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All-Electric versus Hydrogen Engine Vehicles: Acceptance of Emission-Free Driving in Germany, the USA, China, Japan and India – An Exploratory YouTube Study

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Abstract: *Ditfurth and Arzt highlight the continuous, evolutionary process of general vehicle development from the horse-drawn carriage to the steam vehicle and eventually up to the internal combustion engine vehicle of today. Mutation and selection shaped this development to best meet customer needs. Technical, infrastructural and sociocultural requirements and needs are decisive. Thus, it was also a process of balancing different desires for human transportation and mobility culture: the vehicle as an urban, touring, racing, and luxury means of transport. Especially the transfer from the electric vehicle to the gasoline vehicle transformed the latter from a purely adventurous and speedy option to a more utilitarian mobility solution. Through the rising similarities in car features, price and the affordability – socioeconomic advantages of the gasoline car – became decisive prerequisites for the mass motorisation. In the 21st century the development of sustainable mobility solutions takes place between different drive systems. The acceptance of the public and the (potential) customers, as well as a sustainably value-creating business model for the OEMs and the customers, are prerequisites for the successful future of sustainable automotive mobility worldwide.*

Key words:
All-electric driving – Hydrogen engine vehicles – Social Media – Technology Management

1 Introduction

1.1 The 20th century's drive train contest as a blueprint for today's emission-free drive train competition

Ditfurth and Arzt highlight the continuous, evolutionary process of general vehicle development from the horse-drawn carriage to the steam vehicle and eventually up to the internal combustion engine vehicle of today.[1] Mutation and selection[2] shaped this development to best meet customer needs. Technical, infrastructural and sociocultural requirements and needs are decisive.[3] Thus, it was also a process of balancing different desires for human transportation and mobility culture: the vehicle as an urban, touring, racing, and luxury means of transport.[4]

Especially the transfer from the electric vehicle to the gasoline vehicle transformed the latter from a purely adventurous and speedy option to a more utilitarian mobility solution, including the entire city-car concept, the front-wheel drive favoured by inexperienced drivers. It also brought "the ease of operation, the quieter engine, the controllability of the combustion engine, the suppression of noise and smell" and last not least "the cord tire … in 1915-16."[5] Through the rising similarities in car features, price and the affordability – socioeconomic advantages of the gasoline car – became decisive prerequisites for the mass motorisation. In the 21st century the development of sustainable mobility solutions takes place between different drive systems.[6] The acceptance of the public and the (potential)

[1] Ditfurth & Arzt 1982, 118. Nakicenovic 1986, 309. Eckermann 2001, 10-23. Mom & Kirsch 2001, 490.
[2] Geissler et al. 1978, 13.
[3] Mom 2004, 275.
[4] Geels 2005, 459-460. Mom 2004, 283-284. Kortzfleisch 1976, 287.
[5] Mom 2004, 298.
[6] Heimes et al. 2024, 21-23.

customers,[7] as well as a sustainably value-creating business model[8] for the OEMs and the customers, are prerequisites for the successful future of sustainable automotive mobility worldwide.

1.2 Study outline

A follow-up study measuring public and customer acceptance of the three most relevant (pollutant) emission-free driving technologies using social media data[9] analyses the following research questions again:

Q1: Are there discrepancies in the acceptance of different emission-free drive systems between Germany, the USA, China, Japan and India, and what factors influence these differences?
Q2: Has the acceptance of various emission-free drive systems changed over time in Germany, the USA, China, Japan and India?

For this research approach, video-based data from YouTube[10] provides insights into different factors of technological acceptance, such as the type of drive system, the vehicle market, and the user views/perceptions. The discussion of answers to the research questions will be followed by appropriate conclusions.

The abstract of the theoretical foundations and the research approach is based on the study about all-electric driving presented at the 42nd International Vienna Motor Symposium in 2021 and the study about emission-free driving of 2023.[11] The subsequent description of YouTube data collection and evaluation, supported by descriptive statistics, is followed by a summary and discussion of the results. The outlook concludes the study.

2 Theoretical Foundations and Research Approach

2.1 Technology acceptance and emission-free driving

Social and ethical aspects determine the construct “technology acceptance” and reflect benefit and risk perceptions of technologies.[12] The Technological Acceptance Measuring Model with social media, TAMMSO©[13] uses views and clicks of audio-visual or video-based Social Media applications. A benefit and risk rate, based on the YouTube data “like” (R+) and “dislike” (R-),[14] is essential for measuring of technology acceptance as follows:

Benefit rate = $(\Sigma R+ / (\Sigma R- + \Sigma R+)) = 1 - \text{Risk rate}$
Risk rate = $(\Sigma R- / (\Sigma R- + \Sigma R+)) = 1 - \text{Benefit rate}$

Emission-free driving encompasses several technologies. The battery electric drive, the fuel cell electric drive and the hydrogen engine drive[15] are the focus of this investigation. “Emission-free” or “zero-emission” refers to the absence of greenhouse gas emissions, as defined by state regulations.[16]

2.2 Basics of YouTube-based analyses

The data query via YouTube concerning battery electric vehicle (BEV) uses the English term “electric car,” the German term “Elektroauto,” the Chinese term “电动汽车（电池” (electric car (battery)) and the Japanese term “電気自動車” (Elektroauto), for the fuel cell

[7] Kohl et al. 2018, 620.
[8] Chesbrough 2010, 354.
[9] The risk of manipulating social media data: Marcellino et al. 2023. Thiele et al. 2025. Ruhlig 2025. Google (1) 2025. Google (4) 2025.
[10] YouTube© is a trademark of YouTube LLC, a subsidiary of Google LLC.
[11] Wittmann 2021, 3-5. Wittmann 2023, 393.
[12] Wittmann 2021, 3.
[13] TAMMSO© 2019. The collection of data for determining social indicators was carried out in a similar manner in Japan prior to the introduction of social media. Kortzfleisch 1976, 287-288.
[14] Google (2) 2025.
[15] Erren 1939.
[16] EU 2019, 124. EPA 2025. Wang et al. 2025, 1.

electric vehicle (FCV) the English term "hydrogen car," the German term "Wasserstoffauto," the Chinese term "中国的氢能汽车" (hydrogen car) and the Japanese terms "水素自動車 / 燃料電池車" (Wasserstoff-/Brennstoffzellenauto), for the hydrogen engine vehicle (HYV) the English terms (for the US and Indian samples) "hydrogen engine car" and "hydrogen engine combustion car," the Japanese term "水素燃焼エンジン車" (hydrogen engine combustion car), the German term "Wasserstoffverbrennerauto," and the Chinese term "装有氢内燃机的汽车 (Table 1).

Table 1. Term Assignment by Technology

Term Assignment by Technology				
Abbrev.	Search Terms	Battery	Fuel Cell	Hydrogen Engine
DE_BEV	Elektroauto	x	-	-
US_BEV	electric car	x	-	-
CN_BEV	电动汽车（电池）	x	-	-
JP_BEV	電気自動車	x	-	-
IN_BEV	electric car	x	-	-
DE_FCV	Wasserstoffauto	-	x	-
US_FCV	hydrogen car	-	x	-
CN_FCV	中国的氢能汽车	-	x	-
JP_FCV	水素自動車 / 燃料電池車	-	x	-
IN_FCV	hydrogen car	-	x	-
DE_HYV	Wasserstoffverbrennerauto	-	-	x
US_HYV	hydrogen (combustion) engine car	-	-	x
CN_HYV	装有氢内燃机的汽车	-	-	x
JP_HYV	水素燃焼エンジン車	-	-	x
IN_HYV	hydrogen (combustion) engine car	-	-	x

In the first step, 7,246 videos were extracted using the fourteen search terms (Step 1). YouTube orders the videos first that are most popular and up-to-date ensuring sample relevance.[17] Step 2 and 3 encompass the exclusion of videos with less than 50,000 views and videos with deviating and redundant content, e.g. hybrid electric vehicles. The final overall sample of the study contains 645 videos (Table 2).

Table 2. Three Steps of Selecting YouTube Videos

Number of Videos on YouTube				
Abbrev.	Search Terms	Total Selection	Selection > 50,000 views	Adjusted Selection
DE_BEV	Elektroauto	430	101	92
US_BEV	electric car	605	177	110
CN_BEV	电动汽车（电池）	391	37	31
JP_BEV	電気自動車	494	101	80
IN_BEV	electric car	[605]	[177]	33
DE_FCV	Wasserstoffauto	610	46	39
US_FCV	hydrogen car	691	129	75
CN_FCV	中国的氢能汽车	393	27	18
JP_FCV	水素自動車 / 燃料電池車	904	61	43
IN_FCV	hydrogen car	[691]	[129]	31
DE_HYV	Wasserstoffverbrennerauto	687	18	7
US_HYV	hydrogen (combustion) engine car	956	60	42
CN_HYV	装有氢内燃机的汽车	754	1	1
JP_HYV	水素燃焼エンジン車	331	53	41
IN_HYV	hydrogen (combustion) engine car	[956]	[60]	2
	Total	**7,246**	**811**	**645**

*General note on data included in all Tables: Sum Totals of categories will not necessarily add up, as numbers have been rounded off to the nearest full digit.

[17] NavigateVideo 2025.

Table 3 lists 645 videos with 485 million views according to the initial sample of June 2024, of which 227 videos (35%) originating from the USA represent 279 million views (58%). This includes 110 videos about BEVs, 75 videos about FCVs and 42 videos about HYVs. A total of 138 videos (21%) are from Germany, accounting for 43 million views (9%), divided into 92 videos about BEVs, 39 videos about FCVs, and 7 videos about HYVs. Fifty videos (8%) are from China[18] with 12 million views (2%), divided into 31 videos about BEVs, and 18 videos about FCVs, and 1 video about HYV. A total of 164 videos (25%) are from Japan with 58 million views (12%), divided into 80 videos about BEVs, 43 videos about FCVs and 41 videos about HYVs. Finally, 66 videos (10%) are from India with 93 million views (19%), divided into 33 videos about BEVs, 31 videos about FCVs, and 2 videos about HYVs.

Further data retrievals of the video samples were conducted in December 2024 and June 2025. Notably, the growth rate of the category DE_BEV (12%) is lower than the growth rates of the category CN_BEV (14%), US_BEV (18%), IN_BEV (22%), and JP_BEV (25%). The growth rate of the category JP_FCV (16%) is higher than that of the category US_FCV (12%), IN_FCV (9%), CN_FCV (8%), and DE_FCV (4%). In the HYV category, the growth rate in the USA (34%) surpass es the growth rate in India (25%), China (19%), Germany (5%), and Japan (4%). In the USA (2024, 2025), the number of views for the category BEV (nearly) equals the views in India, Japan, Germany and China combined. By contrast, the views in the FCV and HYV categories are more than double the views in the USA compared with India, Germany, Japan and China combined.

Table 3. Share and Growth of Number of Views

Abbrev.	Search Terms	Videos	Jun 2024 Views [Mil]	Dec 2024 Views [Mil]	Jun 2025 Views [Mil]	Total Change
DE_BEV	Elektroauto	92	23.1	24.8	25.9	12%
DE_FCV	Wasserstoffauto	39	13.9	14.3	14.4	4%
	Subtotal	131	37.0	39.1	40.4	9%
US_BEV	electric car	110	144.7	163.2	170.9	18%
US_FCV	hydrogen car	75	92.4	99.4	103.6	12%
	Subtotal	185	237.2	262.6	274.5	16%
CN_BEV	电动汽车（电池）	31	9.2	10.0	10.5	14%
CN_FCV	中国的氢能汽车	18	2.9	3.1	3.1	8%
	Subtotal	49	12.0	13.1	13.6	13%
JP_BEV	電気自動車	80	38.5	45.1	48.1	25%
JP_FCV	水素自動車 / 燃料電池車	43	8.7	9.5	10.0	16%
	Subtotal	123	47.2	54.6	58.1	23%
IN_BEV	electric car	33	74.1	85.6	90.4	22%
IN_FCV	hydrogen car	31	16.1	17.1	17.5	9%
	Subtotal	64	90.2	102.7	107.9	20%
	Subtotal	**552**	**423.6**	**472.1**	**494.4**	**17%**
DE_HYV	Wasserstoffverbrennerauto	7	6.3	6.5	6.6	5%
US_HYV	hydrogen (combustion) engine car	42	41.9	46.9	56.4	34%
CN_HYV	装有氢内燃机的汽车	1	0.1	0.1	0.1	19%
JP_HYV	水素燃焼エンジン車	41	10.6	10.8	11.0	4%
IN_HYV	hydrogen (combustion) engine car	2	2.4	2.9	3.0	25%
	Subtotal	**93**	**61.3**	**67.2**	**77.1**	**26%**
	Total	**645**	**484.9**	**539.3**	**571.6**	**18%**

3 Test Results

3.1 Analyses of technology acceptance of emission-free driving

The analyses of the video footage and descriptions resulted in the identification of positive, negative, and neutral statements on emission-free driving (Table 4).

The views of each video were assigned to the categories accordingly (positive, negative and neutral). Positive statements represent advantages that highlight benefits, while negative statements represent disadvantages that emphasis risks of emission-free driving.

[18] People in (Mainland) China can bypass the video ban of YouTube through using premium VPNs. Dorn 2024. VPN:= Virtual Private Network.

Neutral statements refer to videos about general descriptions or balanced discussions about emission-free driving. Between June 2024 and June 2025, the total number of views for BEVs and FCVs increased from 424 to 494 million views (+17%). This includes growth rates of 18% and 12% in the USA, 12% and 4% in Germany, 14% and 8% in China, 25% and 16% in Japan, and 22% and 9% in India. In the USA, 42% and 58% of views were positive videos, with 55% and 47% of the same in Germany, with 63% and 40% of the same in China, with 21% and 65% of the same in Japan, and with 86% and 74% of the same in India. The videos containing negative statements about BEVs and FCVs comprise 32% and 35% of the US views and 29% and 14% of the German views, 16% and 11% of the Chinese views, 67% and 19% of the Japanese views, and 2% and 18% of the Indian views (an average of all samples).

Table 4. Development of Video Views

Views [Mil]		Total	Total	Total	DEU		USA		CHN		JPN		IND		Total	DEU	USA	CHN	JPN	IND
		BEV/FCV	BEV	FCV	BEV	FCV	BEV	FCV	BEV	FCV	BEV	FCV	BEV	FCV	HYV	HYV	HYV	HYV	HYV	HYV
All	Jun 2024	423.6	289.6	134.0	23.1	13.9	144.7	92.4	9.2	2.9	38.5	8.7	74.1	16.1	61.3	6.3	41.9	0.1	10.6	2.4
	Jun 2025	494.4	345.8	148.7	25.9	14.4	170.9	103.6	10.5	3.1	48.1	10.0	90.4	17.5	77.1	6.6	56.4	0.1	11.0	3.0
	Delta [%]	17%	19%	11%	12%	4%	18%	12%	14%	8%	25%	16%	22%	9%	26%	5%	34%	19%	4%	25%
Positive	Jun 2024	224.4	144.2	80.2	12.3	6.7	57.3	55.1	5.5	1.2	5.7	5.3	63.4	11.9	34.4	0.4	23.4	0.1	8.2	2.4
	Jun 2025	268.7	180.7	88.0	14.1	6.8	72.4	60.3	6.6	1.2	10.0	6.5	77.6	13.0	41.5	0.4	29.4	0.1	8.5	3.0
	Delta [%]	20%	25%	10%	15%	3%	26%	9%	18%	4%	77%	23%	22%	10%	20%	2%	26%	19%	4%	25%
	Share [%]	54%	52%	59%	55%	47%	42%	58%	63%	40%	21%	65%	86%	74%	54%	6%	52%	100%	77%	100%
Negative	Jun 2024	126.9	88.3	38.6	6.8	1.9	50.6	31.5	1.6	0.3	27.9	1.8	1.4	3.0	5.2	-	3.9	-	1.3	-
	Jun 2025	141.9	98.3	43.7	7.5	2.0	55.4	36.3	1.7	0.3	32.1	1.9	1.6	3.1	5.5	-	4.1	-	1.3	-
	Delta [%]	12%	11%	13%	10%	5%	9%	15%	5%	6%	15%	3%	19%	3%	6%		7%		4%	
	Share [%]	29%	28%	29%	29%	14%	32%	35%	16%	11%	67%	19%	2%	18%	7%	0%	7%	0%	12%	0%
Neutral	Jun 2024	72.3	57.0	15.3	4.0	5.3	36.8	5.8	2.0	1.4	5.0	1.5	9.3	1.2	21.7	5.9	14.7	-	1.1	-
	Jun 2025	83.9	66.8	17.0	4.3	5.6	43.1	6.9	2.2	1.5	6.0	1.6	11.2	1.4	30.2	6.2	22.8	-	1.2	-
	Delta [%]	16%	17%	11%	7%	5%	17%	19%	12%	12%	20%	4%	21%	14%	39%	5%	56%		6%	
	Share [%]	17%	19%	11%	16%	39%	25%	7%	21%	49%	12%	16%	12%	8%	39%	94%	40%	0%	10%	0%

Between June 2024 and June 2025, HYVs views increased from 61 to 77 million views (+26%) in all countries. This covers a growth rate of 34% in the USA, a growth rate of 25% in India, a growth rate of 19% in China, a growth rate of 5% in Germany, and a growth of 4% in Japan. In the USA, 52% of views were positive videos, with 77% of the same in Japan, with 100% of the same in China and India (only 1 and 2 videos), and 6% of the same in Germany. The videos containing neutral statements about HYVs comprise 94% of the German views, 40% of the US views and 10% of the Japanese views. The high number of

views of the positively and neutrally rated videos is likely due to their authenticity and high information content.[19]

3.2 Measurement of technology acceptance of different emission-free driving technologies

a) Detailed analyses of BEVs, FCVs and HYVs

FCVs, BEVs and HYVs have different levels of innovation, with fuel cell vehicles generally categorised as disruptive technologies, BEVs as new technologies and HYVs as partly new technologies (Table 5). BEVs are in the early stages of market penetration[20] and reached global sales of 10.4 million units in 2024.[21] In contrast, FCVs sales were less than 13,000 units.[22] HYVs currently exist mainly as test vehicles, for example in motorsport applications.[23]

In the BEV category (2024-2025), the USA accounts for a total of 49% of views, with 72 million positive views, 55 million negative views, and 43 million neutral views in 2025. In the FCV category, the USA represents 70% of views in total, with 60 million positive, 36 million negative, and 7 million neutral views.

In Germany, the BEV category accounts for 7% of total views, with 14 million positive and 8 million negative views, while the FCV category accounts for 10% of total views, with 7 million positive views and 8 million negative or neutral views in 2025.

In China, the BEV category accounts for 3% of total views, with 7 million positive, 2 million negative and 2 million neutral views in 2025, while the FCV category accounts for 2% of total views, with 1.2 million positive, 0.3 million negative and 1.5 million neutral views.

In Japan, the BEV category accounts for 14% of total views, with 10 million positive, 32 million negative and 6 million neutral views in 2025, while the FCV category accounts for 7% of total views, with 7 million positive, 2 million negative and 1.6 million neutral views.

In India, the BEV category accounts for 26% of total views, with 78 million positive, 2 million negative and 11 million neutral views in 2025, while the FCV category accounts for 12% of total views, with 13 million positive, 3 million negative and 1.4 million neutral views.

In the HYV category (2024-2025), the USA has a total share of 73% of views, with 29 million positive, 4 million negative and 23 million neutral views in 2025. Japan accounts for 14% of HYV views, with 9 million positive, 1.3 million negative and 1.2 million neutral views. In this category, Germany accounts for 9% of total views, with 0.4 million positive, and 6.2 million neutral views. India accounts for 4% of total views, with 3 million positive views, and China accounts for less than 1% of total views, with 0.1 million positive views.

In comparison, the BEVs have around five times the number of positive views in the USA and India compared with Germany, China and Japan combined (150 million vs. 31 million in 2025), and around eight times more negative views in the USA and Japan than in Germany, China and India combined (87 million versus 11 million in 2025). In comparison, the high number of neutral views in the USA (43 million) and in India (11 million) is also significant, highlighting strong demand of information about BEV technology.

In the FCV category (2025), the USA ranks first with 60 million positive views, followed by India with 13 million, Germany ranks third with 6.8 million, Japan fourth with 6.5 million, and finally China with 1.2 million positive views. The USA also accounts for 36 million negative views, indicating strong reservations regarding FCV technology. In comparison, the high number of neutral views in the USA (7 million) and Germany (6

[19] Faster Capital 2025.
[20] Victor et al. 2019, 14. Dugoua & Dumas 2024, 1,4.
[21] Marcus 2025.
[22] Collins 2025.
[23] Tafel & Martin 2024, 130. Köllner 2025.

million) is significant, demonstrating high demand of information about FCV technology in both countries.

In the HYV category, the USA ranks first with 29 million positive views, followed by Japan with 9 million, India ranks third with 3 million, Germany fourth with 0.4 million, and finally China with 0.1 million positive views. The USA accounts for 4 million negative views, followed by Japan with 1.3 million. The high number of neutral views (23 million) in the USA, 6 million in Germany and 1.2 million in Japan underscores the rising interest in and innovation of HYV technology among potential customers and the public in these countries.

Table 5. Classification of Videos regarding BEVs, FCVs and HYVs

	Views [Mil]	BEV					FCV					HYV				
		DEU	USA	CHN	JPN	IND	DEU	USA	CHN	JPN	IND	DEU	USA	CHN	JPN	IND
June 2024	Total Views	23.1	144.7	9.2	38.5	74.1	13.9	92.4	2.9	8.7	16.1	6.3	41.9	0.1	10.6	2.4
	Positive Views	12.3	57.3	5.5	5.7	63.4	6.7	55.1	1.2	5.3	11.9	0.4	23.4	0.1	8.2	2.4
	Negative Views	6.8	50.6	1.6	27.9	1.4	1.9	31.5	0.3	1.8	3.0	-	3.9	-	1.3	-
	Neutral Views	4.0	36.8	2.0	5.0	9.3	5.3	5.8	1.4	1.5	1.2	5.9	14.7	-	1.1	-
June 2025	Total Views	25.9	170.9	10.5	48.1	90.4	14.4	103.6	3.1	10.0	17.5	6.6	56.4	0.1	11.0	3.0
	Positive Views	14.1	72.4	6.6	10.0	77.6	6.8	60.3	1.2	6.5	13.0	0.4	29.4	0.1	8.5	3.0
	Negative Views	7.5	55.4	1.7	32.1	1.6	2.0	36.3	0.3	1.9	3.1	-	4.1	-	1.3	-
	Neutral Views	4.3	43.1	2.2	6.0	11.2	5.6	6.9	1.5	1.6	1.4	6.2	22.8	-	1.2	-
	Share Total Views [%]	7%	49%	3%	14%	26%	10%	70%	2%	7%	12%	9%	73%	0%	14%	4%

b) Analyses of the video evaluation function

The video evaluation function of videos with positive statements (PoS) and negative statements (NeS) uses “Likes” to enable further, in-depth data analyses.[24] The benefit rate (Σ R+) is calculated as the likes of videos with PoS divided by the sum of likes of the videos with PoS and NeS. The risk rate (Σ R-) is calculated as the likes of videos with NeS divided by the sum of likes of the videos with PoS and NeS. The benefit and risk rates refer to the five markets – based on the sample from June 2025 (Table 6).

The benefit rate for BEVs is highest in India and significantly higher in China and Germany than in the USA and Japan. The benefit rate for FCVs is the highest in Japan, followed by Germany and India. In China, the FCV benefit rate ranks fourth, while the USA has the lowest rate at 60%. The benefit rate for HYVs is markedly higher in Japan and

[24] There are not any “Dislike” counts in the samples.

the USA. This study essentially confirms the January 2021 study regarding the benefit rate of FCVs in the USA.[25]

Table 6. Benefit Rate for BEV, FCV and HYV[26]

Sample 06/2025		BEV	FCV	HYV
Benefit Rate	DEU	74%	72%	[100%]*
	USA	54%	60%	90%
	CHN	73%	61%	[100%]*
	JPN	31%	81%	92%
	IND	97%	71%	[100%]*

In a further step of the analysis, the benefit ratios are calculated according to different release dates of the videos, distinguishing between videos that are less than one year old and those that are older than one year (Table 7).

Table 7. Partial Benefit Rate for BEV, FCV and HYV

Sample 06/2025	BEV					FCV					HYV	
Benefit Rate	DEU	USA	CHN	JPN	IND	DEU	USA	CHN	JPN	IND	USA	JPN
0-12 Months	79%	44%	76%	32%	100%	49%	71%	53%	90%	62%	93%	96%
> 12 Months	71%	63%	63%	27%	96%	82%	58%	77%	60%	97%	76%	83%
Average	74%	54%	73%	31%	97%	72%	60%	61%	81%	71%	90%	92%
Total Average	70%					62%					91%	

In Germany, the positive evaluation of BEVs increases from 71% (videos released more than 12 months ago) to 79% (videos released within the last 12 months), while in the USA it decreases from 63% to 44%. In China, the benefit rate rises from 63% to 76%, and in India, the benefit rate increases from 96% to 100%, in contrast to Japan, which has the lowest benefit rates, rising from 27% to 32%.

In Germany, the benefit rate of FCVs decreases from 82% (videos released more than 12 months ago) to 49% (videos released within the last 12 months), while in the USA it increases from 58% to 71%. In China, the benefit rate drops from 77% to 53%, and in India from 97% to 62%, whereas Japan's rate rises significantly from 60% to 90%.

In the USA, the benefit rate of HYVs increases from 76% (videos released more than 12 months ago) to 93% (videos released within the last 12 months), while in Japan, a benefit rate of HYVs increases from 83% to 96%. Germany, China and India are excluded from the HYV ranking due to a low number of videos. Regarding overall ranking: Germany ranks BEV first and FCV second. The USA favours HYV first, followed by FCV and finally BEV. China switches its preference to BEV ahead of FCV (for videos released within the last 12 months). Japan ranks HYV first, FCV second and BEV third. Finally, India favours BEV first, followed by FCV.

c) Emission-free driving in comparison to ICV driving

The arguments[27] for and against the different options of emission-free driving have been largely consistent across markets over three studies undertaken between 2021 and 2025

[25] Wittmann 2021, 9.
[26] (* less than 8 videos each)
[27] ACEA 2024 & 2025.

(Table 8).[28] The core argument of higher energy efficiency[29] for all-electric vehicles, especially battery electric vehicles, is under scrutiny[30] due to its pure technical and supply-oriented character.[31] The potentially lower operating costs of BEVs compared with hydrogen powered (HYVs, FCVs) and internal combustion engine vehicles (ICVs) represent only one component of the total cost of ownership.

In general, the scarcity of green energy diminishes the environmental benefits of emission-free vehicles. Additionally, there is a lack of charging and fuelling stations and supporting infrastructure. Higher product prices for all-electric vehicles result from high product costs, investments and technical and commercial risks of accumulators, fuel cells and refuelling systems, combined with moderate and low sale volumes. The limitations of BEVs have remained consistent over the years.[32]

BEVs suffer from limited range, long charging times, different plugs and charging standards and a reduced usability during grid problems and blackouts. Table 8 summarizes the criticism against emission-free driving.

Table 8. Main Points of Criticism about Emission-free Driving in comparison to ICV driving[33]

Main Points of Criticism about Emission-free Driving	BEV	FCV	HYV*	(ICV)
High Prices; Poor Price/Performance Ratio	x	x	-	-
Lack of Charging/Fuelling Stations	x	x	x	-
Limited Product Programme	(x)	x		-
Green Energy: Less Available than Claimed	x	x	x	
Limited Range (esp. for Driving with Heavy Loads, Trailers)	x	-	-	-
Long-Lasting Charging/Fuelling Time	x	-	-	-
Complicated Charging with Different Standards and Plugs	x	-	-	-
Limited Usability during Grid Problems and Blackouts	x	-	-	-
Technical Risks of Accumulators, Fuel Cells, and Refuelling Systems	x	x	x	-
* no market availability yet				

Nevertheless, the ICV still seems to set the prevailing gold standard for most customer-preferred vehicle characteristics,[34] reflected in fewer points of criticism. Toyota has been a pioneer in the development of (test) HYVs, favouring a simple, clean and low-cost solution for emission-free driving on the one hand, while saving substantial resources across the value chain compared with all-electric vehicles on the other hand.[35]

Furthermore, HYVs are competitive with all-electric vehicles due to their low carbon footprint over the entire life cycle.[36]

4 Discussion

In comparison with several international studies on buying intentions of all-electric vehicles, the validity of the study is under scrutiny.

The acatech Study 2025 reports a renewed rising interest in purchasing a BEV in Germany decreasing from 20% (2023) to 17% (2024) and increasing to 23% (2025).[37]

[28] Wittmann 2021 & 2023 & 2026.
[29] The parameter “energy efficiency” exclusively focuses on a technical and supply-oriented perspective. Diekmann et al. 1999, 25-26. In contrast, Bellmann recommends “economic efficiency” and “ecological effectiveness” for market-oriented evaluation in the energy branch. Bellmann 1990, 1262.
[30] Wittmann 2026.
[31] Diekmann et al. 1999, 25-26.
[32] Acatech 2024 & 2025.
[33] Table following Wittmann 2023, 406.
[34] Lyon 2021.
[35] Watkins 2025. Lyon 2021.
[36] Sens et al. 2021, 10, 13. Wittmann 2026.
[37] Acatech 2025.

Among the population segment with higher socioeconomic status, 30% prefer BEVs, compared with only 8% among people with lower socioeconomic status.[38]

In the Continental Mobility Study 2024, conducted in five countries with 1,000 respondents each (including Germany, USA, China and Japan), participants responded positively to the question, "How likely is it that your next car will be electric?" as follows: Germany 39%; USA 45%; China 87% and Japan 32%.[39] When asked whether they would willingly buy an electric car even without government subsidies, respondents answered as follows: Germany 26%; USA 37%; China 66% and Japan 12%.[40]

The Deloitte 2024 Global Automotive Consumer Study, covering six countries and a market region including Germany (1,273 respondents), the USA (969), China (817), Japan (667) and India (864), asked participants, "What type of engine would you prefer in your next vehicle?". The responses were as follows: Germany BEV 13%, other including FCV 5%; USA 6%, 1%; China 33%, 1%, Japan 6%, 2% and India 10%, other 3%.[41]

The Deloitte 2025 Global Automotive Consumer Study, with feedback from over 31,000 respondents worldwide, reported preferences for the engine type in the next vehicle purchase as follows: Germany BEV 14%, other including FCV 3%; USA 5%, ca. 1%; China 27%, ca. 1%.[42]

Higher values of the YouTube analyses than classical studies can be explained as follows:

(1) Videos, in contrast to (online) interviews and questionnaires, provide higher information content and greater authenticity, resulting in higher benefit rates.
(2) A higher proportion of YouTube users come from higher socioeconomic backgrounds.
(3) Younger and more interested users may account for a larger share of YouTube users.
(4) Technology acceptance facilitates purchasing intentions; thus intention rates represent only a fraction of the benefit rates.

In detail, the benefit rates of the YouTube study are distinguished by five markets and different time periods. The high evaluation in the Indian market, exceeding 90%, highlights India as a potential future lead market for BEVs. In contrast, in the USA as lead market, the initial benefit rate of 63% decreases to 44%, while in Japan it remains consistently around 30%. Only China and Germany show an increase of benefit rates, from 63% to 76% and from 71% to 79%, respectively. Scepticism and reservations regarding the long-term success of BEVs remain widespread, not only in the automotive industry.[43]

Customers' perception of the technical and commercial development of FCVs are reflected in extremely low global sales, with only Japan showing a very high evaluation (90%). In contrast, the benefit rate in the USA is relatively moderate at around 71%, while in China it falls significantly from 77% to 53%. Three of five markets show a marked decrease in benefit rates, accompanied by very low sales volumes, highlighting the disappointing market performance of FCVs despite their advantages over BEVs (Table 8). HYVs, in contrast, clearly reflect the established, particularly emotional characteristics that (potential) customers continue to value.

The increasing benefit rate in the USA from 76% to 93% and the very high benefit rate in Japan (96%) strongly suggest low benefit rates for BEVs in the USA and Japan and FCVs in China, India and Germany.

In the future, many more new videos about HYV will likely become available, which will significantly broaden the horizon for HYVs (also in China, Germany and India) and expand public experiences with this emission-free technology.

[38] Acatech 2024.
[39] Continental 2024, 19.
[40] Continental 2024, 22.
[41] Deloitte 2024, 6.
[42] Deloitte 2025.
[43] Acatech 2024. Buchal et al. 2019, 40.

Several OEMs and first-tier suppliers are preparing or considering preparing hydrogen-powered vehicles for motorsport events.[44] The Automobile Club de l´Ouest has scheduled the 24 hours car race in Le Mans for hydrogen-powered vehicles (FCV, HYV) in 2028.[45] This event represents an important opportunity to showcase the potential of emission-free driving with hydrogen, following the success of the Formula E[46] championship with BEVs.

The implementation of national hydrogen strategies[47] and the intensification of R&D efforts in HYV and FCV technologies pave the way for additional competitive options in emission-free automotive mobility, thereby enhancing business perspectives for the global automotive industry.

5 Conclusion

The YouTube analyses comprise 645 videos on emission-free driving, with between 485 and 572 million views (2024-2025). They highlight the importance of emission-free driving from a global perspective. The metadata of the videos[48] reflects product presentations, reports, lectures and recommendations covering a wide range of opinions. The ideas and creativity of the video creators seem limitless and surpass classical questionnaires and interviews of empirical research. The management of the automotive industry faces various challenges.

Firstly, the different concerns of (potential) customers and the public regarding emission-free driving have remained stable over the years and should be taken seriously. The comparable environmental impacts of emission-free driving variants over the product life cycle are important buyer information and should be communicated in promotional videos. This is a prerequisite for winning the hearts and minds of potential customers. Secondly, the neglect of subjective customer requirements leads to the effective costs[49] through a limited range, a lower top speed, or a mediocre car design[50]. This reduces the effectiveness of emotional car characteristics like driving pleasure, sportiness, and prestige, and increases the technological and commercial risks of emission-free vehicles, often leading to a decline in market demand. Therefore, these topics should be addressed in competitive strategy as well as in product and commercial planning at an early stage.[51] Thirdly, the pitfalls of all-electric driving have remained unchanged over a long period, raising the question of the most sustainable emission-free drive variant for (potential) customers.[52] The impression arises that evolutionary classical vehicle development is more advantageous and more readily accepted by customers than disruptive vehicle development exemplified by all-electric drives. It is the merit of the plurality of videos to make this connection transparent.

The YouTube analyses have some restrictions. The use of machine reading technology, such as Twitter analyses by Kohl et al.,[53] could support the evaluation of user comments, thereby improving the authenticity and validity of YouTube analyses.

Finally, the YouTube analyses enable the comparison of benefit rates across several countries and of different opinions, perspectives and conditions of emission-free drives. The contest of emission-free drives and vehicles reflects technical, infrastructural, sociocultural and socioeconomic requirements of the public and (potential) customers, posing opportunities and challenges for incumbent and emerging OEMs.

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[44] Köllner 2025.
[45] Watkins 2025. Backhaus 2025.
[46] Formula E 2025.
[47] DECHEMA & acatech 2024, 6. Krebs 2021, 3. Robinius et al. 2018, 77.
[48] Google (3) 2025.
[49] Simeu & Kim 2018, 8.
[50] Kessler 2025.
[51] Kersten 1989, 3-5.
[52] Continental 2024, 3-4, 23-25. Acatech 2024 & 2025.
[53] Kohl et al. 2018, 624-634. NAS 2025.

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