Recent Trends in the Alternative Fuel Vehicle Market in Japan

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1. Outline

- As of December 2017, Japan had a stock of light-duty plug-in vehicles of about 207,200 units.
- Sales totaled 24,660 units in 2015, and 24,851 units in 2016.
- The segment market share declined from 0.68% in 2014 to 0.59% in 2016.
- Declining sales growth reflected the governmental and domestic carmaker decision to promote hydrogen fuel cell vehicles instead.
- Sales recovered in 2017, with almost 56,000 plug-in cars sold, and the segment's market share reached 1.1%.
- In May 2009 the Japanese Diet passed the "Green Vehicle Purchasing Promotion Measure".
- The program provided purchasing subsidies for cars, mini and keis, trucks and buses, including an extra subsidy for purchases trading in a sufficiently old used car. The program ended on March 31, 2010.
- The Japanese electric vehicle charging infrastructure climbed from 60 public stations in 2010 to 1,381 in 2012.
- Mitsubishi introduced multiple plug-in vehicles: the Mitsubishi i MiEV in 2009, the Mitsubishi Minicab MiEV in 2011, a truck version of the Minicab MiEV and the Mitsubishi Outlander P-HEV in 2013. As of December 2014, Mitsubishi had sold 36,386 light-duty plug-ins.
- The Nissan Leaf launched in 2010. The Toyota Prius PHEV launched in January 2012, selling 19,100 units through September 2014. Tesla Model S deliveries began in September 2014.
- Leaf sales in 2016 were 14,795 units. Nissan had sold 72,494 units cumulatively through 2016, making the Leaf Japan's all-time best-selling plug-in car.
- Sales of the Outlander PHEV fell sharply from April 2016 as a result of Mitsubishi's fuel mileage scandal. Sales totaled 34,830 units through August 2016.

2. Alternative fuel vehicles

2.1. Electric vehicles

In contrast to hybrid vehicles, electric vehicles are powered by one or more electric motors and make use of electricity which is stored in energy storage devices installed in the vehicles, usually rechargeable batteries. One characteristic of electric motors is that they can provide instant torque (internal combustion engines can not do so), thus generating smooth and instant acceleration of the vehicle. Also, they are significantly more efficient than conventional cars with internal combustion engines. Electric vehicles have a long history, the first ones were built in the 1880s[1]. Their popularity was high in the late 19th century and the early 20th century, until improved internal combustion engines, cheaper gasoline and mass production of gasoline-powered cars caused a decline in their use. Further interest in electric cars was generated in the 1970s and 1980s by the energy crises, however it was short-lived and no electric cars entered the mass market. Nowadays, the share of electric cars in the mass market is growing.

In recent years technological progress in energy storage devices, fears of depleting oil resources, and increasing carbon emissions have caused a renewed interest in mass production of electric vehicles. Subsidies, tax credits, and other economic incentives have been adopted by a number of governments in order to facilitate the introduction and mass production of electric vehicles. There are significant benefits from the use of electric vehicles. They generate considerably less noise than vehicles with internal combustion engine and do not emit exhaust gasses[2], thus significantly reducing air pollution. Depending on the way electricity needed for recharging battery packs is generated, the use of electric vehicles can also reduce greenhouse gas emissions. Concerns over dependency on foreign oil, disruption of supply, and volatility of oil price can be addressed by the adoption of electric vehicles. The downside is that battery recharging may consume significant time and in a large number of places recharging infrastructure is non-existent. Public chargers that in half an hour can provide around 80% charge are available for vehicles that need to cover long distances[3]. Another disadvantage, which however is rapidly diminishing, is the high cost of the battery

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[1] *Guarnieri, M. (2012). "Looking back to electric cars". Proc. HISTELCON 2012 - 3rd Region-8 IEEE History of Electro - Technology Conference: The Origins of Electrotechnologies. 5-7 Sept. 2012,*

[2] "Electro Automotive: FAQ on Electric Car Efficiency & Pollution". *Electroauto.com*. http://www.electroauto.com/info/pollmyth.shtml Accessed 2017-02-18.

[3] "13 Key Questions and Answers about Nissan Leaf Battery Pack and Ordering" http://www.hybridcars.com/news/13-key-questions-and-answers-about-nissan-leaf-battery-pack-and-ordering-28007.html Accessed 2017-02-18

packs for electric vehicles, which determines their limited range and somewhat higher purchase cost than gasoline-powered vehicles. Fear that the electricity stored in the batteries may not be sufficient to reach the destination may cause range anxiety in some cases.

More than 30 models of electric cars capable to run on highways were available for purchasing mainly in North America, Western Europe, Japan, and China as of December 2015, and in September 2016 their cumulative global sales reached one million units[4]. The top selling electric car capable to run on highways is the Nissan Leaf which was first sold in December 2010, with worldwide sales exceeding 250,000 by December 2016. The second top selling electric car is the Tesla Model S, which was first sold in June 2012, with cumulative global sales exceeding 158,000 units as of December 2016[5]. The Tesla Model S has held the top place in the worldwide sales ranking in two years, 2015 and 2016[6].

2.2. Fuel cell vehicles

Fuel cell vehicles use a device called fuel cell instead of a battery pack to power an electric motor installed in the vehicle. Electricity is generated by the fuel cells in vehicles using oxygen from the atmosphere and compressed hydrogen carried in the vehicle. Due to the fact that most fuel cell vehicles emit only heat and water, they can be classified as zero-emission vehicles. In comparison with vehicles with internal combustion engines, the pollutants associated with the production of hydrogen are usually localized at the site where hydrogen is produced, typically from natural gas. Hydrogen is may create pollutants also due to transportation and storage[7].

Fuel cell vehicles have relatively short history, however they have been used in a variety of vehicles, for example forklifts, that are used indoors, where zero emissions are needed to maintain the quality of the air. Toyota released the first fuel cell vehicle (Toyota Mirai) that is produced commercially and more car makers appear to be

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[4] *Shahan, Zachary.* "1 Million Pure EVs Worldwide: EV Revolution Begins!". *Clean Technica*. https://cleantechnica.com/2016/11/22/1-million-ev-revolution-begins/ Accessed 2016-02-23.

[5] *Cobb, Jeff.* "Nissan's Quarter-Millionth Leaf Means It's The Best-Selling Plug-in Car In History". http://www.hybridcars.com/nissans-quarter-millionth-leaf-means-its-the-best-selling-plug-in-car-in-history/ Accessed 2017-01-10.

[6] *Cobb, Jeff.* "Tesla Model S Is World's Best-Selling Plug-in Car For Second Year In A Row". *HybridCars.com*. http://www.hybridcars.com/tesla-model-s-is-worlds-best-selling-plug-in-car-for-second-year-in-a-row/ Accessed 2017-01-26.

[7] "How Do Hydrogen Fuel Cell Vehicles Work?", Union of Concerned Scientists, http://www.ucsusa.org/clean-vehicles/electric-vehicles/how-do-hydrogen-fuel-cells-work, Accessed 2017-03-04

planning to release their own models. Toyota Mirai is sold in a number of countries, including Japan, the United Kingdom, Norway and the State of California[8]. There seems to be interest in testing and developing fuel cells for motorcycles, boats and buses too.

The infrastructure needed for refueling of fuel cell vehicles is quite limited as of 2016, even in the above-mentioned countries where they are commercially available, however there seem to be plans for expanding this infrastructure, especially in California. Public hydrogen stations foe refueling are also available or being planned in Europe and Japan. However, it is doubtful whether hydrogen as fuel will be efficient enough or effective in terms of cost when compared with other technologies.

3. Sales

Cumulative light-duty plug-in electric vehicle sales in Japan totaled about 151,250 units between July 2009 and December 2016, consisting of 86,390 all-electric cars (57.1%) and 64,860 plug-in hybrids (42.9%)[9]. Also, as of September 2016, it can be calculated that total Japanese sales of light-duty plug-in vehicles represent 8.1% of the global stock of plug-ins. These figures indicate that at the end of 2016, Japan ranked as the world's third largest light-duty plug-in vehicle country market after China and the U.S. The plug-in segment sales climbed from 1,080 units in 2009 to 12,630 in 2011, and reached 24,440 in 2012. Only all-electric cars were sold in Japan between 2009 and 2011[10]. Global sales of pure electric cars in 2012 were led by Japan with a 28% market share of the segment sales. Japan ranked second after the US in terms of its share of plug-in hybrid sales in 2012, with 12% of global sales[11].

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[8] "First Toyota Mirai delivered to Uno-X Hydrogen in Norway, with plans to harness the power of renewables for true zero-emission" *(Press release)*. Brussels*:* Toyota Europe*. 2016-06-20*.
http://newsroom.toyota.eu/first-toyota-mirai-delivered-to-uno-x-hydrogen-in-norway-with-plans-to-harness-the-power-of-renewables-for-true-zero-emission-2/ Accessed 2017-02-24.

[9] International Energy Agency (IEA), Clean Energy Ministerial, and Electric Vehicles Initiative (EVI) (June 2017). "Global EV Outlook 2017: Two million and counting". IEA Publications. Accessed 2018-01-20. See pp. 5–7, 12–22, 27–28, and Statistical annex, pp. 49–51.
https://www.iea.org/publications/freepublications/publication/GlobalEVOutlook2017.pdf

[10] International Energy Agency (IEA), Clean Energy Ministerial, and Electric Vehicles Initiative (EVI) (May 2016). "Global EV Outlook 2016: Beyond one million electric cars". IEA Publications. Accessed 2017-10-01. See pp. 4-5, and 24-25 and Statistical annex, pp. 34-37.
https://www.iea.org/publications/freepublications/publication/Global_EV_Outlook_2016.pdf

[11] International Energy Agency, Clean Energy Ministerial, and Electric Vehicles Initiative (April 2013). "Global EV Outlook 2013 - Understanding the Electric Vehicle Landscape to 2020". International Energy Agency. Accessed 2017-11-20. See pp. 4, 6-8, and 11-12.
http://www.iea.org/publications/globalevoutlook_2013.pdf

About 30,600 highway-capable plug-in electric vehicles were sold in the country in 2013, representing a 0.58% market share of the 5.3 million new automobiles and kei cars sold in 2013[12]. In 2014 the segment sales remained flat with over 30,000 plug-in electric vehicles were sold, with the plug-in market share achieving a record market share of 1.06% of new car sales (kei cars not included). Accounting for kei cars, the plug-in segment market share falls to 0.7%[13]. During 2014, cumulative plug-in sales in the Japanese market passed the 100,000 unit mark. However, as a result of the slow growth from 2013, Japan was surpassed in 2014 by China, with over 50,000 units sold, as the second largest world market that year. Plug-in vehicle sales totaled 24,660 units in 2015 and 24,851 units in 2016, with the segment market share declining from 0.68% in 2014 to 0.59% in 2016[14]. As a result of the decline in sales that occurred after 2013, annual sales fell behind Europe, the U.S. and China during 2014 and 2015.

3.1. First battery switch station

The first prototype battery switch station from Better Place[15] was demonstrated in Yokohama on May 14, 2009 and in April 2010, a 90-day switchable-battery electric taxi demonstration project was launched in Tokyo, using three Nissan Rogue crossover utility vehicles, converted into electric cars with switchable batteries provided by A123 Systems[16]. The battery switch station deployed in Tokyo is more advanced than the Yokohama switch system demonstrated in 2009[17]. During the three-month field test the EV taxis accumulated over 25,000 miles (40,000 km) and swapped batteries 2,122 times, with an average battery swap time of 59.1 seconds. Despite these encouraging results, Nissan decided to continue the trial until late November 2010[18].

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[12] See note 9.
[13] See note 10.
[14] See note 9
[15] A venture-backed international company that developed and sold battery-charging and battery-switching services for electric cars.
[16] A wholly owned subsidiary of the Chinese Wanxiang Group and a developer and manufacturer of lithium iron phosphate batteries and energy storage systems.
[17] John Murphy (2009-05-09). "A High-Tech Twist on the Filling Station; In Japan, a California Start-Up Unveils System for Quickly Swapping Batteries in Electric Cars". Wall Street Journal. Accessed 2017-10-05. https://www.wsj.com/articles/SB124223719358315997
[18] *Sam Abuelsamid* (2010-08-27). "Tokyo battery swap trials". AutoblogGreen. Accessed 2018-03-20. https://www.autoblog.com/2010/08/27/better-place-expands-tokyo-battery-swap-trials-taxis-have-chang/

3.2. Mitsubishi

The first electric car available in the Japanese market was the Mitsubishi i-MiEV, launched for fleet customers in Japan in late July 2009[19]. Retail sales to the public began in April 2010 and the cumulative sales since July 2009 reached 11,144 i-MiEVs through April 2016[20]. Sales of the Mitsubishi Minicab MiEV electric van began in December 2011, and a total of 6,172 units have been sold through April 2016, and a truck version of the Minicab MiEV was launched in January 2013, with sales of 927 units through April 2016[21]. Mitsubishi also launched in January 2013 a plug-in hybrid version of the Outlander, called the Mitsubishi Outlander P-HEV, becoming the first SUV plug-in hybrid in the world's market, with a significant for the time all-electric range of 60 km[22]. The Outlander P-HEV sold 9,608 units during 2013, ranking as the second top selling plug-in electric car in Japan after the Nissan Leaf[23]. As of April 2016, Mitsubishi Motors had sold 52,234 plug-in electric vehicles in Japan since July 2009[24].

3.3. Nissan, Toyota, Honda and Tesla

Sales of the Nissan Leaf began on December 22, 2010, when the first ten vehicles were delivered to the government of Kanagawa Prefecture. The prefecture government decided to assign six Leafs for official use and the other four were made available for the car rental service run by the local government[25]. As for Toyota, sales of the Prius Plug-in Hybrid began in January 2012, and a total of 19,100 units have been sold through September 2014. The Honda Accord Plug-in Hybrid was introduced in Japan in June 2013 and it is available only for leasing, primarily to corporations and government

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[19] *Yuri Kageyama* (2010-04-01). "Japanese Start Buying Affordable Electric Cars". ABC News. Associated Press. Accessed 2018-01-12. http://www.greencarcongress.com/2009/06/imiev-20090605.html

[20] "三菱 i-MiEV などの 2016 年 4 月度 販売実績" [Mitsubishi i-MiEV production and sales results for April 2016] (in Japanese). Electric Vehicle News. 2016-05-31. Accessed 2017-11-19. http://evn.blog.eonet.jp/weblog/2016/05/

[21] See note 8

[22] *Jay Cole* (2013-01-24). "Mitsubishi Outlander PHEV On Sale In Japan Today, Extended Promotional Video Released". Inside EVs. Accessed 2018-01-28. http://insideevs.com/mitsubishi-outlander-phev-on-sale-in-japan-today-extended-promotional-video-released/

[23] "三菱 i-MiEV などの 2013 年 12 月度 販売実績" [Mitsubishi i-MiEV sales results for December 2013] (in Japanese). Electric Vehicle News. 2014-01-29. Accessed 2018-02-01. http://evn.blog.eonet.jp/weblog/2014/01/i-miev201312-5b80.html

[24] See note 20

[25] "Nissan delivers first LEAF cars in Japan". International Business Times. 2010-12-22. Accessed 2017-12-23. http://www.ibtimes.com/articles/94510/20101222/nissan-leaf-japan-kanagawa-prefectural-government.htm

agencies. As of December 2013, the Accord PHEV ranked as the third best selling plug-in hybrid in the Japanese market[26].

Sales of the plug-in electric drive segment during 2013 were led by the Nissan Leaf with 13,021 units sold, up from 11,115 in 2012, allowing the Leaf to continue as the top selling plug-in electric car in the country since 2011, and also during 2013, a total of 45 Nissan NMC all-electric low-speed neighborhood vehicles were sold in the country[27]. Sales during the first nine months of 2014 again were led by the Nissan Leaf with 10,877 units, followed by the Outlander P-HEV with 8,630 units, together representing 78.8% of the plug-in segment sales during this period[28].

Retail deliveries of the Tesla Model S began in Japan in September 2014, however, the Leaf continued as the market leader in 2014 for the fourth year running with 14,177 units sold, followed by the Outlander P-HEV with 10,064 units, together representing about 80% of the plug-in segment sales in Japan in 2014[29].

In 2015 the Outlander plug-in hybrid surpassed the Leaf as the top selling plug-in electric car in the country that year with 10,996 units sold, while the Leaf sold 9,057 units[30]. Japan is the Outlander P-HEV largest country market with 30,668 units sold through December 2015, however, at the end of 2015 the Nissan Leaf continued to rank as the all-time best-selling plug-in car in the country with 57,699 units sold, and as of December 2015, cumulative sales of plug-in electric cars totaled 126,420 units since 2009[31].

During the first eight months of 2016 the Nissan Leaf led sales with 11,120 units delivered, and since December 2010, Nissan has sold 68,819 units through August 2016, making the Leaf the all-time best-selling plug-in car in the country[32]. Between January and August 2016, a total of 4,162 Outlander P-HEVs were sold in Japan[33], however,

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[26] *Naoki Watanabe* (2014-02-12). "Plug-in hybrids quickly becoming Japan's favorite way to drive green". Nikkei Asian Review. Accessed 2018-02-19. http://asia.nikkei.com/print/article/16829

[27] Mark Kane (2014-01-30). "Nissan LEAF Sales In Japan Up 17% in 2013". InsideEVs.com. Accessed 2018-02-21. See graph for Leaf sales by year between 2009 and 2013.
http://insideevs.com/nissan-leaf-sales-in-japan-up-17-in-2013/

[28] "三菱 i-MiEV などの 2014 年 9 月度 生産・販売実績" [Mitsubishi i-MiEV production and sales results for September 2014] (in Japanese). Electric Vehicle News. 2014-10-27. Accessed 2017-10-27. Also, see note 19.
http://evn.blog.eonet.jp/weblog/2014/10/mitsubishi-moto-2c47.html

[29] Jose Pontes (2015-01-30). "Japan December 2014". EVSales.com. Accessed 2015-02-18.
http://www.ev-sales.blogspot.ca/2015/01/japan-december-2014.html

[30] Jose, Pontes (2016-02-08). "Japan December 2015". EVSales.com. Accessed 2018-02-25.
http://ev-sales.blogspot.com.br/2016/02/japan-december-2015.html

[31] See note 10.

[32] See note 10

[33] "三菱 アイミーブなどの 2016 年８月度 販売実績" [Mitsubishi i-MiEV production and sales results for August 2016]. Electric Vehicle News (in Japanese). 2016-09-28. Accessed 2017-10-01.
http://evn.blog.eonet.jp/weblog/2016/09/mitsubishi-moto-2c47-1.html

sales of the Outlander plug-in hybrid fell sharply from April 2016, which can be attributed to Mitsubishi's fuel mileage scandal. Since its release, sales of the plug-in hybrid totaled 34,830 units through August 2016[34].

The following table presents sales for the top selling highway-capable plug-in electric vehicles by year since July 2009 up to April 2016.

Figure 1. Top selling highway-capable plug-in electric vehicles available in the Japanese market between 2009 and April 2016 (1)

Model[(2)]	Market launch	Total sales	2016 CYTD	2015	2014	2013	2012	2011	2010	2009
Nissan Leaf	Dec 2010	64,978	7,279	9,057	14,177	13,021	11,115	10,310	19	
Mitsubishi Outlander P-HEV	Jan 2013	33,991	3,323	10,996	10,064	9,608				
Toyota Prius PHV	Jan 2012	22,100	148	1,344	5,187	4,452	10,970			
Mitsubishi i-MiEV	Jul 2009	11,144	86	635	1,021	1,491	2,295	2,290	2,340	986
Mitsubishi Minicab MiEV van	Dec 2011	6,172	111	501	865	1,461	2,487	747		
Mitsubishi Minicab MiEV truck	Jan 2013	927	35	161	177	554				
BMW i3	2014	+ 400	NA	NA	+ 400[(3)]					
Total sales shown models Jul 2009 - Apr 2016		139,712	10,982	22,694	31,891	30,587	26,867	13,347	2,359	986

Notes:(1) Data source: Annual Reports on Registered New Vehicles 2007-1016 [新車登録台数年報 2007-2016] published by the Japan Automobile Dealers Association

(2) The Tesla Model S and Smart ED are also available in Japan, but sales figures are not available.

(3) Sales only between April and August 2014.

[34] See note 33.

4. Future trends

The sales data indicate that the rate of growth of the Japanese plug-in segment slowed down from 2013, with annual sales falling behind Europe, the U.S. and China during 2014 and 2015. There are a number of reasons for this slow decline, the most significant of which appears to be the Japanese government and the major domestic carmakers decision to adopt and promote hydrogen fuel cell vehicles instead of plug-in electric vehicles. The Japanese strategy aims to focus in investing heavily in fuel-cell technology and infrastructure as part of a national policy to foster what it calls a hydrogen society, where the zero-emission fuel would power homes and vehicles[35].

In August 2012, Toyota announced its plans to start retail sales of a hydrogen fuel-cell sedan in California in 2015[36]. This indicates that Toyota expects to become a leader in this technology. Furthermore, in September 2012 Toyota announced that it is backing away from fully electric vehicles. The company's vice chairman at that time, Takeshi Uchiyamada, pointed out that the current capabilities of electric vehicles do not meet society's needs, whether it may be the distance the cars can run, or the costs, or how it takes a long time to charge. Toyota's emphasis would be re-focused on the hybrid concept, and 21 new hybrid gas-electric models scheduled to be on the market by 2015[37].

As part of Toyota's effort to maintain its alternative propulsion lead, it launched for retail customers the Toyota Mirai hydrogen fuel cell vehicle in late 2014, and Honda began retail deliveries of the Clarity Fuel Cell in late 2016[38]. Toyota seems to be responding to interest in the hydrogen economy in its home market, where, as of December 2014, there were 100,000 residential hydrogen fuel cells already installed across Japan. The country is aiming for 5.3 million households, or roughly 10%, to have fuel cells by 2030[39]. Nevertheless, it appears that in recent years Toyota has made a

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[35] *Shirouzu, Norihiko; Lienert, Paul* (2015-10-28). "Auto power play: Japan's hydrogen car vs China's battery drive". Reuters. Accessed 2017-12-19.
https://www.reuters.com/article/us-autoshow-japan-electric-insight-idUSKCN0SM04F20151028

[36] *Alisa Priddle* (2013-03-17). "Toyota to start selling hydrogen fuel-cell car in 2015". USA Today. Accessed 2012-08-08.
http://content.usatoday.com/communities/driveon/post/2012/08/toyota-to-start-selling-hydrogen-fuel-cell-car-in-2015/1#.UXK8KLWG18E

[37] *Ludwig, Sean* (2012-09-24). "Toyota kills electric car plans, says 'capabilities of electric vehicles do not meet society's needs'". VentureBeat. Accessed 2017-11-10.
https://venturebeat.com/2012/09/24/toyota-kills-electric-car-plans/

[38] See note 35.

[39] *Deign, Jason* (2015-02-10). "Japan Makes a Big Bet on the Hydrogen Economy". Green Tech Media. Accessed 2017-12-19. http://www.greentechmedia.com/articles/read/japans-big-bet-on-hydrogen

significant effort to continue a strong promotion of plug-in hybrids starting with the introduction of the Prius Prime.

However, further improvement of fuel economy may involve solving increasingly difficult problems. In September 2016, Shoichi Kaneko, assistant chief engineer for the Prius Prime, said in an interview with the website AutoblogGreen that creating the next-generation Prius will be a tremendously difficult challenge due to the physical limitations to improve the Prius' fuel economy. And considering that Toyota wants to lead the way in reducing (and eventually eliminating) fossil fuels from its vehicles, simply making a better standard hybrid powertrain might not be enough, the carmaker is considering making every future Prius a plug-in hybrid beginning with the fifth-generation models[40].

5. Charging infrastructure

The Japanese electric vehicle charging infrastructure climbed from only 60 public charging stations in early 2010 to 1,381 public quick-charge stations as of December 2012, representing the largest deployment of fast chargers in the world, and the number of non-domestic slow charger points increased to around 300 units[41].These numbers, when compared to the number of sold electric vehicles, indicates that Japan is also the country with the highest ratio of quick charging points to electric vehicles, with a ratio of 0.030 as of December 2012. There are 1,967 CHAdeMO quick charging stations across the country by April 2014, and the Japanese government has set up a target to deploy 2 million slow chargers and 5,000 fast charging points by 2020[42]. Currently all Family Mart convenience stores with sufficient parking space have one space specialized for quick-charge use or are in the process of having one installed.

6. Government incentives

The Japanese government introduced the first electric vehicle incentive program in 1996, and it was integrated in 1998 with the Clean Energy Vehicles Introduction Project, which provided subsidies and tax discounts for the purchase of electric, natural gas,

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[40] *Blanco, Sebastian* (2016-09-28). "Toyota: Every future Prius might be a plug-in hybrid". Autoblog.com. Accessed 2017-10-02. http://www.autoblog.com/2016/09/28/toyota-every-future-prius-plug-in-hybrid/

[41] See note 11.

[42] See note 11.

methanol and hybrid electric vehicles. The project provided a purchase subsidy of up to 50% of the incremental costs of a clean energy vehicle as compared with the price of a conventional engine vehicle. This project was extended until 2003[43].

In May 2009 the Japanese Diet passed the "Green Vehicle Purchasing Promotion Measure" that went into effect on June 19, 2009, but retroactive to April 10, 2009. The program established tax deductions and exemptions for environmentally friendly and fuel efficient vehicles, according to a set of stipulated environmental performance criteria, and the requirements are applied equally to both foreign and domestically produced vehicles. The program provided purchasing subsidies for two type of cases, consumers purchasing a new passenger car without trade-in (non-replacement program), and for those consumers buying a new car trading an used car registered 13 years ago or earlier[44].

6.1. Incentives for purchasing new environmentally friendly vehicles

Subsidies for purchases of new environmentally friendly vehicles without scrapping a used car are 100,000 yen (~US$1,100) for the purchase of a standard or small car, and 50,000 yen (~US$550) for the purchase of a mini or kei vehicle. Subsidies for purchasing trucks and buses meeting the stipulated fuel efficiency and emission criteria vary between 200,000 yen (~US$2,100) to 900,000 yen (~US$9,600)[46].

Subsidies for purchases of new environmentally friendly vehicles in the case of owners scrapping a 13-year or older vehicle are 250,000 yen (~US$2,700) for the purchase of a standard or small car, and 125,000 yen (~US$1,300) for the purchase of a mini or kei vehicle. Subsidies for purchasing trucks and buses meeting the stipulated fuel efficiency and emission criteria vary between 400,000 yen (~US$4,300) to 1,800,000 yen (~US$19,000)[47]. The above-mentioned incentives for new purchases with or without trading were applicable in Japan's fiscal year 2009, from April 1, 2009 through March 31, 2010.

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[43] *Max Ahman* (2006). "Government policy and the development of electric vehicles in Japan". *Energy Policy* Vol 34, Issue 4, pp. 433–443.

[44] "Fact Sheet- Japanese Government Incentives for the Purchase of Environmentally Friendly Vehicles". Japan Automobile Manufacturers Association. Accessed 2017-12-24. http://jama.org/pdf/FactSheet10-2009-09-24.pdf

[46] See note 44

[47] See note 44

6.2. Tonnage and acquisition tax reductions

New next generation vehicles, including electric and fuel cell vehicles, plug-in hybrids, hybrid electric vehicles, clean diesel and natural gas vehicles are exempted from both the acquisition tax and the tonnage tax[48]. Acquisition taxes on used vehicles are reduced by 1.6% to 2.7%, or between 150,000 yen (~US$1,600) and 300,000 yen (~US$3,200). Electric and fuel cell vehicles have a 2.7% reduction while plug-in hybrids have a 2.4% reduction[49].

These incentives were in effect from April 1, 2009 until March 31, 2012 for the acquisition tax which is paid once at the time of purchase. The tonnage tax reductions were in effect from April 1, 2009 until April 30, 2012 and the incentive is applicable once, at the time of the first mandatory inspection, three years after the vehicle purchase. As an example, the amount exempted for the purchase of a new next generation vehicle is 81,000 yen (~US$975) corresponding to the acquisition tax, and 22,500 yen (~US$271) for the tonnage tax, for a total of 103,500 yen (~US$1,246). Moreover, consumers purchasing new next generation electric vehicles, including fuel cell, benefit of a 50% reduction of the annual automobile tax. These incentives were in effect from April 1, 2009 until March 31, 2010, applicable only once[50].

A specific example of how these incentives apply and what price reductions are achieved can be given with Mitsubishi i-MiEV. The sales price of this electric vehicle in Japan during the period when the above-mentioned incentives were in effect was approximately 4,000,000 yen. This price fell to 2,800,000 yen after all government incentives were discounted from it, which is a significant reduction of 30% from the original sales price.

7. Conclusion

Sales of plug-in electrified vehicles have been increasing worldwide since their advent in 2008, however, Japan has slipped from its leading position and is now behind Europe, the United States, and China. On the other hand, Japan's push to develop hydrogen storage technologies has received a significant boost in recent years. This push is a form or response to interest in the hydrogen economy in the Japanese home

[48] "The Motor Industry of Japan 2010". Japan Automobile Manufacturers Association. Accessed 2017-12-24. See pages 45–46. http://www.jama-english.jp/publications/MIJ2010.pdf

[49] See note 47

[50] See note 47

market. By December 2014, there were 100,000 residential hydrogen fuel cells already installed across Japan. However, transportation is where Japan is making its strongest hydrogen bet. All the major Japanese automakers have fuel-cell models. To help sales, Japan is introducing a massive subsidy program worth more than three times the one being offered to prospective owners of Mitsubishi's i-MiEV electric cars. Refueling ease is another reason Japanese consumers are increasingly choosing hydrogen. Car owners can top up a hydrogen tank within about five minutes, compared to the two hours or so that it can take to recharge lithium-ion car batteries. Finally, Toyota Mirai comes with a range of about 500 kilometers per tank, beating electric models. The Tesla Model S with an 85 Kwh battery pack has a range of about 420 kilometers.