

The Federal Electric and Hybrid Vehicle Program

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On September 17, 1976, the Congress passed Public Law 94-413, which created a Federal program of research, development, and demonstrations to promote the commercial development and use of electric and hybrid vehicles. The law placed the responsibility for the program with the Department of Energy (DOE).

As illustrated in figure 1, electric and hybrid vehicles are of importance today because they represent one way in which we can move our Nation's transportation system off a petroleum energy base and onto an energy base that would consist of whatever form of energy the local electric power company was using. Obviously, that could mean the use of coal, nuclear power, or any of the other sources shown in the figure to fuel our automobiles. Within the DOE program, an electric vehicle is defined as one that is fueled solely by wall-plug electricity. A hybrid vehicle is one that uses a combi-

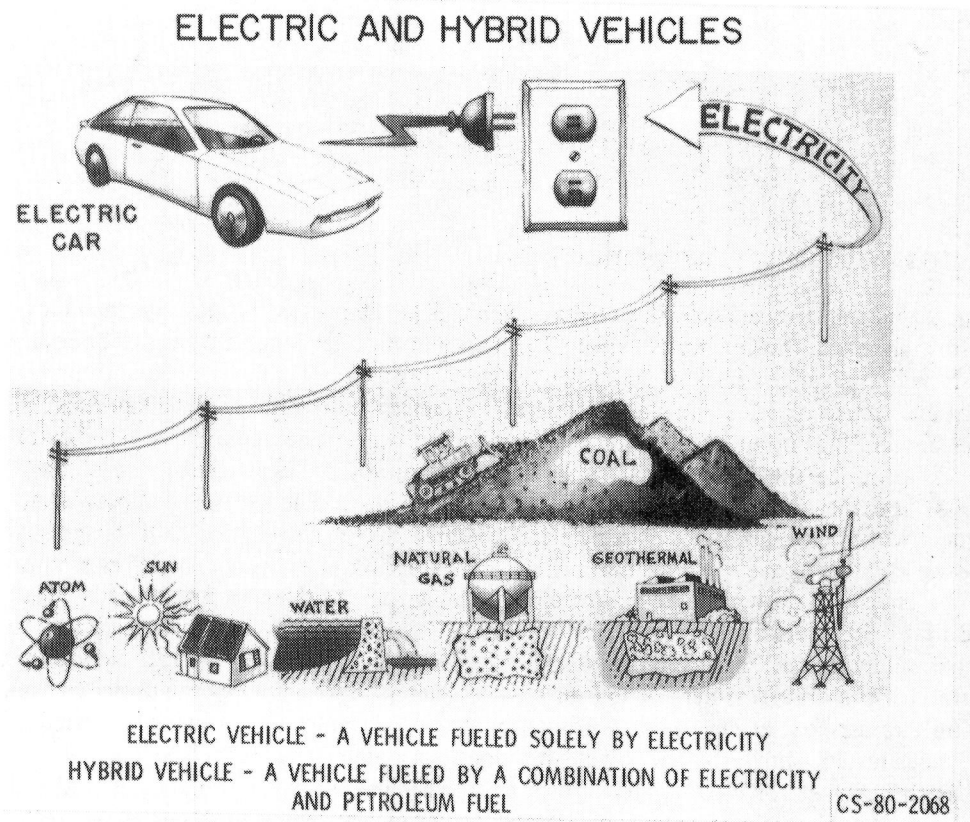
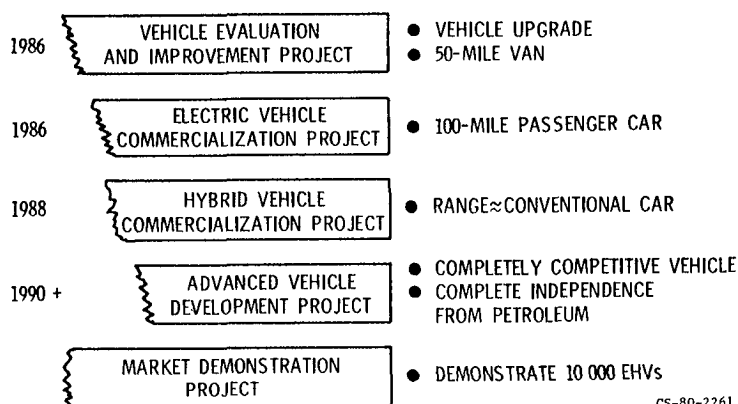


Figure 1

nation of wall-plug electricity and a petroleum fuel. The organization of the DOE Electric and Hybrid Vehicle program is shown in figure 2. The program is divided into five separate projects. The Vehicle Evaluation and Improvement project has as its goals the development of a 50-mile-range delivery van and the general upgrading of existing vehicle technology by 1986. The goal of the Electric Vehicle Commercialization project is to have in place in private industry the manufacturing capability to produce a 100-mile-range electric passenger car, also by 1986. The Hybrid Vehicle Commercialization project has established a goal of producing a commercially viable hybrid vehicle with a range comparable to that of a conventional automobile by 1988. The Advanced Vehicle Development project is targeted for 1990. Its goal is to develop a vehicle that has all the performance and range capability of present-day vehicles but is independent of petroleum as a fuel. This could mean either electric vehicles running on electricity generated from other fuels or hybrid vehicles that use synthetic fuels derived from nonpetroleum sources. In support of these four projects there is an on-going Market Demonstration project that seeks to place 10 000 electric and hybrid vehicles into public and private sector demonstrations within the next 4 years.

FEDERAL ELECTRIC AND HYBRID VEHICLE PROGRAM



CS-80-2261

Figure 2

Problems with Electric Vehicles

The major inhibitor to the growth of electric vehicles at the present time is that they lack the range and performance that the consumer expects from an automobile. Studies of automobile use patterns (fig. 3) show that a range of about 100 miles per day would be optimum for maximum market penetration of an electric vehicle. The market potential increases until a range of 100 miles is reached and decreases beyond that point because the cost and weight penalties associated with the extra batteries required to produce the incremental range increase cannot be justified by the small additional segment of the market that would be served by such a vehicle. If we compare that 100-mile requirement with the capability of existing electric vehicles at the start of the DOE program, as shown on the lower right in figure 3, we see that only a small fraction of existing vehicles even approach this range. The envelope shown in the figure encompasses the range at various speeds of all vehicles reported in the literature at that time. The two lines shown on the figure represent actual test results of approximately 23 different vehicles tested by NASA as part of an overall electric and hybrid vehicle state-of-the-art assessment. The four best vehicles as represented by the upper line only exceed the 100-mile-range goal at very low speeds, approaching 25 miles per hour; the average for all the other vehicles tested, shown by the lower line, does not come close to the goal.

Because the market for electric and hybrid vehicles is presently so limited, we find that today's industry consists primarily of small entrepreneurial manufacturers. These companies are generally handicapped by a lack of production facilities, limited engineering staffs, and, because of the small

PRESENT TECHNOLOGY INSUFFICIENT TO STIMULATE LARGE MARKET

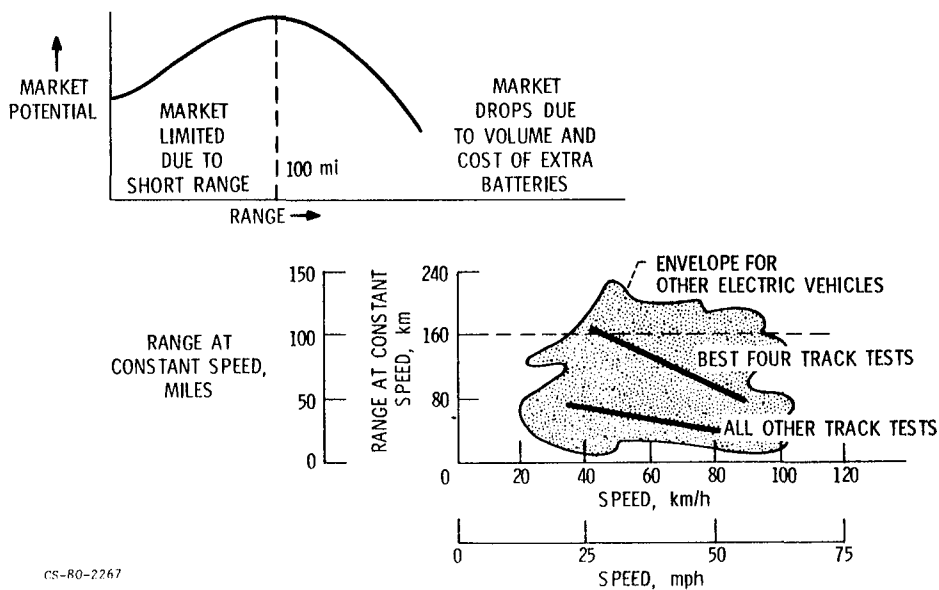


Figure 3

market they represent, insufficient leverage on the suppliers. In addition, these companies are facing a market that is going to grow at a rate that can only be described as uncertain at present, as well as a shortage of capital with which they might expand production facilities or improve their products. Therefore the challenge faced by DOE in the Electric and Hybrid Vehicle program is to find ways to maintain the viability of the present industry, to accelerate the development of the market, and to stimulate investment by those companies that have the potential for mass production, which is required in order for electric and hybrid vehicles to have a significant effect on the Nation's petroleum consumption.

Solving the Problems

These challenges are being met in several ways: Some companies have received direct support from DOE to improve the vehicles that they produce. Funds are being provided to purchase vehicles for the Market Demonstration project. Planning grants have been made available to assist small manufacturers in preparing proposals, and a loan guarantee program to help manufacturers expand their production plants in getting under way. The Market Demonstration project and its associated public awareness activities are intended to stimulate market development. The DOE is also supporting technology development that will lead to better vehicles. And, although investment risk is still high, ways are being sought to stimulate private investment in electric and hybrid vehicle production, perhaps by joint cost-shared commercialization projects. The next figures illustrate how this is being done.

Market demonstrations are an important part of the DOE program at present. As shown in figure 4, DOE has established performance standards for electric and hybrid vehicles that can be purchased for demonstration projects and has selected a sizeable number of site operators, each of whom is willing to participate on a cost-sharing basis with the Government and has agreed to operate a fleet of the minimum acceptable size. The site operators purchase vehicles from the manufacturers, thus providing an important source of capital to the manufacturers. In addition, DOE has established a loan guarantee program to help manufacturers expand their production capabilities. The money comes from a revolving fund that can guarantee loans of up to \$3 million for this

ELECTRIC AND HYBRID VEHICLE PROGRAM - MARKET DEMONSTRATIONS

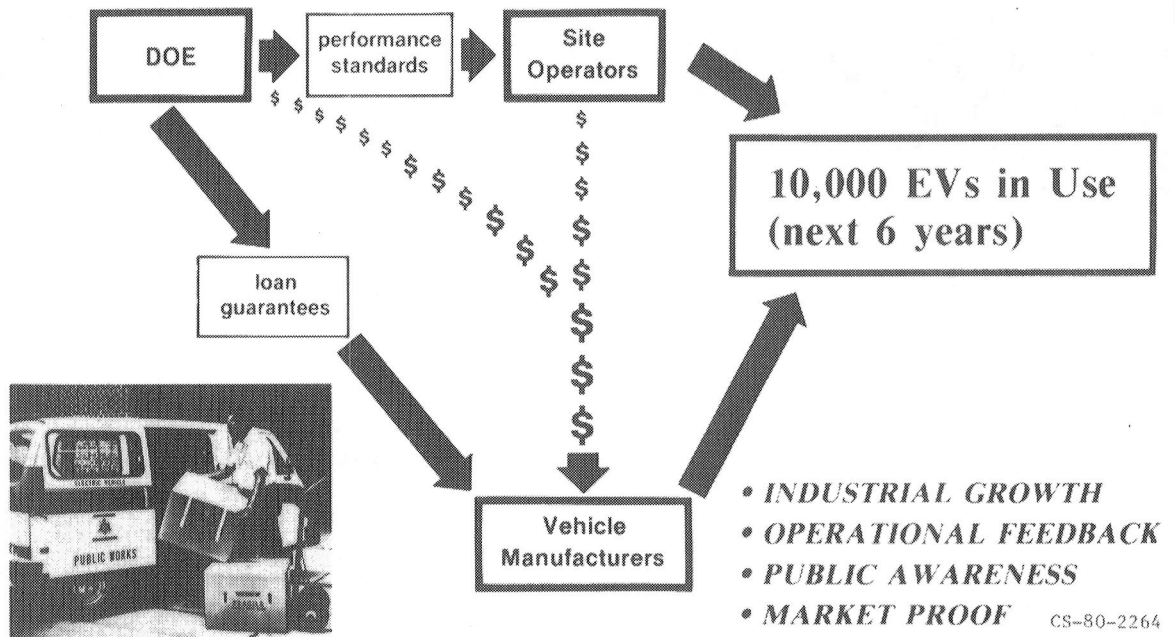


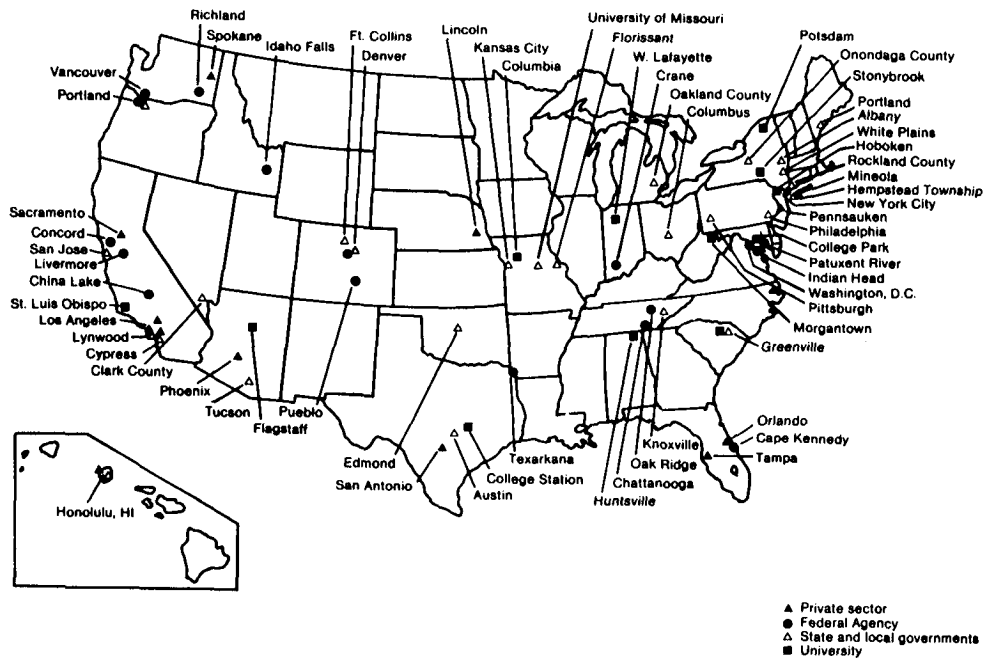
Figure 4

purpose. It is anticipated that within the next 4 years approximately 10 000 electric vehicles will be placed in service through the Market Demonstration project. Although hybrids can also be purchased for the project, at present none are commercially available.

The locations of the various demonstration sites around the country are shown in figure 5. There are four types of sites: public sector demonstrations, Federal agencies, State and local governments, and universities. In addition to showing the suitability of electric and hybrid vehicles for "real world" applications, another important function of the demonstration project is to identify the infrastructure required to support electric vehicles in day-to-day service, such as the existence of gas stations, garages, and spare-parts warehouses supports the operation of conventional vehicles on the road today. To provide better vehicles for the demonstration program, DOE has financed product improvement projects with four manufacturers. The vehicles produced under this program have operating ranges of 40 to 50 miles per day in city traffic, which is roughly twice the range of similar vehicles built in 1976. They also have greater acceleration rates and higher top speeds.

Technology development is clearly going to be required in order to produce a commercially successful vehicle. The Department of Energy is using the resources of other Government agencies in order to produce this technology. The responsibility for battery research and development is vested in the Argonne National Laboratory. Major technical thrusts at present include the improvement of the lead-acid battery and the development of nickel-zinc, nickel-iron, and zinc-chlorine batteries for near-term vehicle use. Mechanical storage technology is the responsibility of the Lawrence Livermore Laboratory. They are working on flywheels and other mechanical devices for storing regenerative braking energy, as a means for extending the range of an electric vehicle. The NASA has the responsibility for the rest of the technology development associated with electric and hybrid vehicles. This responsibility is divided between two NASA centers: The Lewis Research Center in Cleveland, Ohio, is responsible for propulsion subsystems development. This includes the development of motors, motor controllers, transmissions, and controls; the identification of battery-propulsion

DEMONSTRATION SITES IN EHV PROGRAM



CS-80-2263

Figure 5

system interactions; and the development of complete propulsion systems. The Jet Propulsion Laboratory in Pasadena, California, is responsible for vehicle system technology. JPL's activities include mission analysis, aerodynamic drag reduction, rolling resistance reduction, mass reduction, and the integration of the battery and propulsion system into a complete vehicle.

Much has been accomplished in the 3 1/2 years since the passage of Public Law 94-413, but much still remains to be done in order to make the electric vehicle a viable transportation option for our country.