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THE SELF-DRIVING CAR REPORT: Forecasts, tech timelines, and the benefits and barriers that will impact adoption

John Greenough | May 27, 2015



BUSINESS INSIDER

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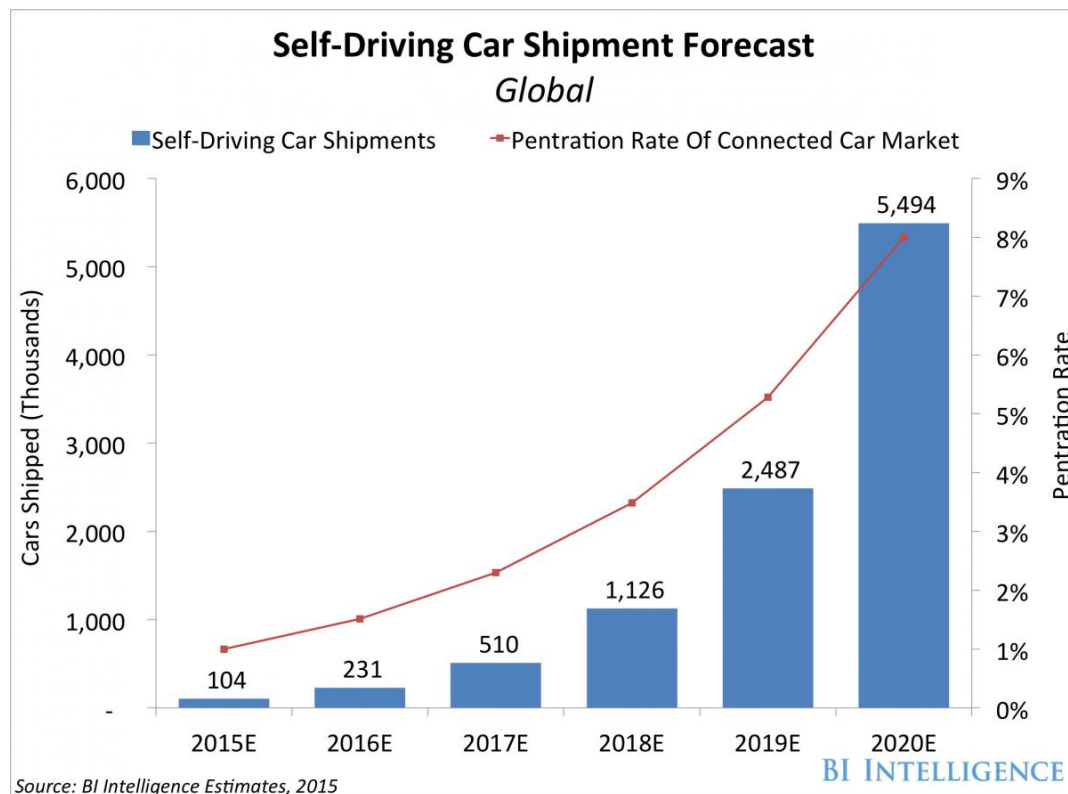
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Key Points

- **Self-driving cars are not some futuristic auto technology; in fact there are already cars with self-driving features on the road.** Our estimates show that there will be 104,000 self-driving cars shipped this year. We define the self-driving car as any car with features that allow it to accelerate, break, and steer a car's course with limited or no driver interaction.
- **By 2020, more self-driving capabilities will come to market and prices will drop.** By the end of the forecast period, we expect there will be about 5.5 million cars shipped globally with self-driving capabilities, representing a five-year CAGR of 88%.
- **We divide the self-driving car into two different types: semi-autonomous and fully autonomous.** A fully autonomous vehicle can drive from point A to point B and encounter the entire range of on-road scenarios without needing any interaction from the driver. These will debut in 2019.

- **Fully autonomous cars are further divided into user-operated and driverless vehicles.** Because of regulatory and insurance questions, user-operated fully autonomous cars will come to market within the next five years, while driverless cars will remain a long ways off.
- **The biggest benefits of self-driving cars are that they will help to make roads safer and people's lives easier.** In the UK, KPMG estimates that self-driving cars will reduce 2,500 deaths between 2014 and 2030.
- **But the barriers to self-driving cars remain significant.** Costs need to come down and regulations need to be clarified, especially as concerns insurance liability, around certain self-driving car features before the vehicles fully take off among mainstream consumers.

[Download the charts and data in Excel »](#)



The self-driving car market forecast

Self-driving cars are often portrayed as a futuristic technology, but there are actually already cars with self-driving capabilities on the road and out of testing.

We define the self-driving car as any car with features that allow it to accelerate, break, and steer a car's course with limited or no driver interaction.

It's important to note there are many different levels of self-driving car.

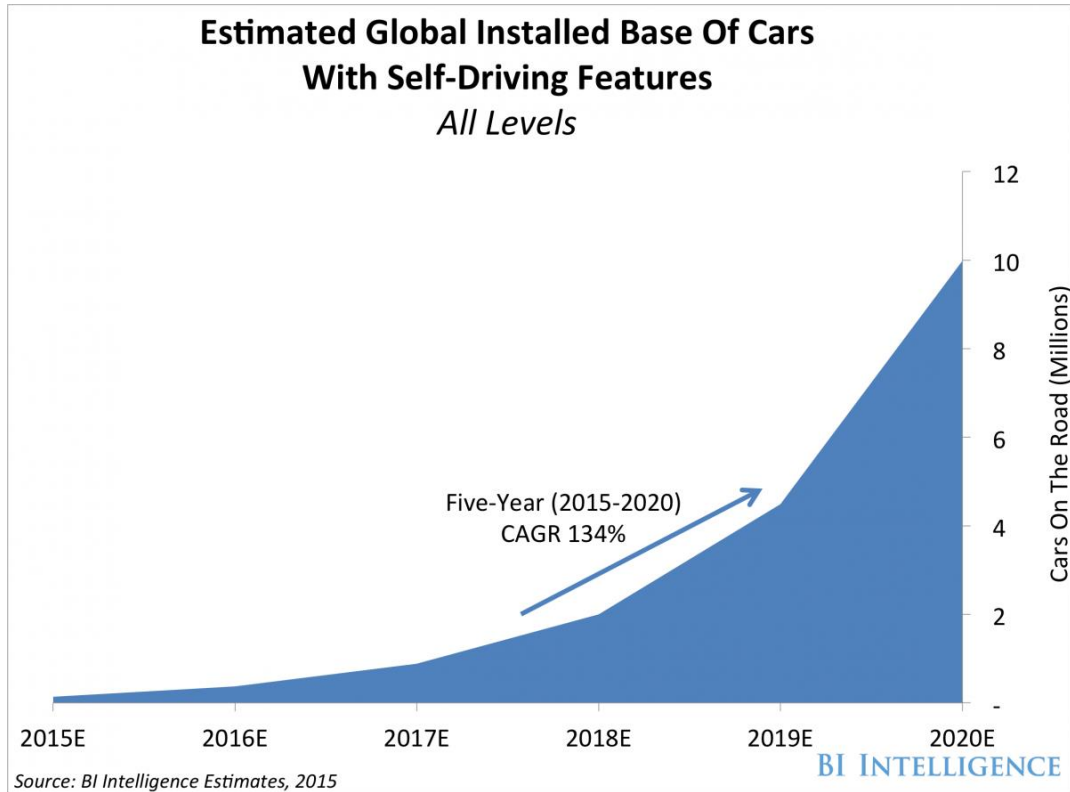
At its most basic, a self-driving car offers an extension of cruise control — the driver does not need to manage the steering wheel, accelerator, or brakes as long as she is staying in the same lane. Once the car needs to change lanes, though, and account for other conditions on the road, the driver must take over.

Later iterations of the self-driving car will move beyond single-lane driving and the car will be able to switch lanes at the driver's request or according to the car computer's own assessment of conditions. We discuss the full spectrum of the self-driving car in the next section.

Currently, sales forecasts for the self-driving car are relatively low. This is primarily because many analysts are worried about self-driving car capabilities' associated cost, regulatory barriers, and consumer perception. However, after completing an analysis of both the connected car and self-driving car markets, speaking with executives at various firms, and examining the current technologies, we have determined that in fact, cars with some self-driving features are already available in select markets, and that wider adoption is only a few short years away.

- **Our estimates show that 104,000 cars with self-driving capabilities will be shipped this year.**
- **By 2020, shipments will grow to 5.49 million, rising by a compound annual growth rate (CAGR) of 89%.** These estimates include cars and trucks shipped to both enterprises and consumers.

- The installed base of cars with self-driving features will grow even faster, from 140,000 this year to just under 10 million in 2020, up by a CAGR of 134%.



The levels of a self-driving car

Many cars available today already have features, such as lane assist and valet parking, that will serve as the building blocks for a self-driving car. These features, combined with mapping technology and an internet connection, will help turn the car into a basic self-driving vehicle. Internet-enabled safety features already respond to conditions on the roads, by slowing down in traffic or assisting with parallel parking. Now, capabilities will begin to advance from reactionary features to self-directed features that allow the car to make decisions continuously in order to get from one location to another without driver interaction.

Cars with self-driving features have a range of capabilities.

On one side of the spectrum are semi-autonomous vehicles that are able to drive themselves in certain specific situations according to very specific capabilities.

On the other end of the spectrum are the fully autonomous self-driving cars that can drive from one location to another while navigating a wide range of on-road situations.

Here are the different levels of semi-autonomous self-driving capabilities and the order in which we expect these technologies to come to market:

- LEVEL 1 - Stop & Go Autopilot:** This was one of the first self-driving features to debut and is offered in the majority of cars in our self-driving car forecast. The capability enables cars to drive themselves in traffic jams by monitoring the lane ahead and stopping and accelerating in traffic. It's currently offered by a few luxury car brands, including Mercedes and Tesla. Additionally, the Cadillac CTS is scheduled to have the feature in 2017.
- LEVEL 2 - Remote Valet Assistant:** This refers to a car that can be beckoned via a smartphone or smartwatch application without anyone in the actual car; it can drive itself to the car's owner within small confines, for example in a parking garage or on non-public land. This is particularly helpful for private, large parking garages and in cold weather scenarios when a user does not want to walk to their car. However, due to regulations, the feature, which is essentially driverless, is only allowed in private spaces that have sanctioned them. BMW showcased the technology at this year's Consumer Electronics Show but gave no timetable for when it will be made available. We expect it will be offered as a very expensive add-on that consumers can opt for in 2016 or 2017 BMW i-series electric car models.
- LEVEL 3 - Highway Autopilot With Lane-Changing:** This feature enables the car to monitor the environment around it, locating nearby cars, tracking weather/road conditions, and following speed limits. Additionally, the car uses blind-spot technology to shift lanes

when the driver indicates she would like to move over. Tesla showcased this feature on their Model S vehicle but it likely won't come to market until between 2016 and 2017. The Model S can shift from one lane to another when the user touches the turn signal. The car will then drive itself over when the other lane is clear. It's important to note that these cars do not choose to switch lanes based on the car's own reading of the environment; a user must first indicate a desire to change lanes.

Based on our analysis, we believe that cars offering remote valet assist and highway autopilot with lane changing will be offered at roughly the same time.

Following the debut of highway autopilot with lane-changing, automakers will move beyond semi-autonomous cars to finally introduce fully autonomous vehicles.

Fully autonomous cars can drive from point A to point B and encounter the entire range of on-road scenarios without needing any interaction from the driver.

There are two levels of fully autonomous cars:

- **LEVEL 4 - User-Operated:** For these cars, there is still a driver behind the wheel. However, the driver has the option of pushing a button to have the car drive itself. The car can then turn, change lanes, and navigate between two distant locations without driver interaction. Nissan has told us that they plan on releasing a vehicle with this capability by 2020.

It's important to note that because fully autonomous cars rely heavily on mapping technology to pinpoint where the driver is and where to go, users will have to take over these vehicles when an internet connection is lost, for example in rural environments. This is one of a number of reasons why the next level of self-driving car — the level 5 driverless car — is still well over five years away from coming to market.

- **LEVEL 5 - Driverless:** Because of Google's testing of driverless cars, this is the image of the self-driving car most people have in their heads. These cars don't require a steering wheel or a driver behind the wheel. They are only expected to come to market after 2020.

The primary difference between user-operated and driverless cars is that one requires a driver in the driver's seat and the other does not.

Google is a pioneer of fully autonomous self-driving cars. Currently, it has 23 cars in its fleet that are fully autonomous and have logged nearly 1 million miles on the road. The majority of its fleet is existing cars that have been retrofitted with sensors and other technology that makes fully autonomous driving possible. But, despite Google's association with driverless cars, these cars are actually considered user-operated because there is a safety driver behind the wheel in case they need to take over in an emergency.

In addition, Google has prototype driverless cars with a removable accelerator, brake, and steering wheel. These cars are coming to public roadways for testing this summer but regulations will require that the cars still have a driver behind the wheel and that the driver has the option of operating the accelerator, brake, and steering wheel. Still, the cars could, in theory, navigate themselves on roadways without a driver. Regulations are the only things standing in the way of this.

We foresee fully autonomous vehicles coming to the market faster than most people expect. However, we expect that the vast majority will fall into our user-operated category: They will have steering wheels and require drivers.

We expect the first user-operated fully autonomous vehicles will be trucks. The tech in these vehicles will help to keep truck drivers safer on longer drives (e.g., a driver who falls asleep at the wheel is less of a concern), and will increase their up-time. Daimler, for example, recently showcased their first self-driving truck in Nevada. After fully autonomous self-driving trucks come to market we believe that passenger vehicles will be next.

We expect a similar progression for driverless cars. Truck companies will use them first, followed by ride-sharing/taxi companies like Uber, which has already partnered with Carnegie Mellon University to build a self-driving car. We think Uber will eventually launch a driverless car. Closely following the launch of taxi/ride sharing driverless cars, we expect driverless cars to come to the consumer market.

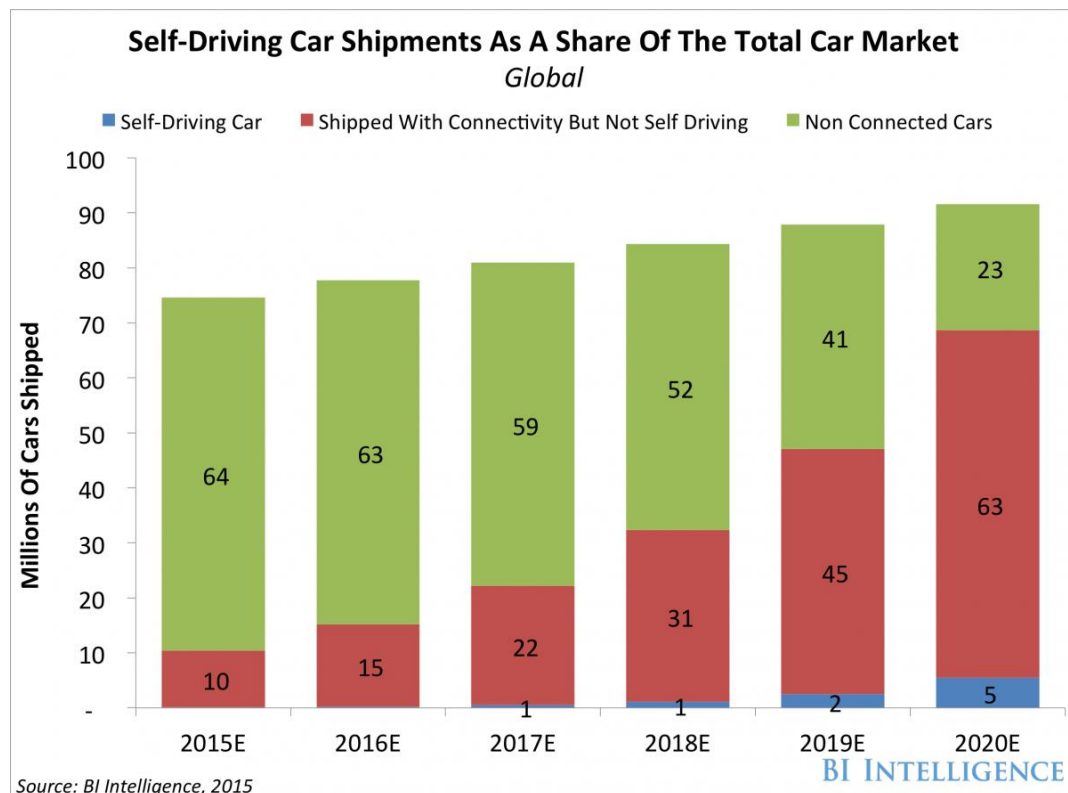
There are a few reasons why user-operated fully autonomous vehicles will take off much faster than driverless cars:

- **Insurance concerns:** If there is an accident, the insurance company will look for who is liable — is it the driver or the company that provided the fully autonomous car? Car companies will likely try to push the liability to the owner of the vehicle, something that will be easier to do if there is still an individual behind the wheel who could have taken control of the vehicle. The car company executives we have spoken to have told us this is a major barrier to driverless cars and something that regulators must figure out in the near future.
- **Regulations:** Related to insurance concerns are questions around who will be charged with a crime when a driverless car is at fault. Because law enforcement would need to find someone at fault in any case in which a self-driving car hit another vehicle, governments will likely require a driver behind the wheel for a long time to come.
- **Internet availability:** Fully autonomous cars will need to be connected to the internet to run; otherwise, they won't know where to go. However, the internet is not available in many areas. Therefore, car makers will have to give the driver the ability to drive the car themselves when in areas that don't have available internet connection.
- **Consumer reluctance:** The final reason that driverless cars are still a long way off is that people don't want to give up control over their car. Car company executives have told us that they want to give their customers the ability to drive their cars because that's a primary selling point — people like driving and want to retain control. In addition,

consumers still believe having a car that can be taken over by a driver is safer than having a car where this is impossible.

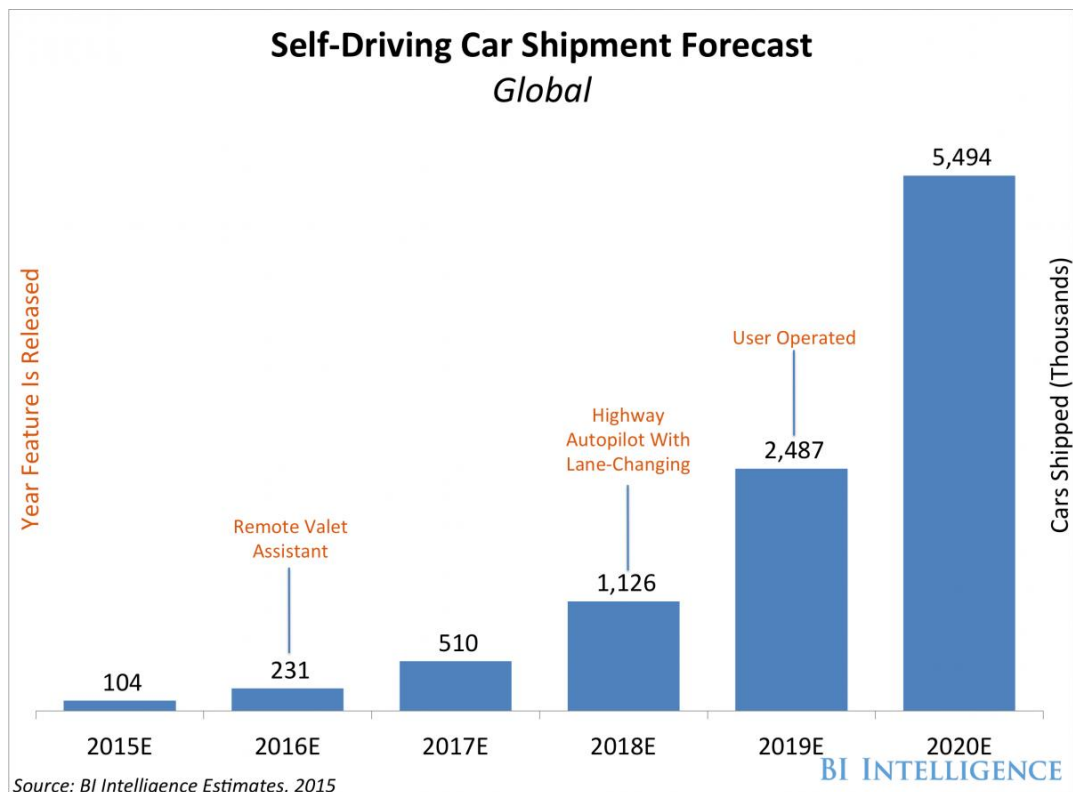
Timeline for the rollout of self-driving car capabilities

We believe that cars with one of our defined levels of self-driving capabilities will only make up a small portion of the connected car market this year. **However, by 2020, our estimates show that self-driving capabilities will be installed in nearly 6% of cars shipped.**



- Level one semi-autonomous self-driving cars first debuted in 2013. Electric vehicles were the first cars to include this feature since electric car consumers tend to be tech savvy and high-income.

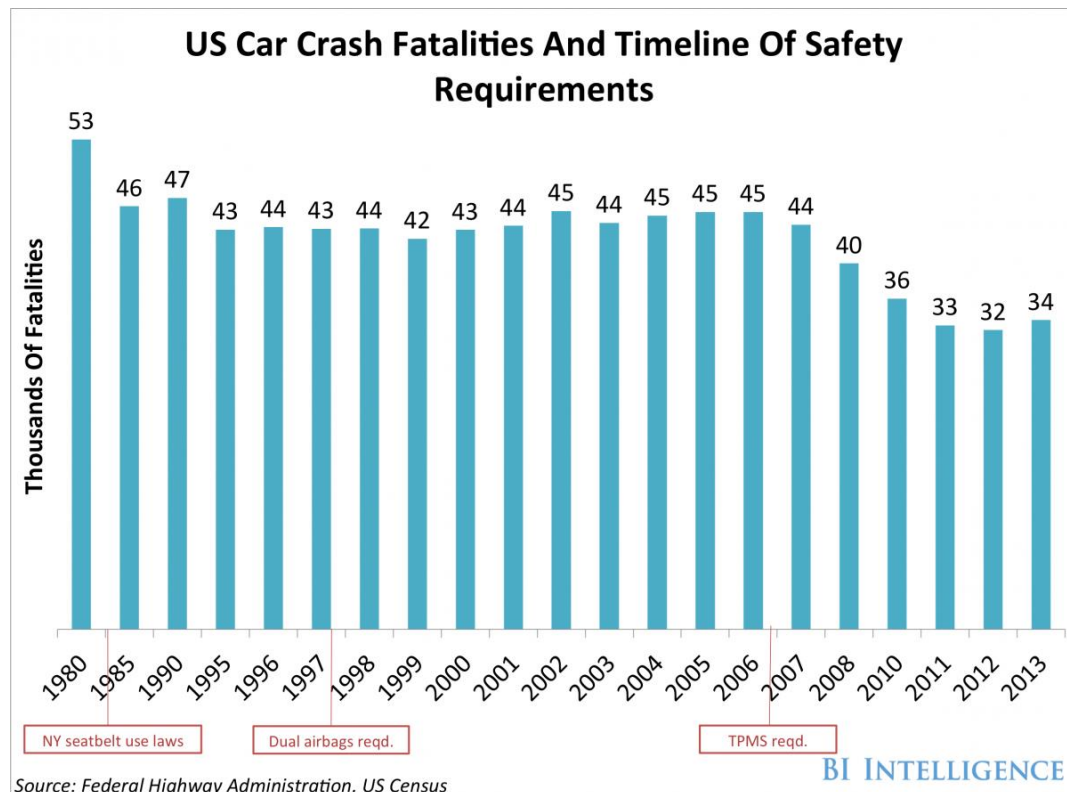
- Level 2 and 3 capabilities will debut around 2016 and 2017, followed by the first fully autonomous user-operated cars coming to market in 2019.
- By 2020, prices will drop, economy vehicles will begin to have self-driving features installed, and the range of self-driving features installed in car models will increase.
- As previously discussed, we don't believe level 5 driverless cars will be available within the next 5 years. However, we see driverless trucks coming to roadways in 2021 or 2022. Taxis will likely follow in 2023 and in the mid- to late 2020s we expect a driverless car will be available to consumers.



Benefits of the self-driving car

There are some very clear benefits to bringing self-driving capabilities to cars. Ultimately these benefits will help spur adoption over the next five years.

The largest benefit is that self-driving technology makes driving safer.



Over the last 30 years, cars have become much safer with the introduction of advanced seat belts, anti-lock braking systems, and more.

Carmakers have recently capitalized on sensor technology to advance car safety further, introducing technology such as front and rear collision avoidance — reactionary capabilities that are building blocks towards self-driving car features.

As more robust self-driving car features like these come to market, many expect safety on the road to improve dramatically.

Collisions are largely caused by human error — 94% in the US, according to the [National Highway Traffic Safety Administration](#). In the UK alone, self-driving cars will reduce traffic fatalities by 2,500 between 2014 and 2020, according to a 2015 study from KPMG. To put that in perspective, in 2013 there were 1,713 deaths caused by car crashes in the UK, meaning the number could drop by more than 150 deaths per year. Presumably accidents that cause more minor injuries will also be reduced after self-driving cars debut on the road.

But despite the potential safety benefits of self-driving cars, self-driving capabilities are unlikely to be mandated any time soon, at least in the US. The first passenger car with an airbag was released in 1973. However, it took 17 years before it was mandated across all vehicles in the US. We believe that self-driving technology that helps to prevent crashes will eventually be mandated similar to airbags. But for this to happen, the price of the technology must drop to a low enough point that it won't economically hurt the automaker, or significantly increase the price of the car. This could easily take between twenty and thirty years.

The next benefit of self-driving cars is that they make drivers' lives easier.

OEM executives we have spoken to believe that one of the most unpleasant parts of the driving experience is commuting and waiting in traffic. On average, Americans spend 38 hours a year stuck in [traffic](#). Self-driving features will help to reduce the amount of active driving people have to do, as well as reducing traffic congestion when the cars reach widespread adoption. When the vast majority of cars have self-driving features, traffic should be greatly reduced.

Self-driving cars could also be good for the environment and help reduce gas bills.

The Intelligent Transportation Society of America believes that intelligent transportation systems could reduce oil consumption and greenhouse gas emissions by 2%-4% over the next ten years.

Barriers to self-driving car adoption

Regulations are the biggest barrier to self-driving car adoption and a gray area in most countries right now.

For either semi or fully autonomous self-driving vehicles to become widely available, regulations will need to be put in place that address what types of self-driving capabilities are allowed on the road and who is responsible if the vehicles crash.

Currently, most regulations around the world seem to imply that as long as there is a driver behind the wheel of a car with self-driving capabilities, the car can be on the road. The reason a driver is so critical is because then there is someone to fault if the vehicle were to crash. In the US, regulations follow insurance policies, which are implemented on a state-by-state basis, meaning that in the future you might be allowed to drive a self-driving car in California, but you couldn't cross the border into Nevada.

Unsurprisingly, regulations will likely vary depending on the self-driving capability. For example, remote valet parking is a self-driving feature that we expect to debut next year, but even though it is a semi-autonomous feature, it is also driverless, making it more likely to be closely regulated.

Based on conversations we have had, we expect consumers will only be allowed to use Remote Valet Assistant features in privately owned spaces, such as a privately owned parking garages that let the owner of the vehicle beckon their car. However, no regulations have addressed who would be at fault if the car were to crash. Despite this, we believe at least one country, or US state, will allow the capability in private spaces by sometime next year.

One self-driving car company executive told us that he believes driverless cars will likely come to nations that are generally quick to make regulatory decisions.

There have been a few proposals for insurance legislation governing fully autonomous driverless cars.

- The RAND Corporation has suggested a no-fault auto insurance system, where the injured party's insurance pays for damages regardless of who's at fault.
- The Insurance Information Institute has said that another option is to create a system similar to the National Childhood Vaccine Injury act, a program that offers money to those who have had an adverse reaction to a vaccine. In the case of self-driving cars, there would be a fund set up to pay anyone injured by a self-driving car. Presumably the assumption is that insurance costs overall will go down if self-driving cars are proven safe, and the insurance fund will help mitigate consumer fears around having the vehicles on the road.

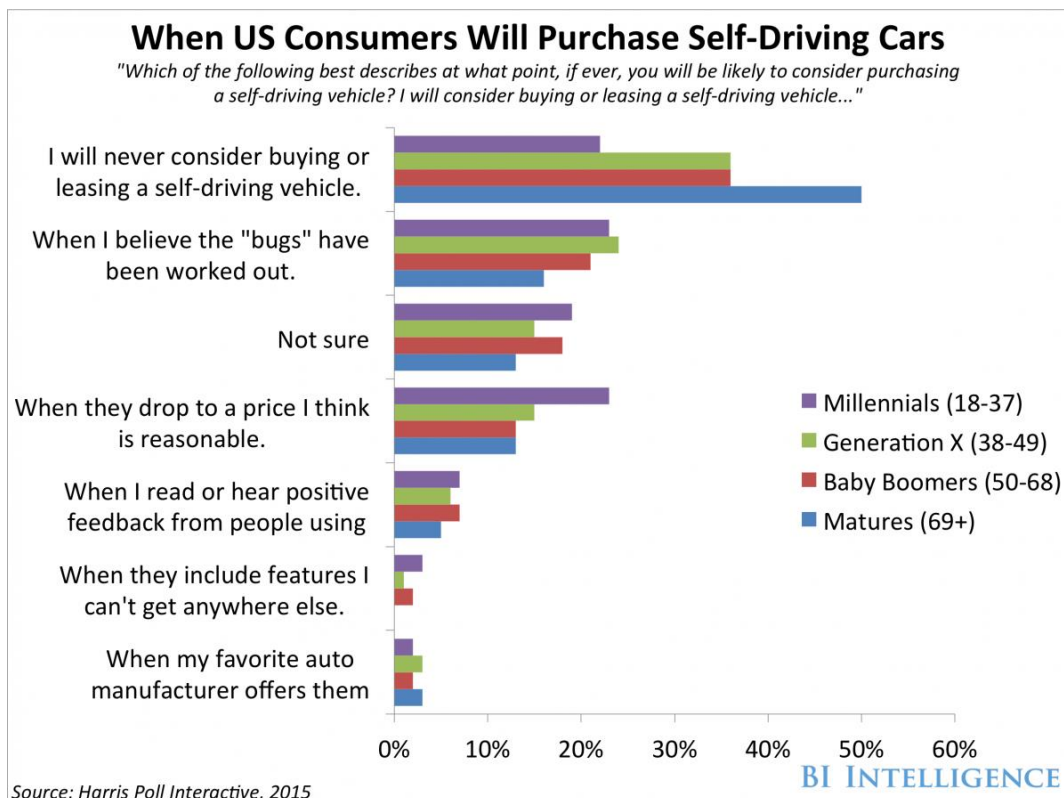
Cost is the second major barrier to self-driving car adoption.

There will likely be an added cost for buyers when purchasing a self-driving car with either semi-autonomous or fully autonomous features. For Stop & Go Autopilot, for example, the added cost is roughly \$3,000 for the customer. However, over the next few years, we expect that price to drop, as it will for other self-driving features in the years after they debut.

Other features will likely cost the driver between \$1,000 and \$10,000 based on the level of technological sophistication required. In our view, we expect electric vehicle customers to pay for self-driving features first because these individuals are often tech-savvy and high-income. Next, we expect luxury vehicle owners to opt for self-driving car features in new cars. Finally, when the prices of the features drop further, they will likely be purchased by economy class vehicle customers. Presumably those most interested in safety will opt for these features first.

Consumer reluctance is another barrier to adoption, although this barrier will certainly lessen dramatically over time.

- 33% of all adults said they would never consider buying or leasing a fully autonomous vehicle, according to a Harris Poll that defined the self-driving car as "a car, truck, or SUV capable of navigating without or with limited human input."
- Not surprisingly, older generations reported a much higher aversion to buying/leasing a fully autonomous car than younger generations.
 - 22% of millennials (ages 18-37), 36% of both Generation X (ages 38-49) and Baby Boomers (ages 50-68), and 50% of Matures (ages 69+) said they would never buy/lease a fully autonomous vehicle.
- 22% of respondents said that when the "bugs" have been worked out, they would consider buying a fully autonomous car.
- Millennials are more concerned about the price of the fully autonomous car than consumers in other age brackets. 23% of millennials said they would purchase a self-driving car when the price drops.



THE BOTTOM LINE

- There will be 231,000 self-driving cars shipped this year. We define the self-driving car as any car with features that allow it to accelerate, break, and steer a car's course with limited or no driver interaction.
- By 2020, we expect there will be about 5.5 million cars shipped globally with self-driving capabilities, representing a five-year CAGR of 88%.
- We divide the self-driving car into two different types: semi-autonomous and fully autonomous. User-operated fully autonomous cars will first come to market in 2019.
- The biggest benefits of self-driving cars are that they will help to make roads safer and people's lives easier.
- But costs need to come down and regulations need to be clarified around certain self-driving car features before the vehicles fully take off among mainstream consumers.

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