White paper

ALTERNATIVE ENERGY FOR ROAD TRANSPORT: the one-size-does-not-fit-all solution

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Fuel drives the logistics industry. Without it, the whole supply chain would come to a standstill. Until the last decade, the choice of which kind of fuel to use was never really a question nor an issue. However, as climate change, awareness has grown, so has the call for logistics companies to limit their impact.

This is hardly surprising given that 7% of global CO₂ emissions originate from trade-related freight transport¹. Faced with increasingly stricter regulations and evolving customer demands, every stakeholder in the supply chain is looking to diversify its energy mix and reduce its reliance on oil.

But which renewable should they choose? Unfortunately, there is no one-size-fits-all solution. Each alternative energy has its own advantages and disadvantages, suiting distances and situation. From electricity and hydrogen to natural gas and biofuels, it’s not easy to get a clear picture of the road ahead.

That’s what this white paper is for. You’ll learn about the alternative energy sources set to dominate road transport in the short and long term. We’ll discuss their pros and cons, their feasibility for various use cases and how they can help you reduce your environmental footprint. We will look at real-world examples of companies having already invested in such innovations and examine other technologies that can put you on the route to a greener future.

So, are you ready to start saving the planet? If so, let’s get started.
A report by the Argonne National Laboratory estimated that the adoption of alternative-energy vehicles could result in annual fuel savings of up to $109 billion by 2035. Moreover, renewables are more stable than price-volatile oil, making for a much safer and predictable procurement strategy.

From a more intangible point of view, using renewable energy can improve a company’s reputation both inwardly and outwardly. Customers and employees are increasingly conscious of their environmental impact and choose companies that follow suit. In 2015, Nielsen found that 66% of consumers would pay more for a product or a service if the company was committed to positive social and environmental change, a figure that rose to 73% amongst millennials.

So much choice… so little time

While electric vehicles (EVs) have stolen the renewable energy limelight in recent years, they are not the only option. Biofuels, hydrogen, natural gas and magnetic levitation are just some of those also jostling for their place in the green energy mix. There is no single alternative energy source that eclipses the rest: if that were the case, there would be no need for this white paper. And since they all reduce emissions of CO₂ and atmospheric pollutants, we must look beyond their environmental benefits when deciding which to adopt.
Electricity, natural gas and hydrogen will shape the supply chain’s future energy mix.

Electric vehicles: the urban solution

EVs are by far the most well-known and mature of all renewable technology. Almost every major car manufacturer has some form of electric car and charging facilities are an increasingly common sight. EVs have also started to make their mark in the logistics sector — originally being restricted to short-distance urban vans, electric trucks are now being brought to market. In reality, the term Electric Vehicle encompasses four types of technology:

- **Hybrid Electric Vehicles (HEV):** The combustion engine remains the main motor but is supplemented by a battery that takes over at low speeds.
- **Plug-in Hybrid Electric Vehicles (PHEV):** Similar to a HEV, but the bigger battery can be charged externally and

France’s La Poste has 7,000 electric vehicles with plans to reach 10,000 by 2020.

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Practically speaking, there are several other criteria that must be taken into account:

- **Initial cost:** how much does it cost for the initial vehicle?
- **Ongoing costs:** how much does it cost to fuel and maintain?
- **Range:** how far does the technology allow us to travel before refuelling?
- **Infrastructure:** what infrastructure is needed to make this renewable viable?
- **Size:** how large and heavy does the engine, battery or tank need to be?
- **Fuelling time:** how long does it take to refuel?

Given the current infrastructure and technology maturity, electricity and natural gas are the most viable renewables for logistics in the short term. UPS and La Poste are two companies who evidently echo this belief. The former recently announced the addition of 35 EVs to its already 300-strong fleet and has invested $130 million dollars in natural gas infrastructure in 2018. While France’s postal service boasts an impressive 7,000 electric vehicles and hopes to increase this figure to 10,000 by 2020.

Looking further ahead, hydrogen fuel cells will benefit greatly from further R&D and a greater support infrastructure. This will help cut the cost of hydrogen technology and make large-scale adoption more feasible. In May 2018, brewer giant Anheuser-Busch placed an order for 800 hydrogen-powered semi-trucks from the Nikola Motor Company. With Tesla, Daimler and Hyundai all announcing new vehicles in the next few years, hydrogen vehicles will only go from strength to strength.

Other alternative energy sources such as biofuels, solar energy and magnetic levitation all suffer from their own drawbacks and stiff competition from the other renewables mentioned above. The high maturity of electricity, natural gas and hydrogen technology mean they will monopolise the time and money of investors and researchers for years to come. This is perhaps for the best: by focusing on these more mature innovations, we will be able to quickly build the infrastructure needed for wide-scale uptake and make immediate, meaningful progress towards climate change goals. While other renewables may be useful in limited scope, it’s electricity, natural gas and hydrogen that will shape the supply chain’s future energy mix.

With that in mind, let’s look closer at these three alternative energy sources.
performs all the work until it has no charge. At this point, the combustion engine takes over.

- **Battery Electric Vehicles (BEV):** No combustion engine, 100% electric.
- **Range-Extended Electric Vehicle (REEV):** A fully-electric vehicle that has a combustion engine to charge the battery when it runs low. The combustion engine has no direct link to the wheels.

In the first two cases, the combustion engine still plays an integral part in the propulsion. Despite being greener than conventional cars (40% less emissions), they are far from ideal. They have helped smooth the transition away from ICE vehicles, but BEVs and REEVs will come to replace them completely over time.

One key issue for EVs is decarbonising the electricity source. For such vehicles to have a positive impact on the environment, electricity must be produced in a sustainable manner. That is why, for instance, that EV emissions in India are almost four times higher than in France, since the latter generates the majority of its electricity through low-carbon nuclear power stations. Saying that, an EV running on ‘dirty’ electricity still emits 25% less CO₂ over its lifetime than a diesel car.

### Urban electric vehicles: short but sweet

The urban environment is the ideal habitat for EVs for several reasons. Their zero tailpipe emissions (see box) not only help in the fight against climate change, but also mean they can roam freely in the low-emission zones of major cities (264 in 2017).

Companies will have a commercial case for switching to battery by the early- to mid-2020s.

ALAN MCKINNON

Besides air pollution, EVs also combat noise pollution by being almost silent: so much so that the EU has ruled that they must be fitted with sound emitters when travelling at low speeds. Travelling in the city also facilitates charging. The close proximity means one charging station could meet the needs of an entire electric fleet, reducing capital costs and overheads. On top of that, the frequent stops allow EVs to make maximum use of regenerative braking technology.

As can be expected, there are downsides. While EVs offer a greener urban delivery solution, they do nothing to reduce city-centre traffic, suffer from the same parking issues as conventional vehicles and still require new infrastructure. Moreover, their initial cost is higher (although total cost of ownership is lower). However, since EVs are perhaps the best solution we have available to us, many governments provide subsidies to encourage adoption. But it won’t be long before these are no longer needed.
As Professor Alan McKinnon, author of Decarbonizing Logistics, points out: “by the early- to mid-2020s, the price differential will narrow, and companies will have a commercial case for switching to battery”.

Longer distances = bigger challenges

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Freight trucks represent 39% of road vehicle GHG emissions despite only accounting for 9% of global vehicle stock. Electrified heavy-duty trucks thus have huge potential, but also huge challenges.

First and foremost, the technology itself. Up until recently, the weight, size and range of batteries have constituted a major roadblock for the electrification of long-distance vehicles.

As technology has progressed, these problems have been mitigated but not eliminated. Tesla’s semi, for example, claims to have a range of up to 500 miles off a single charge. However, the NACFE believes it won’t be before 2030 that we see parity between class 7/8 electric and diesel trucks.

Secondly, infrastructure. While it may be simple to build private charging stations at warehouses at either end of a popular freight corridor, trucks with variable routes must be sure of finding a public station wherever they may be.

Manufacturers are aware of this issue and have joined forces to establish international charging networks. One such venture is Ionity, which plans to have 400 charging stations across Europe by 2020. Ultra-E is another, which will deploy 25 sites to connect over 1,000km of corridors between the Netherlands, Belgium, Germany and Austria.

Another issue is the time it takes to recharge, especially for trucks unable to benefit from off-shift, overnight charging. While the aforementioned networks both implement ultra-fast charging, doubts remain over the promised refill times of heavy-duty trucks such as the Tesla Semi.

Investments are needed

Electrification represents an essential contributor to the decarbonisation of the logistics sector. However, investments in infrastructure and technology are needed to make EVs a fully viable solution for the supply chain. While light-duty vehicles are already relatively mature and a suitable alternative in some situations, they still lack the necessary charging infrastructure and remain expensive.

As for heavy-duty vehicles, there is still a lot of work to be done. The technology and infrastructure may certainly be on its way, but we are looking at another 5-10 years before class 8 trucks become a realistic substitute.

Natural Gas: ready to go

Charlotte Migne, Sustainable Development Director at FM Logistic, believes that natural gas is the only immediate alternative to diesel fuel. Mainly composed of methane, natural gas comes in two forms: compressed natural gas (CNG) and liquified natural gas (LNG).

When compared to diesel, CNG and LNG can reduce NOx emissions by up to 70% and particulates by 85%. Although when it comes to GHG emissions, the picture is not so clear. While a study by NGVA Europe found that natural gas is up to 20% cleaner at the tailpipe for heavy-duty vehicles, another by Transport & Environment concluded it had no meaningful overall effect, mainly due to issues of methane leakage. Such leakage will surely be minimised in time through R&D.

Contrary to electric vehicles, natural gas vehicles (NGVs) are more suited to the heavy-duty than light-duty format. Payback times for light-duty vehicles are relatively long due to the limited distances they cover, and when coupled with...
government policies weighted favourably towards electrification in this category, it is difficult to imagine light-duty NGVs really taking off. On the other hand, heavy-duty NGVs are worth a much closer look. There are already several NGV trucks commercially available, from the likes of Volvo, Scania and Mercedes. One of the main draws to NGVs is fuel price. Like electricity, the price of CNG is much more stable since only around 20% of the price at the pump comes from the natural gas commodity itself, in contrast to 70% for diesel. On top of that, gas benefits from tax breaks in many countries, with average tax rates across the EU 76% lower than that of diesel. This results in a lower TCO and a payback time as little as 2.8 years. Moreover, natural gas engines are 50% quieter than their diesel counterparts.

### Hydrogen: a potential for the future

Hydrogen is the most abundant element in the galaxy and can be extracted from a variety of sources. Vehicles that use hydrogen as a fuel are called Fuel Cell Electric vehicles (FCEV) since they use a fuel cell instead of a battery to power the motor. The string of announcements in the last year have shown the industry’s confidence in hydrogen technology:

- In May 2018, Anheuser-Busch ordered up to 800 Nikola Motor Company semi-trucks
- In June 2018, Toyota unveiled the 2.0 version of its Project Portal truck with further range and better performance.
- In September 2018, Hyundai announced a partnership with H2 energy to produce 1,000 heavy-duty hydrogen trucks and an adequate supply chain

However, there are some reservations. Alan McKinnon, for example, points to the problem of energy loss in the fuel cell process. Another is the production of green hydrogen, which will be essential if the fuel is to play a part in the energy mix of tomorrow. With that in mind, what benefits do FCEVs bring with them?

### How fuel cells are better than batteries

Like EVs, FCEVs produce zero tailpipe emissions and are more energy efficient than diesel engines (and natural gas). Moreover, for medium- and heavy-duty applications, there are several areas where hydrogen fuel cells have the upper hand. Firstly, they are lighter and less voluminous: a battery requires about six times more weight and twice the volume to achieve the same range as a fuel cell. On top of that, they are more scalable since several fuel cells can be easily combined into a fuel stack. Thirdly, they require less maintenance as batteries deplete over time, whereas a fuel cell will operate continuously as long as it receives hydrogen. Lastly, refuelling a hydrogen fuel cell takes just as long as a diesel engine, and thus is considerably quicker than a battery.

### Price & infrastructure: not before 2025

Given the multiple benefits of FCEVs, you may be wondering why the roads aren’t teeming with hydrogen-powered vehicles. Simply put, it’s because they are expensive to make and there is nowhere to fuel them.

The current generation of hydrogen fuel cells require costly raw materials such as platinum, the supplies of which are starting to run out. Furthermore, methods for producing hydrogen have yet to strike the perfect cost-efficiency balance. While R&D is searching to overcome both these issues, we still have a way to go before FCEVs become a viable option for the mass market. Price is also a factor behind the lack of infrastructure. Unlike electricity and natural gas, hydrogen requires an entirely new network, and each station can come with a hefty price tag of anywhere between $330,000 and $5 million.

Consequently, hydrogen infrastructure is lacking with only a few hundred stations currently in operation. They are primarily found in Japan, Germany and the USA (California in particular), although the situation is looking up. According to McKinsey, countries are investing $850 million annually in hydrogen and have announced the development of 2,800 fuelling stations across the world by 2025.

This is why forecasts suggest that hydrogen won’t see its heyday until post 2025, when the cost of fuel cells will be sufficiently low and the infrastructure sufficiently large. If government policy and private backing remain on course, FCEVs have a bright future ahead.
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A new dimension to your supply chain