TOWARDS ZERO-EMISSION CITY LOGISTICS

Source: Breytner

TNO innovation for life

SUSTAINABLE URBANIZATION

Managing urban areas has become one of the most important development challenges of the 21st century. Urban populations continue to grow and sustainable urbanization is key to successful development. Growing cities facilitate more attractive opportunities for employment, education, and cultural, shopping, social and sport activities. Many cities are adopting a *Smart City* agenda to improve quality of life by using urban information technology to improve the efficiency of services. Passenger and freight transport is essential for the development of cities and the supply of their residents and businesses.

Cities depend on an efficient and sustainable city logistics system to ensure their attractiveness, economic power, and quality of life. Increasing traffic within limited city space leads to negative effects in terms of emissions, traffic safety, congestion and nuisance (noise, stench, vibration etc.). City logistics service providers compete against other road users for the scarce traffic space. Moreover, they are exposed to a variety of challenges resulting from the future development of markets, increasing environmental requirements, new technologies, and evolution of complex supply chains.

Many major cities have introduced Low Emission Zones in areas where local air pollution has reached levels which are dangerous to human health. As a consequence, the most polluting vehicles are restrained from entering the cities. Furthermore, air quality in cities is expected to improve in the medium term due to stringent European pollutant emission regulation for new passenger cars, light commercial vehicles (vans) and heavy-duty vehicles (trucks). CO_2 emissions on the other hand are not (yet) regulated for trucks and for cars and vans it is uncertain how stringent targets will be set in the 2025–2050 timeframe. In large cities such as Rotterdam, commercial freight transport vehicles make up about 10% of the vehicle fleet, but take account for more than 30% of traffic CO_2 emissions, *see figure 1*. In particular, the number of light commercial vehicles and CO_2 emissions from these vans have approximately doubled since 1990 in the Netherlands.

Apart from the reduced amount of CO_2 emissions, zero-emission transport brings about multiple co-benefits: improved air quality, lower noise levels and less vibration. Therefore Europe has set an intermediate goal *to...*
"achieve essentailly CO_2-free city logistics in major urban centres by 2030 (that would also substantially reduce other harmful emissions)"...
In its roadmap towards a low-carbon and resource-efficient transport sector by 2050. As a result, increasingly stringent rules and low-carbon regulations are expected in urban areas.

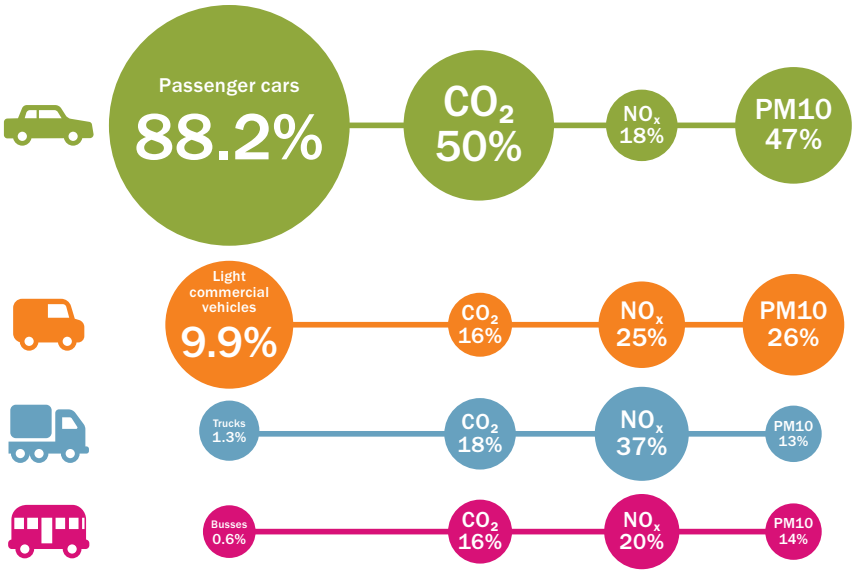

Fig. 1. Traffic emissions inventory in Rotterdam.

The focus of policy makers, industry, shippers and logistics service providers is therefore expected to shift more and more towards climate-neutral transport. In the Netherlands, a large coalition of public and private stakeholders have signed a 'green deal' showing their ambition and willingness to take action to achieve zero-emission city logistics by 2025. Strictly speaking, *zero emission* refers to both zero pollutant emissions and zero carbon dioxide emissions. However, until now for many large cities the primary reason to aim for zero-emission city logistics was to improve the air quality in the short and medium term. In the medium and long term, when the air quality is expected to improve autonomously due to cleaner conventional vehicles as well, zero-emission city logistics should be targeted both for further improvement of air quality as well as for the reduction of GHG emissions. In practice, however, the transition to zero-emission city logistics is currently still in an early stage of proof of concepts in living labs (local pilots). Complexity of the logistics organization and the number of stakeholders involved are resulting in a variety of barriers that hampers the wider uptake of zero-emission vehicles.

TRENDS, BARRIERS AND OPPORTUNITIES

City logistics service providers are facing a very challenging operation. Due to, amongst others, growing e-commerce and tracking and tracing and other information technologies, customers are demanding shorter delivery times such as same-day delivery and almost instant-delivery as well as more flexible and more reliable delivery times. Current just-in-time production and distribution practices are based on low inventories and timely deliveries. This requires more reliable delivery schedules taking into account local rules and regulations such as tight delivery time windows in the environment of congested urban areas.

However, changing stock keeping patterns and corresponding delivery patterns also lead to more frequent, smaller deliveries undertaken by small freight vehicles. Last-mile delivery involves transport over short distances with smaller trucks or vans, and is often carried out by the receiving depots in their regions. More than 80% of today's road freight trips are of distances below 80 km and can be defined as urban or urban regional transport. Last-mile delivery schedules with smaller vehicles and relatively short trip distances turn out to be favourable parameters for a zero-emission logistics operation. Nevertheless, the highly competitive transport prices (costs) and service levels (delivery time and reliability) of city logistics operations are yet important constraints for the feasibility of a transition towards zero-emission vehicles in city logistics. Fierce competition and low profit margins hamper bottom-up innovations in this sector. City logistics also comprises a large share of low-cost transport on own account by suppliers or receivers. This segment requires top-down approaches in order to improve the logistics efficiency and reduce its carbon footprint.

One major barrier is the limited availability of electric vans and trucks. As yet, models from OEMs are hardly available for large trucks or medium sized trucks. Trucks with a gross vehicle weight of up to 18 tons are currently only available as a retro-fit solution from manufacturers such as Terberg, Ginaf, Emoss or VDL in the Netherlands. Leading OEMs have announced first models to be produced soon.

"MORE THAN 80% OF TODAY'S ROAD FREIGHT TRIPS ARE OF DISTANCES BELOW 80 KM"

"This is our greenest truck."

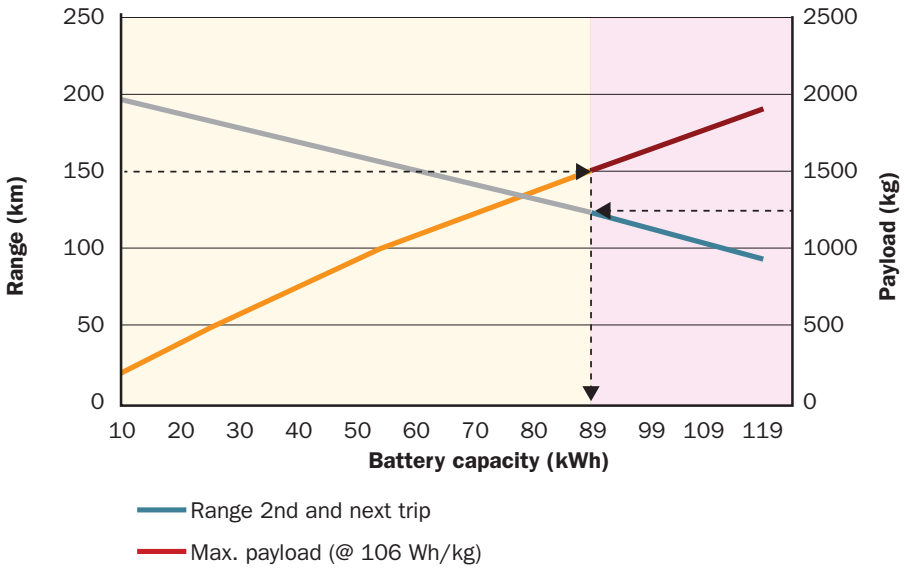

Fig. 3. Trade-offs between battery size, energy density, range, payload and charging strategy.

Many manufacturers (OEMs) argue that there is currently not enough demand for electric freight vehicles that would justify large scale production. Logistics operators argue that there are no electric freight vehicles offered for a feasible price. In order to overcome this gridlock, a higher level of collaboration is likely to be required.

In addition, finding the right operational settings in which a zero-emission truck can compete with a conventional diesel truck in terms of total cost of ownership of the vehicle turns out to be a challenge. Depending on its size and specifications, the purchase price of electric trucks is roughly twice as high compared to their conventional counterparts. Consequently, this has to be earned back during a feasible payback period in which operational costs per kilometre are significantly lower and during which the number of kilometres driven should be sufficiently large. The cost competition between conventional and alternative technologies is further hindered by a lack of level playing field in the sense that the external costs of pollution are not internalised in the business case. This leads to a split incentive situation in which society benefits from investments that are not or only marginally profitable for the companies making these investments.

As most logistics operators lack experience with such vehicles and no independently validated performance data is publicly available, there are also hesitations and concerns about the operational reliability and performance (battery lifetime, depreciation, energy-efficiency, etc.), creating an additional risk for the required investments.

Another concern is the development of new charging infrastructure and integrating the charging cycles into the logistics operation. Municipalities and grid operators should be involved in order to facilitate or invest in charging infrastructure at loading docks or at designated parking bays for unloading on street.

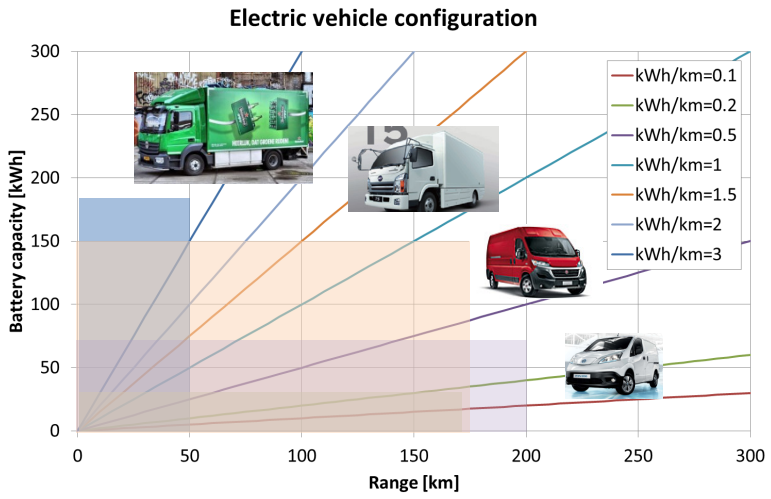

Fig. 2. Trade-offs between truck size, battery size, range, costs.

THE WAY FORWARD...

Clearly, there is no silver bullet that could instantly accelerate the mass adoption of zero-emission city logistics. However, a systems approach allows to systematically search for the most promising logistics operations to start the transition to zero-emission logistics, to reshape the logistics settings, to match the technological options and specifications, to optimize the TCO and to provide validation and guidance during implementation. The systems approach TNO developed enables to seize the opportunities for an earlier and wider adoption of zero-emission vehicles in city logistics.

Starting point is to analyse the local characteristics in a specific city and the logistics operation of a specific logistics service provider. The existing vehicle fleet can be characterised in terms of size, payload, mission profiles (speed, trip distance, number of stops, etc. based on data from various Transport Management

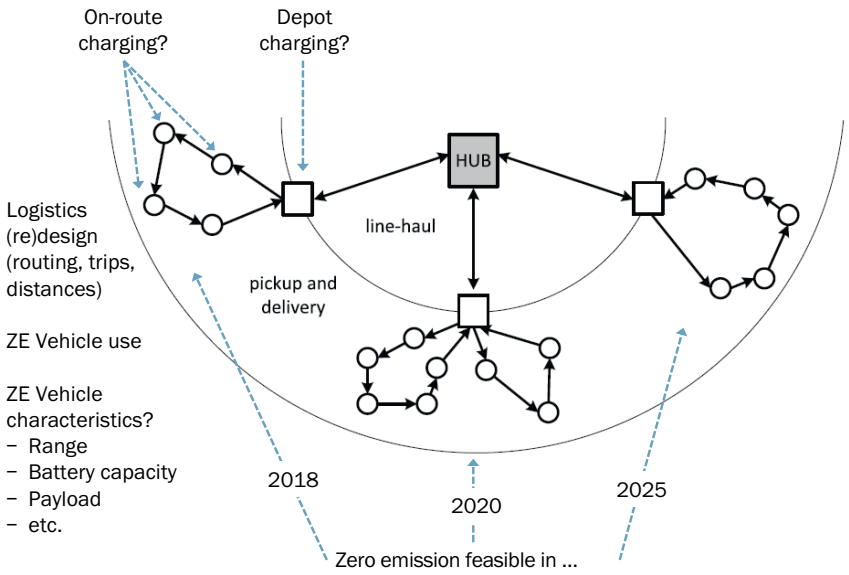

Fig. 4. Reshaping the logistics system with TNO toolset.

Systems (TMS)) and worst case conditions. Next, a systems approach is applied to find those parts of the operation that are promising for a cost-effective transition to electric vehicles. This is a complex and iterative design and optimisation task in which many trade-offs are made and synergies can be identified. The TNO toolset incorporates a multi-level energy optimisation framework in which the specific logistics characteristics of the operator are matched with state-of-the-art technology insights, options and costs. For example, a larger battery capacity results in a higher range, but it also leads to a lower payload due to the weight of the battery and to extra costs for the battery. The payload could be increased by selecting a battery with a higher energy density reducing the weight and volume of the battery, however, batteries with the highest energy densities are also the most expensive batteries. The result of the analysis will lead to a strategic roadmap, for example for the next 5 to 10 years, in which step by step an increasing share of the existing logistics operation is transformed into a zero-emission operation. The design and optimisation tasks of the systems approach should be repeated for every next step on the roadmap as new information about the availability, costs and performance of zero-emission vehicles and the logistics context may require to adjust the roadmap.

The TNO toolset and framework includes an increasing evidence base from validated user experiences, which is helpful to narrow down the levels of uncertainty about the transition to zero-emission transport.

Also municipalities have an important role to facilitate the adoption of electric trucks. A number of measures could improve the TCO. Cities could exempt zero-emission vehicles from tight delivery time windows. Designated parking bays for unloading could be better located and their number increased or exclusively designated for zero-emission vehicles—with appropriate enforcement. Finally, it is important to show the shared benefits of stakeholders with split incentives. Coordinated action by first movers among vehicles suppliers as well as logistics service providers in a partnership, will likely turn their experience and leadership in climate-friendly transport into a competitive advantage.

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LIVING ENVIRONMENT

As part of the Living Environment theme, we apply ourselves to devising innovations for vital urban regions. We work together with partners to create solutions for today and opportunities for tomorrow to enhance the viability, accessibility and competitiveness of these urban regions.

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Version: September 2017 - TNO 2017 R10954