament, devoted a budget to a feasibility study on automotive technology.

This action is aimed on the research of technologies adapted for energy economy and reduction of pollution, without using an exhaust gas catalyst.

The guide-line set by the Parliament is clear: one should abandon conventional propulsion systems needing a catalyst, and intentionally track new development paths.

These new propulsion systems could involve "electric traction".

Even if electric traction cannot solve all automobile-related problems, it represents a compromise on what modern technology could develop at its best without disturbing to much a such important industrial sector. The funds available would not be sufficient to launch experimental R&D work or prototype construction of electric propulsion systems. One should therefore aim to a large-scale conceptual study on electric traction systems, in association with the European automotive industry, main component manufacturers and independent research centres.

It would be a "study of concept and design methodology" of the different components of an electric traction system, and their harmonious adaptation in an electric road vehicle. Each vehicle needs an adequate feasibility study, which is

to give different technological solutions for the electric drive system. The priority themes to be considered in each case are ecological aspects, energetic aspects and economic and industrial aspects.

Ecological aspects: the standards for air pollution and noise are to become stricter in the future than they are now.

Energetic aspects: energy economy should be a constant in the conception of future traction systems, even with fuels as abundant as today.

Economic and industrial aspects: considered technologies must for all cases show a certain economic and industrial credibility. Industrial realisation on medium term even if for some systems R&D is still going on.

The EDS programme was open to all industrial enterprises, research institutes, universities and all interested organisations within the European Community. Organisations participating in EDS do so under research contracts concluded with AVERE (European Electric Road Vehicle Association), normally on a shared-cost basis.

Technical areas

The priority themes of the EDS programme cover the main technical areas involved. Both vehicle-oriented, component-oriented and general themes are present. Different technologies are to be compared to allow a trade-off study for the vehicle system.

In the vehicle-oriented studies, following types of vehicles are considered:

- personal cars,
- small vans,
- buses.

In all cases 100 % battery powered and hybrid solutions are to be considered.

Following aspects are considered in these vehicle studies:

- mission analysis,
- performance specifications,
- system trade-off analysis, including:
 - batteries (as prime energy source or as buffer),
 - electric generators (with several prime movers, e.g. lean-burn petrol engine, diesel engine, gas turbine, fuel cell, hydrogen-fueled engine, etc.),
 - electromechanical drive systems,
 - power electronics and control.

Component-oriented studies to provide data in the following fields:

- energy storage: electrochemical energy storage (different types of batteries) and mechanical energy storage (fly-wheels);
- fuel cells and reformers;
- electric components:
 - power electronics,
 - control electronics,
 - electromechanical drive systems using a main electric traction motor,
 - electromechanical drive systems using wheel hub motors,
 - combustion engines to drive electric generators,
 - electric generators for the generation of electricity on board of the vehicle.

Other, non directly vehicle-related aspects are covered by following study themes:

- infrastructure for battery charging;
- environmental aspects: energy consumption and pollution.

The trade-off study will be based on market considerations. The study contracts involving "vehicles" will be mainly granted to automotive constructors; the other studies are to be granted to specialist companies or research institutions.

It is here that one of the most important aspects of the EDS programme appears: the different participants are encouraged to provide each other with the necessary information to complete their studies. This point, which is even explicitly written down in the contract text, is characteristic for the whole spirit of the EDS programme.

The reports resulting from the different contracts will be synthesized into a final report under the authority of the Project Leader. The final report will be presented to the European Parliament.

Management

The Commission of the European Communities signed a contract with AVERE (European Electric Road Vehicle Association), to manage the EDS programme. AVERE, as main contractor, has the financial and legal responsibility for the project.

The scientific responsibility is carried by an Advisory Committee, formed by a number of known electric vehicle experts from the European industry and research world. The Advisory Committee is headed by a Project Leader, who cares for the day to day management of the programme and who reports to the Advisory Committee and to AVERE.

The Commission of the European Communities made an official call for tenders, inviting interested companies or research institutions to submit proposals for the EDS programme. More than 40 proposals were submitted.

The selection of the proposals was done by the Advisory Committee. After this procedures, 17 proposals were accepted. The proposers were invited to take part in technical discussions with the Project Leader, in order to define their exact activity programme and to establish possible cooperation links with other participants; afterwards they were offered a contract to be signed with AVERE.

Actual contracts

Most of the contracts were made active by mid 1990; the action will run for 18 months to the end of 1991, when a final report will be presented. The contracts awarded cover most of the priority themes discussed before.

For the theme "hybrid electric vehicles" three contracts were awarded, each time to a group of a different European country.

A first contract, from *PSA Etudes et Recherches* (France) and related companies, aimed to design ideal hybrid traction systems, using simulations to compare different configurations and to verify if they can cope with the previously defined performance specifications.

A second project is runned by the *University of Birmingham* (UK), in collaboration with major automotive and related industries. The project evaluates the impact of various electric and hybrid vehicle concepts on vehicle emissions and the potential improvement in energy efficiency and performance associated with new drive system technology and vehicle structures. The problem whether these alternative fuel vehicles can satisfy the operational requirements of the users is also treated.

The *Rheinisch-Westfälische Technische Hochschule Aachen* (Germany) analyses and evaluates different serial and parallel hybrid structures using computer simulation. The evaluation of the results is conducted with the help of assessment criteria; one structure will be selected, dimensioned and optimized.

The theme "hybrid buses" is covered by two contracts:

PTI Albatech (Italy) provides a feasibility study for a hybrid bus with wheel hub motors. The wheel hub motor concept makes it possible to implement innovative concepts in the design of the vehicle. The suspension kinematics are to be optimized and the most suitable electric motor is to be selected by a trade-off study

Genova Ricerche (Italy) is studying a low emission urban hybrid bus, based on a thermal engine properly set on

average power values and driving an electric generator, in combination with a storage accumulator for electric energy. The peculiar traffic conditions in city centres are a stimulus to study the use of such a vehicle to reduce the environmental impact.

Different "energy sources" are available for use in electric or hybrid vehicles. They are analyzed in following proposals:

Elenco (Belgium) studies and compares different types of fuel cells in view of their application in vehicles. The energy supply to the fuel cells by means of reformers is also considered.

Hydrogen, another important energy source for fuel cells or internal combustion engines, is treated by *Hydrogen Systems* (Belgium). More in particular, the economy of the production and storage of electrolytic hydrogen is studied.

A proposal by *ABB Hochenergiebatterie* (Germany) covers high-energy sodium-sulphur battery for electric vehicles, with their associated battery management units. The batteries adapted to the different electric and hybrid vehicles in order to meet the technical and economic targets are to be defined.

The introduction of another type of vehicle, for instance electric or hybrid, creates the need for an adapted electricity infrastructure: this includes chargers, energy supply, automatic renting systems. The characteristics of these infrastructures is studied jointly by two proposals emerging from the *Vrije Universiteit Brussel* (Brussels Free Dutch-speaking University, Belgium) and the *Technischen Universität Berlin* (Germany).

One of the main advantages of the introduction of electrically driven vehicles in road traffic, and particularly in urban traffic, is their environmental benefit. Three proposers work together to analyze different aspects of this problem.

Studiengesellschaft Nahverkehr (Germany) evaluates advanced electric drive systems concerning their environmental benefits, using an indicator system to make clear the interdependence of cause and effect of different elements.

Energiestudiecentrum Nederland (The Netherlands) focuses its study on the social acceptance of urban electric transportation systems and their impact on environment and on electricity production.

Electric Vehicle Development Group (UK) reports on the environmental impact covering materials supply, energy consumption and air pollution, related to cost benefits.

Finally, the different solutions for the electric traction systems are discussed.

Université Libre de Bruxelles (Brussels Free French-speaking University, Belgium) studies power converters for AC motors, more particularly the definition of control strategies adapted to the specific needs of road vehicle traction systems, and the integration of the strategies in ASIC technology.

ABB Hochenergiebatterie (Germany) offer to design its "smart battery driving system" which is an integration of DC motor, controller and charger in one unit using hybrid electronic circuits for different case studies, offering the necessary input in the field for the trade-off studies of the car manufacturers. Furthermore, their study will be extended to AC drive systems.

Universität Kaiserslautern (Germany) proposes a study about the specific problem of data communication between the different vehicle components. Decentralizing of electric vehicle components, monitoring using a communication network is to be investigated.

Conclusion

The EDS programme clearly aims to define the future road vehicles. Therefore, it will propose to the European Parliament the corresponding R&D action with short, medium and long term targets, the main aim being the reduction of environmental pollution and consequently of energy consumption. The urgent character of short term actions in the pollution field will be highlighted.