FuelSaver25

Current Trends and Developments in the Hybrid Vehicle Industry

It's an exciting time for hybrid commerce as advancements in manufacturing and alternative fuel sources are consistently testing the capabilities of the market models.

This white paper is intended to demonstrate the current developments in the hybrid industry, the brands at the forefront, and the current market position. As environmentally conscious consumers demand newer and cleaner versions of hybrids, the industry is feeling the pressure to produce at a higher rate than ever.

By the year 2050, conventional car stock is expected to decrease by .5% whereas stock for alternative cars will increase by 5%. (ref 1) (see figure A) By the year 2020, the market for hybrid vehicles is expected to reach 10 million in the United States (2016 ended with almost 8 million cars sold).

Brief History of Hybrids

Hybrid Technologies

- Full Hybrid
- Mild Hybrid
- Micro-Hybrid
- Plug-in Hybrid

The Current Advantages

The Trends

- Fuel-cell Technology
- Ultracapacitors
- Energy-dense Batteries
- 48v systems
- E-axles
- Low-cost

The Market

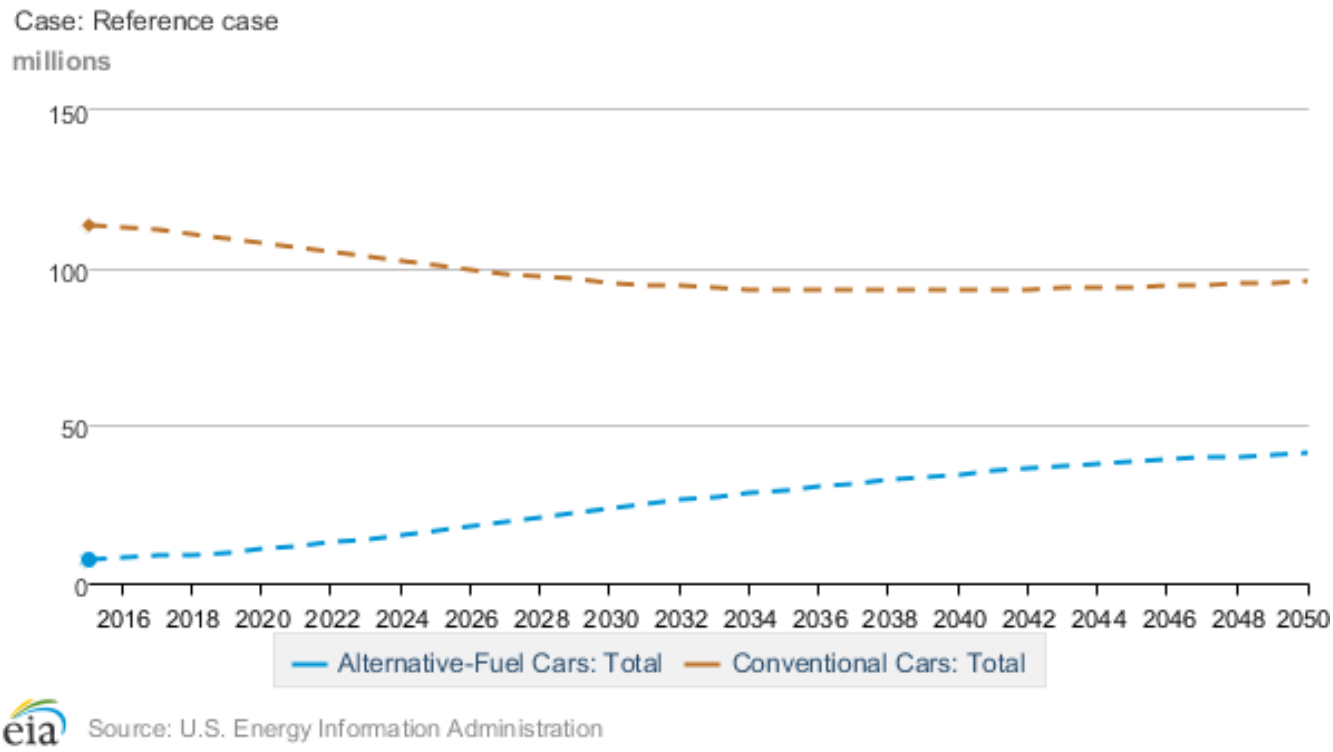


Figure A

In Japan, certain hybrid models are currently selling better than mainstream models, with the Toyota Prius Liftback being one of them. (ref 2) In fact, each new generation of the Prius has delivered a 10% improvement in efficiency while simultaneously reducing costs. (ref 3)

As technologies are developed, hybrid cars are becoming increasingly affordable for consumers and thus, their popularity is rising exponentially.

The market peaks in 2013 at 3.19% share

A BRIEF HISTORY

The history of hybrid vehicle production can stretch as far back to the year 1665 when Jesuit Priest Ferdinand Verbiest drew plans for the first steam car. (ref 4) The first electric was soon to follow in 1889. (see figure 1) but the scope of this white paper will stick to the last 20 years.

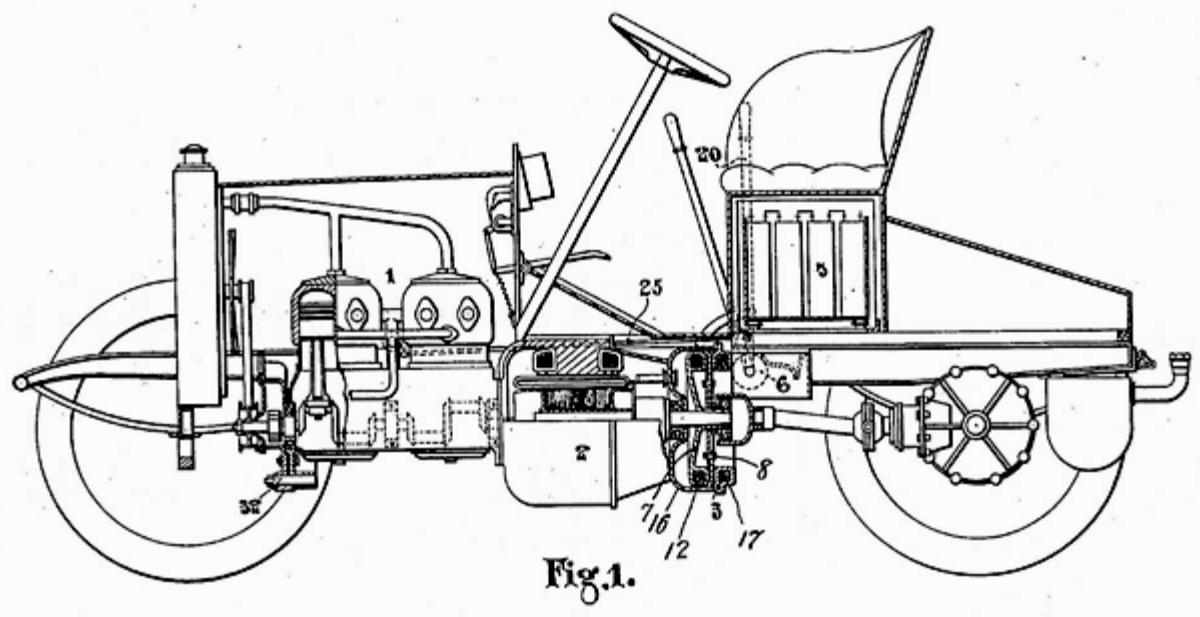


Fig.1.

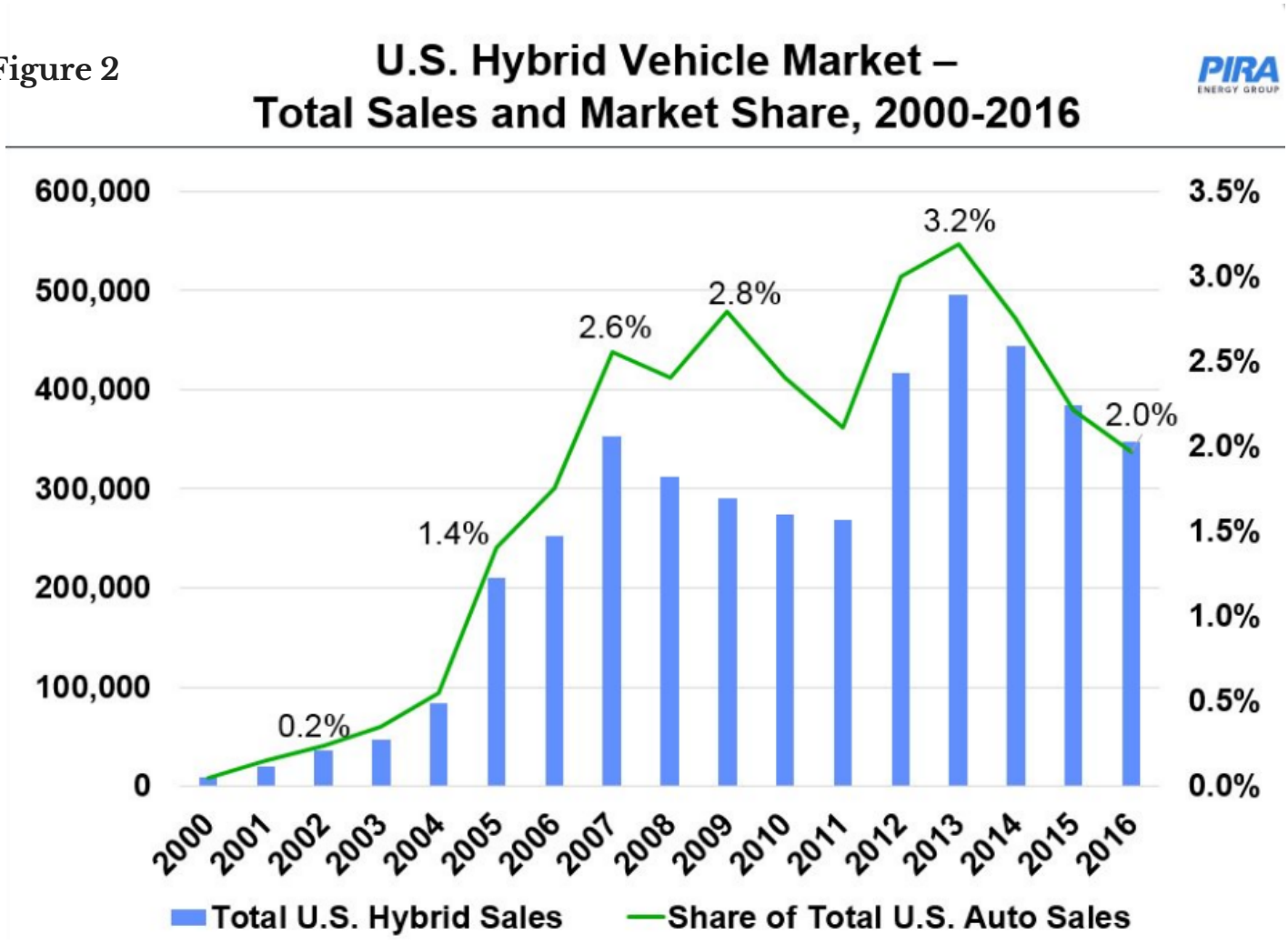
Toyota was the first company to produce a hybrid vehicle in Japan in 1997, which they named "The Prius." Hybrids emerged as a way to bridge the gap between the limitations of electric and gasoline powertrains, and to develop a more environmentally friendly means of transportation.

The Honda Insight was the first hybrid introduced to the American market in the year 1999, with just 17 units sold. The Prius came to market the following year, and both models did considerably better, with Honda selling 2,788 units, and Prius doubling that at 5,562. (ref 5)

In 2006, as part of the Energy Policy Act of 2005, (ref 6) up to $3,400 in tax credits was offered to anyone that purchased a hybrid car. This boosted the market considerably, and the policy lasted until it was changed in 2010 when the industry shifted towards electric plug-in vehicles.

The market has steadily increased since the early 2000s but seems to have peaked in 2013, when hybrid sales owned a 3.19% share. (ref 7) (see figure 2) Now in the lower 2%, hybrid cars are currently selling less due to the decrease in gas prices. However, market projections show they are expected to have a healthy competition with regular vehicles throughout the next few decades.

Figure 2



HYBRID TECHNOLOGIES

The majority of hybrid vehicles are smaller and equipped with four-cylinder gas engines (with the exception of some high-performing V6 and V8 engines in SUV and sports models). (see figure 3) Hybrids usually come with a continuously variable transmission (CVT) and are front-wheel drive.

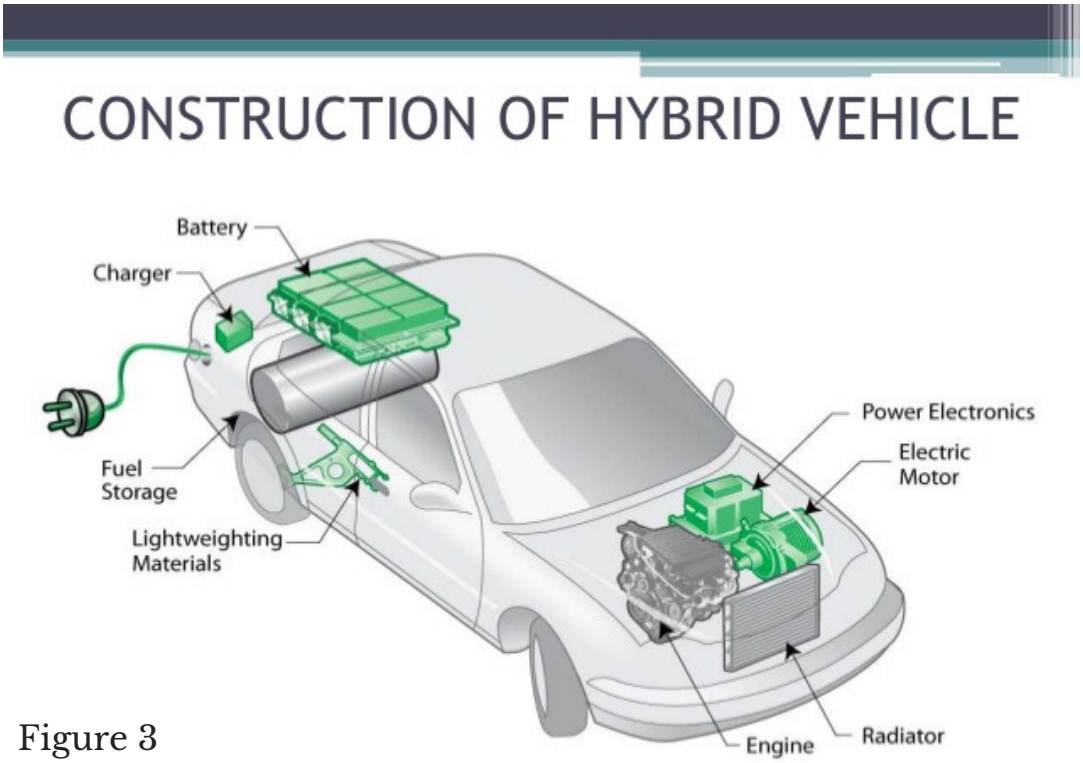


Figure 3

Hybrids are typically

front wheel drive

As the market increases in popularity, the stereotypical ideas of what a hybrid vehicle looks like are consistently broken. Since gas and powertrains can be combined in a variety of ways, it makes sense that hybrids come in a few different styles. The following are the standard examples of the different hybrid technologies on the market:

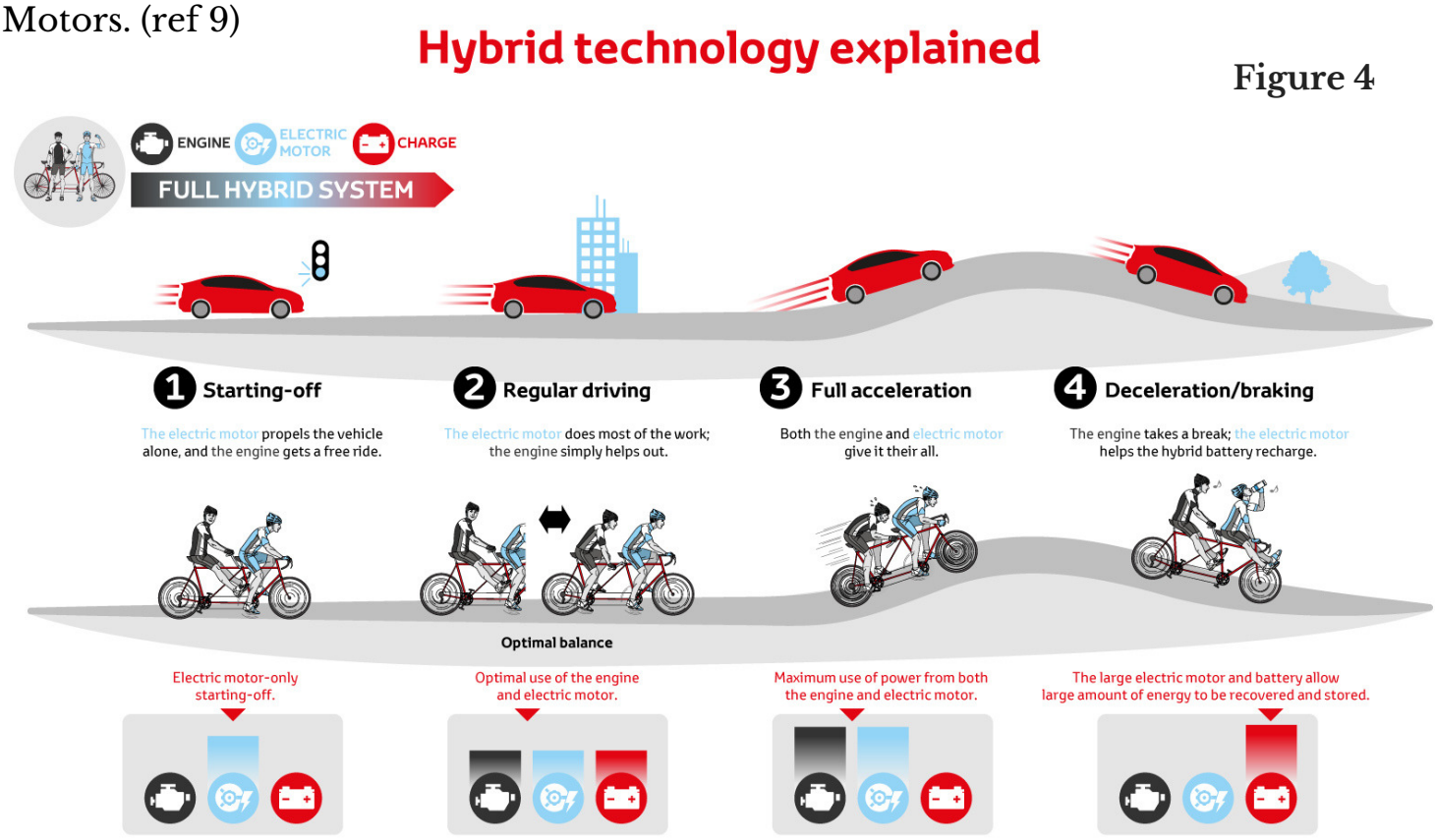
FuelSaver25

Full Hybrid

These are the vehicles that are best known to the public. They typically use a planetary gear which creates an input power split between the various components of the system, like the engine, generator, alternator, traction motor, and drivetrain. That is what makes these types of hybrids capable of launching forward at low speeds without consuming any gas. (see figure 4) At their present state of development, full-function hybrids reduce fuel consumption up to 30%, at a manufacturing cost increment of roughly $2,500 to $3,500. (ref 8)

Full hybrids typically run on electricity for a limited time and have a gentle throttle. They are the most sophisticated of all hybrids, have been on the market the longest, and excel in optimizing engine efficiency. Easily adaptable to plug-in operation, the downside to a full hybrid is generally the cost. The most popular brands on the market for full hybrids are Toyota, Ford, Hyundai, and General Motors. (ref 9)

Figure 4



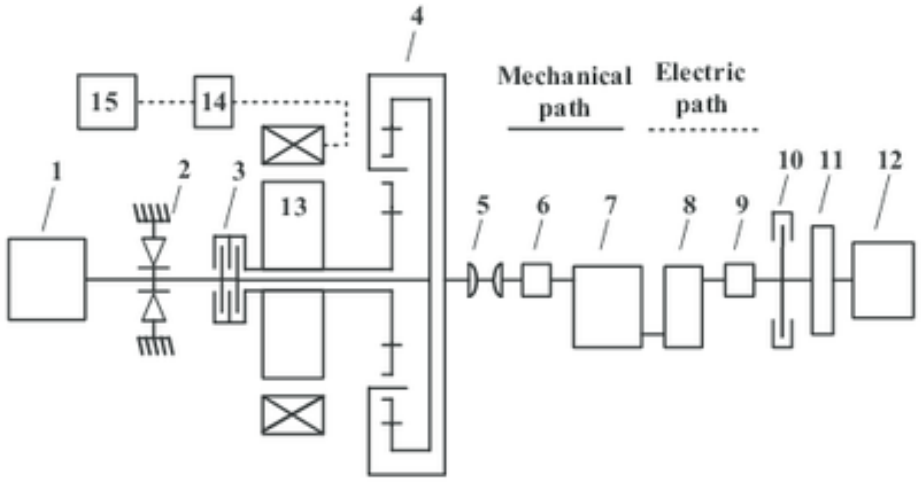
Two-Motor System

One of the newer examples of a full hybrid is the two-motor system. Much like the input power-split system, all of the energy for the traction motor is provided by the engine through the generator. However, unlike the original hybrids, the two-motor system does not use a planetary gear to transmit power. Although the two-motor system is known to have better efficiency than an input power-split system, they come at a much higher cost. Front runner brands for this type of system include GM, Chrysler, BMW, and Mercedes.

Parallel System

Typically referred to as a P2, a hybrid with a parallel system is a single motor with two clutches. (see figure 5) This makes it highly scalable, from electric motor power to plug-in hybrids. There are different variations of this system that have been introduced by brands like BMW, Nissan, Hyundai/Kia, Subaru, and Porsche. Hyundai is by far the leader in this niche, however, and cornered 8% of the market in 2014 with their P2 design. (ref 10)

Figure 5



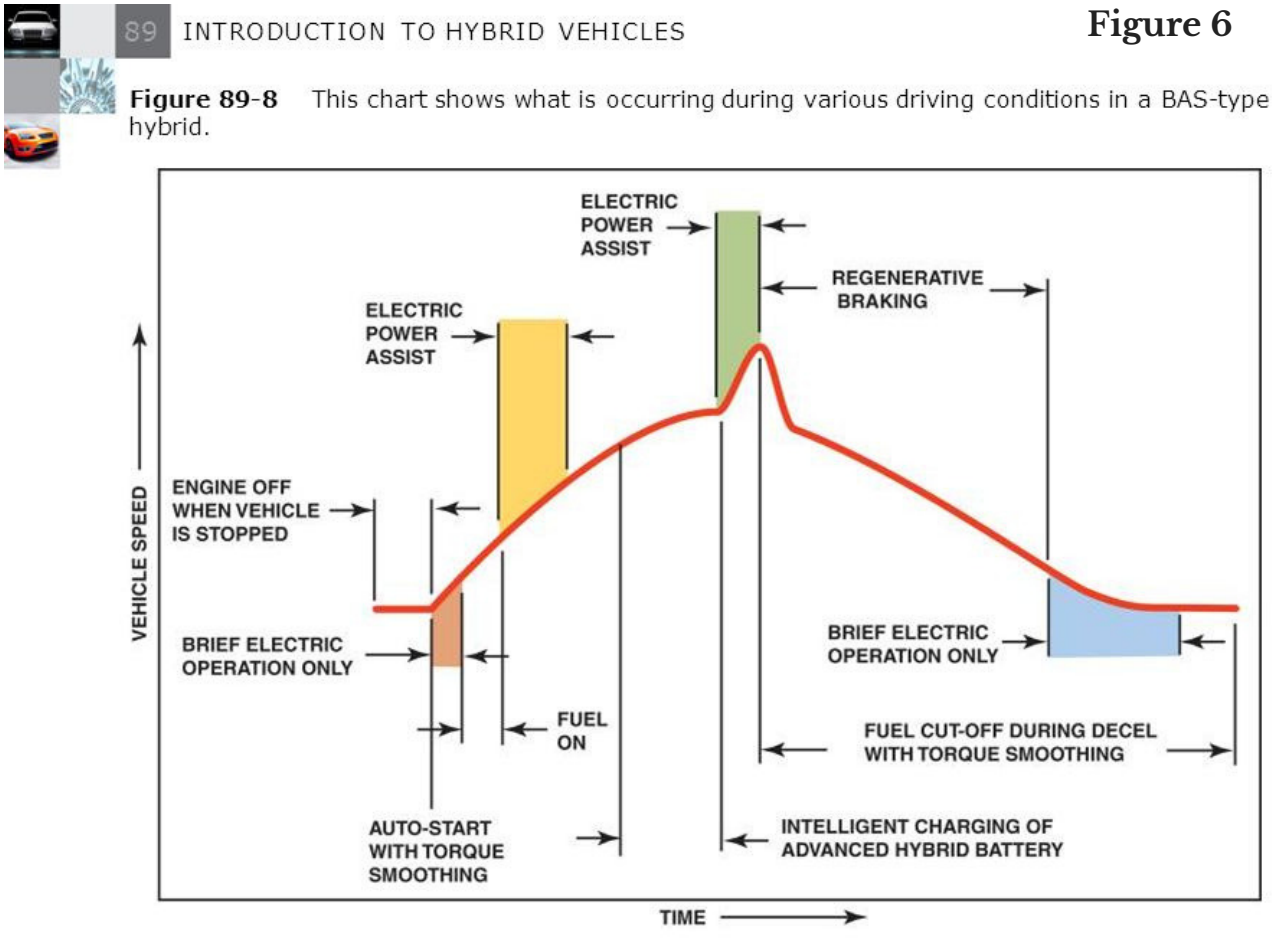
1. Engine, 2. One-way clutch, 3. Wet multi-disk clutch, 4. Planetary gear, 5. Universal joint, 6. HBM200 Sensor for Rotational speed and Torque, 7. AMT, 8. Speed increaser, 9. HBM1000 Sensor for Rotational speed and Torque, 10. Braking, 11. Flywheel, 12. Dynamometer, 13. ISG EM, 14. Power converter, 15. Battery pack.

A lesser version of a P2 system has been created by Honda. It features a clutch between the engine and the electric motor, but is still considered a parallel system. This type is often referred to as an integrated motor assist (IMA) and is considered more of a "mild hybrid."

Mild Hybrid

A "mild hybrid" is a term loosely applied to hybrids that lack full-function capabilities. Mild hybrids can move from a standstill only when the combustion engine is engaged, and require the use of a gas engine when reaching higher speeds (about 20-25 mph). The electric motor is used primarily to assist the gas engine when needed.

Figure 6



One of the best examples of a mild hybrid is known as a BAS (belt-alternator-starter) system. A BAS system replaces the traditional alternator with a high-powered electric motor and a high-tension belt. The belt is designed to work in both directions to provide power assist to the engine and to capture energy from regenerative braking. (see figure 6)

Micro-hybrids can achieve fuel savings of up to 25%

Lower in cost than Hybrid systems with dedicated motors, belt drives are not always as efficient as gear drives and power is limited by the belt itself. A 12v–24v BAS system is generally referred to as a "micro-hybrid," and higher power BAS systems are called "mild hybrids." In 2012, GM pioneered a higher power (115v) BAS system with the Buick Lacrosse that was very successful. GM's BAS system had 2% of hybrid market share in 2014, down from 5% in 2013. (ref 11)

New designs using 48-volt hybrid systems are currently in development and often include a small electric motor integrated into the turbocharger. This is said to eliminate turbo lag which allows for additional engine downsizing.

Micro- Hybrid

Much like the name implies, these are the least of the hybrids on the market (i.e. they use the most gas). Micro-hybrids provide limited energy for regenerative braking and alternator functions. Micro-hybrids are growing in popularity because they can achieve fuel savings of up to 25% compared to normal gas-only models (with "stop-start" systems accounting for 10% of the savings). (ref 12)

The newer models use some level of electrification, such as "sailing" and "start-stop." Sailing is when the engine disconnects from the drivetrain during high-speed decelerations. Start-stop technology is when the engine cuts rather than idling, and starts up again when the brake is released. All hybrid GM trucks have the start-stop feature built into them.

A micro-hybrid that takes the start-stop technology one step further is the integrated starter alternator with damping (ISAD) hybrid. This type of system allows energy from the electric motor to help move the vehicle, in addition to stop-starting.

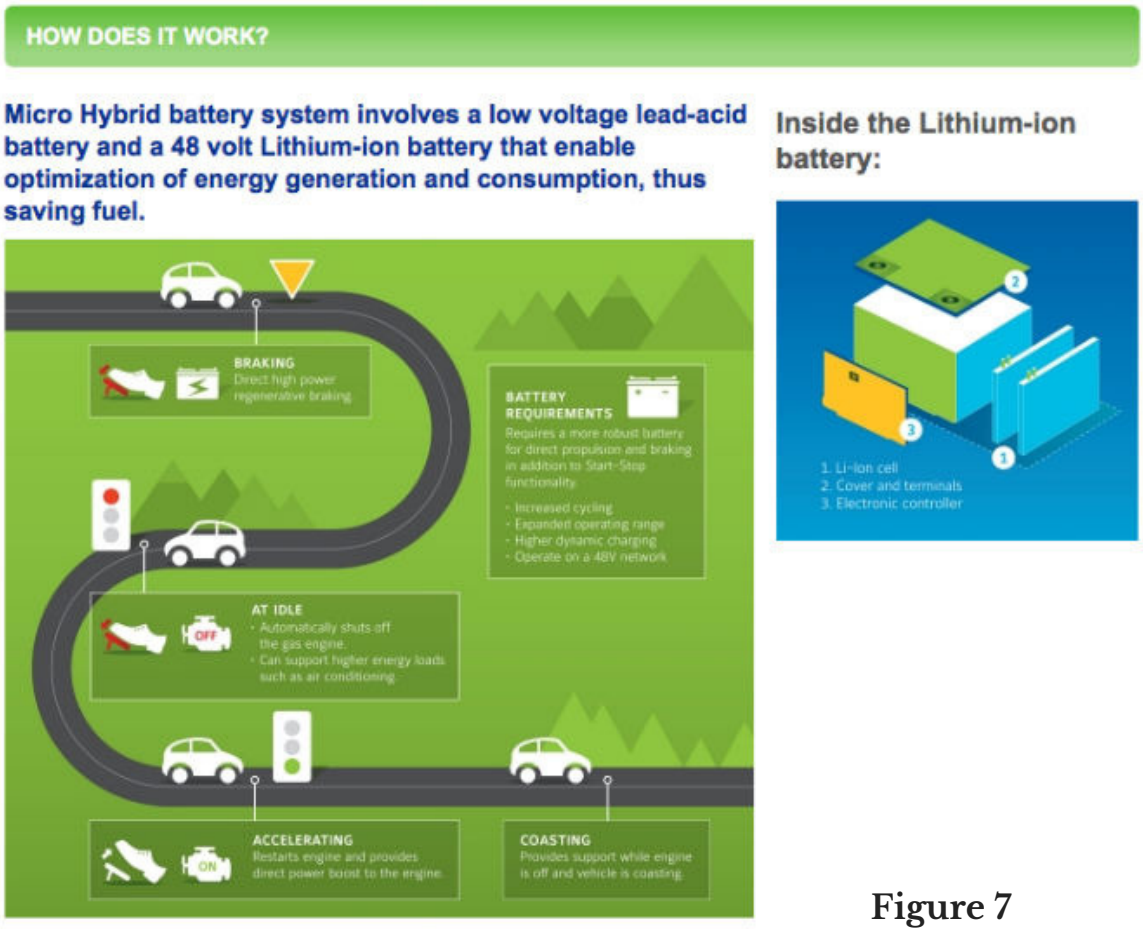


Figure 7

Batteries are another big trend in micro-hybrids. (see figure 7) Larger battery packs can provide additional torque and power up driver-assist. 48-volt batteries can supply as much fuel assist as a full hybrid, at a portion of the price.

Many different styles of micro-hybrids are being developed, from 12v systems that use lead-acid batteries to 24v systems employing small ultracapacitors (or using NiMH or Li-ion batteries).

In 2014, Mazda's i-ELOOP was the first micro-hybrid introduced to the market. It uses an ultracapacitor to capture a limited amount of regenerative braking energy and provide power for conventional vehicle electronics in place of the alternator.

Plug-in Hybrid

Designed to plug into the wall, these hybrids work as electric cars only some of the time. They typically utilize their electric range between 10-35 miles before switching to normal hybrid operation. Plug-ins can be categorized as parallel or series hybrids, and sometimes they can alternate between the two (depending on the brand and model). (see figure 8)

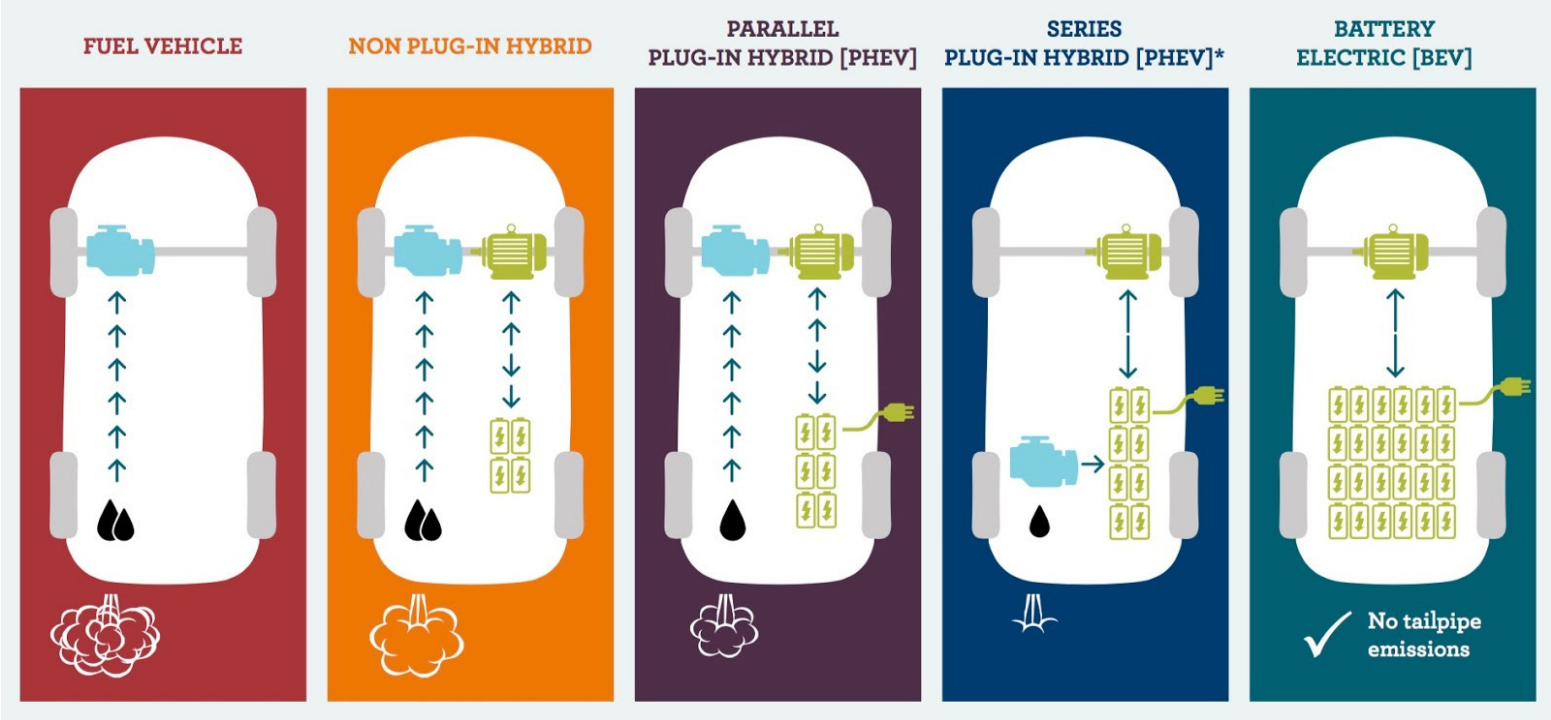


Figure 8

THE CURRENT ADVANTAGES TO OWNING A HYBRID VEHICLE

Most consumers purchase a hybrid vehicle for fuel efficiency, but depending on the sophistication of the system, hybrids can offer a variety of advantages. The following are a few of these current benefits:

• Regenerative braking (i.e. the ability to capture and reuse energy normally lost to the brakes).

• Shut the engine off at idle, conserving fuel and cutting tailpipe emissions to 0%.

• Maintain performance while using a smaller, more efficient vehicle.

• An electric motor provides instant torque for low-speed acceleration and better response.

• Enables the engine to run at lower speeds when it is efficient.

• Replaces the alternator with a more efficient means of generating power.

• Replaces less efficient oil and water pumps with electrical pumps that only operated as needed.

• Supplies the large amounts of electrical power needed for safety features, chassis control, heated seats, and other power-hungry features of modern cars.

CURRENT TRENDS

Every industry on the planet is experiencing a sense of disruption when it comes to technology, and the hybrid market is no different. As brands continuously compete with each other for the cheapest and highest-performing model, the technology with which we build these cars is rapidly changing.

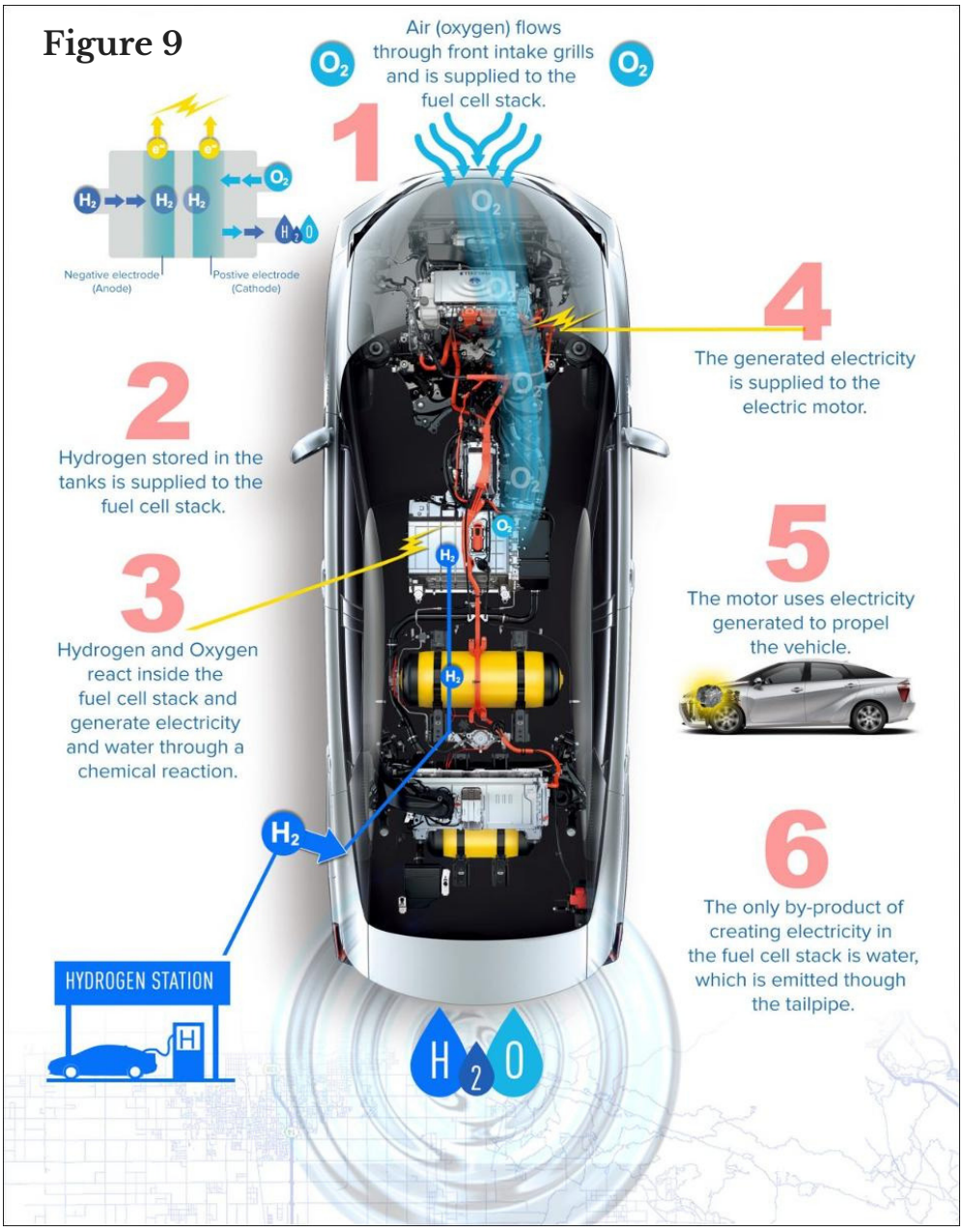


Figure 9

Systems that were once considered a "pipe-dream" or much too expensive for the average consumer, are now becoming a reality thanks to advancements in technology. Here are some of the current trends that a well-informed consumer should keep their finger on.

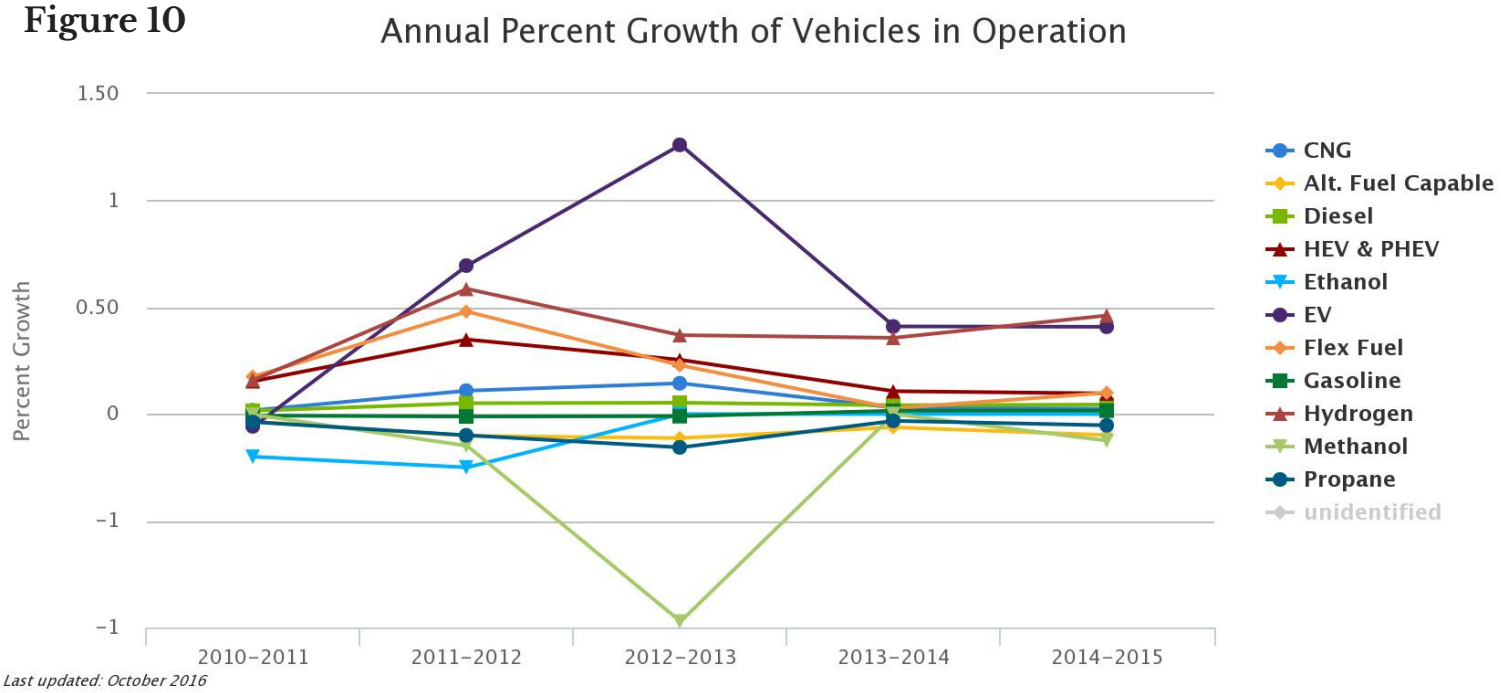
Fuel-Cell Technology

Hydrogen-based hybrid systems have been waiting for the technology to catch up. That's because, although the concept is incredible on paper, the energy to create the hydrogen was not always deemed clean. Toyota's new Mirai is changing that with fuel-cell technology. (see figure 9)

Offering 312 EPA-rated miles per fill, (ref 13) with zero emissions, the car acts like something from the future. Hydrogen is stored in carbon-fiber fuel tanks that are shock resistant and able to withstand high impact. (This is important as consumer concerns of hydrogen often involved handling combustible material). Air then flows through the front grill and is stored in the fuel cell stack. Hydrogen from the tanks mixes with the oxygen from the air, and the chemical reaction creates electricity. The only byproduct of this system is water, which flows out of the exhaust while driving.

Hydrogen currently holds a tiny place in the market as annual increases are more volatile for fuel types with small populations. (see figure 10).

Figure 10



Last updated: October 2016
Printed on: May 21

Now may be the time to invest as fuel cells are becoming increasingly popular in military vehicles, forklifts, even scooters in Japan. (ref 14)

The following are a few of the brands currently developing this technology:

- BMW Germany
- Ford USA
- GM USA
- Honda Japan
- Hyundai Korea
- Toyota Japan
- Audi Germany

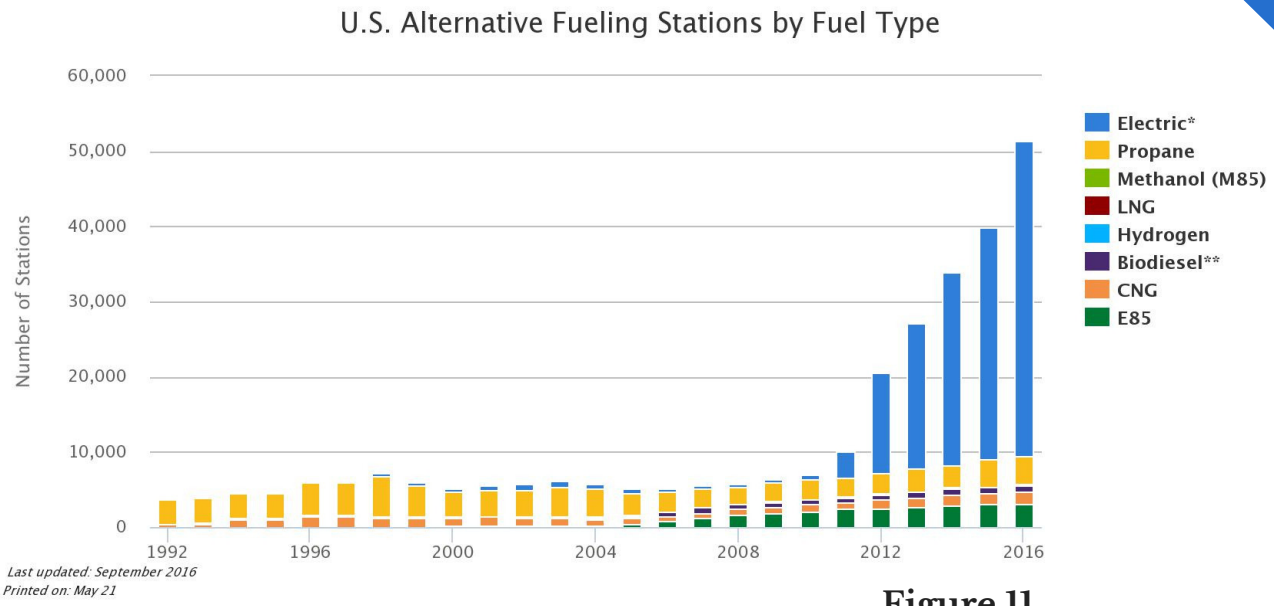
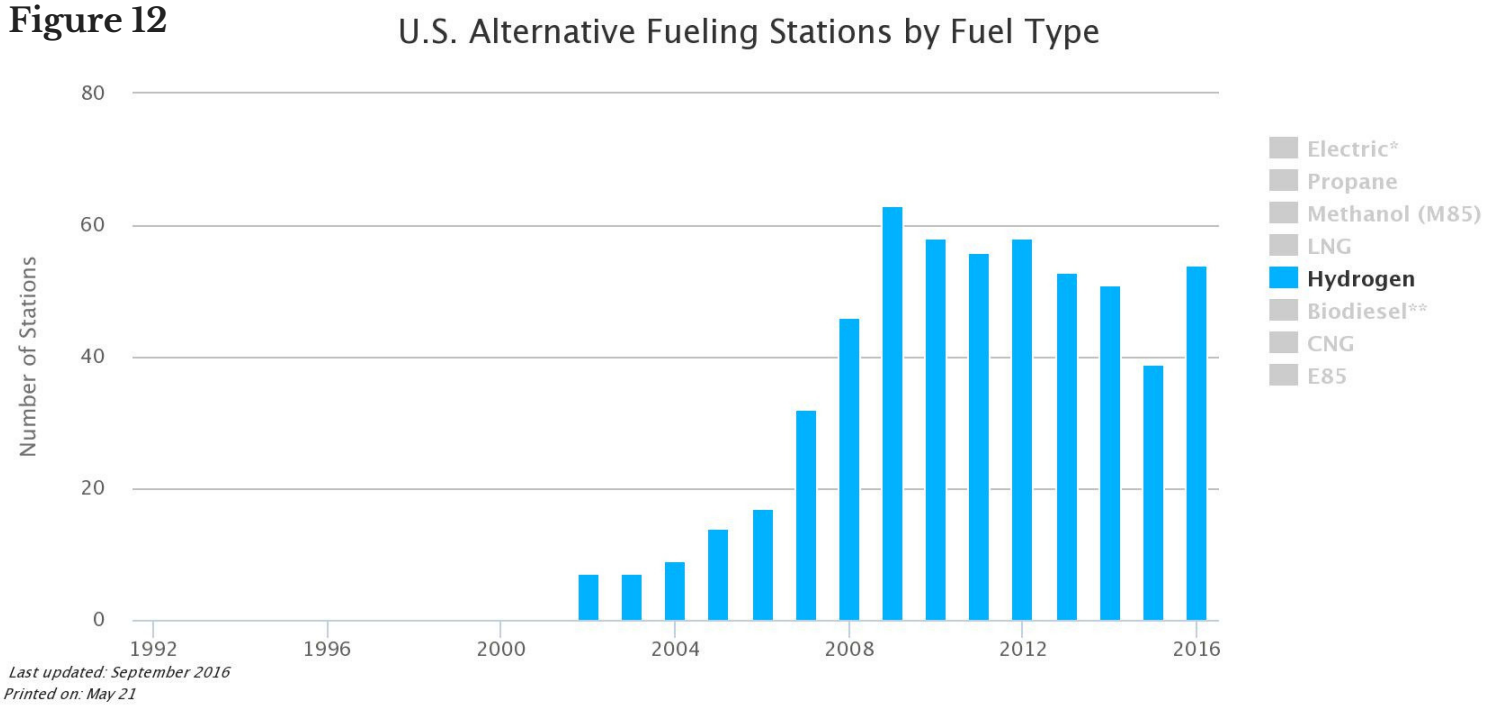


Figure 11

One of the only challenges left for hydrogen technology is where consumers will locate refueling stations. Toyota offers its customers 3-year's worth of free fuel to resolve this current issue, but with less than 60 stations in America, it still remains a very real roadblock to this technology. (see figure 11 and 12)

Figure 12



One solution to the lack of refueling stations is a new cutting edge solution called FuelSaver 25. (ref 15) The technology consists of fuel saver units that can be added to any fossil fuel burning engine.

FuelSaver 25 technology helps save up to 40% on mileage

These units have shown to improve mileage by 33.89% for Edwards Mail Service, in 65 trucks of their Dallas fleet. They now have future plans to install them on a total of 225 trucks throughout Texas. CEO and founder of FuelSaver 25 installed the unit on his Toyota Tundra and personally experienced a savings of 40.5%.

Ashley Furniture Distribution is currently testing the FuelSaver 25 product and has plans to install it in their fleet of 1,000 trucks. FuelSaver25 has no impact on factory warranty and is approved for use in California.

Ultracapactiors

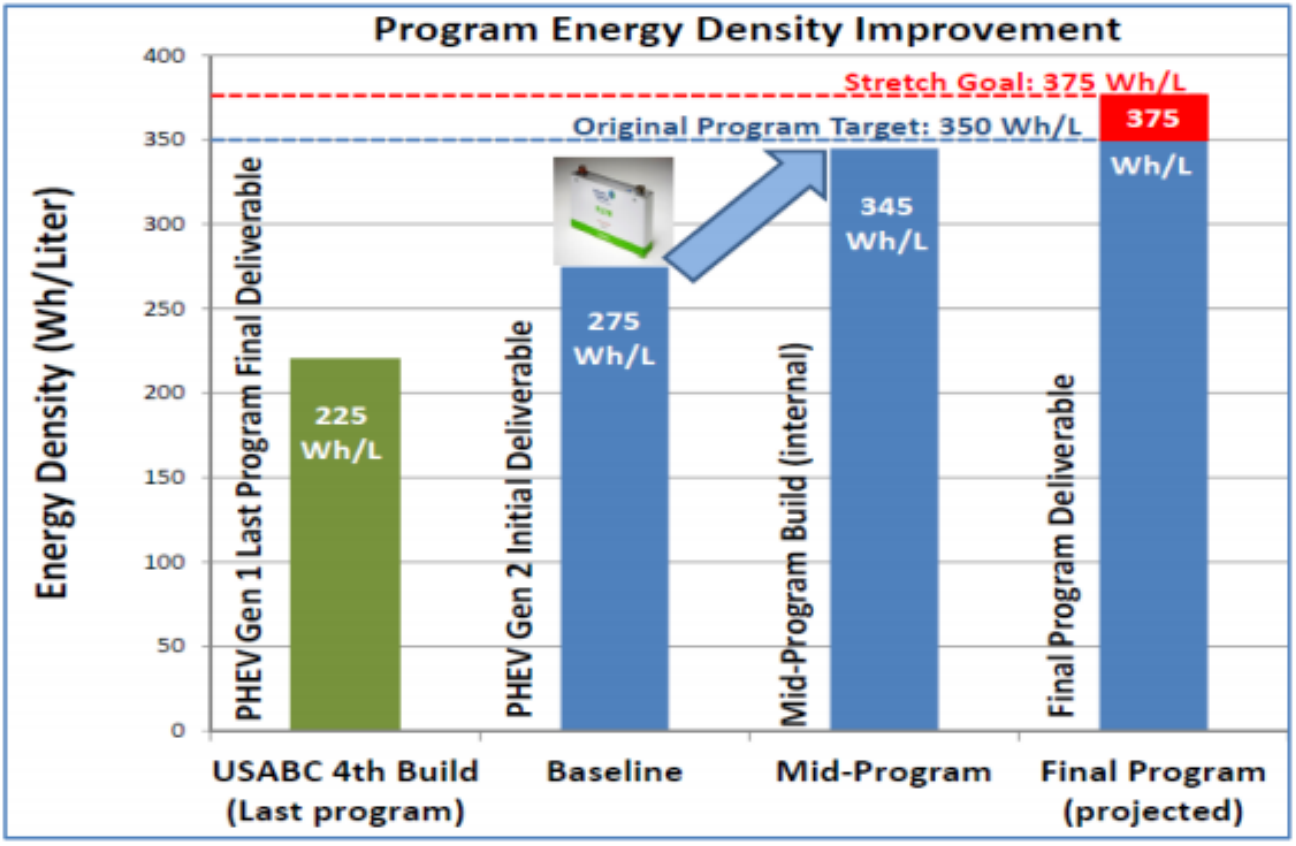
Mild and micro-hybrids are now replacing alternators with a higher power electric motor/generator and a high tension 2-way belt. This system is referred to as an "ultracapacitor" and it allows for the same type of fuel efficiency as a full hybrid (without costing the consumers a steep premium). Also referred to as a BAS, the ultracapacitor captures regenerative brake energy and feeds it back into the power of the vehicle.

Energy-Dense Batteries

2017 is the year for hybrid batteries and Chevrolet's new Bolt model is giving all other brands stiff competition. With an EPS range of 238 miles on a single charge, it is the highest performing electric hybrid on the market. It is also priced very affordable at just $30,000 after tax incentives. (ref 16) In fact, brands like Chevy have made such strides with battery development, that the 2015 DOE Battery Cost Reduction Milestone of $275/kWh has been accomplished. (ref 17)

Batteries are a huge part of the cost of hybrid systems. One major cost-reduction opportunity is to make the Li-ion battery designs with a higher power density. (see figure 13) (on average about $1,375 for a 1.0 kWh Li-ion battery pack, based on the 2012 FEV cost report). (ref 18)

Figure 13



The objective of the program is to increase the energy density of the cell technology and drive down the cost to capacity ratio. So far, discharge power is already up over 20%. (see figure 14)

Version parameters and base & mid-program performance

Figure 14

Cell Type	Size	1C_Rate Capacity (Ah)	Energy Density (Wh/L)	Discharge Power (10s, 50%SOC) (W)	Discharge R (10s, 50%SOC) (mOhm)	P/E Ratio
USABC 4th Build (Last Program)	141x124x22.6	23.7	245	1510	1.99	17
Baseline New Program	148x91x26.5	27.0	275	1540	1.92	16
Mid-Program	148x91x26.5	33.3	345	1880	1.60	16
Final	148x91x26.5	36	375	TBD	TBD	TBD

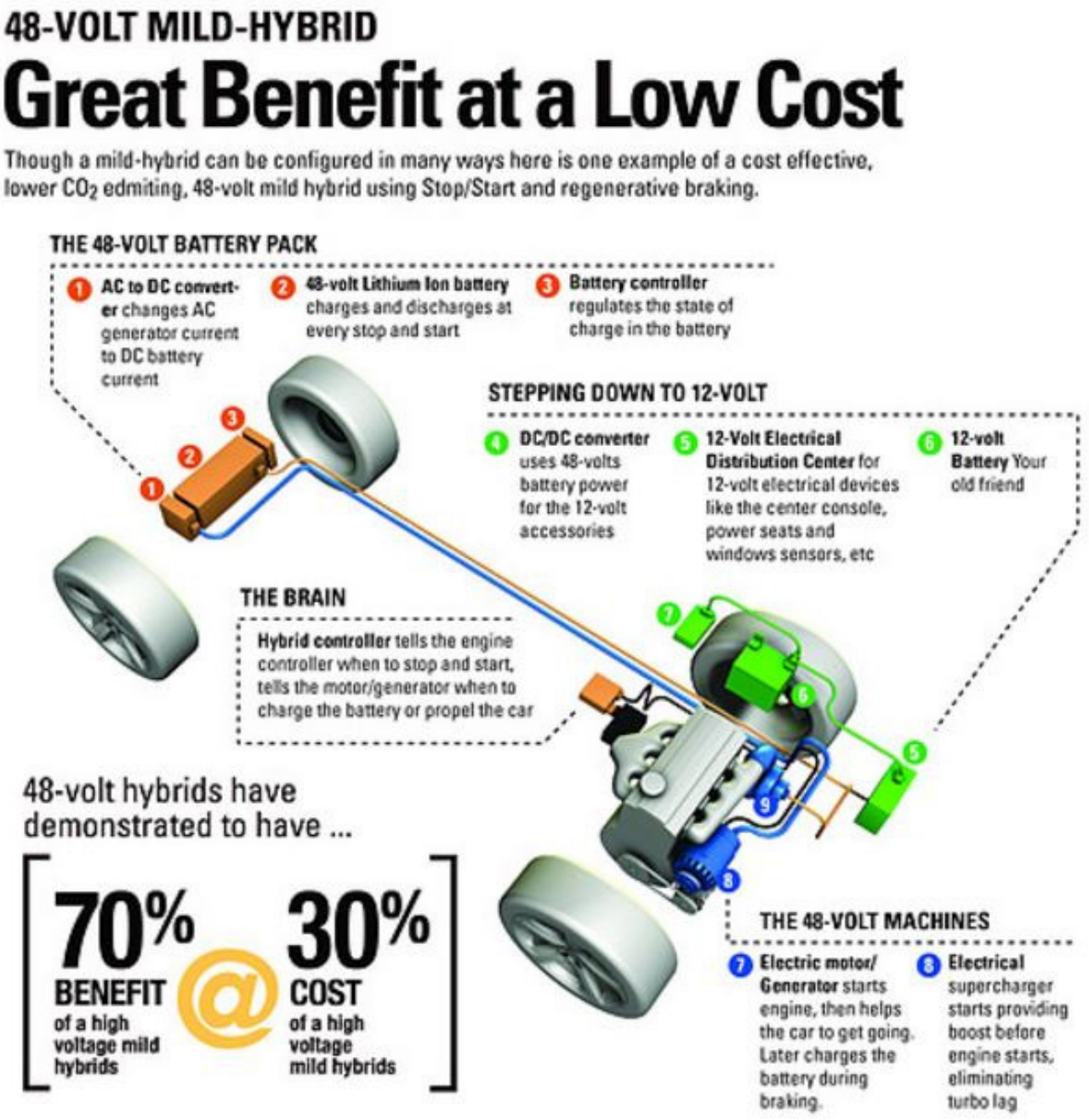
Hybrid models typically run nickel-metal hydride batteries which have very good reliability. The long-term track record for Lithium-ion has yet to be determined. Automakers are required to warranty the battery for 8 years or 80,000 miles in most states, and in some states, the time frame is 10 years or 150,000 miles. (ref 19)

48-Volt Electric System

Hybrid technologies are being developed for a 48-volt system that is so cost effective, price points could start at as low as $500 more than a base model. The system benchmarks features like shock absorbers that transfer energy to the engine, lightening fast dashboards, better performance, and improved fuel economy.

One of the primary advantages to a 48v system is that they can power an electric motor within a turbocharger (commonly referred to as an "e-boost"). (see figure 15) This, in turn, reduces lag and improves engine efficiency and response. The Bentley Bentayga luxury SUV is currently the only hybrid 48v vehicle sold in the U.S., but there is plenty of competition on the horizon.

Figure 15



E-Axles

Despite environmental consciousness, consumers still love their SUVs. With rising fuel economy standards, electrically powered axles are helping some hybrids gain traction. The Volvo XC90, the BMW i8, and the Toyota Rav4 hybrid are all models that offer this fuel-saving feature. The technology is simple. A rear electric powered axle is added to a front-wheel drive hybrid vehicle, which in turn improves performance while consuming less fuel. As 48v systems become more common, e-axles will soon follow.

Low Cost

Now that there is a multitude of tools at their disposal, manufacturers are still trying to figure out the best levels of hybridization for the best prices. This includes factors like:

Voltage level (12v-48v)
Energy storage (battery and ultracapacitor, NiMN, Li-ion)
Drive type (P2 or BAS configurations)

Less expensive hybrid systems have been waiting for the ongoing revolution in computer-aided design, computer simulations, and on-board computer controls. In fact, the revolution in computers is essential to developing lower cost hybrid systems.

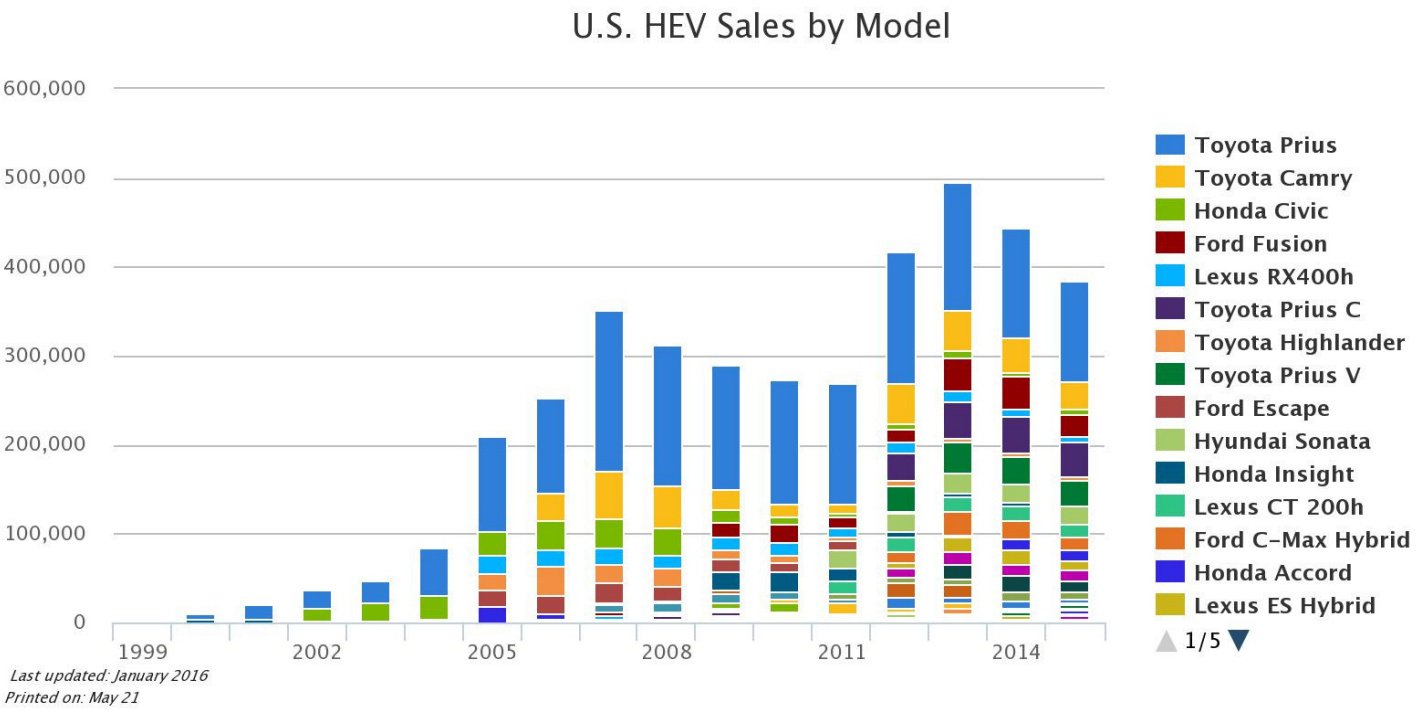
The revolution in computers is essential to developing lower cost hybrid systems.

As hybrid designs continue to multiply, assessing the cost of these variables can be difficult. This is a good sign as it demonstrates the market is shifting and innovating in order to meet the pricing demands of the consumer. The BAS system (designed by GM) is a prime example of this flexible development as it's affordability comes from simply replacing the alternator, rather than entire systems.

The low-cost experimentation goes like this: GM's first system in 2007 was the Saturn Vue Green. It used a 36v NiMH battery pack and a 5 hp electric motor. (ref 20) In 2012, after more development, a superior system called eAssist was introduced. GM increased the voltage from 36v to 115v, used a 0.5 kWh Lithium-ion battery instead of a NiMH battery, and improved the motor power from 5 hp to 20 hp for regeneration and 15 hp for assist. It also happened to be lower in cost.

THE MARKET

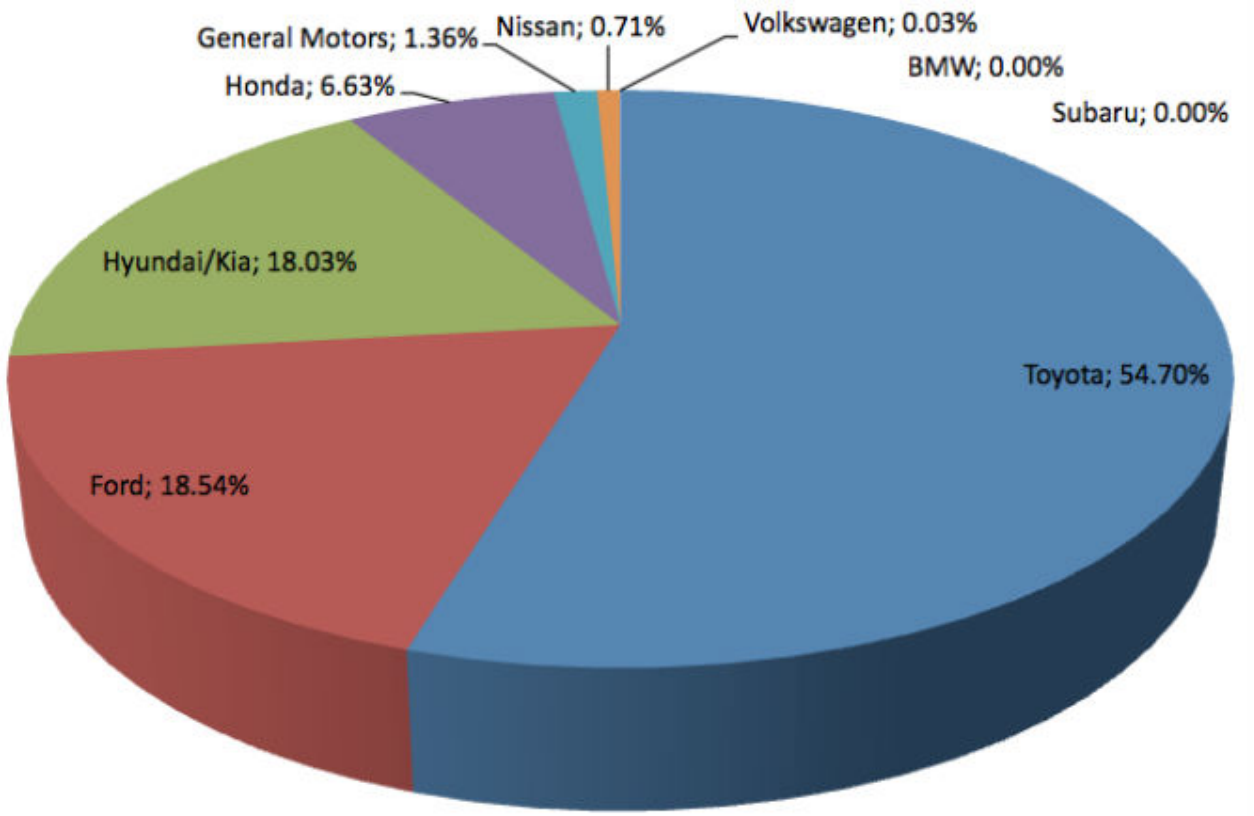
Figure 16



The hybrid market is nearly classified as mainstream. However, due to the decrease in gas prices over the past 2-3 years, the market share has fallen from 3.2% to just 2%. (see figure 2) Hybrid vehicles sales surged in 2005 with the concurrent tax breaks and peaked in 2013. The sales decline between 2008 and 2011 is consistent with the Great Recession and decline in vehicle sales.

As of April 2017, the brand leader in the United States still consistently remains as Toyota. (see figure 16 and 17) In 2015, sales for the Prius totaled over 1.6 million since it's introduction in 1997. (see appendix A)

Figure 17



April 2017 Hybrid Car Sales Numbers

The global hybrid market is typically segmented by type, energy source, and make/model.

- **TYPE:**

Series hybrid

Parallel hybrid

Plug-in hybrid

Series-Parallel hybrid

- ENERGY SOURCE:

ICE hybrids

Fuel cell hybrids

Solar hybrid

Natural gas hybrid

It is difficult to determine the tipping point at which hybrid systems become cheap enough for the mainstream consumer.

Competition from improvements in other powertrain technologies is creating a consumer-friendly market. Mild hybrid systems (which cost much less) will be able to compete directly against conventional technology improvements on a cost-benefit basis. Just a 10% reduction in the weight of some systems, can result in a cost decrease of 5%.

Advances in hybrid processes, like fuel cell technology, energy-dense batteries, and 48-volt systems, will eventually drive the cost of hybrids down—making them affordable for the majority of the population. As the types and makes of hybrid vehicles continue to expand, the advantages to the consumer follow suit.

The fuel-saving effectiveness of hybrid architecture goes beyond simply saving money. For every advancement we make in this green technology, we lessen our carbon footprint, making the environment a cleaner place for future generations...and that's what is truly at the heart of hybrid innovation.

APPENDIX A

Hybrid Electric Vehicle Sale by Model

Vehicle	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Toyota Prius	107,897	106,971	181,221	158,574	139,682	140,928	136,463	164,618	145,172	122,776	113,829	1,637,959
Toyota Camry		31,341	54,477	46,272	22,887	14,587	9,241	45,656	44,448	39,515	30,640	339,064
Honda Civic	25,864	31,251	32,575	31,297	15,119	7,336	4,703	7,156	7,719	5,070	4,887	234,048
Ford Fusion					15,554	20,816	11,286	14,100	37,270	35,405	24,681	159,112
Lexus RX400h	20,674	20,161	17,291	15,200	14,464	15,119	10,723	12,223	11,307	9,351	7,722	154,235
Toyota Prius C								30,838	41,979	40,570	38,484	151,871
Toyota Highlander	17,989	31,485	22,052	19,441	11,086	7,456	4,549	5,921	5,070	3,621	4,015	132,685
Toyota Prius V								28,450	34,989	30,762	28,290	122,491
Ford Escape	18,797	20,149	21,386	17,173	14,787	11,182	10,089	1,440				117,996
Hyundai Sonata							19,673	20,754	21,559	21,052	19,908	102,946
Honda Insight	666	722	0	0	20,572	20,962	15,549	5,846	4,802	3,562	1,458	86,669
Lexus CT 200h							14,381	17,831	15,071	17,673	14,657	79,613
Ford C-Max Hybrid								10,935	28,056	19,162	14,177	72,330
Honda Accord	16,826	5,598	3,405	196					996	13,977	11,065	53,124
Lexus ES Hybrid								7,027	16,562	14,837	11,241	49,667
Kia Optima Hybrid								10,245	13,919	13,776	11,492	49,432
Toyota Avalon Hybrid								747	16,468	17,048	11,956	46,219
Ford Lincoln MKZ						1,192	5,739	6,067	7,469	10,033	8,403	38,903
Chevy Malibu				2,093	4,162	405	24	16,664	13,779	1,018	59	38,204
Nissan Altima			8,388	8,819	9,357	6,710	3,236	103				36,613
Buick Lacrosse							1,801	12,010	7,133	7,353	4,042	32,339
Honda CR-Z						5,249	11,330	4,192	4,550	3,562	3,073	31,956
Lexus HS 250h					6,699	10,663	2,864	650	4			20,880
Mercury Mariner	998	3,174	3,722	2,329	1,693	890						12,806
Saturn Vue			4,403	2,920	2,656	50						10,029
Chevy Tahoe				3,745	3,300	1,426	519	533	376	65	8	9,972
Volkswagen Jetta Hybrid								162	5,655	1,939	740	8,496
Nissan Infiniti Q50									307	3,456	4,012	7,775
Lexus GS 450h		1,784	1,645	678	469	305	282	615	522	183	91	6,574
Buick Regal							123	2,564	2,893	662	186	6,428
GMC Yukon				1,610	1,933	1,221	598	560	288	31	10	6,251
Cadillac Escalade				801	1,958	1,210	819	708	372	41	7	5,916
Chevrolet Sierra/Silverado					1,598	2,393	1,165	471	104	24	2	5,757
Subaru XV Crosstrek											5,589	5,589
Nissan Pathfinder Hybrid									334	2,480	2,245	5,059
Nissan Infiniti QX60									676	1,678	2,356	4,710
Porsche Cayenne						206	1,571	1,180	615	650		4,222
Lexus NX Hybrid										354	2,573	2,927
Mercury Milan					1,468	1,416						2,884
Acura ILX Hybrid								972	1,461	379	22	2,834
Lexus LS600hL			937	907	258	129	84	54	115	65	47	2,596
Nissan Infiniti M35h							378	691	475	180	176	1,900
Saturn Aura			772	285	527	54						1,638
Audi Q5 Hybrid								270	854	283	97	1,504
Toyota RAV4											1,494	1,494
BMW ActiveHybrid 3 (335ih)								402	905	151	30	1,488
Mercedes S400						801	309	121	64	10	1	1,306
Mazda Tribute						570	484	90				1,144
BMW ActiveHybrid 5 (535ih)								403	520	112	12	1,047
Chevy Impala Hybrid									56	565	272	893
VW Touareg Hybrid							390	250	118	30	16	804
BMW ActiveHybrid 7						102	338	230	31	45	25	771
Porsche Panamera S							52	570	113			735
Mercedes ML450h						627	1	22	11	20	10	691
Mercedes E400H									282	158	53	493
Acura RLX										133	250	383
BMW X6						205	43	3				251
Chrysler Aspen				46	33							79
GMC Sierra									65	6	1	72
Dodge Durango					9							9
TOTAL	209,711	252,636	352,274	312,386	290,271	274,210	268,807	434,344	495,534	443,823	384,404	3,915,883

REFERENCES

[1] "Annual Energy Outlook 2017." U.S. Energy Information Administration. www.eia.gov/outlooks/aeo/data/
[2] "Hybrid Sales Rising Globally, Say Toyota." HybridCars.com. http://www.hybridcars.com/hybrid-sales-rising-globally-says-toyota/
[3] German, John. "Hybrid Vehicles: Technology Development and Cost Reduction." International Council on Clean Transportation. http://www.theicct.org/sites/default/files/publications/ICCT_TechBriefNo1_Hybrids_July2015.pdf
[4] Berman, Brad. "History of Hybrid Vehicles." hybridcars.com. http://www.hybridcars.com/history-of-hybrid-vehicles/
[5] Cobb, Jeff. "Americans Buy Their Four-Millionth Hybrid Car." hybridcars.com. http://www.hybridcars.com/americans-buy-their-four-millionth-hybrid-car/
[6] FERC.gov. https://www.ferc.gov/enforcement/enforce-res/EPAct2005.pdf
[7] Cobb, Jeff. "Americans Buy Their Four-Millionth Hybrid Car." hybridcars.com. http://www.hybridcars.com/americans-buy-their-four-millionth-hybrid-car/
[8] German, John. "Hybrid Vehicles: Technology Development and Cost Reduction." International Council on Clean Transportation. http://www.theicct.org/sites/default/files/publications/ICCT_TechBriefNo1_Hybrids_July2015.pdf
[9] "Hybrids 101: Guide to Hybrid Cars." Consumer Reports. http://www.consumerreports.org/hybrids-evs/hybrids-101-guide-to-hybrid-cars/
[10] German, John. "Hybrid Vehicles: Technology Development and Cost Reduction." International Council on Clean Transportation. http://www.theicct.org/sites/default/files/publications/ICCT_TechBriefNo1_Hybrids_July2015.pdf
[11] German, John. "Hybrid Vehicles: Technology Development and Cost Reduction." International Council on Clean Transportation. http://www.theicct.org/sites/default/files/publications/ICCT_TechBriefNo1_Hybrids_July2015.pdf
[12] Deign, Jason. "Ultracapacitor Makers Look to Micro-Hybrid Vehicles for Growth." https://www.greentechmedia.com/articles/read/ultracap-makers-look-to-micro-hybrid-vehicles-for-growth
[13] Toyota Mirai. https://ssl.toyota.com/mirai/fcv.html
[14] IDTechEx. http://www.idtechex.com/research/reports/fuel-cell-electric-vehicles-2017-2027-land-water-air-000515.asp
[15] Fuelsaver25.com
[16] Miller, Mark. "Hottest Car Technology Trends for 2017." Bid Network Online. https://bno.com/blog/hottest-car-technology-trends-for-2017
[17] IdTechEx. "Hybrid and Electric Systems." http://www.idtechex.com/research/articles/hybrid-and-electric-systems-r-d-at-the-u-s-doe-00009676.asp
[18] Energy.gov https://energy.gov/sites/prod/files/2014/05/f15/APR13_Energy_Storage_d_III_Adv_Battery_Dev_0.pdf
[19] Consumer Reports. http://www.consumerreports.org/hybrids-evs/hybrids-101-guide-to-hybrid-cars/
[20] https://www.coursehero.com/file/p6v32d8/A-much-improved-system-called-eAssist-was-introduced-in-the-2012-Buick-LaCrosse/
[21] Hyrbidcars.com. http://www.hybridcars.com/americans-buy-their-four-millionth-hybrid-car/
[22] German, John. "Hybrid Vehicles: Technology Development and Cost Reduction." International Council on Clean Transportation. http://www.theicct.org/sites/default/files/publications/ICCT_TechBriefNo1_Hybrids_July2015.pdf

Figure A US Dept of Energy
Figure 1 Wikipedia.com
Figure 2 Pira Energy Group
Figure 3 Carsdirect.com
Figure 4 Toyota Europe
Figure 5 Applied Science
Figure 6 Pearson
Figure 7 Hybridcars.com
Figure 8 Hybridcars.com
Figure 9 Forbes
Figure 10 eia.gov
Figure 11 eia.gov
Figure 12 eia.gov
Figure 13 energy.gov
Figure 14 energy.gov
Figure 15 gas2.org
Figure 16 US Dept of Energy
Figure 17 Hybridcars.com