More range please!

Electric cars are becoming increasingly popular, but costly and environmentally questionable batteries and charging times that are sometimes protracted are not to everyone's taste. Range extenders and series hybrids could be a solution. We take a look at the HyperHybrid from Obrist Powertrain and other concepts.

A Tesla Model 3 is used as the technical basis. The new generator unit fits into the compartment under the front hood

Driving an electric car can be a lot of fun; even small electric cars have an amazing acceleration from a standing start. What's more, e-drives are convenient and amazingly efficient, especially in urban areas and over short distances.

But if you take a closer look, sooner or later you will get stuck on issues such as charging times and the life cycle assessment. Although it's becoming increasingly easy to integrate charging into everyday life and the network of rapid charging points near motorways is growing, frequent drivers have to adapt and allow for more time. To date, greater ranges can almost only be achieved with larger batteries.

However, these have such a large carbon footprint from their production that the overall life cycle assessment is usually damning.

Because of this, people have been tinkering with alternative concepts for some time now in order to increase the range. One possible solution is series hybrids, which are used as the basis for constructing models with range extenders. These vehicles are driven solely by an electric motor that draws its energy from a battery storage unit. However, it can be considerably smaller than in purely electric cars, as it can be charged on the road as required.

An additional combustion engine or fuel cell works exclusively as a generator to produce electricity, but is not connected to the drive axle or wheels. While typical range extenders, such as those previously available on the market, mainly use classic gasoline engines, series hybrids tend to use stationary combustion engines. Two-cylinder engines in particular score well in terms of running smoothness and convenience.

A Tesla with new technology

Obrist Powertrain, a development company from Austria, also sees great potential in the series hybrid

MAZDA

Wankel engine makes a comeback

The principle of the range extender does not seem to be completely off the table with car manufacturers either. For example, Mazda is working on a range extender concept with a rotary piston engine.

As in music and fashion, it's true to say that in automotive engineering, many things come round again. Even in two forms, in Mazda's case. Because the Japanese manufacturer's first battery-powered electric model, the **MX-30,** will apparently also be subsequently available in a version with range extender. In contrast to previous concepts such as the first Opel Ampera and BMW i3, Mazda will not be using a classic reciprocating gasoline engine, but is reactivating the Wankel engine. This design was last used in Mazda's RX-8 sports coupé.

In its repurposed form, the **rotary piston engine** is to operate mainly in stationary mode, i.e. at a constant engine speed (rpm). According to Mazda, the previous disadvantages of classic operation, such as lower efficiency and higher pollutant emissions, can largely be eliminated. The drive also offers various advantages. Firstly, it is significantly lighter than a comparable reciprocating engine and runs with much less vibration. This helps it come very close to the electric drive in terms of driving comfort and noise level.

Secondly, the rotary piston engine **can use multiple fuels**, in accordance with the Wankel principle. This means that it can be operated not only with gasoline or diesel, but also with liquid and natural gas or with pure hydrogen – making it future-proof with regard to synthetic fuels. The option of using hydrogen in particular makes the Wankel engine interesting, as – in contrast to conventional combustion engines – the very hot hydrogen combustion does not damage components such as freely suspended valves. What's more, it runs very quickly and point by point, which is why dead spaces in the combustion chamber pockets do not lead to disadvantages.

Concrete details of the planned industrial-scale use of the Wankel range extender in the MX-30 are not yet known, but a single-disc unit with a chamber volume of some 700 cubic centimeters is under discussion. When tuned for European requirements, this could deliver a generator output of just under 20 kW, thereby enabling relaxed travel with virtually no range limit for speeds of up to 120 km/h. However, another conceivable option according to Mazda is a concept with a serial plug-in hybrid, which then combines greater engine power and a larger generator with a smaller battery. As things currently stand, the new Wankel engine will probably not go into series production before the end of 2021 or the beginning of 2022.

The Wankel is designed to run with very little vibration and burns either gas or hydrogen

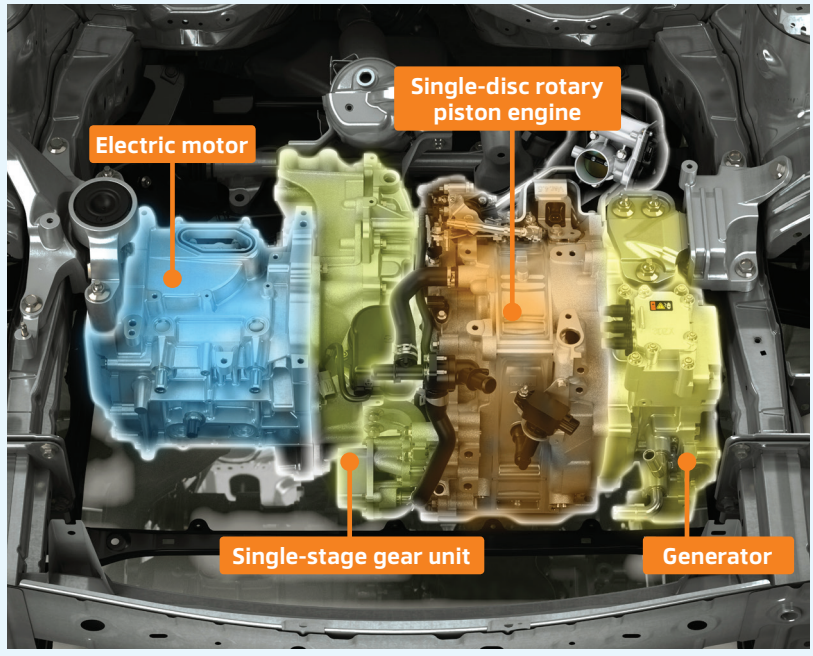
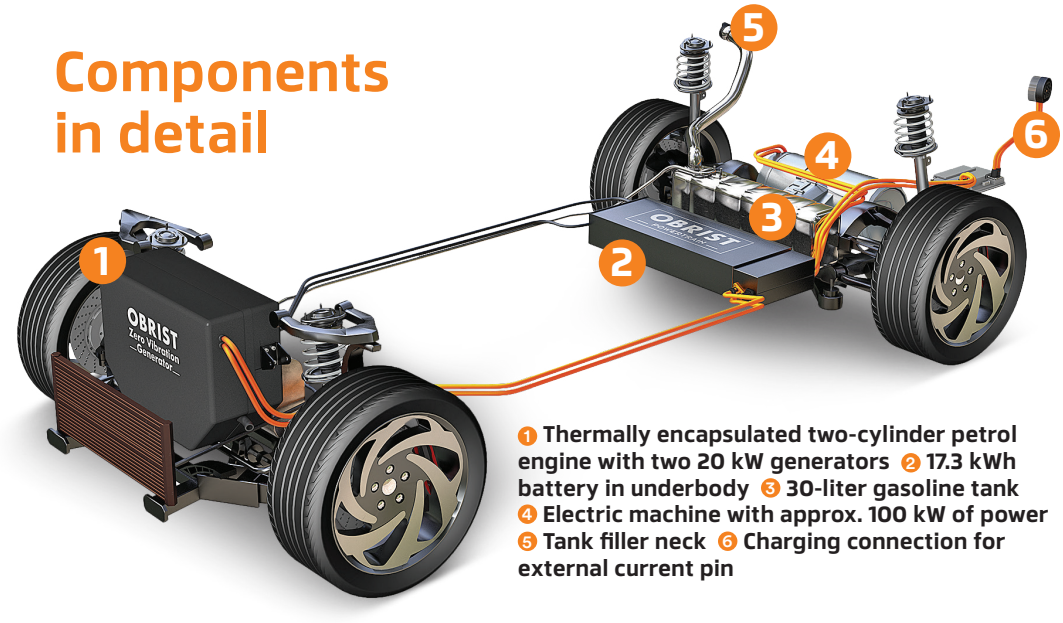


Image: Mazda

Components in detail



1 Thermally encapsulated two-cylinder petrol engine with two 20 kW generators 2 17.3 kWh battery in underbody 3 30-liter gasoline tank 4 Electric machine with approx. 100 kW of power 5 Tank filler neck 6 Charging connection for external current pin

and has developed a concept for a drive of this type: the "HyperHybrid Mark II". The team chose a Tesla Model 3 as the technical basis for the prototype, in order to demonstrate the performance of the new drive in a mid-range model. The previous traction battery and control system had to make way for the new components. These include a 100 kilowatt electric machine and a battery with a capacity of only 17.3 kWh, which can either be charged externally by cable with a charging capacity of about 3.7 kW or by the "Zero Vibration Generator" while driving. Behind all this is a compact, two-cylinder gasoline engine with two

integrated 20 kW generators for electricity production.

The concept has several advantages. Firstly, the prototype weighs around 250 kilograms less than the original model thanks to the significantly lighter battery, and the small combustion engine has no negative impact on comfort. Secondly, even long distances are no problem, as it easily provides range, while keeping fuel consumption at a significantly lower level than that of plug-in hybrids and normal range extenders.

The crucial differences with the HyperHybrid: Due to its design, the two-cylinder gasoline engine runs almost vibration-free and is designed for operation in optimum speed ranges with a constant air/fuel mixture (lambda = 1). As a result, it works very efficiently and no pollutants such as NOx or particles are produced during combustion. The motor is also thermally insulated.

Special charging strategy

This means that it hardly loses any heat and thus energy, which reduces cold-start phases with particularly high pollutant emissions. According to Obrist, the drive manages on 2.0 liters of gasoline and 7.3 kWh electricity per 100 km in real traffic. Another special feature is the concept's charging strategy. Instead of running the battery empty, the combustor keeps its capacity in the range of 50 to 70 percent to preserve the cells.

This all sounds quite nice in theory, but what's it like to drive a HyperHybrid? So we take a seat in the prototype and go for a spin. Touch speed "D" and we gently start cruising. Everything feels like in a battery-driven electric car: there is no engine to be heard, and the full torque is available from a standing start. Only on the motorway do we feel the difference. Once we hit around 65 km/h, the combustor switches on automatically, and anyone paying close attention will feel tiny vibrations in the steering wheel and hear a slight humming noise.

A disappointment? Not at all. After

VARIOUS SUPPLIERS

Concepts on the shelf

The range extender idea is not a new one. Some suppliers have already spent years researching this topic and have presented fully developed approaches.

As early as 2009, i.e. more than ten years ago, Opel introduced the first Ampera – an electric car with range extender. Back then, they were not the only ones with that idea: suppliers were also already developing similar concepts at that time to get the early electric cars started with their very manageable ranges. Among others, **Rheinmetall Automotive** (formerly KSPG) presented a study of its compact 30 kW unit in 2012. This was first tested in a trial run in a Fiat 500, and a street scooter with a natural gas version of the range extender has also since been added.

Similarly to the HyperHybrid, the Rheinmetall Automotive team uses a two-cylinder gasoline engine, but arranges the cylinders in a V-configuration. Thanks to its vertical crankshaft, the module is compact enough to be easily installed in the underbody or find room in the spare wheel well of a small car. In other respects, too, the unit remains discreetly in the background. It reportedly runs with virtually no noise or vibration and, thanks to greatly reduced interfaces, can be integrated into the vehicle with little effort. There are even more advantages for the driver, because the small combustion engine can also comfortably control the temperature of the battery, drive train and interior, without any significant loss of range.

At automotive supplier **Mahle**, the developers have even gone one step further. The 30 kW range extender – also a two-cylinder unit – was first used in a test vehicle in 2014. In 2018 it served as the technical basis for the development of the Mahle Modular Hybrid Powertrain (MMHP) with up to 90 kW of power. This is a drive concept, which combines the advantages of serial and parallel hybrid drives, thereby promising even greater efficiency, especially at higher speeds.

However, industrial-scale use of the two concepts is not yet foreseeable. Although they have been developed to series production readiness and the suppliers are in talks with various manufacturers, no concrete projects have as yet taken shape from these.

Both supplier drives use a smooth-running two-cylinder gasoline engine as a generator

Image: Mahle, Rheinmetall Automotive

BADEN-WUERTTEMBERG COOPERATIVE STATE UNIVERSITY (DHBW) STUTTGART

A different kind of fuel cell

A fuel cell can also produce electricity on the move. In cars, hydrogen-powered variants have been used to date; alternative concepts use methanol as fuel.

When it comes to e-mobility, the question of hydrogen cars crops up regularly. They are emission-free for local journeys, but the fuel can be **refilled quickly** like classic gasoline. The problem is that there are hardly any hydrogen filling stations. This is why some companies are now experimenting with fuel cells that use methanol as fuel and convert it into electrical energy for the electric drive by means of electrochemical processes while driving. The principle is not entirely new; in the camping sector, for example, devices of this type have been used as power suppliers for several years.

In addition to Gumpert with its electric sports car called Nathalie, the Baden-Wuerttemberg Cooperative State University (DHBW) Stuttgart is also working with partner companies to construct test vehicles that use the technology as range extenders. However, there are a few differences. For example, the high-temperature methanol fuel cell from Siqens used by the team operates at 160 °C and thus has a higher efficiency than camping systems. What's more, it does not require heating at temperatures below zero degrees, but starts at conditions down to -20 °C and can be stored safely down to -40 °C.

There's one catch, however: Although the **methanol fuel cell** does not emit exhaust gases such as NOx, CO, or particulate matter, it emits CO_2 as a matter of principle. So why all the effort? While hydrogen can only be stored at high cost and the filling station infrastructure is expensive, vehicles be filled up with methanol from a normal gasoline pump. In addition, it can be produced synthetically – so in a way that is largely carbon-neutral, is already standardized as a fuel in the EU, and can also be used in classic combustion engines.

The Moke is based on the original Mini and has been available for purchase since the early 1960s. Baden-Wuerttemberg Cooperative State University (DHBW) Stuttgart is working with partners to convert it to a methanol fuel cell

Image: Baden-Wuerttemberg Cooperative State University (DHBW) Stuttgart/Wolf Burger

all, sound insulation did not play a major role in this prototype. The dynamic qualities of the drive are much more important. According to Obrist, the HyperHybrid should be able to go from zero to 100 in 6.6 seconds and reach speeds of up to 170 km/h.

We can't test that, but we can roar up the mountain on a winding minor road. We manage the ascent without any effort, can accelerate out of every bend, and quickly leave behind the photographer following us in a powerful motorized limo. Another plus point: We don't feel any jerkiness when switching the combustor on and off.

Start of series production is planned

Obrist also wants to set standards in terms of costs, and is aiming to offer a mid-range vehicle with the new drive system at prices starting at around EUR 20,000 for example. Alternatively, the concept should also allow several variants to be developed – for example with other charging options or more power.

Prospective customers will still have to be patient, however. Although Obrist has already sold a license for the construction of the drive, the new manufacturer does not plan to start series production until 2023/24.

Text: Annette Bender-Napp
Photos: Getty Images, Dino Eisele