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Wide-spreading situations and factors of HEVs in Japan

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Summary

In promoting measures against global warming in transportation, mass dissemination of next-generation vehicles in automobile traffic is essential. The aim of this study was to analyze the current state of popularization of HEVs and the dissemination factors in Japan in order to make it a material for planning effective diffusion promotion measures. The HEVs' sales share in Japan was 23.3% in FY 2015. The owned HEVs' share will reach 10% soon. There are 5,500,437 HEVs and 119 vehicle types of owned HEVs at the end of FY 2015. Owned HEVs' price, total displacement of engine, weight, types of driving wheel, types of transmission and CO_2 emissions rates were analyzed. The penetration rate by prefecture vary from 5.9% in Okinawa to 12.9% in Aichi in FY 2015. Furthermore, Penetration factors of HEVs in Japan were analyzed using multiple linear regression analysis. We clarified that the household annual income, the number of household-owned vehicles and the number of snowy days are factors of HEV popularization.

Keywords: environment, HEV, mass market, promotion, strategy

1 Introduction

In promoting measures against global warming in transportation, mass dissemination of next-generation vehicles in automobile traffic is essential. A wide range of research of next-generation vehicles has been conducted, for example, studies on policy evaluation for market expansion [1],[2], studies on charging station [3], studies on technology development [4],[5]. In Japan, HEVs are becoming popular as next generation vehicles. From now on, it is necessary to aim at further spreading HEVs and spreading next generation cars other than HEVs. The aim of this study was to analyze the current state of popularization of HEVs and the dissemination factors in Japan in order to make it a material for planning effective diffusion promotion measures.

2 Overview of HEVs in Japan

2.1 HEVs' share

Figure1 shows HEVs' share of passenger car sales in Japan. After fiscal year (FY) 2013, the HEVs' sales share was over 20%. The share was 23.3% in FY 2015. Figure2 shows HEVs' share of owned passenger car at the end of FY 2015. The owned HEVs' share will reach 10% soon.

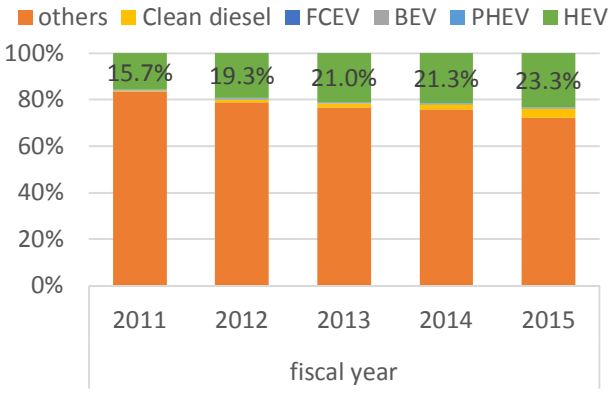


Figure1: HEVs' share of passenger car sales

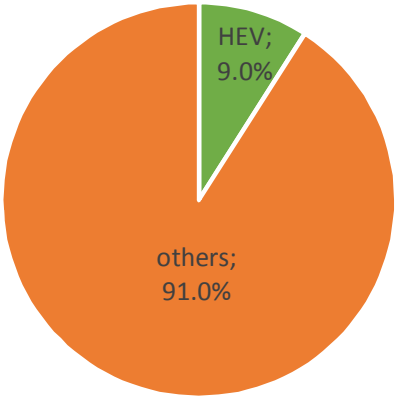
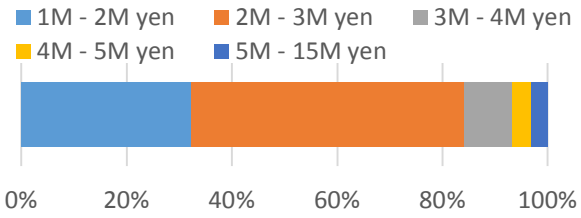


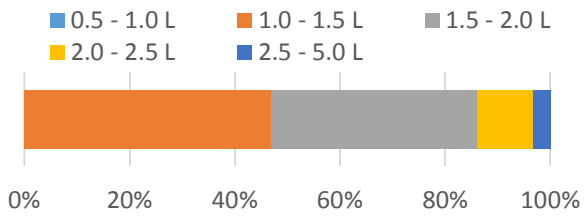
Figure2: HEVs' share of owned passenger car

2.2 Characteristics of HEVs

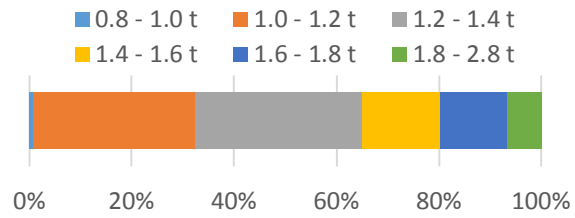
There are 5,500,437 HEVs and 119 vehicle types of owned HEVs at the end of FY 2015. The vehicle type means a product-specific designation systematically determined by the manufacturer etc. to identify the vehicle. Figure3 shows the characteristics of HEVs in Japan. New HEVs' price of 3 million yen or less, total displacement of engine from 1.0 L to 2.0 L, vehicle weight from 1.0 t to 1.6 t, front wheel HEVs accounts for 80% or more. CVT as a type of transmission exceed 90%. More than 70% of HEVs have small CO_2 emissions of 100 g-CO_2/km or less based on JC08 test mode.



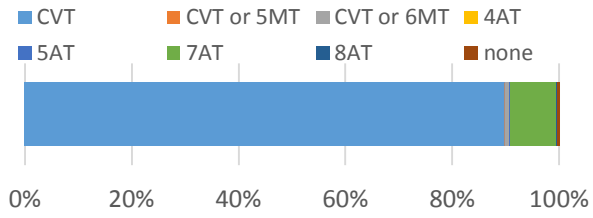
(a) Vehicle price



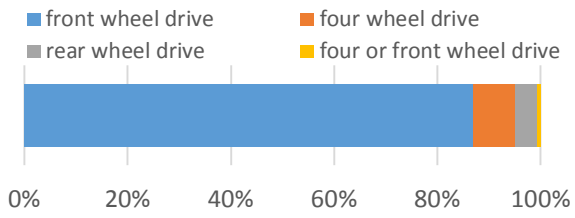
(b) Total displacement of engine



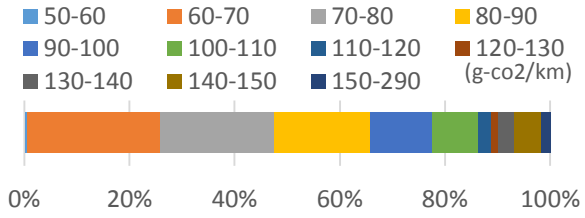
(c) Vehicle weight



(d) Transmission



(e) Drive wheel



(f) CO_2 emission factor

Figure3: Characteristics of owned HEVs (passenger car, FY 2015)

2.3 HEVs penetration rate by prefecture

There are 47 prefectures in Japan (Figure4). Figure5 shows the HEVs penetration rate by prefecture. The penetration rate vary from 5.9% in Okinawa to 12.9% in Aichi at the end of FY 2015.

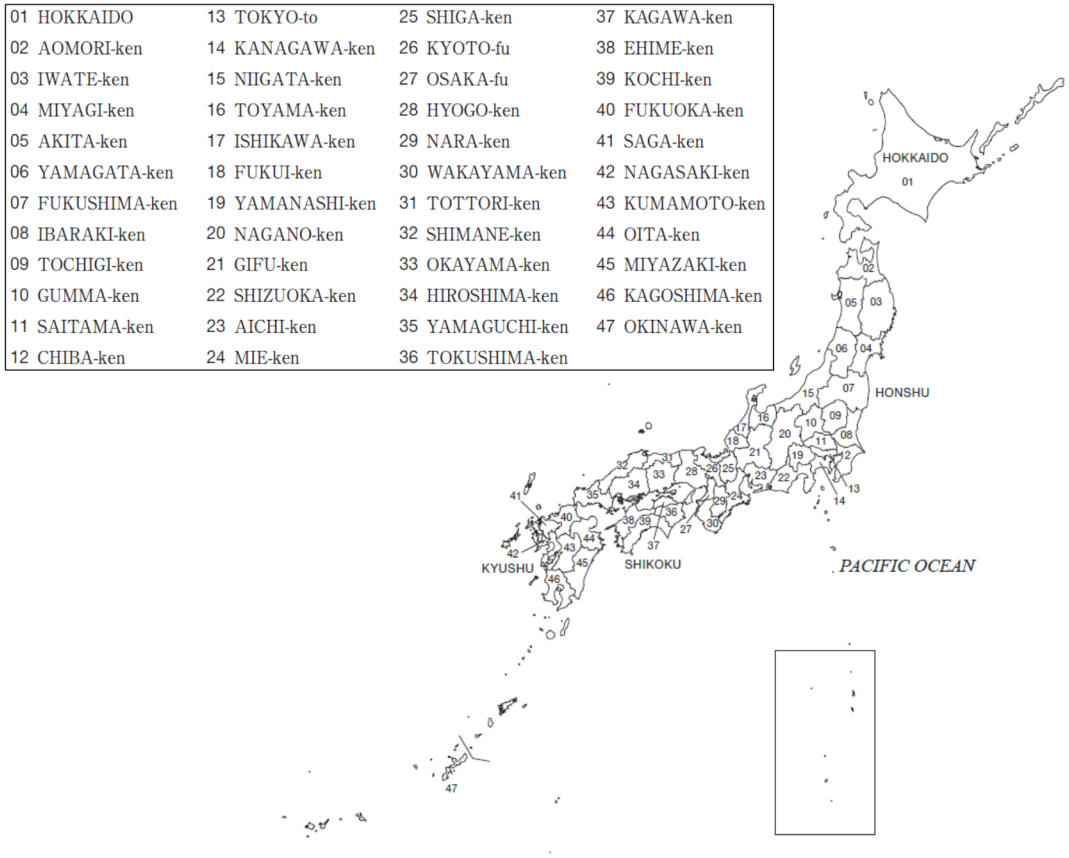


Figure4: 47 Prefectures in Japan [6]

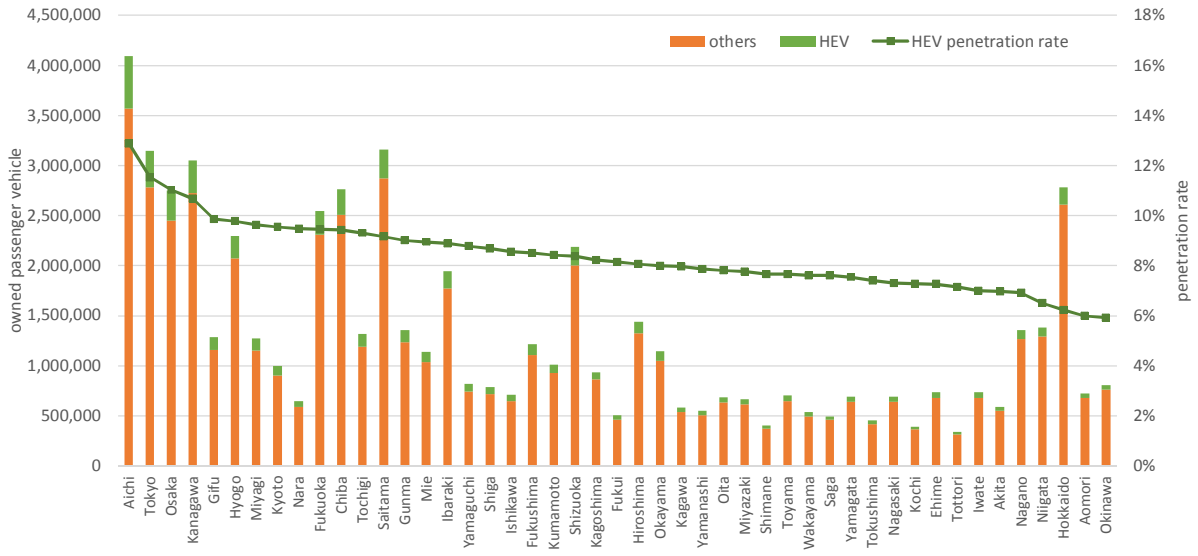


Figure5: HEVs penetration rate by prefecture (FY 2015)

3 Penetration factors of HEVs in Japan

Penetration factors of HEVs in Japan were analyzed using multiple linear regression analysis with forward selection method. Table1 shows explanatory variables used as attributes of prefectures. The variables were compiled by prefecture.

Table1: Explanatory variables used as attributes of prefecture for analysis

Explanatory variables	Sources
Household ratio with annual income over 7M yen	House and land statistics survey 2013
Household ratio with annual income over 10M yen	House and land statistics survey 2013
Household ratio with annual income over 15M yen	House and land statistics survey 2013
Household ratio with annual income over 20M yen	House and land statistics survey 2013
Aging population ratio (over 65)	Statistical Observations of Prefectures 2017
Number of snowy days per year	Statistical Observations of Prefectures 2017
Automobile ownership per household	Statistical Observations of Prefectures 2017
Traveling kilometers per passenger car	Survey on motor vehicle transport 2015 Number of passenger cars by prefecture at the end of March 2016

Three objective variables selected are shown in Table2. Because the penetration factors could be different depending on the car price, the penetration rate classified by the passenger car price range was set as the objective variables. Three objective variables were also compiled by prefecture. Table2 also shows coefficients of determination. While the adjusted R squared of vehicle price less than 2M yen was comparatively low 0.323, the adjusted R squared of vehicle price 2M yen or more and less than 3M yen, and vehicle price over 3M yen were 0.608 and 0.765, respectively.

Table2: Three objective variables used for analysis and coefficients of determination

Objective variables	R squared	Adjusted R squared
HEV penetration rate with vehicle price		
1) less than 2M yen	0.353	0.323
2) 2M yen or more and less than 3M yen	0.633	0.608
3) over 3M yen	0.775	0.765

Table3 shows the results of multi linear regression analysis for each objective variables. As a result of applying the forward selection method, only explanatory variables with high explanatory power are shown. Table3 (a) shows that the penetration factor of HEV with vehicle price less than 2M yen are annual household income and number of snowy days. Percentage of households with household income over 7M yen is a positive factor and the high number of snowy days is a negative factor for low price HEV popularization. Table3 (b) shows that the penetration factor of HEV with vehicle price 2M or more and less than 3M yen are automobile ownership per household in addition to the previous factors. The number of vehicles owned by a single household is a negative factor of the spread of middle price HEV. Table3 (c) shows that the penetration factor of HEV with vehicle price over 3M yen are annual household income and automobile ownership per household. However, the ratio of households earning high incomes whose annual household income exceeds 20M yen was a positive factor in the spread of high-cost HEVs.

Table3: The results of multi linear regression analysis for each objective variables

(a) Vehicle price less than 2M yen

Explanatory variables selected	Passenger HEV with price less than 2M yen			
	partial regression coefficient	standard partial regression coefficient	t value	*:P<0.05 **:P<0.01
Household ratio with annual income over 7M yen	3.98E-02	0.451	3.72	**
Number of snowy days per year	-4.02E-05	-0.390	-3.21	**
Constant term	2.39E-02	-	14.45	**

(b) Vehicle price 2M yen or more and less than 3M yen

Explanatory variables selected	Passenger HEV with price 2M yen or more and less than 3M yen			
	partial regression coefficient	standard partial regression coefficient	t value	*:P<0.05 **:P<0.01
Household ratio with annual income over 7M yen	1.21E-01	0.525	5.69	**
Number of snowy days per year	-9.56E-05	-0.356	-3.65	**
Automobile ownership per household	-9.46E-06	-0.380	-3.89	**
Constant term	4.42E-02	-	8.87	**

(c) Vehicle price over 3M yen

Explanatory variables selected	Passenger HEV with price over 3M yen			
	partial regression coefficient	standard partial regression coefficient	t value	*:P<0.05 **:P<0.01
Household ratio with annual income over 20M yen	1.86E+00	0.707	8.97	**
Automobile ownership per household	-3.40E-06	-0.307	-3.90	**
Constant term	8.81E-03	-	4.22	**

4 Conclusions

In order to make it a material for planning effective diffusion promotion measures, the current state of popularization of HEVs were analyzed. The HEVs' sales share in Japan was 23.3% in FY 2015. The owned HEVs' share will reach 10% soon. The penetration rate by prefecture vary from 5.9% in Okinawa to 12.9% in Aichi in FY 2015. By using statistical data, we clarified that the household annual income and the number of household-owned vehicles are factors of HEV popularization. However, this is obviously the expected result. It is a new finding that it showed a line that there is a possibility of dissemination when the annual household income exceeds 7M yen. Furthermore, we have revealed the current situation that HEV penetration has not progressed in the snowy areas. Four-wheel drive vehicles are widespread in the snowy area, whereas the lineup of four-wheel drive HEV was small. We believe that it is important to provide vehicle model options that meet local needs in the case of aiming for massive popularization of next-generation automobiles, not only HEV but also EV, PHEV, FCV.

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