Quo Vadis Engine Oil
The developments from internal combustion engines to electro-mobility

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Looking back at the beginning of mobility, we see people in ancient times move objects around with the materials that were available to them. Often these materials were rudimentary in nature and freely available with very little human intervention or processing. The stone columns of Stonehenge in England or the Pyramids in Egypt would have been using elementary forms of mechanics to move large heavy objects from point to point.

Over time as the centuries passed people also made use of animals to help with their mobility. Oxen with ploughs, horses with carts or chariots in Roman times.

It was not until 1813 that a significant advancement in mobility was made with the advent of the hydrogen combustion motor. Francois Isaac de Rivaz was born in Paris in 1752 and studied mathematics, chemistry, geography and history. He experimented with printing & engraving machines, steerable balloons, and production processes for his glass, paper and nitric acid factories. He also developed a steam truck based on Joseph Cugnot's (Paris 1769) invention. In 1813 he undertook his first with hydrogen operation. Unfortunately the test was not successful and on the 30th July in 1828 he gave up testing approximately three weeks before his death.

So what did he test? Actually it was the Rivaz-Motor-Car which he tested on 30th October 1813 at Vevey near Geneva in Switzerland. The vehicle was 6.5 metres long with a wheel diameter of around 2.5 metres. The vehicle was driven by combustion involving an explosion of hydrogen with each ignition being independently and manually actuated. By the ignition pressure a piston was catapulted upwards in a 2 metre long cylinder. When the cylinder fell down again, the piston burst over the linkage at a gear wheel and tore a chain that moved the "car" a little further along. After 25 ignitions the chain burst and the car stopped having driven over a distance of around 26 metres at an average speed of 3 kilometres an hour.

Soon word got out about his invention and other inventors produced their own version of propelled vehicles. In 1898 his invention was joined by the Lohner-Car with Pygmée- Motor and the Egger-Lohner-Car with electric drive.

It wasn't until 1881 that the first electric car was born. Then in the summer of that year the French Gustave Trouvé, made a test for the newly created electricity fair in Paris with the Coventry-Tricycle with a third supported wheel. And the vehicle was equipped with an electric motor. The technical equipment for the battery and for measuring speed was rather strange than well-suited to the roads. Via cord plates, lead plates were submerged into the open batteries and their acid. Depending on the depth of submersion the Tricycle became more rapid or slower. As there were still some pedals available, one was able to move, even when the "electrification" suddenly became deficient. The title 'First Pedelec of the World', therefore would be a more suitable name for this vehicle.

Today Tesla has caught the imagination of the electric car audience. Their roadster can be called a 'Racing car with no roaring engine', high acceleration but without the throaty roar of the engine that we associate with sports or racing cars. Tesla's roadster achieves nearly a maximum speed of 200 kilometres an hour and accelerates from 0 to 60 miles an hour in just 3.9 seconds. During this action, only the rolling sound of the wheels and the howling of the wind are the sounds perceivable by its driver. So far, Tesla Motors has been the only manufacturer to offer such a "racing car" with electronic drive out of a series production. Among the customers of the Californian factory is Google's co-founder Sergey Brin.

The depletion of conventional fuel and lubricants is one of the key drivers of this move towards electrified vehicles. But this is not a new issue. The first electric drive/hybrid car was developed as far back as 1900 when Ferdinand Porsche joined forces with the then electro-technical firm Bela Egger in Vienna (now ABB) to produce a vehicle called Semper Virus or the one that is 'always alive'. For this vehicle there was no mechanical connection between the combustion motor and the drive. Combustion motors were fed via generators batteries and hub motors. The car could be driven as a full electrical vehicle or with the combustion motor. In essence this was a true, full hybrid car. Porsche's idea was to integrate the drives into the steerable front wheels but unfortunately the car did not go into series production.

Today for automobile drives the media is full of buzzwords and conjecture. They say that fossil fuels will definitely come to an end, sooner or later. Petrol prices keep rising. Bio-fuel is made from foods, really? With energy from the wind, sun and atoms you cannot drive a car. If the battery is the heart of any new generation of vehicles it will always be heavy and have a limited capacity. Small cars will therefore be needed for short distances. The energy for the battery cannot always be produced CO2-free, there is no innovation nor technical breakthrough in sight. A statement from a German car expert: 'The universally usable car remains a dream'.

Vehicle manufactures are already producing not just one type of hybrid or electric vehicles but many types to overcome these issues. We have Micro Hybrid cars with a Start-Stop-System where the motor stops simultaneously with the car and re-ignites when started again. The fuel saving effect produces savings of between 5 – 10% and examples of these types of vehicles include BMW, Citroen, and Mercedes.

Next we have the Mild Hybrid when braking, energy is accumulated in the battery. The battery drives the electric motor which supports the combustion motor when accelerating. Here the fuel saving ism ion the region of 10 – 20 % and examples of these vehicles are the Honda Civic Hybrid.

Then there is the Full Hybrid like the Toyota Prius that combines both a traditional combustion engine and an electric motor. The full electric range is short, at just a few kilometres. The fuel saving effect is between 25 – 40%.

The Plug-In Hybrid comes next like the Mitsubishi Outlander PHEV providing a combination of traditional combustion with an electric motor. The battery can be recharged at an ordinary plug, with the first models introduced in 2010 by General Motors. Here the combustion motor only serves for a mobile recharge of the vehicle's battery.

Finally we have the true electric car, exclusively driven by an electric motor without a combustion engine which in turn is driven by a battery.
In terms of their development, about 30 years before the gasoline/diesel motors existed, electric drives existed. At the beginning of the 80s of the 19th century with speeds of between 12 – 15 km/h. In 1899 the Belgian e-car manufacturer Camille Jenatzy achieved more than 100km/h. At the turn of the century even New York had cabs with electric or e-drive.

But there was a problem. For one century the accumulation of energy, how to generate and store sufficient energy to propel the vehicle over distance. The solution was that an old lead battery needs for a full charge 5-times as long as it does for supplying that energy. Nickel-metal-hybrid-batteries in comparison are fast in accumulating energy, but offer a limited energy content. The lithium-Ion-technology offers a much better efficiency, extended life time, and quick response. The application of this technology today has produced small devices like mobile phones, laptops, model planes, or even the battery screw-driver.

In the future we need to look at more radical solutions to meet the needs of an ever-expanding population that is estimated to reach 8 billion people by the year 2020. In the future crude oil will deplete, depending on the scenario for consumption and technical possibilities of extraction, this could occur within a few hundred years (150-300 yrs). Coal too is estimated to deplete depending on extraction and consumption between 300-600 yrs. For metals depending on consumption although it is known that existing resources shall not increase, e.g. mercury, lead, tin, tungsten, copper, nickel could deplete within 50 years. For non-metals e.g. sulphur, potash this could be less than 100 years. However for wind, solar and water energy these are not limited in the same way.

The energy challenge is that people consume energy. Global demand for energy is expected to double by the year 2050. Population growth will see around 3 billion additional energy customers will need access to electricity & transport. At this rate energy supply from all sources will struggle to satisfy demand with the result that there may well be a continued dependence on fossil fuels such as oil, gas and coal. There will also be a need for rapid growth in renewables and nuclear power to satisfy everyone's energy needs. At the same time environmental stresses from energy use and its production will continue to increase. Already climate change is of predominant importance and there is a critical need to reduce greenhouse emissions.

In future energy choices will be between the old and the new. On one hand conventional fuels that are based on crude oil, natural gas, hydrogen to newer energies such as biomass-based Fuel and also not forgetting electricity.

If we look at a roadmap into the future then we can see that governments will move towards reduced fuel consumption and a resulting reduction in transportation. Already we see the introduction of technical measures such as national regulations for vehicle fuel efficiency and engine/vehicle modifications. A move towards electric-drive vehicles such as EV or PHEV. Also let us not forget non-technical measures such as energy saving or a frugal life style choice made by citizens and/or local governments using current technology and/or infrastructure.

Professor Nakada from Tokyo summarised electric vehicles into two broad categories. Firstly EV (Electric Vehicles), or pure EV which are driven by electricity from battery. Secondly PHV or Plug-in-Hybrid Vehicles which are driven by both a gasoline engine and an electric motor with a broad approximation that the vehicle will use electric propulsion for 70% of the vehicle's requirements, and the gasoline engine for 30%. These PHVs are charged mostly during night when most energy is generated by nuclear technology. In the future it is expected that they will be charged by renewable energy.

One issue that is limiting both the popularity and utility of electric cars is their limited range. If the range of electric cars are to be extended then we need to look towards the production of electricity on board the vehicle. Prof. Dr. Deflerstolten, Forschungszentrum Jülich, has looked at this issue and concluded that typically a fuel cell that is required to produce electricity in the car will be needed to operate electric motors. We can achieve this by the reaction of hydrogen with oxygen to become water. This process produces energy which is transformed in the fuel cell into electricity which is used by the electro-motor to drive the car. The resultant emission is water which is the only raw material that is expelled through the exhaust pipe.

The disadvantage of this system is the lack of hydrogen pumps and their associated high cost of circa 43,000 euros as they require use of a precious metal Platinum. However there advantage is that, unlike a typical electric battery with a limited range of between 100 and 200 kilometres, this type of fuel cell has an extended range of between 450 to 600 kilometres. The benefit to the environment is that using these fuel cells it is possible to achieve new limits on CO_2.

So how far have the car manufacturers, or OEMs, pursued this opportunity? In 2013 Erdöl, Erdgas, Kohle looked at this issue. They reported that the German Hydrogen Car Association, or Deutscher Wasserstoffverband, set a preliminary timetable for its development in 2013. Both BMW and Toyota have cooperated on a fuel cell system that is a hybridised E-Drive that utilises a hydrogen battery, and are looking to introduce this as a mass market product in 2020. Daimler, Ford and Nissan/Renault are looking at the introduction of such a vehicle from 2017.

Toyota and Honda, a series production from 2015 and Hyundai ion 2013 introduced a small series of 1,000 cars with both fuel-cell e-drive are looked to 2015 to produce an onwards series production.

Hydrogen cars also need infrastructure to support them and so in January 2013 the European Union introduced draft legislation for the infrastructure of fuel pumps up to 2020 and for establishing minimum ranges for these types of vehicles. In Germany by 2015, there were to be 50 H2O stations to support Hydrogen vehicles and by 2020 400 pumps. In the United Kingdom 65 stations were expected for initial supply and by 2020 1150 stations supplying an estimated 1.6 million hydrogen cars. Also in Denmark it was expected by between 2015/2025 there would be 200 H2O stations.

Fuel cells operated by hydrogen are not without their challenges. Approximately two-thirds of the earth are covered by water from which hydrogen can be obtained. Although hydrogen represents rather a difficult material to manage, especially as safety aspects have to be considered and solved, certainly special safety conditions have to be provided to manage this material safely.

Hofmann Hybridfahrzeuge, Springer in 2014 concluded that there were both advantages and disadvantages of using a hydrogen fuel cell system for vehicles. The advantages were that there were no direct emissions, that when using regeneratively they produced hydrogen and no CO_2 emissions, that there were no sound emissions and no moving parts, and they had good partial load efficiency. However there were also disadvantages. The catalysts containing platinum were expensive to produce and gave the vehicles high starting costs, the accumulation of hydrogen and the filling of the material were costly, in an intermittent operation the lifetime of the material is reduced significantly, they have high specific weight, loss in efficiency under high load conditions whereas the full load efficiency was nearer that of combustion engines, in cold winters operation was only conditional, and the installation volume demand of the material is great.

Given these drawbacks there are however, some hydrogen production vehicles already on the market. The Toyota car ‘Mivai’ uses a fuel cell to produce electricity that is powered by hydrogen as a fuel. It has a range of 550 kilometres and a maximum speed of 175 km/hour. In Japan the vehicle is already on the market with a production target in 2016 of 3.000 cars. The Mivai has a price tag of around 80,000 euros although full service leasing can cost as little as 1,200 euros a month. The car can be refilled in just three minutes, similar to that of a combustion engine vehicle. In Germany where the car is expected to go on sale shortly, there are actually 19 existing stations for hydrogen vehicles by the end of 2023 this is expected to increase to around 400 units.

Closer to home the Mercedes F2015 uses an electric hybrid system and has a total range of 1,100 kilometres, including around 200 kilometres of battery-powered driving and around 900 kilometres on the electricity from the fuel cell, source Daimler Las Vegas 5th January 2015.

In order for new technology to be adopted, certain conditions must be met. One of these conditions, and perhaps one of the most important, is refuelling infrastructure. Refuelling infrastructure must follow any development. Refuelling stations for hydrogen vehicles must be sustainable as hydrogen and efficient as well. Going back to the early days of the combustion engine when gasoline was dispensed in bottles by the local pharmacy, is not an option.

In the future renunciation of the combustion engine and its replacement by a central/main electro- motor using electricity produced by a fuel cell is one outcome. Here no conventional fuels and engine oils are needed, only greases for the bearings of the electro-motor, and lubricants for the gear are needed. For a futuristic and ‘fantastic’ look into the far future then we can one day imagine vehicles where any wheel of the car is operated independently by an own electric- motor. A central computer in the vehicle would have to control these electric motors which would be operated by the driver, the different electro-motors in the wheels. No conventional fuel and no engine and gear oil would be needed and already we can see that technical solutions for single electro-motors in the wheels are available so perhaps this is not as far into the future as one might expect.

We have witnessed in the media recently that Norway has released a law, according to which from 2025 on no new gasoline or diesel engine cars will be allowed. Until 2020 no cars are allowed producing exhaust gas with more than 85 g CO_2/km. The situation now is that 15 % of new cars use electro-mobility. Electricity is about 100% could be obtained from renewable sources. In the future there is a planned step to reducing CO_2 until 2029. In New Delhi diesel engines are sometimes not allowed to be used due to incidence of poor air quality. In Paris starting with 2020 no diesel engines will be allowed. Tesla has already produced production mass market electromotor-driven cars. The future will be characterized by electro-mobility. Between now and the electric future hybrid cars with a gasoline engine and an electromotor will be increasingly popular for short distances.

So in summary we are consuming available resources like crude oil, gas and other energy carriers much faster than they can be developed again. Therefore the necessity exists to look for other bases for producing energy. Probably electricity will help us to solve this problem. Using electrical power to move cars is already well-known and used. In this article I have tried to explain how electricity is used to charge electro- motors on-board the car.

Using fuel cells on the car fuelled by hydrogen might be the future way to drive cars. At the very end of this development no internal combustion engines and main gears are necessary. No engine nor gear oils are necessary. This means Hydrogen might be the future energy carrier to drive cars, only time will tell.

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