

**HYBRID CARS: THE CHAUFFEUR OF NEXT-GEN  
WORLD'S AUTOMOBILE MARKET (WITH RESPECT TO  
FOUR WHEELER CARS)**

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*Abstract: This research paper is mainly prepared to find out the alternative of conventional car powered by petrol and diesel. The research paper has described how hybrid cars are slowly dominating the global car market. It is also discovered that the price of hybrid cars are more than the conventional one, but the hybrid cars are more fuel efficient than the conventional cars. The paper also showed that hybrid cars are more cost efficient than conventional cars in terms of fuel cost savings of the customers.*

*It also portrayed the future of hybrid car market worldwide and concluded that in forth coming 5 years the hybrid cars are going to dominate the world car market. As of now hybrid cars are having a huge market in USA, European Countries and Japan. But in near future because of Government initiatives by various countries hybrid cars will acclaim a powerful position in Asia-Pacific countries especially in India and China.*

**Keywords:** Hybrid Cars, Evolution, Conventional Cars, Emission.

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**Introduction:**

The Automobile Industry is a pedestal of the global economy. It is considered being a main chauffeur of macroeconomic growth and stability. It boosts the technological advancement in both developed and developing countries, along with providing support to many adjacent industries.

The automotive industry consists of a wide range of companies and organizations involved in the design, development, and manufacture, marketing, and selling of motor vehicles. It is one of the world's most important economic sectors by revenue. The automotive industry does not include industries dedicated to the maintenance of automobiles following delivery to the end-user, such as automobile repair shops and motor fuel filling stations. The term automotive was created from Greek 'autos' (self), and Latin 'motivus' (of motion) to represent any form of self-powered vehicle. This term was proposed by SAE<sup>1</sup> member Elmer Sperry.

**History of Automobile Industry Worldwide:**

Several important milestones have helped to shape the modern automobile industry. When we examine the historical context of the auto industry, it's noticeable that these major forces of the U.S. economy have weathered many ups and downs over the years. Recent events like the auto industry slowdown, globalization of vehicle manufacturing, and car companies filing for bankruptcy are only a few of the many challenges faced by the auto industry in the twentieth and twenty-first centuries.

**Before 1900: The Beginning of Auto Industry:**

Prior to 1900, the automobile was really a novelty item, not yet a major force that represented an industry. While many developments contributed to the birth of the modern automobile, most automotive history buffs and the Library of Congress credit German inventor Karl Benz with creating the first modern automobile. The three-wheeled "Motorwagen," first created by Benz in 1886, became the first production automobile. Benz made several improvements in the Motorwagen, which eventually featured four wheels, a fuel tank, and rear brakes.

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<sup>1</sup> SAE: Society of Automotive Engineers. This society of engineers of the American automobile industry presents an independent association taking responsibility for the standardization and classification in the American automobile construction.

### 1900s: Cars Are Marketed to the Average Family:

During the first few years of the twentieth century, automobiles had a fairly limited audience. Because they were expensive and time consuming to produce, most cars were too costly for the general public. However, Colorado State University reports that between 1904 and 1908, 241 different firms began producing cars aimed at the American consumer. In 1908, Ford Motor Company created the Model T, the first car aggressively marketed to the average family. By widening the sales base for the automobile, Ford did a great deal to create an industry for cars and car products.

### 1910s: The Assembly Line Lowers Car Prices:

The Model T, which was originally built individually, was the first car to be mass-produced on the assembly line. When Henry Ford invented the assembly line in 1913, he was able to make the Model T even more affordable and accessible. By 1918, Bryant University reports that half of American car consumers owned Model T's. Meanwhile, William C. Durant established General Motors in 1908, combining Buick, Oakland, and Oldsmobile. Later, he added Cadillac and Chevrolet. The Dodge brothers, both bicycle builders, created the four-cylinder Dodge Model 30 in 1914.

### 1920s: The Automobile Takes Off:

The roaring 20s were a time of great growth for the auto industry, as more and more consumers bought their first car. The Chrysler Corporation was started in 1925, and many other small car companies began during this decade. By 1929, the year of the stock market crash that began the Great Depression, car companies were producing and selling 5.3 million vehicles a year according to the University of Michigan.

### 1930s: Sales Slow During the Depression:

The Great Depression hit the car industry hard, according to the GM Heritage Centre. Many automotive historians estimate that up to half of all car companies failed during the 1930s. At the start of the Great Depression, car companies were mostly small and specialized. By the end of the decade, they had been consolidated into larger, stronger corporations. There was less

specialization, but the "Big Three" emerged as an important force. The Great Depression was also an important time for organized labour.

#### 1950s: Freeways Mean More Cars for Americans:

After the end of World War II, Americans began a great love affair with the automobile. The freeway network, first begun in the 1920s, grew dramatically during the 1950s. Cars were a permanent part of the American way of life. According to PBS<sup>2</sup>, the 1950s saw cars with innovative new technologies and rocket-inspired designs. The American public was buying more cars than ever before.

#### 1960s: Carmakers Focus on Safety:

In the 1960s, the auto industry focused on making safer vehicles that could meet the needs of the modern consumer according to Bryant University. In 1964, Studebaker-Packard was the first company to introduce seat belts as standard equipment on all of its vehicles. In addition to safety, car buyers of this era expected vehicles to be powerful and spacious, and fuel economy was not a major concern.

#### 1970s: Oil Crisis Forces Temporarily Improved Fuel Economy:

In the 1970s, a major oil crisis forced automakers to create vehicles that were more fuel-efficient. According to CNBC, 20 percent of gas stations in 1974 had no gas to sell to consumers. This focus on gas mileage wouldn't last long, however. When the oil embargo ended, carmakers returned to producing fast, powerful vehicles.

#### 1980s and Beyond: Car Production Goes Global:

After the 1980s, the most significant impact of the growth of the global auto industry was the influence of globalization. The high demand for vehicles, combined with the low cost of skilled workers in countries like China and India, led to a situation where manufacturers in those countries could produce cars at a fraction of the cost of unionized U.S. manufacturers. Automakers could then export those less expensive vehicles to developed countries across the world. According to a report (1975) by Duke University on the auto industry 80% of global auto

<sup>2</sup> PBS: Public Broadcasting Service. It is an American broadcast television network.

production came out of seven countries. By 2005, 80 percent of global production came from 11 countries, representing a widening of the playing field and a significant growth in global competition.

### **Recent Trends in Automotive Sector:**

During the first few years of the new millennium, car companies catered to consumers who expected powerful vehicles. The sport utility vehicle (SUV) was king, and it was easy for consumers to obtain credit to purchase one of these expensive automobiles. However, in 2008, a major economic downturn prompted banks to tighten financing requirements. Fewer people could afford to buy an expensive vehicle. At the same time, fuel became more expensive. In the summer of 2008, record fuel prices caused many consumers to sell their large vehicles and buy smaller, more efficient cars. Hybrids and gas-sipping compacts now ruled the road. As the recession lifted, this focus on fuel efficiency and practicality remained. This trend is expected to affect the auto industry in years to come.

Today, the modern global automotive industry encompasses the principal manufacturers like General Motors, Ford, Toyota, Honda, Volkswagen, and Daimler Chrysler, all of which operate in a global competitive marketplace. It is suggested that the globalization of the automotive industry, has greatly accelerated during the last half of the 1990's due to the construction of important overseas facilities and establishment of mergers between giant multinational automakers.

Industry specialists indicate that the origins in the expansion of foreign commerce in the automobile industry date back to the technology transfer of Ford Motor Company's mass-production model from the U.S. to Western Europe and Japan following both World Wars I and II. The advancements in industrialization led to significant increases in the growth and production of the Japanese and German markets, in particular. The second important trend in industrial globalization was the export of fuel efficient cars from Japan to the U.S. as a result of the oil embargo from 1973 to 1974. The underneath figure is providing a clear picture of total production of four wheeler cars worldwide from 1997 to 2013. During 1997 the total production of four wheeler cars was 54,434,000 units which were increased to 73,266,061 units in 2007 (increased by 34%). But during the global recession the trend had been decreased and reflecting

a downturn in global automotive production (four wheeler). Again after the global recession the automotive sectors recovering its strength and again the global production touched a new high of 87,300,115 units worldwide in 2013.

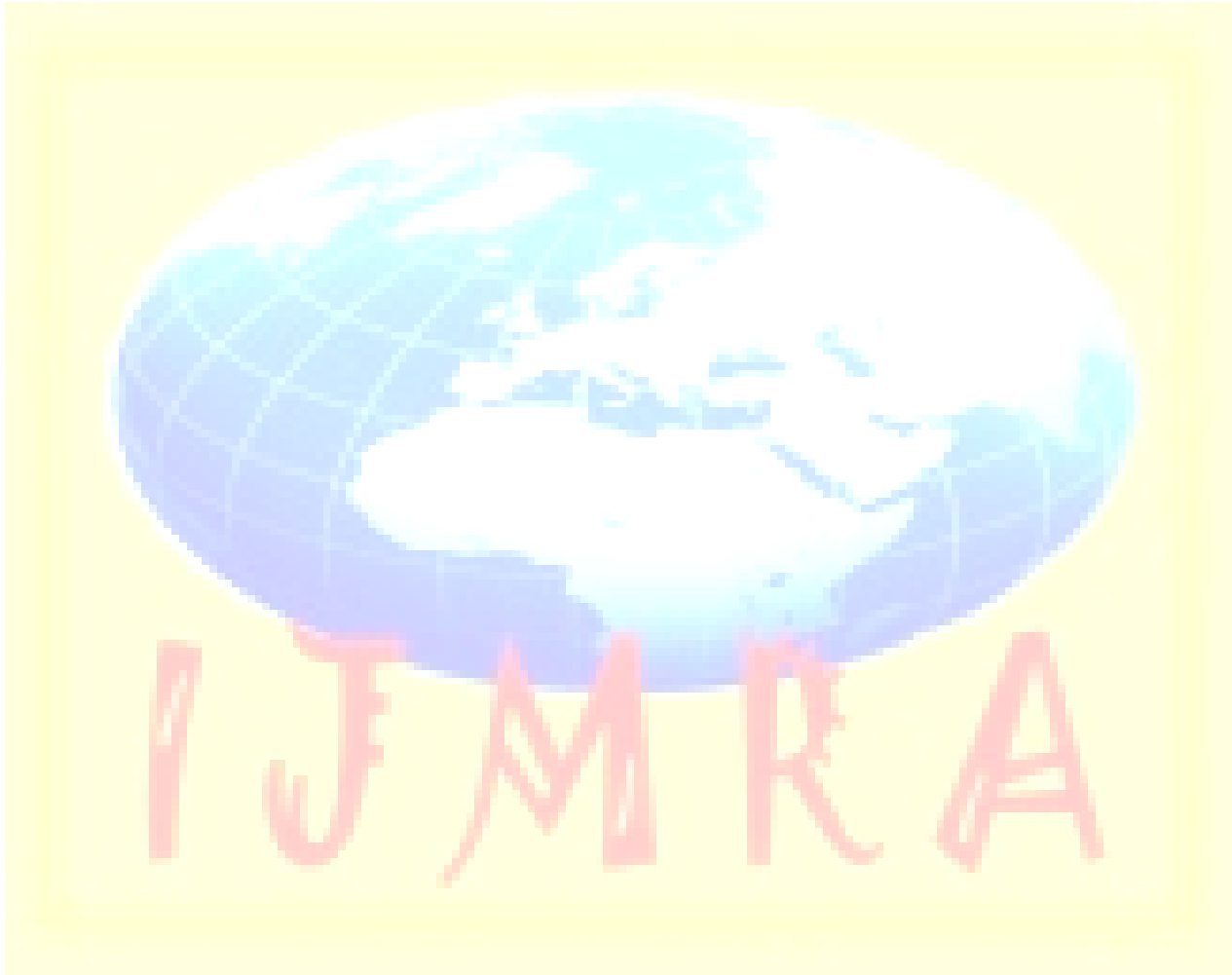
**Table1: Total Production of four wheeler car worldwide from 1997 to 2013:**

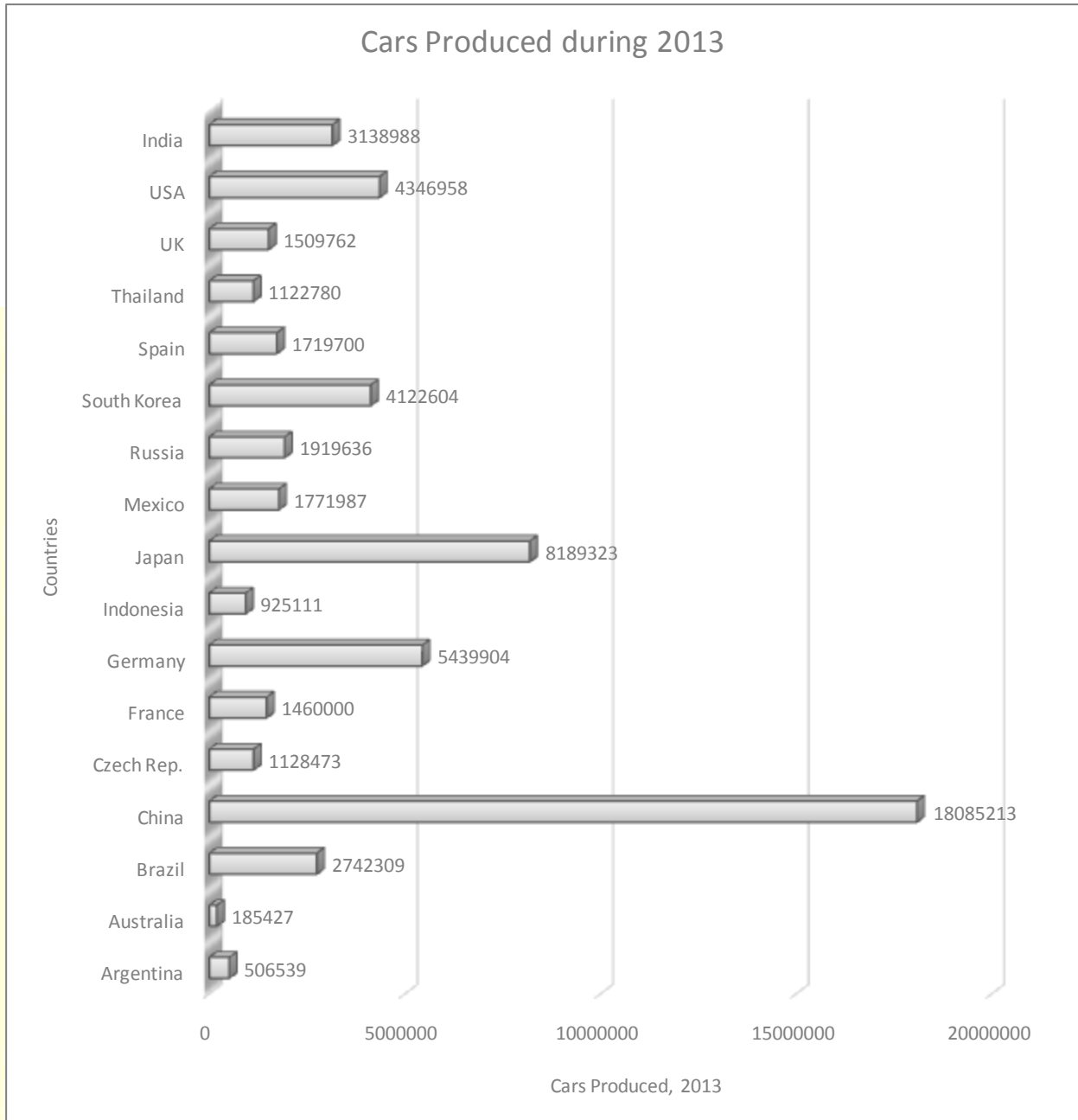
Year	Production	Change
1997	54,434,000	-
1998	52,987,000	-2.7%
1999	56,258,892	6.2%
2000	58,374,162	3.8%
2001	56,304,925	-3.5%
2002	58,994,318	4.8%
2003	60,663,225	2.8%
2004	64,496,220	6.3%
2005	66,482,439	3.1%
2006	69,222,975	4.1%
2007	73,266,061	5.8%
2008	70,520,493	-3.7%
2009	61,791,868	-12.4%
2010	77,857,705	26.0%
2011	79,989,155	3.1%
2012	84,141,209	5.3%
2013	87,300,115	3.7%

Source: OICA.

The beneath table is displaying the production of four wheeler cars country wise during 2013. During 2013, Australia has produced least number of cars in compare to other countries, whereas China holds the first rank in car production worldwide. Again Japan holds the 2<sup>nd</sup> position in terms of total production of four wheeler cars. And, USA and South Korea is holding 3<sup>rd</sup> and 4<sup>th</sup> position respectively in respect of four wheeler production.

**Chart1: Total Production of Four Wheeler cars Country wise worldwide during 2013:**





Sources: Organisation Internationale des Constructeurs d'Automobiles, (OICA).



## Hybrid car: An Option for the Future:

*"A vehicle with more than one power source such as a small internal combustion engine and an electric motor."*

A hybrid vehicle is a vehicle that uses an on-board rechargeable energy storage system (RESS) and a fuel based power source for vehicle propulsion. These vehicles use much less fuel than their counterparts and produce fewer emissions. Hybrid vehicles recharge their batteries by capturing kinetic energy through regenerative braking. Some hybrids use the combustion engine to generate electricity by spinning a generator to either recharge the battery or directly feed power to an electric motor that drives the vehicle. This takes place when cruising or in other situations where just light thrust is need.

The three basic types of hybrid cars are as follows:

- **Series Hybrid Car:**

In the series hybrid car, the gasoline engine is used to start up the car, and after the car reaches a certain speed, the electric motor takes over. When one applies the brake, the electric motor transfers the charge to the gasoline motor. The gas engine helps charge the electric motor, and never actually powers the car directly.

- **Parallel Hybrid Car:**

The parallel hybrid car uses the gasoline engine to turn the transmission and the electric motor to enhance the car power as and when required. This means the two motors work simultaneously to provide energy that helps in propelling the car forward.

- **Full Hybrid Car:**

The full hybrid car uses the electric power for propulsion and uses the gasoline engine for power and acceleration. The full hybrid cars are also known as the 'two mode' hybrids.

## A Brief History of evolution of Hybrid Cars:

The first electric vehicle invented by **Mr. Robert Anderson** of Aberdeen, Scotland during 1839. But In the late 19th and very early 20th centuries, back when the idea that cars must run on

gasoline wasn't yet set in stone, inventors tinkered with a number of ways in which automobiles could be powered -- including electricity, fossil fuels, steam and combinations of these things. During 1900, **The Lohner-Porsche Elektromobil** makes its debut at the Paris Exposition. Although initially a purely electric vehicle, designer Ferdinand Porsche soon added an internal combustion engine to recharge the batteries, making it the first hybrid electric vehicle. The Woods Motor Company introduces the **Woods Dual Power**, a hybrid electric vehicle (with a 4-cylinder internal combustion engine) in 1917. The Dual Power had a top speed of around 35 miles per hour (56.3 kilometres per hour). But it did not reach to the success. All the while in 1968, GM developed the **GM 512**, an experimental vehicle that runs on electricity at low speeds and gasoline at high speeds. Audi also introduced **Audi Duo** during 1989 which combined with 12-horsepower electric motor and with a 139-horsepower internal combustion engine. **Toyota Prius**, the first successful electric cars went on sale in USA amid of 1997 followed by **Honda Insight** in 1999. In the 20<sup>th</sup> century the electric vehicles started penetrating the world's automotive market with **Honda Accord Hybrid** (2002) and **Ford Escape** by Ford (2004).

#### Market of Hybrid cars Worldwide:

*"We developed the first-generation Prius with the aim of making it a car for the twenty-first century and as an indication of Toyota's response to environmental issues. We had to develop a hybrid system from scratch, making our task extremely difficult. Nevertheless, we took on the challenge. The launch of the first-generation Prius had effects beyond our expectations, with the vehicle increasing consumer environmental awareness and raising hybrid vehicle expectations. The understanding of consumers at launch time laid the foundation for the widespread adoption, and, since then, consumers have continued to support TMC hybrid vehicles. For this, I am extremely grateful."*- Takeshi Uchiyamada, Vice Chairman, Toyota Motor Corporation.

#### Chart2: Global Hybrid Car Market by Volume from 2000- 2015:



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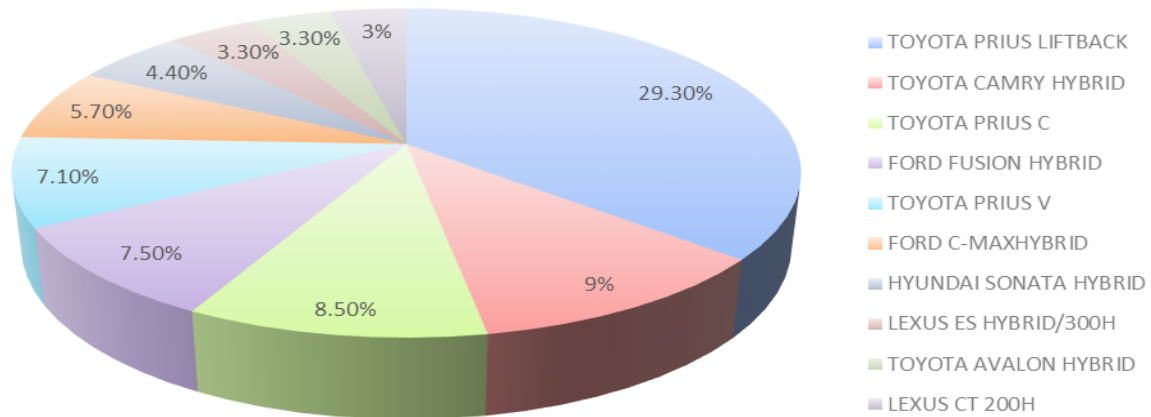
ources: GBI Research.

The above chart is showing the increasing trend in hybrid car market globally. According to the report, ‘**Electric Vehicle Market Forecasts**’, by 2017, 3.1 percent of global auto sales will be hybrid and plug-in hybrid electric vehicles. According to this report the then world hybrid-electric vehicle industry will be worth of \$2.8 billion.

- US Market:** The fleet of hybrid electric vehicles in the United States is the largest in the world. Cumulative sales passed the 2 million mark in May 2011. In 2012, total 43, 690 units of Hybrid cars sold in USA which was 31,100 units in December, 2011. The Toyota Prius family is the market leader with 2,22,140 units sold through December 2013, representing a 44.9% market share of total hybrid sales in the U.S. Out of the 5.125 million hybrids sold by Toyota Motor Company worldwide through March 2013, the United States accounted for 38% of Toyota Motor Corporation global hybrid sales.

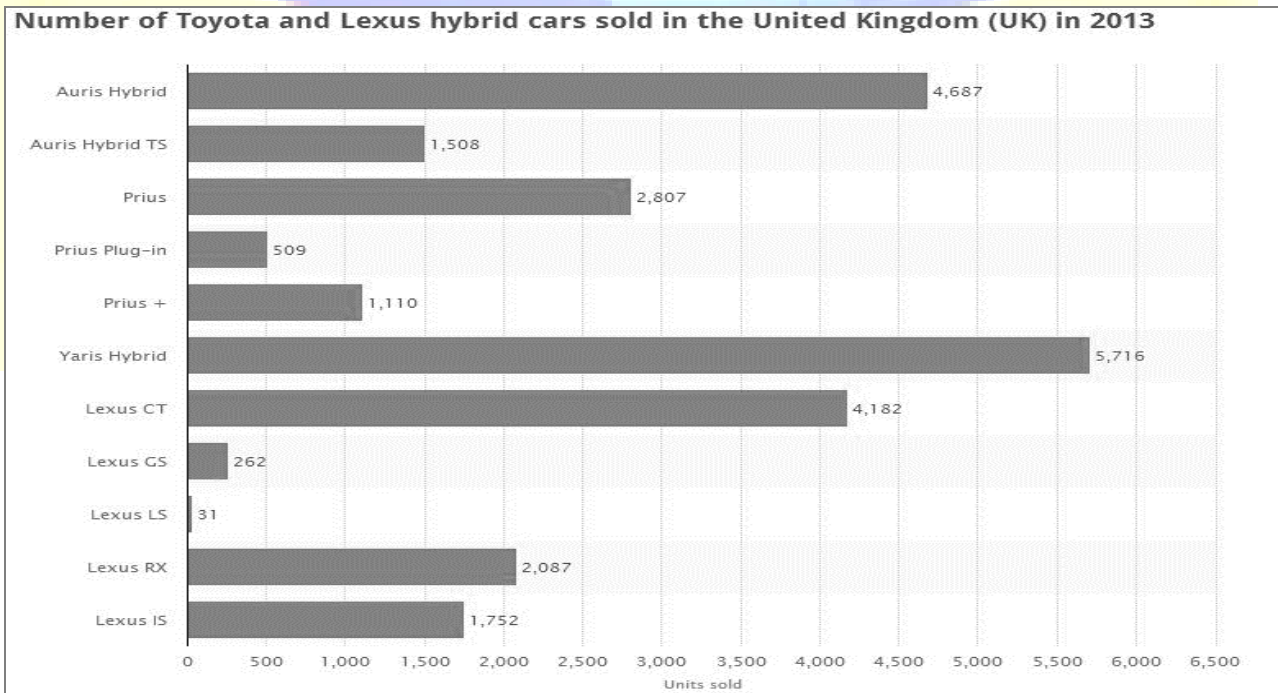
**Chart3: Market Share of Top 10 Hybrid Models in USA in 2013:**

U.S Top 10 Selling Hybrid Models by Market Share in 2013



- Market in United Kingdom:** During 2013, the total new car registered in UK 22, 64, 737 units; out of this total hybrid cars registered (including Petrol/electric and Diesel/electric) were 6698 units. In 2013, Toyota Prius sold 2807 units and 1110 units of Prius+ sold in UK. 4182 units of Lexus CT sold in UK during 2013 followed by Lexus RS and Lexus ES.

Chart4: Various Models of Hybrid Cars of Toyota sold in UK in 2013:



- **Japanese Market:** Toyota's hybrid sales in Japan since 1997, including both Toyota and Lexus models, crossed the 1 million mark in July 2010 and reached 2 million in October 2012. Cumulative sales of the original Prius in Japan reached the 1 million mark in August 2011 and sales of the Prius family vehicles reached 1,639,800 units in October 2012. Toyota Motor Company announced that cumulative global sales of its hybrid cars touched the 6 million unit mark as of 31<sup>st</sup> December, 2013. During 2013, total 6, 79,100 units (including Prius and Lexus) of hybrid vehicles had been sold in Japan.

- **Indian Market:**

*“What makes cities in India and China so frustrating to drive in – heavy traffic, aggressive driving style, and few freeways – makes them ideal for saving fuel with hybrid vehicles.”*- Researchers at the US Department of Energy’s Lawrence Berkeley National Laboratory (Berkeley Lab).

The hybrid car market still not much existed in Indian automotive market. Though Mahindra Reva e2o has been introduced in Indian car market on March, 2013.

### **Comparison between Hybrid and Conventional Cars (With respect of USA):**

In recent world more than 60 models of hybrid cars are available by various automotive companies, out of which some models are still existed with new specifications (Toyota Prius) and some models are discontinued (Toyota Volta, 2008 Lexus RX 400h etc.). The underneath table has shown the comparison of hybrid cars and non-hybrid cars of the same model.

- **Cost of the car:** From the price/cost point of the view the price of hybrid cars are little bit higher than the non-hybrid cars. Toyota Prius, the first and the most popular hybrid car in whole world. The price of hybrid Prius is higher than the non-hybrid Prius. The same figure can be seen in the other mentioned models by various companies also.
- **Miles per Gallon:** For every customer one of the most important factors before purchasing a car is miles per gallon of the car. It’s not only control the fuel efficiency but also indicates how much one customer has to spend to run his car annually. So, according to the beneath table the hybrid cars are covering more distances/miles per gallon than the non-hybrid cars. Toyota Prius, the most acknowledged hybrid car in worldwide which is

covering 50 miles which is much higher than the miles covering by 2014 Toyota Camry LE (32 miles/gallon). Lexus ES 300h (hybrid) is also covering 40 miles/gallon whereas the non-hybrid one is covering only 24 miles/gallon. The same picture can be seen in other models by various companies.

- Fuel Cost Savings (Monthly & Yearly): The fuel cost savings is another most important factor which is considered by each and every car purchaser. All the hybrid cars help the customers to save the fuel cost. If any customer is buying Infinity Q70, he/she can save \$926/year and \$77.17/month, though the price of hybrid model is little bit higher than the non-hybrid one. In case of Toyota Prius one customer can save \$563 per year. The scenario can be seen in case of other models of hybrid cars by various companies.

**Table2: Comparison between Hybrid Cars and Non-Hybrid Cars of same model (in 2014):**

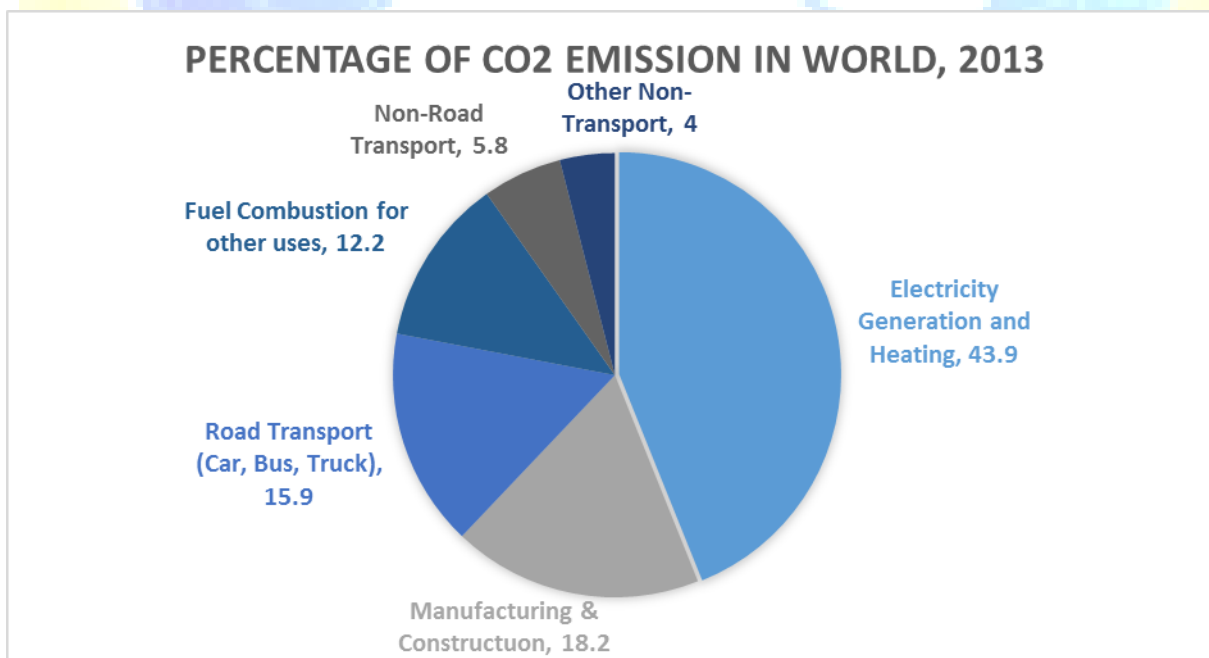
Car Models	Price		Miles Per Gallon		Fuel Cost Savings in \$	
	Hybrid	Non- Hybrid	Hybrid	Non-Hybrid	Monthly	Yearly
Toyota Prius	\$19,890	\$17,629	50	32	46.92	563
Toyota Camry XLE	\$29,435	\$ 26,620	40	29	41.75	501
Nissan Pathfinder 4WD SV	\$36,900	\$33,900	27	21	42.58	511
Ford Lincoln MKZ	\$36,085	\$36,085	38	26	52.08	625
Lexus ES 300h	\$39,500	\$36,620	40	24	69.33	832
Kia Optima LX	\$26,135	\$22,300	38	27	47.08	565
Infinity Q70	\$55,650	\$49,600	31	21	77.17	926
Hyundai Sonata Limited	\$31,560	\$30,810	37	28	41.33	496
Honda Civic w/Nav	\$26,135	\$ 24,240	45	33	35.67	428
Honda Accord Touring	\$35,695	\$34,270	47	26	78.08	937

Source: Retrieve from <http://www.fueleconomy.gov/feg/hybridCompare.jsp>. Data Collected from U.S. Department of Energy's Alternative Fuels Data Centre.

- CO<sub>2</sub> Emission and Hybrid Car: Now a day's pollution is a major concern for each and every country. Hybrid cars are mainly manufactured to reduce the pollution. As per the underneath figure 43.9% CO<sub>2</sub> emits from electricity generation worldwide. Again manufacturing & construction (18.2%) and road transport (15.9%) are holding 2<sup>nd</sup> and 3<sup>rd</sup> position in CO<sub>2</sub> emission.

*“With more than 50 hybrid vehicle models from various manufacturers available in the US today, hybrids on the road are saving nearly 500 million gallons of petroleum annually in this country.”*- Tony Markel, senior engineer with the National Renewable Energy Laboratory (NREL).

**Chart5: Percentage of Man Made emission in World in 2013:**



Source: Organisation Internationale des Constructeurs d'Automobiles, (OICA).

*“Driving a car is the single most polluting thing that most of us do. Therefore, reducing vehicle emissions should be near the top of the green agenda. One of the priorities must be to*

*reduce the amount of Carbon dioxide, otherwise known as CO<sub>2</sub>, emitted into the environment. Carbon dioxide is one of the main greenhouse gases, and there is strong evidence that greenhouse gases are causing climate change.”* - The U.S. Environmental Protection Agency (EPA).

**Table3: Reduction of Green gas and CO<sub>2</sub> by Hybrid Cars (in 2014):**

Vehicle	Gas Reduction (%)	CO <sub>2</sub> Reduction (%)
Toyota Prius	38	42
Honda Civic Hybrid	28	31
Lexus RX 450H	28	30
Lincoln MKZ FWD Hybrid	31	36
Toyota Camry Hybrid	18	24
BMW Active Hybrid	11	6
Ford Escape Hybrid 4WD	19	24

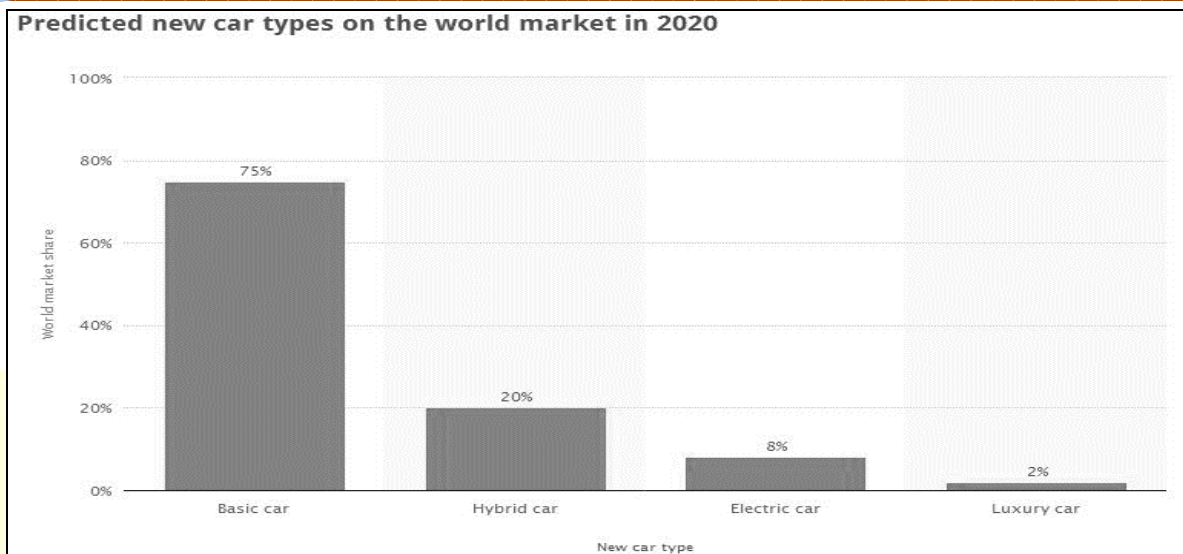
According to the above table the mentioned models of Hybrid cars of various companies are reducing Greenhouse gas as well as CO<sub>2</sub>. Toyota Prius is reducing 42% of CO<sub>2</sub> and 38% of Greenhouse gas. Lexus RX 450H is reducing 30% of CO<sub>2</sub> as well as 28% of Greenhouse gas. Other models of Hybrid cars are also following the same path.

**Future of Hybrid Cars in World Car Market:**

*“Some people say hybrid vehicles such as the Prius are only a bridge to the future. But we think it could be a long bridge and a very sturdy one. There are many more gains we can achieve with hybrids.”* - Takeshi Uchiyamada, Chairman, Toyota Motor Corporation.

**Chart6: Prediction of Future car types on the World Market by 2020:**



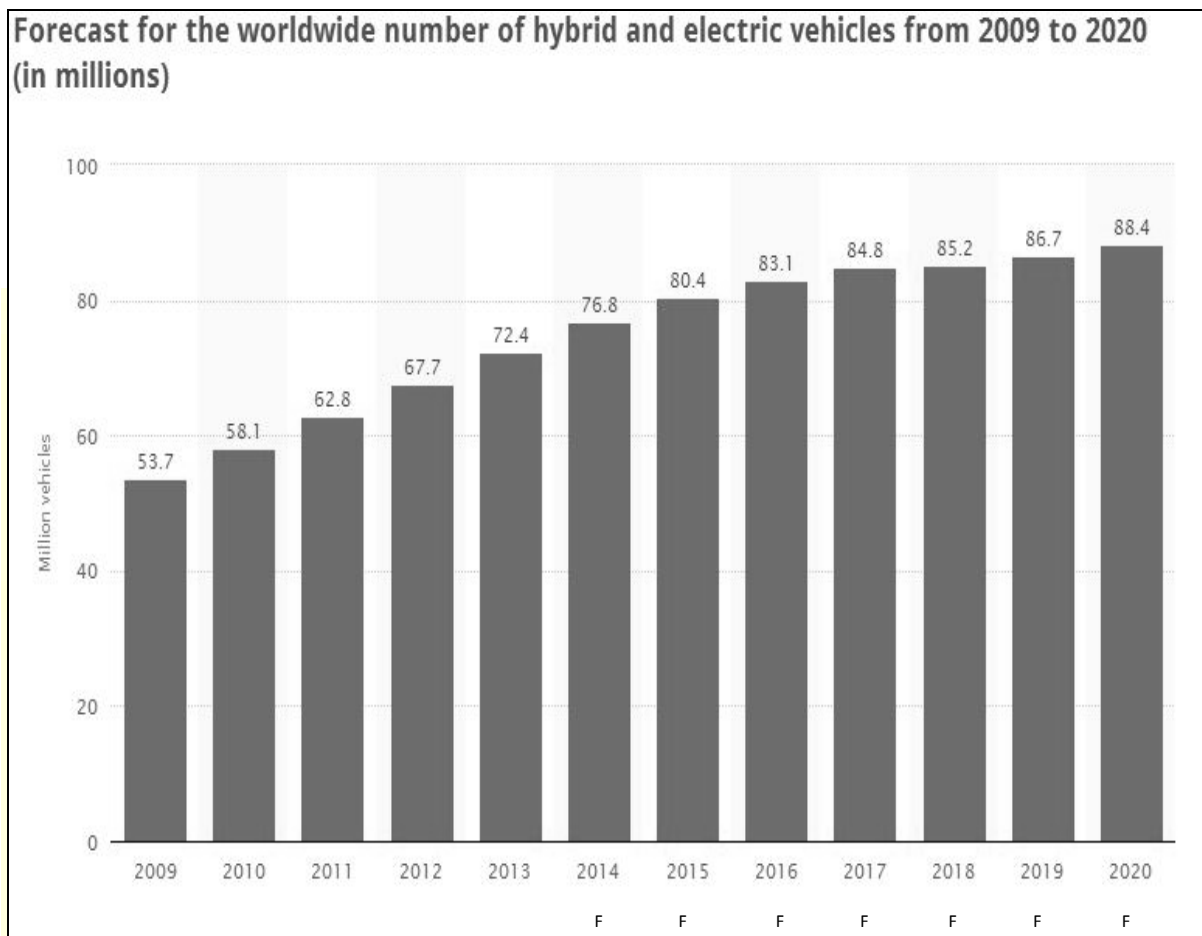


Source: Statista.

The above figure shows the future scenario of Hybrid Cars in world car market as of 2020. The 20% of the total car market will be dominated by the Hybrid Cars, though the basic cars will be the market leader.

The underneath figure is forecasting the increasing demand of hybrid and electric vehicle worldwide by 2020. The figure is showing an increasing trend in demand of hybrid and electric cars worldwide. In 2015, the total demand will be 80.4 million units worldwide which will increase to 88.4 million units by 2020. In forth coming 5 years the total demand of electric and hybrid vehicle will increase by 10.44%.

Chart7: Forecast of Hybrid cars and Electric vehicles worldwide from 2014-2020:



Source: Statista.

The various researchers are expecting that the demand of hybrid cars will be doubled by 2020. According to the Freedonia, Group, a Cleveland-based research firm, by 2015, the Hybrid Electric vehicle will touch 4.3 million units worldwide. Recently, the cost variation among hybrid cars and conventional cars lies from \$1,000 to \$ 3,000, which is expected to be declined because of increasing demands of hybrid cars worldwide. According to the the Freedonia, Group, the demand of hybrid cars will be continued in USA, European market, Japanese market along with the emerging market in India and China. In future Japan will be the colossal market of hybrid cars because of the initiatives taken by the various government agencies in form of reduction of taxes and providing other incentives to promote the hybrid cars. Again in Asia-

Pacific region China and South Korea will be the next substantial market for hybrid cars by cause of government initiatives in dealing with mobile emissions.

### Conclusion:

As petrol/diesel is a sub product of crude oil, the availability of petrol/diesel will constraint up to a certain limits. In forth coming years the quantity of crude oil will decrease drastically. The first result will be an enormous hike in pricing of petrol/diesel followed by unavailability of petrol/diesel to run the entire conventional vehicle. The prime object of this research paper is to find out alternate ways to run vehicles (Four wheeler). The data is clearly indicating that in near future electric, gas and hybrid vehicles are going to dominate the world automobile market. Among of the alternatives the hybrid vehicle is most suitable one in terms of cost effectiveness, fuel effectiveness, and durability. As of now the hybrid vehicle market mostly confined in USA. But initiatives from the government of various countries in Europe and Asia-Pacific will build an emerging hybrid car market in future.

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