Whitepaper
The electrification of home deliveries: a practical business case

Imagine: the entire home delivery truck fleet of one of the world's largest retailers becomes fully electrified by 2025. One of Vos Logistics' clients has set this ambitious goal, which is helping drive rapid change in the world of transport. Vos Logistics – committed to driving clean and efficient transport solutions – has taken on this challenge too. Willem Goudriaan performed a thorough study of the technical and economic feasibility of zero-emission home deliveries from Vos Logistics.

In 2015, almost every country in the world signed the Paris Agreement. This agreement is intended to limit the global warming caused by the enhanced greenhouse effect created by mankind due to the excessive consumption of fossil fuels.

In the Netherlands, transport and storage is the third biggest polluting sector, causing 45.8 megatons (Mtons) of CO2 emissions each year. 24.7 of these Mtons are caused by the transport of people and freight over land. The European Commission's goal is a 55% reduction in CO2 emissions by 2030 (compared to 1990) and to be emission-free by 2050.

On 6 September 2019, Vos Logistics outlined four main topics that will impact the industry in the near future as part of its 75th anniversary: 'Imagine Vos Logistics 100'. These topics are:

- Sustainability through energy transition
- Digitalization and data analytics
- The impact of e-commerce on supply chains
- How autonomous driving and robotics will impact the way of working in logistics

During the last decade, Vos Logistics has initiated several green initiatives to accelerate the energy transition. Now, in order to reach the goals of the Paris Agreement, it needs to reduce its emissions even further. Fortunately, a new technology that will change the world of transport as it is known today stands on the verge of breakthrough: the electric truck.

This case study will research the technical and economic feasibility of this innovation, discuss the potential barriers that currently stand in the way of implementation, and clarify what needs to happen in order to turn electric transport into a viable solution. It will pay specific attention to the role of Vos Logistics' truck fleet for home deliveries, and specifically for one of their clients.

Vos Logistics aims to respond to the fast growing market demand for home deliveries of large consumer products (e.g.,

Figure 1. Box van

Figure 2. Box truck

furniture, domestic appliances, etc.) in the Benelux by building a dense and digitally-supported delivery network.

General overview

The fleet that currently delivers the products of this large Swedish furniture retailer runs entirely on diesel. It is made up of a combination of approximately 30 box vans and box trucks, with the first having a slight majority. Since electric truck technology is highly novel and not yet as well-developed as its diesel counterpart, it currently forms a niche in the truck market. As a consequence, both the breadth and depth of electric trucks is limited. This leads to the first potential barrier: electric box vans – the only type of electric truck that is both practical and available for this type of operation – are not available yet. In order to guarantee operational feasibility, the box vans in the current fleet have to be replaced by electric box trucks.

Operational feasibility

Operational feasibility in this area is determined by analysing two important variables in the current truck fleet – mileage and payload – and comparing them to the capabilities of available electric box trucks. In this case, Vos Logistics uses the DAF LF electric model as a reference. This vehicle has an effective range of 254 km and a payload capacity of 11.7 tons. The replacement ratio for box vans to electric box trucks is based on the previously-mentioned variables as well as the number of trips per day and the load factor.

Data analysis from the current fleet shows that day-to-day operations could also be performed by electric box trucks. However, a very small number of trips in the data set would push the electric truck to its limits in terms of mileage, which is generally considered to be detrimental for the battery. A builtin safety margin is therefore recommended when planning trips, so that the battery is never fully discharged.

Grid capacity

Technical feasibility is not just determined by operational feasibility, because electric truck technology introduces a new potential barrier in the form of charging. Since distribution centres generally do not require large amounts of electricity the contracted peak power in their energy contract is selected accordingly. This could pose a problem, since charging a single electric truck – let alone an entire fleet – could double a building's peak power requirements. It is therefore vital to determine the amount of power that remains available at any given moment, and that can be used to charge electric trucks. This also means considering the building's own electricity production (e.g., PV system), since this could be used alongside electricity from the grid – essentially increasing the bandwidth that could be used by the trucks.

$$P_{left\ minimum} = P_{contract} + P_{production\ minimum} - P_{usage\ maximum}$$

The equation above shows how to determine the power bandwidth left for electric trucks. Obviously, the trucks need to be able to charge each day of the year. This means that they cannot depend on a building's electricity production (assuming that the building will not always require the maximum amount of power). Vos Logistics can depict a worst-case scenario by taking contracted peak power, adding the minimum amount of produced power, and subtracting the maximum amount of power used by the building. If the trucks are able to charge under these circumstances, they will be able to charge under any circumstances.

If the implementation of electric trucks turns out to be a success, their number could increase rapidly in the near future. This means that it is vital to keep monitoring available power. Future research should optimise the charging strategy, aiming to charge as many trucks as possible with currently available energy before increasing the contracted power of the charging location in question.

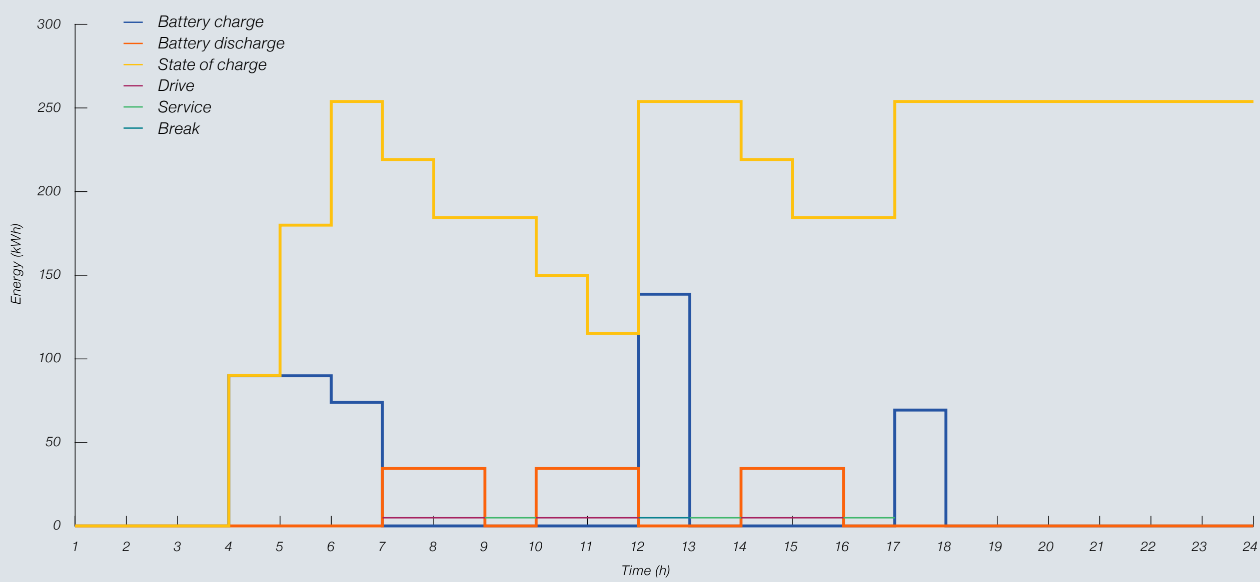
Charging profile

The charging profile of the entire fleet has to stay within the bandwidth (as determined above) to guarantee technical feasibility in terms of charging. However, there are not yet any electric trucks in use, so there is no data available regarding the fleet's charging profile. Therefore, a model was made to compute a charging profile based on the operational data set, which includes driving time, service time and break hours. Figure 3 provides an example charging profile for a truck that makes two trips a day, takes a service hour every three working hours, and comes back to reload and recharge during the break.

The trucks operate from different locations throughout the Netherlands, so each location has different operational data and therefore a different charging profile. Multiplying the charging profile of a single truck by the number of trucks at

Figure 3

Charging and discharging profile of a single electric box truck during the day



each location provides the charging profile of the entire fleet at that specific location. The trucks are divided into two groups to prevent enormous peaks in power, resulting in a more even charging profile. To check grid capacity, the final charging profile is compared to the power bandwidth as calculated in the equation at the top of the page.

The conclusion of this analysis is that the grid capacity at each location is sufficient in terms of availability of the required hardware (e.g., cables). However, some locations do not have power bandwidth large enough to charge all of the trucks. This is simply because the contracted power is set lower than what the grid can maximally provide. In other words, it is a software problem – a minor barrier that could easily be overcome by increasing the power in the energy contract at these locations.

Economic feasibility

To determine the economic feasibility of this project, a total cost of ownership (TCO) model was made for an electric truck and a diesel truck to serve as a reference. As the name suggests, a TCO model combines all costs associated with owning a truck over its entire lifecycle, typically on an annual basis. The model makes a distinction between direct costs, which can be divided into fixed and variable costs, and indirect costs. Direct fixed costs are costs that are independent of the operation of the truck, such as insurance fees and interest. Direct variable costs, such as fuel, electricity and tires, depend on the operation of the truck. Indirect costs include labour and overhead. However, since these indirect costs are the same for both types of trucks, they will not be shown.

Scenarios

The TCO model was run for three different scenarios to find the break-even point. The scenarios become increasingly favourable for the electric truck compared to the diesel truck.

They are:

A. The baseline or market scenario: comparing a diesel truck with an electric truck.

B. The realistic scenario: scenario A, including financial incentives for electric trucks.

C. The optimal scenario: scenario B, including financial disincentives for diesel trucks.

In scenario A, the TCOs appear as if they were left to free market forces. This mainly serves as a reference scenario, since in practice, the government provides financial incentives in the form of subsidies and deductions (as modelled in scenario B). Scenario C models a more ideal world for electric trucks in which the government immediately applies extra taxes for diesel trucks, such as CO2 or kilometre pricing. The outcome of the three scenarios is shown in the table below. A positive number represents how much more expensive the electric truck is compared to the diesel truck and vice versa.

Scenario	Fixed costs	Variable costs	Total costs
A	~ 240%	~ 60%	~ 15%
B	~ 130%	~ 5%	~ 5%
C	~ 150%	~ 15%	~ 0%

Outcome of the TCO model for a diesel truck and electric truck, with the diesel truck as a reference state

The conclusion of this analysis is that an electric truck is still more expensive than a diesel truck, even with financial incentives from the government. However, the gap is not insurmountable, and there are practical tools available for the government to close the gap between diesel and electric trucks.

Another way to make scenario B break even is to increase the annual mileage by roughly 50%. This is because the business model of an electric truck revolves around compensating its high initial costs by exploiting the relatively low costs for electricity compared to those of fuel. This would increase the daily driven distance to such an extent that it could only be done with multiple battery recharges. In short, the TCO gap appears to be the only barrier that stands in the way of electrifying the current truck fleet, since it does not have an immediate and viable solution.

The future of electric driving

It is expected that the TCO for electric trucks will decrease each year, mainly due to the ongoing development of battery technology. Although estimations made by experts vary, the general consensus is that the break-even point will be reached between 2023 and 2028. Vos Logistics is not going to stand idly by waiting for this to happen. Instead, it will lead the way and start experimenting with this technology on a small scale starting this year. It is merely a matter of time before electric vehicle technology catches up to the current regime of fossil fuelled transport. When it does, it will change the world for the better.

The roadmap to electrification

Imagine: Vos Logistics runs a fleet of 400 all-electric distribution vehicles. What is needed to make this happen? It requires a variety of truck offerings in different configurations from multiple suppliers. It requires an onsite loading infrastructure, as well as at hotspots along the highways. It requires battery charging solutions that occur during loading and unloading and during driver rest times to minimize the downtime of the electric trucks.

The conventional diesel truck will face governmental restrictions such as prohibition from entering city centres because of zero-emission zones. They will also become more expensive than electric trucks, which will decrease their numbers even further. This will have a huge impact on the current fossil fuel lobby (ranging from oil companies to workshops to car dealers). These upcoming issues will have to be faced by the affected companies in the transport sector and – indirectly – the government as well.

About Willem Goudriaan

Willem Goudriaan (23) is a second year Masters student from TU Eindhoven, studying Sustainable Energy Technology. His internship at Vos Logistics was a step-up to his graduation project which he will be doing next year. Willem is fascinated by almost all technologies regarding the energy transition, especially those with a practical implementation, just like this feasibility study. His plan is to finish his studies at an engineering firm and start working there as an energy consultant as soon as he graduates.

About Vos Logistics

Vos Logistics is a specialist in a wide range of transport and logistics services. Through a network of 30 group-owned locations, the company is active throughout Europe. Solutions offers customer-specific logistics solutions, from forwarding, warehousing, value-added services and distribution to full supply chain solutions in which Vos Logistics assumes management of all of the customer's goods flow. In the bulk and volume (Mega and High Volume) transport markets, Vos Logistics is one of the largest road haulers in Europe. With 3,000 employees, it operates a modern fleet of 1,400 trucks, 4,000 loading units and 340,000 m2 of storage space.

Collaboration will be key as we transition to electrification. And there will no doubt be speed bumps down the road. Has this article triggered questions in your mind? Do you have ideas of your own to share? If so, we would love to hear from you.

Contact us with your contribution to the discussion as – together – we help the world of logistics go electric.

Get in touch with Frank Verhoeven,
CEO Vos Logistics through +31 (0)412 699 500 or corporate@voslogistics.com.

Please note that citing from this article is appreciated with the connotation of the source and author.

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