



Tesla Motors factory in Fremont, California. Tesla expects to build 500.000 electric cars per year by 2020. (photo: Tesla Motors)

The Autowende has begun

By Michiel Langezaal, co-founder and CEO

Once in a while a new technology comes along that profoundly changes the way humans relate to energy and transport. Wheels, steam engines and airplanes are all step changes that put humanity on a new trajectory. When I first drove the full electric Nissan Leaf back in 2011, I realised I was sitting in such a technological breakthrough.

An internal combustion engine peaks at ~30% efficiency. This is the result of a century of continuous improvement and trillions of dollars in research and development. The room for improvement that's left in combustion engines is minimal. Yet there I was, driving the first generation of a car that comfortably hit 85–90% efficiency! Immediately I understood the tremendous potential of the electric car: fast acceleration, no noxious emissions, three times as energy efficient—and it could be driven on pure sunlight



From top to bottom: the pure electric Mitsubishi SUV concept; the 200-mile electric Nissan Leaf II concept; the 200-mile electric Tesla Model 3 (mockup); the full electric Phaeton (this is a photo of a previous model); the full electric 1000 HP Aston Martin 'RapidE'.

Since the introduction of the Nissan Leaf, more electric cars have hit the market. But this is just the beginning of a massive shift from fossil fuels and combustion engines to electric cars powered by renewable energy. At Fastned we call this the Autowende.

Here's why I think the European automotive industry has to say goodbye to the internal combustion engine and put all their effort and funds behind the electric revolution.

Combustion engines cannot compete with electric motors

As battery prices continue to fall and more people start to appreciate electric cars, the internal combustion engine

and the traditional European car manufacturers are facing the perfect storm. They have to comply with ever stricter emission regulations and deal with a changing public attitude towards exhaust emissions.

There are three reasons why I believe electric motors are the future.

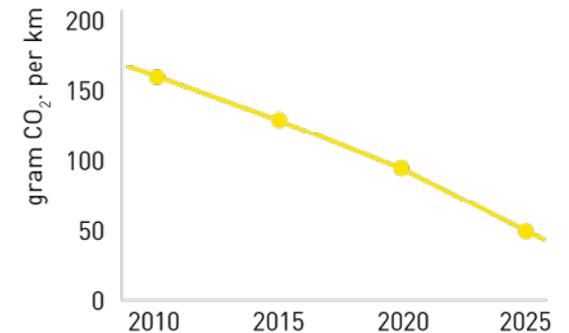
1 // 100% Electric is the new normal for "Freude am fahren"

The joy of driving—"Freude am fahren" as BMW calls it—is no longer possible with internal combustion engines. The internal combustion engine has reached the limits of physics. It may be able to meet stricter emission regulations for the time being, but this results in a dull driving experience.

“ We're a V-12 engine company. Project that into the future. Do I go the way of the rest of the industry and downsize the engine? Do I see Aston Martin with a three-cylinder engine? God forbid. You've got to do something radical. Electric power gives you that power. It gives you that torque. ”

- Andy Palmer, CEO of Aston Martin

EU CO₂ emission requirements



Source: European Commission. After 2021 we rely on projections.

In the coming decade emission regulation forces cars to become even cleaner, which will in turn make fossil fuel cars more expensive. In the EU for example, car companies will have to comply with an average CO₂-emission throughout their fleet of 95 grams per km in 2021. This means that within six years the entire fleet sold by Daimler should have exhaust emissions similar to a Fiat Panda. So car companies can still build a growing

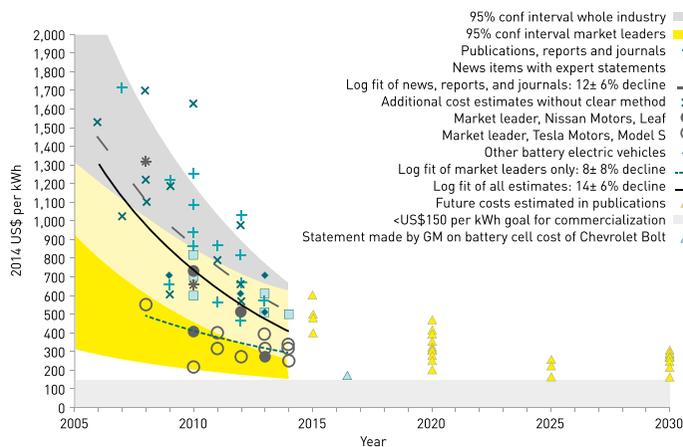
flat six cylinder Porsche, but they have to offset this with a zero emission car. In other words, to comply with emission regulations car makers don't have many options left but to sell serious numbers of fully electric cars.

Electric cars have massive torque from the moment you hit the pedal, which makes them better than gasoline equivalents. And they can deliver hundreds of horsepowers without any emission scheme to worry about.

Soon you'll face the choice between a fun, quickly accelerating electric car, which can be charged on pure sunlight and which might earn some tax breaks—and a dull, heavily taxed fossil car which is banned from city center and packed with expensive emission controls.

This may well be the reason Volkswagen resorted to cheating the emission tests. Building cars with an internal combustion engine that combines great performance and low emissions simply wasn't possible at low costs.

2 // Electric cars are more affordable



Source: Nature Climate Change 5, 329–332 (2015). Statement made by GM (October, 2015) was added by Fastned.

“ I would be disappointed if the price per kWh was not in the \$100 dollar range by 2020. ”

- J.B. Straubel, CTO Tesla Motors

Digital cameras and solar panels were once expensive. Not anymore. These technologies followed a steep 'learning curve' and declining costs. A similar fate awaits the electric car.

In 2010—when the very first Nissan LEAF came to market—lithium-ion battery prices were around \$1000 per kWh. In 2013, at the time of Tesla introducing its Model S, analysts concluded that battery prices had dropped to around \$400 per kWh. GM announced a price of \$145 per kWh for its all electric Bolt which will be introduced in 2016. Tesla Motors expects to produce batteries in the range of \$100 in 2020.

The trend is clear: the price of batteries is declining at an annual rate of around 20%, while the internal combustion engine is getting more expensive in order to comply with emission regulations.

It may be hard to imagine today, but we'll soon see the day that electric cars are cheaper to purchase than comparable gasoline cars. In markets with high taxes on polluting vehicles, electric cars will be competitive even sooner.

3 // The 'cigarette moment' for the internal combustion engine

“ Twenty years from now, the smell of exhaust will be as rare (in cities) as the smell of cigarette smoke is in a restaurant today. ”

-Sir Richard Branson

The vast majority of EV-drivers will tell you that they will never go back to petrol. Internal combustion engine technology feels old and obsolete once you've driven an electric car. These people realise that cars do not necessarily have to be polluting.

It is only a matter of time before society sees gasoline cars as an irresponsible technology, simply because they are hazardous to the health of others and imperil our climate. Think about what happened to smoking. Just thirty years ago people used to accept smoking virtually everywhere

— smoking in airplanes, smoking in schools, smoking in hospitals. People smoked in the presence of babies and the elderly. Pregnant women smoked, doctors smoked, sick people smoked. With hindsight, it is crazy!

This changed when the dangers of smoking became undeniable. Newspapers picked up the story and people became concerned about their health. In response governments around the world introduced age restrictions, mandatory health warning messages on packs of

cigarettes, and smoking bans in hospitals, government buildings, schools, bars and restaurants. Suddenly smoking no longer seemed normal, but dangerous. People who stopped smoking didn't want to be exposed to the smoke of others. Smoking went from cool to decidedly uncool.

I predict this is exactly what will happen to combustion engines. When I cycle to work (like the Dutch tend to do) I smell the exhaust from dirty diesel cars. Every day streets filled with cars blow fine particles and nitrogen oxides in the lungs of pedestrians and cyclists in cities around the world. Exhaust emissions have proven to cause cancer, premature childbirth, increase the risk of heart disease and significantly shorten life of city dwellers. Just like smoking, the public is waking up to this fact and governments are introducing legislation to restrict polluting cars.

The cigarette moment will be driven by peer pressure

Fast forward a couple of years in the future. Affordable electric cars with around 300 kilometers of range are widely available and are an increasingly common sight on the road. Now, try explaining to your neighbours that you have again chosen for a noisy, noxious diesel car which damages the health of their children. The more electric cars on the road, the higher the social pressure on internal combustion engines.

That's why I believe the demise of the internal combustion engine will not follow a straight downward slope, but an accelerating decline.

Each one of these factors—performance, price and public perception—on their own can be a disruptive force, but if they coincide you're dealing with a perfect storm. What should the big car manufacturers do?



The Energiewende didn't bring Europe new industries. The Autowende should.

There's an interesting parallel to the Autowende, and it's called the Energiewende. It began with a whisper when

the German government passed a little noticed energy law in 2000 that guaranteed a steady price for solar and wind power. The first few years, no one paid attention.

*“ Photovoltaic energy in Germany makes
as much sense as growing pineapples
in Alaska ”*

- Jürgen Grossmann, former CEO of RWE

Solar panels were expensive and wind turbines were not very powerful. Renewable energy was like science fiction: it would happen one day, perhaps, but not in the next ten years and certainly not in Germany. As a result, big utilities such as RWE and E.ON didn't react in the year 2000. Nor in 2002. Or 2005. They kept building fossil power plants with lifespans of half a century.

They ignored the gathering storm of renewable energy.

In hindsight we can see how wrong these energy executives were. Thanks to the temporary benefits for solar and wind energy in Germany, demand for solar panels grew. Factories scaled up production and the price of solar panels dropped dramatically. Wind turbines grew larger, cheaper, and more efficient. Solar and wind energy experienced a boom that few predicted.

But only a fraction of the industries profiting from the

Energiewende—solar cell factories, wind turbines, battery storage—are delivering value and jobs to Germany. Most of the manufacturing of these next generation technologies has gone to Asia.

Are we about to make the same mistake again?

During a public talk between Elon Musk (CEO of Tesla Motors) and Germany's vice chancellor Sigmar Gabriel back in September, something interesting happened. After Musk warned about climate change and laid out his vision of a full electric future, Gabriel pleaded for slow, cautious measures:

Gabriel sounded like a captain of a ship who receives all signals of a storm brewing up ahead and expects the storm to wait for him.

Of course the storm is not going to wait. In the last months we have seen one of the world's largest car makers get into deep trouble after rigging emission tests on a massive scale. Dieselgate halved Volkswagen's share price, while the "Made in Germany" brand has been tarnished. At the same time, Tesla Motors is already outselling premium models of the established incumbent brands such as Mercedes and Porsche.

The time has come for Europe to act. It needs to reinvent three industries:

- 1// car manufacturers building electric vehicles;
- 2// battery manufacturers producing batteries;
- 3// the 'Shells of the future' delivering clean and cheap renewable energy to these cars.

The next trillion dollar industry Currently there are only a few 'trillion dollar industries' on the planet. Oil & gas is one, and the automotive industry—with currently the internal combustion engine at its heart—is another.

Electric cars will end both of these industries in their current form.

If European car manufacturers don't lead the Autowende and don't start building massive battery factories and electric car plants, they'll be left behind. Other countries will simply jump in the gap—and that's already happening. The Chinese are investing in electric giants like Build Your Dreams (BYD). The Japanese are well prepared for the Autowende with the largest electric vehicle manufacturer, Nissan, and the battery giant Panasonic. South Korea has KIA, Samsung SDI and LG Chem who are all aggressively betting on batteries and electric cars. Tesla Motors is rapidly building the largest battery factory on the planet in Nevada, and a plant in California which will produce 500.000 Tesla's per year.

These companies employ highly skilled people and develop deep know-how on batteries, electric drive trains and solar cells. Nothing like this is happening on a similar scale in Europe. We do have some initiatives but currently we lack the conviction and ambition to go all in on the Autowende.

If this remains the case these trillion dollar industries and the hundreds of thousands of jobs and the prosperity they bring will move out to other continents. With an estimated quarter of Europe's GDP dependent on the automotive and oil & gas industries, we cannot afford to lose these industries with nothing to replace them.

“ *Europe and its classic automotive industry is focused on traditional drivetrains [...] if we don't want to get into massive problems, we have to move step by step [...] the development in the EU is evolutionary and not disruptive* ”

What to do



Full electric Porsche Mission E with 500 km range and 15 minute fast charge capability. Expected to debut in 2019.

Dieselgate seems to have woken up at least one giant. Volkswagen seems to have found a new CEO who knows what to do. Within weeks after assuming the position as CEO, Matthias Müller accelerated the Volkswagen electrification program. The Volkswagen Phaeton will go full electric and Volkswagen will develop a completely new electric platforms. Both Audi and Porsche will introduce long range luxury cars with fast charging capabilities in 2018–2019.



Audi Q6 e-tron SUV with 500 km range (2018).

In the next 60 months, the European automotive industry has to say goodbye to the internal combustion engine and put all their effort and funds behind the electric revolution.

If Europe wants to maintain its automotive prowess, we have to start building massive battery factories, develop electric car platforms, retool factories and roll out a reliable and dense European fast charging network—all at the same time. And we have to start today.

Michiel Langezaal, Co-founder and CEO of Fastned

Fastned is building a network of fast charging stations for all electric cars along high traffic locations in Europe.

