Global Trends for Electrification of Automotive Powertrain Systems

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INTRODUCTION

THE world urgently needs to create a low-carbon society to prevent global warming and make effective use of various forms of energy. In the automotive area, CO_2 (carbon dioxide) emission regulations are being overhauled especially in Japan, USA, and Europe, accelerating technology development to reduce future CO_2 emissions.

Fig. 1 shows the projections for average automotive CO_2 emission levels in automotive powertrain systems. Traditionally, advanced technologies such as downsizing and combustion control improvements have been applied to ICEs (internal combustion engines). As ICEs explode in growth, mainly in developing countries, proliferation of HEVs (hybrid electric vehicles), EVs (electric vehicles), and FCVs (fuel cell vehicles) will be essential if tight international CO_2 emission regulations are to be satisfied.

In the case of EVs and PHEVs (plug-in HEVs), the vehicles can be driven by electric power derived from green energy such as solar photovoltaic power or nuclear electric power, drastically reducing CO_2 emissions and dependency on oil. However, remaining challenges include the performance and cost of batteries for storing this green energy and improvements to the infrastructure for EV charging. Consequently, in addition to advanced technology development, the key issue for wider adoption of EVs is how to develop and implement EV deployment scenarios that take account of national or regional characteristics and strategies.

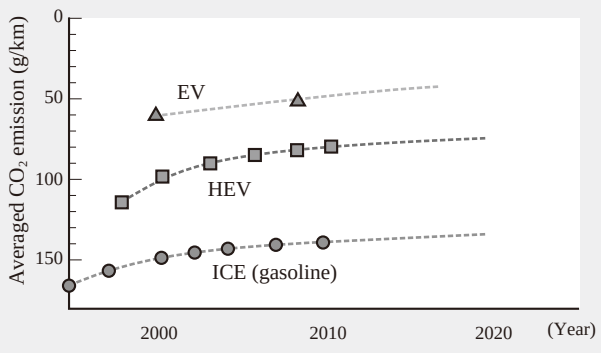

Fig. 1—Projections for Average Automotive CO_2 Emission Levels (Survey by Hitachi Research Laboratory). HEVs and EVs have progressively greater potential for reducing vehicle CO_2 emissions.

GLOBAL TRENDS AND HITACHI RESEARCH AND DEVELOPMENT ACTIVITY

Role of Global Automotive Research and Development

Besides Japan, Hitachi has laboratories in the USA and Germany that focus on automotive R&D (research and development). Their missions are to support local businesses, undertake R&D in accordance with regional characteristics and strategies, and to establish fundamental and applied technologies by supporting the company's global framework. The following sections describe technical trends and activities in the field of EVs in the USA and EU (European Union) together with the expectations for electric powertrain components from the perspectives of the local laboratories.

North America

As American consumers become increasingly vulnerable to rising oil prices and interested in green technology, the environmental and cost benefits of EVs are becoming very attractive (see Fig. 2). Significant hurdles exist on the path toward complete electrification of automobiles, chief among them being range anxiety by drivers who are accustomed to driving hundreds of miles on a single tank of gasoline. To help alleviate these valid concerns held by the public, PHEVs and REEVs (range-extended vehicles) are hitting the market to provide interim solutions that

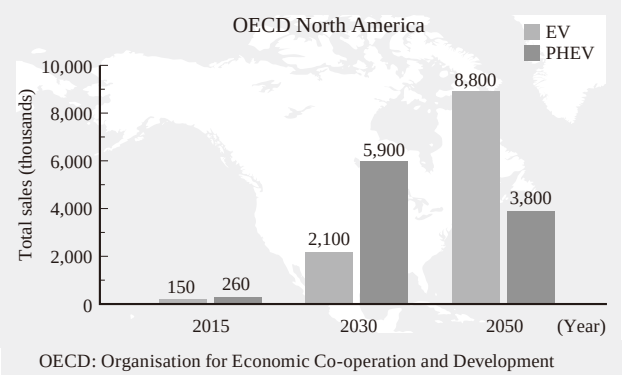

Fig. 2—Projection of EV and PHEV Sales in North America[1]. The International Energy Agency (IEA) estimates that EVs will become the dominant powertrain for vehicles in North America between 2030 and 2050.

can fill the gap prior to full electrification (pure EV).

Alongside the usual supply-chain that has been driving the century-old auto-industry, the push for this green technology has necessitated the inclusion of some unusual players including the establishment by the US Environmental Protection Agency (EPA) and California Air Resources Board (CARB) of combined fuel-economy standards; joint workgroups run by the SAE, The Institute of Electrical and Electronics Engineers, Inc. (IEEE), and Association for Computing Machinery (ACM) to determine specifications for charging and metering; municipalities setting up charging ports and other infrastructure; and public utility companies preparing for mass charging of vehicles. This delicate yet intricate fabric of agencies has been woven together to lead electrification onto the next step.

At the Automotive Products Research Laboratory (APL) located in the Detroit area, Hitachi engages in diverse R&D activities ranging from EMC (electromagnetic compatibility) testing to component modeling and co-simulation of inverters and batteries (see Fig. 3). With federal and state government incentives ranging from $7,500 to $12,500 available for the purchase of greener vehicles in the USA, APL is well positioned to provide Hitachi with strong support in its endeavors when the electrons hit the road.

Europe

In Europe, there is also a strong and increasing appreciation of the need to reduce the environmental impact and fossil fuel dependency of the automotive industry (see Fig. 4). Over the past decade, the conventional ICE has undergone strong technological improvements (such as engine downsizing) which have reduced its carbon footprint without diminishing the fun-to-drive factor which is close to European hearts. Following the economic crisis in the automotive industry, the EU and various individual countries have set in place various initiatives to drive the development and deployment of EVs across Europe. The City of London has promised that all city residents will be within one mile of a charging station by 2015, and attractive subsidies for buying an EV are available in France (where EVs are particularly environmentally attractive due to the large proportion of nuclear power generation) and many other countries. Germany, which takes pride in having been a pioneer of automotive technologies for over a hundred years, has made a goal of having more than 1 million EVs on the roads by 2020. At commission level, the EU has also set in place a public-private partnership called the Green Cars Initiative (GCI) which provides a billion-euro boost for the development of a greener transportation system. Furthermore, many Europeans are already accustomed to driving very small and light vehicles, particularly in the many small cities across Europe,

Fig. 3—Hitachi Automotive Products Research Laboratory in the USA.
The photograph shows the Hitachi Automotive Products Research Laboratory building.

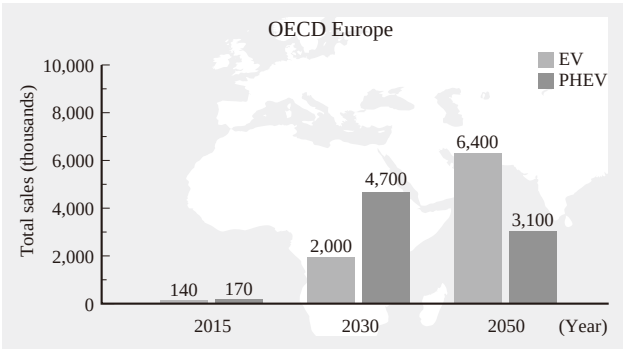

Fig. 4—Projection of EV and PHEV Sales in Europe[1]. The IEA estimates that EVs will become the dominant powertrain for vehicles in Europe between 2030 and 2050.

Fig. 5—Hitachi Automotive R&D Laboratory in Germany. The photograph shows the Hitachi Automotive R&D Laboratory building.

for which the EV and PHEV are very well suited. In consequence, widespread adoption of EVs and greener vehicles is anticipated across Europe aimed at ensuring both environmental sustainability and job security in the European car industry.

At our Automotive R&D Laboratory (ADL) in Munich (see Fig. 5), we apply our fundamental technologies from fields such as NVH (noise, vibration, and harshness) and controls to support Hitachi's automotive business in Europe, particularly for downsized engines and other electrical components. ADL is also increasing its activities in the field of railway and energy systems as Hitachi ramps up its efforts to expand its business in the field of electric transportation in Europe.

CONCLUSIONS

Although powertrain electrification in automotive systems is making progress toward the global need for reductions in CO_2 emissions, it is strongly dependent on the characteristics of each region and strategy. Hitachi R&D has a global commitment to becoming the "propulsion powertrain" that will achieve a low-carbon society through our global technical network and local activities.

REFERENCE

(1) Electric and Plug-in Hybrid Vehicle Roadmap, International Energy Agency, 2009
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