The Third Renaissance of the Electric Car?

Why this time it may stay for good.

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Abstract

Ever since the automobile occurred there were electric vehicles. Guided by the question why the electric vehicle lost against the gasoline car, reappeared several times only to vanish again, this paper explores the reasons for these disappearances and asks the question, if the most recent reappearance might be the one that finally will bring the breakthrough for the electric vehicle.

1. Introduction

At first glance, the current development in the automotive industry, led by Tesla, BMW, Nissan and others, might look as a revolution of how cars are built. At a second glance, it shows, however, that this is no revolution at all. Current events represent merely what I will call the third renaissance of the electric vehicle since the invention of the automobile by Carl Benz over a hundred years ago.

What are the reasons for the repeated appearances of the electric car? Why is the gasoline car with its internal combustion engine is so ubiquitous today?

In this first chapter, I will give a short sketch of the history of the electric vehicle and present answers to these questions by taking a look at the first, second and third appearance of electric cars in the automobile world. I will then briefly introduce two examples of electric cars, the BMW i3 and the Tesla Model S. Both run electric powered engines but have very different philosophies behind them.

2. Gasoline versus Electric

When automobiles – gasoline as well as electric – first appeared at the beginning of the 20th century, they were not seen as a new mode of transportation and travel; this role belonged to the horse. The automobile was rather seen as an adventure, a machine to venture out of the city with, to explore the frontiers; both the machine's and the American. Here the gasoline car had a natural advantage over its electric rivals. It was loud, it was heavy, it was smelly, and it was easily refueled, which means it had significantly longer range. *The stuff adventures are made from.*[1] This led to a preference of gasoline vehicles over the electric ones.

However, the tipping point towards the gasoline vehicle came not until the First World War, when the US Army decided to support their fighting forces with diesel trucks. The increased demand and production of gasoline trucks by far outweighed the number of electric trucks operating on the free market of the United States at that time. Furthermore, many people released of service after the war were accustomed to diesel trucks were skilled in operating and maintaining these machines. It is important to mention that electric trucks to that point had lower operating cost, easier control and greater overall reliability than their combustion engine counter parts. But with the army's decision for diesel trucks, electric trucks at that time were pushed out of the market through scale, not superior technology.[2] That meant the first end of the era of the electric vehicle.

The second reappearance, and therefore the first renaissance, shortly came after the Second World War, when economy was flourishing, people where moving out of

[1] see: Mom, Gijs, 2013. p. 280.

[2] see: Mom, Gijs, 2013. p. 285

the cities and into the suburbs. For the first time, people had the need and purchasing power for a second car. Manufacturers advertised electric vehicles as the ideal second car, the ideal *housewife car*, clean, silent, elegant.

Unfortunately, gasoline cars by that time had become somewhat omnipresent, already filling every niche. The man as head of the family was already accustomed to that type of car. Also, the electric vehicle still had one major disadvantage compared to the gasoline car: range. Gijs Mom perhaps summarized this best when writing: "The gasoline car had become a multifunctional vehicle that appealed to the taste of a growing middle class market, only because the motorist occasionally wanted to use it for touring."[3]

The third reappearance and second renaissance came in the mid 1990s when the California Air Resource Board passed the Electric Car Mandate. It was a law designed to tackle increasing air pollution in Californian cities in order to protect the population and the environment. The law forced car manufacturers to invest heavily into electric vehicle research programs and to build these cars. General Motors was the most successful company, bringing the EV1 to California, a small two seater with an eye-pleasing timely design that ran up to 120 mile with one charge. The car could be charged easily at home or at work.

However, General Motors did not *sell* the car in California, it was only leased to people. At the same time, the car manufacturers fought the Electric Car Mandate in Californian and federal courts, arguing that a shift from oil to coal as primary energy source for cars would result in more coal power plants, which are even more hazardous than gasoline cars. Also electric cars were too expensive to manufacture, resulting in higher selling prices. They were therefore only an option for wealthy people who had the purchasing power to afford an electric vehicle as a secondary or tertiary car. As a primary car, electric vehicles were unfit and too expensive. It is obvious today, that car manufacturers simply had no interest in building electric vehicles at the time. Perhaps the automotive industry's resistance is best shown in the quote by Ford Thik Group engineer John Wallace when he said: "God doesn't want us to have full-functioning electric vehicles. The laws of nature don't allow this."[4] In April of 2003, the Electric Car Mandate was revoked and the electric vehicles once again vanished from roads and manufacturing lines.[5]

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[3] see: Mom,Gijs, 2013. p. 281–282.

[4] Wallace, John. Ford Think Group, 2000, in: *The Electric Vehicle*, Mom, Gijs. p. 275.

[5] see: Paine, Chris. 2006.

3. The Third Renaissance of the Electric Vehicle?

As we have seen in the previous chapter, the electric vehicle was already at our grasp more than once in the past. And even though it was in no way inferior –except for range – to the gasoline car, it was unable to reach significant amounts of market share in order to matter. Given that historic context, it seems the reappearance of electric cars is something similar to an economic law; every 20 to 30 years they appear for a couple of years, only to shortly afterwards fall back into the abyss they all so suddenly emerged from.

This justifies the following question: What has changed in order to think that electric vehicles this time actually may have a chance to stay for good? The answer to that question lies in different aspects; technical, sociological, environmental, and economical ones. In the following, I will state five aspects.

3.1. What is Different Today?

The biggest difference between electric and gasoline powered vehicles is the way their engines work. Gasoline cars have many moving parts, liquids are filled in, gas is exhausted. If a driver accelerates, one can hear and feel the corresponding engine's reaction to the process. All these factors are non existent or are so minor in an electric car that they can be seen as negligible. Except for one single part of a two parted engine (rotor and stator), there are no moving parts, no coils, no gearbox, no valves, no drive shaft or fans for cooling. But all of these parts where essential for people in order to *understand* and *see* how the engine worked. In times when people thought of technology of something that is not only interchangeably synonymous with progress but also something that needs to be experienced with all senses, a gasoline engine was a more *practical* concept than an almost completely silent operating electric engine, whose motion and "fuel" are hidden or even invisible to the eye.[6]

Today, however, people are used to these kind of machines. Due to the rise of electronic technology we are nowadays surrounded by technology that sort of *just works* without any observably explanation. Phones and laptops, billboards, displays, air conditioning, escalators, operate without any cords, moving parts and therefore noise. We are used to be surrounded by electronically operating machines in our daily lives. This, however, is a relatively new development happening only within the last ten to 15 years. Before that, the vast majority of machines in our day to day surroundings were mechanical in nature. With the fast adoption of electronics and software based machine operation, the electric vehicle is much more likely to be accepted by major parts of society.

Thirdly, climate change is a broadly accepted and well discussed fact today. In order to stop climate from further changes, we need to reduce our greenhouse emissions. Gasoline cars provide a significant amount of these gas emissions when in opera-

[6] Mom, Gijs, 2013. p. 288.

tion. Electric vehicles produce no gas emissions in operation. On the other hand, they can in the long run be responsible for even more greenhouse emissions if one considers the way the energy to charge these vehicles is produced. In order to operate an electric car with little to none greenhouse gas emissions one must also choose to charge it only with energy produced from renewable sources. But given the rise of solar-, wind-, and hydro-electric power stations and their technological advances, these options are available today.

Finally, I want to take a look at economical reasons for an electrical vehicle. The most obvious reason is, of course, that an electric vehicle does not need fuel in order to drive. Given the price development of oil and ultimately in fuel, it is fair to say that the days of cheap fuels are gone. And it is likely that prices for fuel in the future might go up even further. A possible objection may be that even though you do not have to pay for fuel when driving an electric car, the limited range, longer charging time and change to renewable energy sources sound like bigger investments than a gasoline car. This certainly is true. One will have to install solar panels or change to a green energy supplier that charges more for the kilowatt hour than conventional energy suppliers do.

Yet, considering that even though these changes may be necessary in order to charge an electric vehicle at home, the benefits of these changes are not limited only to the operation of the electric vehicle itself. In addition, manufacturers of electric vehicles offer optional installation of charging modules and complementary energy contracts with green electricity.[7] Moreover, when driving a gasoline powered car, not only does one have to keep refueling with gasoline or diesel respectively, but also has to weigh in expensive follow-up routine inspections in order to make sure engine, fuel exhaust system catalytic converter, oil filters and many other parts that control and regulate fuel deliverance to the engine and gas exhaustion into the environment work according to manufacturing and environmental standards. These follow-up costs have to be weighed in when considering the overall initial and operating costs of the two different modes of transportation.

The average product lifespan of a car in Germany is about 18 years.[8] If we compare the fuel prices for the past 18 years, one sees that during that period prices on average increased exponentially.[9] This leads to the conclusion that fuel prices are likely to increase in the future as well as oil production stagnates and more cars are sold globally annually. The green energy revolution on the other hand provides the rare opportunity to enable people to produce their own "fuel" for their electric vehicles or buy it from local, eco friendly energy suppliers. In conclusion, this suggests that if you compare the overall average lifespan of a gasoline car in relation with costs for fuel

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[7] see: BMW i3 brochure. p. 18-21.

[8] Statista GmbH. 2014.

[9] Statista GmbH. 2016.

and maintenance, the initially higher costs for an electric vehicle amortize a few years after purchasing the car. In the long run, an electric vehicle may very well be more cost-effective than a gasoline car.

3.2. Two Different Approaches

This brings us to the next part; if we are talking about a third renaissance of the electric vehicle, who is building these cars and what are manufacturers doing different on these cars compared to conventional gasoline cars?

Well, the short and sad answer to this question is: not much! Most automobile manufacturers do offer their regular combustion engine cars as a premium plug-in hybrid or full electric version with higher price but with no real advanced user value. There are, however, two promising approaches I want to focus on in this chapter. The first one comes from an established conventional car manufacturer, BMW, and its small electric vehicle, the i3. The second approach is exemplary for a new generation of car manufacturers, being in business only for a little over ten years and focussing exclusively on electric cars: Tesla.

BMW designed the i3 with a universal goal in mind: to rethink car construction all at once. The i3 stands apart from BMW's regular fleet both in design and construction. The car is essentially built from two different segments, that only at the end of the assembling process are mounted together, the underbody and the cabin. While conventional cars are being constructed in a way where both these parts are interwoven with one another, the i3 construction focusses on building two individual parts.[10] This is possible due to the fact that electric vehicle engines are only a fraction of the size of conventional gasoline engines, therefore rendering a motor compartment and additional shielding for the passenger compartment irrelevant. This reduction in material means, of course, a reduction in weight and lower buckling resistance requirements for the car's frame. As a result, new materials became available that previously were considered unfit to be used in structural elements of a car. Therefore, the i3 is the first car that has a full carbon car frame, making it much lighter than conventional steel alloy frames. In further attempts to design the i3 environmentally friendly, BMW uses recycled materials as well as hemp-fibre increased plastics all of which reduce weight, increase stability and reduce the use of non-degenerative materials in manufacturing the i3.[11]

All of these measures and attempts point towards an environmental awareness in vehicle manufacturing, use of alternative and new materials led to less resource and energy intensive usage. It is fair to say that the i3 might be appealing to a young, environmentally aware clientele and BMW is not really trying to reach its usual customer base with this car. The i3 and its design stand apart from all other cars BMW is

[10] see: BMW i3 Production - Part 1 through 4

[11] see: BMW i3 brochure. p. 20-23.

offering momentarily, making the car even more recognizable at first glance, not only as a BMW but especially as an electric vehicle. People that drive an i3 want to be seen as modern environmentally aware and electric drivers.

Tesla, on the other hand, takes a different approach in manufacturing their electric vehicles, focussing more on the driving experience than on the driver's eco-consciousness. The first mass-manufactured car, the Model S, follows classic design approaches and looks much less futuristic as a car. In that regard, Tesla does follow the lead of conventional car manufacturers of building cars in a more or less similar way, something that people know and are accustomed to. This gets strikingly obvious at the front of the car: The Model S does have a radiator grill silhouette even though it has no radiator. People are so accustomed to the specific appearance of the front of a car, one might even say the face of a car, consisting of front lights, bumper and grill, that missing out on one part would seem strange.

With regard to the front of the Model X and the newly presented, but not yet released, Model 3 which only have a very reduced silhouette of a grill (Model X) or none whatsoever (Model 3), it shows that Tesla is aware of what people are used to and what they expect a car should look like. The design evolution from a big grill at Model S to no grill at Model 3 is a process in which they gradually move away from unnecessary parts that at the same time people have become so very accustomed to see. Same goes for the front of Model S which presents a large hood imitating a classic motor compartment when in reality the engine is mounted between the back wheels.[12]

What really sets apart the Teslas from conventional cars, is the all-digital-control-center approach. By installing basically a computer with bluetooth and internet connectivity that controls not only battery management but everything, from lights to air conditioning and radio, is being controlled through a single interface. This might at first not seem significant but enables the manufacturer to deliver upgrades after the car has been sold. So whenever an upgrade in energy management is implemented, it can also be delivered to older, already manufactured cars enabling the cars de facto to be upgradeable. This is something completely new that no conventional car manufacturers has done before. Even thought there are electronic controls built into cars for years, conventional cars have no central integrated system. By designing a car around a digital interface and an upgradable computerized central control unit, they essentially built a *digital car* able to get benefits from future software optimizations.

This brings us back to our earlier discussion of the digital revolution that already surrounds our day to day life. The gasoline car, representative of the analogous world, appears somewhat antique in that environment where our computers and phones are enabled with new and helpful tools on a regular basis, just with a simple update of installed software. Tesla is trying to close that gap with its cars. This may be the big-

[12] It is noteworthy that Tesla recently released a slightly modified version of the Model S, which now has a very similar reduced grill silhouette much like the Model X.

gest difference that sets their cars apart from other cars and not just the electric propulsion system.

4. The Third Renaissance is Here

As we have seen, the electric car reappeared several times, sometimes stronger, sometimes weaker. We are only at the beginning of a third reappearance of the electric vehicle right now. So the question if it will stay this time, is not to be answered yet with absolute certainty. However, the circumstances that led to its resurgence, point towards a promising direction. Climate change is seen as a vastly accepted fact now and governments all over the world increase pressure to reduce greenhouse gas emissions. The only way to do that in significant numbers for most car manufacturers is by moving away from the internal combustion engine and fossil fuels. The electric vehicle and a battery powered engine appears to be a solid foundation to meet these new requirements without sacrificing too much of individual motor traffic. Because there are significant downsides regarding the range of an electric vehicle, take the i3 exemplary with an official range of roughly above 150 km per charge[13], the electric vehicle cannot yet replace the gasoline car in every aspect. But maybe it will not have to.

Where the internal combustion engine was designed to work best in every situation, commute, off-road, long distance, heavy duty transport, the battery fueled electric engine can be a specific machine, designed for only one purpose, such as the daily commute, and not all possible ones. Modern transport patterns are changing and an electric vehicle will fit right into these new patterns where one takes a bike to the next train station, takes the train to the airport, flies to one's destination and takes a shared car from there to one's final destination instead of driving one's own car from start to finish for ten hours straight. This is a chance for the car to be an integral part of transportation chain instead of standing apart and trying to be the only viable transportation option. BMW's i3 nicely fits into this transportation chain. That is one of its strenghts. It could potentially be enough to render the disadvantage of limited range and long loading cycles irrelevant.

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[13] see: BMW i3 brochure. p. 28.
This range indication is official information provided by BMW. It is fair to assume that under real life conditions the range might very well be lower.

Sources

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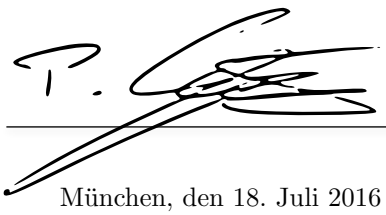

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