

ALTERNATIVE FUELS FOR ROAD TRANSPORT

GREEN TRENDS AND AN OVERVIEW OF VIABLE ALTERNATIVES



Diesel is currently the fuel type of choice for all road related transport. Price volatility as well as negative environmental effects will lead to a decreasing importance of diesel in the future. As of today, several companies are already experimenting with new technologies to gain competitive advantages. We elaborate on why companies are doing this today. We list the existing alternatives that are currently on the market and their viability. Companies can make good use of these trends and the rapidly evolving technologies to become a green leader in their fields and gain a sustainable competitive advantage.

The future is green

The worldwide awareness for environmental issues related to fossil fuels is strongly increasing. The recent climate conference in Paris proved that the environment has gained importance in as good as every country. Where even several countries described global warming as the number one global threat. Public opinion has changed as the public mind-set has shifted to an aversion to large diesel engines. And trends such as the private purchase of electric vehicles seem unstoppable.

Cities are acting on this and are banning polluting fossil fuelled cars. More and more cities across the world are taking measures to reduce the number of cars in their city centres. An example is London where they have the congestion charge system to reduce the number of cars. Closer to home, Antwerp decided in 2013 to ban all diesel cars that are older than 15 years in the city centre starting from the beginning of 2017.

Shareholders and investors are more and more demanding businesses to go green. Several investment funds and other shareholders push companies to go green. In early 2015, a coalition of investors (pension funds, local authorities) has pressured the board of British Petroleum to become more environmental friendly. However this is an extreme example where shareholders have put the leaders with their back against the wall, it can be seen as a leading example. This approach is becoming more and more widespread and will complicate the financing of polluting companies.

Furthermore, employees prefer to work for environmental friendly companies. Several studies have indicated that a company's environmental

friendliness is an important factor when choosing the employer. Employees have indicated an unwillingness to work for companies with a bad environmental reputation¹.

The European Commission reinforces these trends and has set binding emission targets for its member states. The target is to reduce the emissions, compared to 2005 levels, with 10% by 2020 and with 30% by 2030². For Belgium the emission reduction target is set even higher at 15%³. The transport sector accounts for the largest share of non-ETS emissions and will therefore be increasingly subjected to national policies aimed on reducing emissions of GHG and air pollutants (PM and NOx).

The Belgian Government has acted in line with Europe. The Belgian kilometre charge will be implemented in 2016 and will stimulate hauliers to buy greener alternatives or newer diesel models. The kilometre charge system stimulates Euro 5 and Euro 6 models by lower fees. At the moment there is no lower tariff or exemption for alternative fuelled lorries. This might be implemented in the future to stimulate the use of alternative fuels.

In addition to that, the Belgian Government decided in July 2015 to increase the taxes on diesel fuel with 10,6 eurocents by 2018. This measure will equalize the tax rate on diesel and petrol resulting in higher diesel prices, which will stimulate the roll out of diesel alternatives.

As diesel will probably not be able to deliver on the goals and trends, there is a strong expectation for growth in the alternative fuelled lorries market.

The “Black gold” has a historical lead but will lose it.

The diesel legacy

Belgium, and Europe in general, are hooked on fossil fuels for all road-related transport activities. In 2010, 94% of the energy used for transport originated from crude oil⁴. In Belgium, due to the higher fuel taxes on petrol than diesel, 60% of all motor-vehicles use diesel whilst the majority of the

¹ Jobat

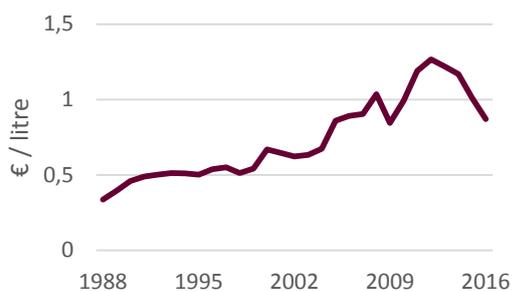
² For the non-ETS sectors

³ European Commission

⁴ European Parliament

remaining 40% uses petrol. For the commercial transport sector the share of diesels rises to 93%⁵. Fuel economy, fuel availability, driving range and power are just a few of the advantages that make diesel the fuel of reference for all road-transport. However, diesel is also related to issues such as price volatility and the significant environmental impact.

FIGURE 1 : EVOLUTION OF DIESEL PRICES IN BELGIUM (EXCLUDING VAT)



Source: Belgian Petrol Federation

Diesel production largely depends on the OPEC countries, who have an important impact on the price levels. Diesel prices have more than tripled over the last 20 years and are expected to increase again after the recent 2015-2016 dip. Moreover, the Belgian Government will increase the taxes on diesel fuel to level out the difference with petrol, which will reinforce the rising trend.

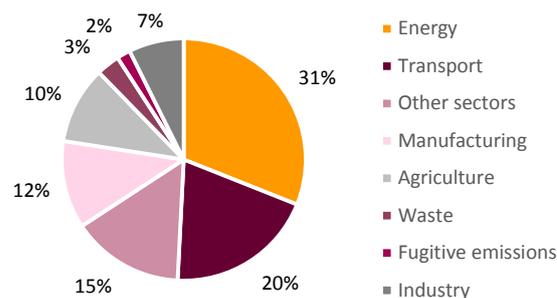
In Europe, the transport sector accounts for 20% of the total Greenhouse Gas (GHG) emissions such as CO₂. This puts it in second place, just after the energy industries (Public electricity and heat production, Petroleum refining and Solid fuel manufacturing). Since the Kyoto Protocol in 1997, the Energy Industries have taken significant measures and successfully reduced emissions by 15% compared to 1990. In contrast to this the GHG emissions of the transport sector continue to grow. From 1990 to 2012 the total GHG emissions originating from the transport sector increased by 14%⁶. Heavy-duty transport vehicles only represent 3% of the fleet but accounts for approximately 25% of GHG emissions from road transport. Important drivers for this are the lack of European CO₂ standards for lorries and stagnating lorry fuel efficiency over the last decade⁷.

⁵ FOD Economie

⁶ European Environment Agency

⁷ Transport and Environment

FIGURE 2 : GHG EMISSIONS BY SECTOR



Source: European Environment Agency

The transport sector is also a major contributor to Europe's air pollution. Much more than petrol, diesel is an important source of particulate matter (PM_{2,5} and PM₁₀) and NO_x emissions. Peak values mainly occur around areas with high economic activity and major roads. With 93% of the commercial transport fleet being diesel, the road transport sector is by far the most important sector for NO_x emissions, representing 41% of NO_x emissions in Europe.

Moreover, Belgium is one of the worst in class. This can be explained by the fact that Belgium is an important transit country as well as the high share of diesel vehicles⁸.

Technological evolutions

To solve the issues from above, diesel engine constructors have worked hard and positive evolutions have taken place in the last decades. The European emission standards system requires increasingly more stringent emission values for each new Euro standard, however there is a lack on standards for fuel economy or CO₂ emissions. As shown in the table below there has been a strong decrease in the allowed emission of NO_x and particulate matter by lorries since the introduction of the standards in 1992⁹. The Euro standards also apply for other pollutants but we focus on the most important substances for Belgium.

As of today 60% of the commercial lorry fleet in Belgium is at least 6 years or older. This implies that an important share of the fleet is categorized at Euro IV or below since Euro V only came to market at the end of 2009. The majority of the

⁸ European Environment agency

⁹ Flemish Environment, Nature and Energy Department

Belgian lorries thus still have very high emission levels, which can lead to small improvements for the future when the fleet is renewed.

TABLE 1 EMISSION STANDARDS PER EURO CLASSIFICATION

	NO _x (g/kWh)	PM (g/kWh)
Euro 0	15,8	-
Euro I	8,0	0,4
Euro II	7,0	0,15
Euro III	5,0	0,1
Euro IV	3,5	0,02
Euro V	2,0	0,02
Euro VI	0,4	0,01

Source: LNE

An important point of consideration though is the reliability and correctness of the emission tests. The Volkswagen “dieselgate” is still fresh in the memory and few people would be surprised if the scandal would expand to other areas.

To meet the new Euro standards lorries require additives to meet the NO_x emission requirements. Since the additives imposes important additional costs on lorry drivers one could wonder if there is no way to “overrule” the system, leading to much higher emission values in the field than the theoretical standards.

Taking this into account, the achieved improvements seem to be more theoretical than actual. A radical breakthrough is needed for the diesel technology rather than the gradual improvements of the last decades. Without major technological evolutions, diesel will not be able to fulfil the goals and alternative fuelled trucks look like the only option for the future.

Lorries on alternative fuels exist but are they viable?

Which technologies are available on the market and for which applications?

Several alternative fuelled lorries are being developed and some are already available on the market. Below is an overview of the main technologies that are under development or being rolled out. In a short overview we describe the pros and cons of each technology, after which we describe the current applications.

Bio-ethanol is the sustainable equivalent of petrol, but is made from organic material that has a high sugar content (sugar cane, corn). The conversion of a petrol engine is simple and low cost, refuelling is quick and the existing refuelling infrastructure can

be used. However, fuel economy is lower and at the moment it is not possible to find 100% bio-ethanol in public fuel stations in Belgium. Other critics are the competition with food production.

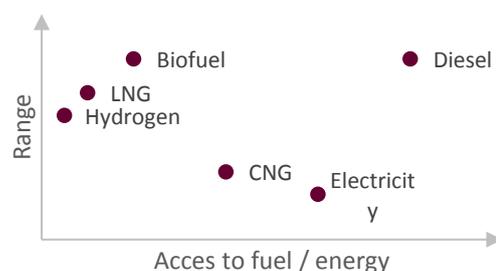
At the moment, a maximum 7% of bio-ethanol is added to conventional petrol in Belgium. Brazil is one of the countries with the highest use of bio-ethanol with regular mixtures of 25% bio-ethanol and a good availability of pure bio-ethanol. Since it is currently not possible to find this fuel in Belgium we will not discuss this technology any further in this article.

Bio-diesel, on its turn, is the green alternative for diesel. It is made from vegetable oils and has the same advantages of bio-ethanol. First generation bio-diesel receives the same criticism as bio-ethanol for its competition with food production, a problem which is solved by the second generation bio-diesel which uses organic material from waste.

Comparable to bio-ethanol, bio-diesel is mixed with conventional diesel for a maximum of 7%. Similar to bio-ethanol, it is currently not possible to find this type fuel in Belgium.

Since pure biofuels are not publically available in Belgium, we do not expect a break-through in the short-term of biofuels in Belgium therefore we will not elaborate further on these technologies.

FIGURE 3: COMPARISON OF DIFFERENT FUELS ON RANGE AND FUEL ACCESS



Source: Sia Partners

Compressed Natural gas (CNG) is natural gas that is compressed to a pressure of 200 bar and can be used directly as fuel or it can be used in combination with diesel (dual-fuel). The main advantages of natural gas are the limited emission of NO_x and particulate matter compared to diesel. CNG lorries emit approximately 15% less CO₂ than diesel per kilometre. On top of that CNG lorries produce 50% less noise than diesel engines. Fuel economy is comparable to diesel and with lower

fuel costs CNG looks to be a promising alternative. The main disadvantages of CNG today, are the low driving range and limited power.

Liquefied Natural Gas (LNG) is identical to CNG with the difference that the gas is stored in a liquid form at -162°C and at lower pressures. The fuel tank space that is required for LNG lorries is significantly lower than for CNG lorries which results in a larger driving range for LNG lorries.

A study executed by the Flemish Institute for Logistics tested CNG and LNG fuelled trucks and made several business cases. The conclusion is that the evolution of diesel prices, fuel station availability and the price premium for alternative trucks are the most important that determine the cost efficiency of the alternative. The business cases show that CNG is between 8 to 12% more expensive per kilometre, whilst LNG was between 0 to 4% more expensive per kilometre. When enough fuel stations are available, as is the case in Italy, CNG proves to be up to 14% cheaper than diesel.

An excellent example of a successful transformation to natural gas is “Castorama” in Paris. Castorama used to supply its shops in the Parisian centre with 7 diesel lorries, acting on the above described trends they decided to completely redesign their logistic flows. Starting from a blank sheet of paper, a new transport plan was designed with spectacular results. For the same volumes the new transport plan only needed 6 lorries instead of 7 and all could be fuelled by natural gas. All this was done with the same budget as before.

Electricity is a fuel with very high growth rates in the car segment. The roll out of high-end, long-range vehicles such as Tesla and the plans from companies such as Audi and Porsche show that this trend will be unstoppable. It will accelerate the development of the technology and gradually expand into the road transport sector. Electric powered vehicles do not generate any emissions and therefore seem to be a very promising alternative. Currently the disadvantages of electric vehicles are the driving range, charging time, cost and weight, however it is important to notice that technology is still in an early development stage and radical evolutions of the technology can be expected.

For intra-city transport electric vehicles are already being tested by several companies. City Depot and H. Essers both tested with electric powered

vehicles. H. Essers tested a full electric vehicle for BASF, the scope was low-volume distribution in the port of Antwerp.

In mid-2015, BMW presented their full electric 40-ton lorry. It has a range of approximately 100km and will be used as a shuttle between two factory sites. This example demonstrates the rapid evolution of electric vehicle technology. Therefore we expect that, high-volume, short-distance transport will prove to be viable in the near future.

For long-distance road transport, currently the roll out is rather limited. With the current battery technology, the weight required for a decent range would be too high to be economically viable. Additionally, long distance transport is more and more organized in an inter-modal way. Using, for example, rail as the environmental friendly option, especially for high volume goods.

Hybrid technology combines a diesel or petrol engine with an electric engine. This combines advantages of both technologies and is especially useful for stop and go traffic, which is observed in city distribution. Prices of hybrid vehicles are rather high due to the need of installing two drivetrains (electrical and diesel or petrol engine).

In the private car market hybrid cars are a popular vehicle type. By combining the advantages of both technologies it creates a very viable alternative. We see the technology as an intermediary phase before the shift to full electric vehicles.

Colruyt Group developed a hybrid truck that is used to deliver their stores in residential areas at night. Making use of the electric engine allows them to deliver their goods during night-time without disturbing the neighbourhood. The lorries are part of an integral approach for a total noise pollution elimination. This also allows them to drive the trucks outside the peak moments in traffic and establish significant time and fuel savings.

Hydrogen can be used in a combustion engine as well as in a fuel cell combined with an electric engine. Hydrogen has many advantages, the only substance emitted is water and refuelling is quick. Some safety concerns regarding storing and fuelling hydrogen are raised but can be related to the early stages of development of the technique.

In the beginning of 2015, the French postal service, La Poste, started a test with a hydrogen lorry. It can be expected that this technology will break

through in the long-term but at the moment it is not viable in Belgium due to the lack of public refuelling stations.

Are they viable for the transport sector?

The examples above show that many companies in different countries are experimenting with diverse new technologies. Certain technologies can prove to be viable for certain applications, but can they substitute diesel? The specific characteristics of each technology determine its potential for application for a particular activity.

As the case study of the Flemish Institute for Logistics pointed out that when enough refuelling stations are available, diesel prices only have to be €0.3 higher than gas prices for a CNG or LNG vehicle to be profitable. In combination with an optimization of transport flows the technology has already proved to be viable in France.

Electricity is already a viable alternative for low-volume, short-distance transport such as distribution in cities. First tests with high-volumes and short-distances are being executed.

Hybrid vehicles combine the benefits of both a diesel engine and an electric engine. Several constructors already offer hybrid vehicles. We expect that the hybrid vehicles will be used during a transition phase before the shift to full-electric vehicles.

To stimulate the roll-out, governments should take care of the necessary measures such as financial stimuli, refuelling infrastructure, ...

How should you act on this?

The increased awareness regarding sustainability together with the fast evolution of available alternatives forces companies to review their road transport. As being green is ever more important now is the time to put this into a competitive advantage. Green businesses attract customers, employees and investors.

There are many possibilities for a company to minimize their environmental impact. Fleet optimization, fuel management and network redesign are just few of the available options.

Companies could optimize the existing diesel fleet to newer, more fuel efficient diesel models. This results in fuel savings and reduced emission levels. It is a possibility that offers marginal improvements

through limited efforts. It is however costly and does not fully take advantage of the current green trends.

Businesses could also completely redesign their logistic flows and aim for radical improvements. This will require an in-depth analysis of the type of flows, customer requirements, financial capabilities and the organizational challenges. The viable alternatives for diesel are electricity for low volumes on short-distances, although first experiments with high volumes over short distances are undertaken. Natural gas for fixed, medium distance trajectories, whereas hybrid can be for a combination of both. For environmental friendly alternatives for long-distance transport of high volumes one would have to look at inter-modal transport, here railway can be a good alternative.

Building the business case requires insight in all the financial aspects to identify points for improvement. For example, building own refuelling infrastructure could be needed to include in the case of natural gas.

Companies should thoroughly analyse their logistic flows, check their current way of doing business in order to see if they can redesign their flows to enable the use of alternative fuelled lorries and promote themselves as green and sustainable. This will allow them to benefit from the many positive aspects and trends mentioned above.

The government should review their financial stimuli to support the roll-out of alternative fuelled trucks and to fully capture the economic and environmental benefits.

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