

This report presents a comprehensive review of the future of electric and hybrid vehicles through the year 2010 in the United States. It discusses the technology, performance, and limitations of probable future electric and hybrid vehicles; the infrastructure necessary to produce and support them; marketability; and finally, effects on the nation if used in large numbers.

The report begins with a discussion of the technology of electric vehicles, and what it may offer in the future. Storage batteries are addressed first because they have always been the principal obstacle to practical electric vehicles. Then electric drive trains and their integration into vehicle design are described. Next, the tradeoff between range and cost is projected. (Electric vehicles may offer competitive cost or long driving range, but probably not both at once.) Finally, the performance and cost of representative future electric vehicles are projected. These are used subsequently in the report as the basis for considering marketability and the impacts of large-scale use.

The technology of hybrid vehicles is discussed after that of electric vehicles because hybrids are an extension of electric vehicle technology which will probably reach the marketplace only after the appearance of electric vehicles, and only if satisfactory storage batteries and electric drive trains have been developed. The hybrid vehicle designs described here are basically electric vehicles to which an internal-combustion engine has been added. The engine supplements the energy and power available from the electric drive, giving either unlimited cruising range or both the range and the high acceleration performance of conventional cars. The performance and costs of representative future hybrid vehicles are projected and compared with those of future electric vehicles. Because range-extension hybrids could electrify light vehicle travel in the US to about the same extent as pure electric vehicles, most of the impacts of hybrid vehicle use on a large scale are similar to those of pure electric vehicles.

After reviewing the potential of electric and hybrid vehicle technology, the report turns to consideration of the infrastructure required to support electrified travel. The principal elements of the infrastructure are the electric power system, which must recharge batteries; the materials industry, which must supply large quantities of materials used in batteries; and the automotive industry, which must both produce and maintain electric vehicles. The discussion begins with electric utilities, an industry larger in the United States than the motor vehicle manufacturing industry, without which electric cars would not be feasible. Materials supply is discussed next. It is, after all, a shortage of petroleum resources and supplies that motivates consideration of electric vehicles, and resources of battery materials are not necessarily more abundant or more assuredly available from foreign suppliers.

Marketability of electric and hybrid vehicles is next reviewed. The discussion begins with existing patterns of vehicle use, since it is often argued--correctly--that future electric vehicles will have adequate range and speed for most urban travel. Market penetration estimates, however, show clearly that this is not enough to ensure large sales of electric and hybrid vehicles~ since buyers are concerned about initial costs as well as limited range and lengthy recharge times. The discussion of marketability points out the critical role of the cost and availability of liquid fuels for heat engine vehicles, and the possible effect of incentives for electric and hybrid vehicles which may be provided by governmental action.

This report concludes with a review of the benefits and costs, monetary and non-monetary, which might accrue if electric and hybrid vehicles were to be widely used in the United States. It begins with energy, since that is the principal problem motivating consideration of electric vehicles. It considers both the petroleum requirements of electric utilities to generate power for recharging electric vehicles and the petroleum savings if conventional vehicles were to be replaced with electric and hybrid vehicles. It next turns to the environment, specifically air pollution and traffic noise. Though electric vehicles emit no air pollutants directly, the power plants which recharge them will run overtime to do so. The effects on the economy of manufacturing and supporting electric vehicles are briefly reviewed, as are resultant demands for battery materials, limitations of US materials resources, and potential dependence on foreign suppliers. The effects of limited-range vehicles on mobility and travel in the US are noted. Finally, the major uncertainties in projecting benefits and costs of electrification are reviewed. The uncertainties arise at every step, in the projection of technological capability and costs, infrastructure, and marketability, as well as in the final accounting of national benefits and costs.

The material presented here is drawn from existing studies. No new analyses were undertaken. Instead, this report offers a comprehensive review for a nontechnical audience. Each chapter begins with an introduction and summary which provides historical background and explains key issues before presenting projections for the future. Graphs and tables are presented only as supplements to material presented in the text, and mathematical models are avoided.