35th International Electric Vehicle Symposium and Exhibition (EVS35)
Oslo, Norway, June 11-15, 2022

User experiences from the first dedicated series-produced battery-electric trucks in Norway

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Summary

Until recently, battery-electric trucks were few, and largely constituted small-scale conversions from diesel vehicles. This paper presents user experiences from the first dedicated and series-produced battery-electric trucks in Norway, introduced since the summer of 2020. Based on interviews with five early adopters, this article provides insights into real-life experiences and themes relevant for the adoption of low- and zero-emission trucks. Topics covered include drivers behind investments in battery-electric trucks, costs, procurement processes, operation, charging, performance/use vs. diesel trucks, incentives, challenges and requirements for larger-scale electrification.

Keywords: BEV (battery electric vehicle), heavy-duty, freight transport, user behaviour, market development

1 Introduction and method

A previous study [1] compiled user experiences from early Norwegian users of battery-electric (BE) trucks, all based on pilot conversions from diesel to electric drivetrains. Starting in summer 2020, the first dedicated, series-produced BE-trucks from major truck manufacturers were delivered to Norway, while manufacturers also announced new upcoming models. Figure 1 illustrates the development in the number of new registrations of BE-trucks and shows that the introduction of series-produced trucks boosted adoption. However, by April 2022 Norway still only counts around 150 BE-trucks. These are mostly owned by large actors and (initially) largely concentrated in the Greater-Oslo region. With more recent deliveries, the adoption of BE-trucks has started to spread out also to several other Norwegian regions.

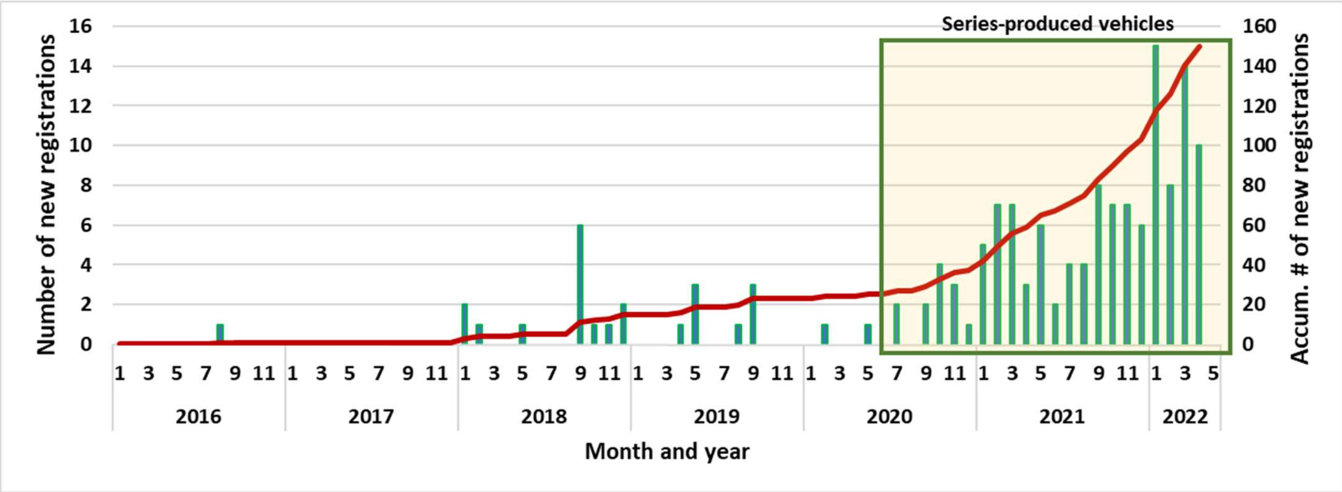

Figure 1: Development in number of new registrations of BE-trucks (left axis) and accumulated number of new registrations (right axis). Status per 26.04.2022. Source: Norwegian Public Road Administration.

For this paper, we interviewed five of the first Norwegian firms operating dedicated series-produced BE-trucks (three distributors; two construction firms). Together, these operate 28 BE-trucks from several manufacturers, including 2-/3-axled distribution trucks and 3-axled construction trucks built on distribution truck chassis. Table 1 provides an overview of key characteristics of the vehicles and time of adoption.

The objective behind the interviews was to gain insights into experiences/themes relevant for the faster and larger-scale adoption of BE-trucks that is required under existing transport-political and climate objectives (e.g. the Norwegian National Transport Plan's objective of 50% of new trucks being zero-emission by 2030). For this reason, the interviews covered topics such as the motivations behind adopting BE-tucks, the vehicle procurement process, approaches to charging and experiences, operation compared to internal combustion engine (ICE) vehicle operation, financial and other incentives, challenges and barriers, and the interviewed actors' view of the requirements for achieving electrification at a larger scale. In addition to the five operators, we carried out interviews with a vehicle manufacturer and the Norwegian Public Roads Administration, who contributed further insights and contextualization.

Table 1: Overview of series-produced BE-trucks operated by the 3 distributors and 2 construction firms interviewed.

Firm	Number	Make/model	Vehicle type	Payload capacity (if reported)	Other characteristics	Battery capacity	Time of adoption
A	2	Fuso e-Canter («Prototype 1»)	Truck with closed chapel, 2-axled		Chapel; tail lift	80-85 kWh	Late summer 2020.
	1	MAN	Truck with closed chapel, 3-axled		Chapel; side door; tail lift	185kWh	2020/2021 transition.
	1	Scania	Truck with closed chapel, 2-axled		Heated chapel (energy from HVO burner); side door; tail lift	270kWh	April 2021.
B	5	Scania	Truck with closed chapel, 3-axled			300kWh	
C	8	Fuso e-Canter («Prototype 2»)	Truck with closed chapel, 2-axled	12 pallets (80x120 cm)	Chapel (simple); tail lift	81,7kWh	Between December 2020 and March 2021.
	3	Volvo	Truck with closed chapel, 2-axled	18 pallets (80x120 cm)	Chapel (extra low); tail lift. One vehicle has side door.	200kWh	1 in August 2020; 2 in December 2020.
D	6	Volvo FE electric	Construction trucks, 3-axled		3x «Gen1» vehicle, 3x «Gen2» vehicle.	"Gen 1" 200kWh. "Gen 2" 260kWh.	"Gen 1" in October 2020. "Gen 2" in April/May 2021.
E	2	Volvo FE	Construction trucks, 3-axled		Both «Gen1» vehicles.	200kWh.	January 2021.

2 Interview findings

2.1 Procurement process

2.1.1 Background, strategy and drivers for BE-truck adoption

From the interviews, drivers behind investments in BE-trucks have had both differences and similarities between the different operators. All operators report that choosing BE-trucks has predominantly been strategy-induced, with firms' own (differing) environmental objectives being major drivers. Also the role of passionate souls in management (often with good knowledge of the firms' transport operations or with (previous) driver experience) was highlighted as an important driver for BE-truck adoption.

For construction firms, incentives in public tenders were further crucial, given their high share of assignments for the public sector (and particularly for the City of Oslo, which has much focus on the environment in awarding tenders). For the distributors, tender requirements were less decisive factors due to (often) relatively low weighting of environmental performance criteria and relatively short tender periods. At the same time, they reported increased customer demand for greener transports in general, but limited willingness-to-pay (especially in business-to-business transport assignments).

2.1.2 Selection of manufacturer and vehicle model

With regard to model selection, the firms pointed out that with the availability of series-produced BE-trucks, it was no longer relevant to invest in diesel-to-BE-truck conversions. Given experiences both from BE-conversions [1] and their existing ICE fleets, the firms further expressed preferences for buying from established suppliers with good problem-solving capacity in close geographical proximity. In practice, however, manufacturer/vehicle model selection was particularly influenced by (until recently limited) availability.

Pricing was considered, but not as decisive factor, as investments were considered strategic. For the small and larger BE distribution trucks and construction trucks in Table 1, BE-models were reported to be respectively 2-2,6x, 3-4,6x and 3-3,5x more expensive than comparable diesel trucks. Although cost premiums fell somewhat between 1st and 2nd generation series-production, high investment costs and uncertain residual values resulted in firms employing longer depreciation periods (yielding lower capital costs per year) or intending to use BE-trucks longer than diesel trucks (increasing the relative payback potential) or "using them up", whereas diesel trucks would normally have been sold on. All firms received government subsidies (varying between 25 and 48 % of the price *premium* vs. comparable ICE trucks) and consider these crucial, despite some challenging administrative and ownership-related requirements which have later been relaxed.

The firms further pointed out that it often took a long time both from models were announced by the manufacturers to when they could be ordered, and from ordering to actual delivery. In practice, this initially set limitations to the ordering of the desired numbers of vehicles and the desired specifications, but this situation has reportedly improved.

2.2 Experiences from operation

As seen from Table 1, the interviewed operators' vehicles were put into operation between the summer of 2020 and April 2021, i.e. experiences reported are for a limited period, but largely from periods with full operation.

All firms made (minor to major) operational adjustments for BE-truck introduction. The distributors' trucks are largely used in city distribution and approach diesel truck performance when sufficient fast-charging is possible. City topography and terminal/customer localization also affect electrification potential (the city of Bergen for example is stated to have more demanding topography and delivery structures). For diesel-based construction trucks, use varies, making direct comparisons with BE-trucks difficult. The latter are largely used in Oslo, for lighter construction works and between construction sites and disposal sites, also due to tender particularities. In general, use flexibility is somewhat limited due to the inability to drive with trailer and on longer routes.

Overall, BE-truck energy consumption is considered low, yielding large energy and potentially also cost saving. At the same time, energy consumption and driving range can vary much: In practice, driving range lies somewhat below manufacturer specifications, but much closer than observed for BE-vans (reported by operators owning both BE-vans and -trucks). Range reductions during wintertime have been limited, and energy efficiency improvements in newer generations series-production are noticeable.

Except for isolated incidents, the five firms experienced few large technical issues, but have mixed experiences regarding training, service, maintenance and pricing. Drivers are generally satisfied and report improved working environments. In practice, reduced payload capacity due to battery weight is not very problematic, but battery placement can yield challenges w.r.t. axle load, placement on 3-axled vehicles and uneven construction site surfaces.

2.3 Charging

Although charging strategies vary, the distributors predominantly started with nighttime depot charging, but desire more (daytime) fast-charging. The construction firms also employ nighttime charging, alongside several (daytime) fast-charging solutions. While depot charging is relatively cheap (infrastructure/electricity costs), fast-charging is expensive. Subsidies being awarded only to publicly available chargers is perceived as huge barrier, as are potentially high additional costs for grid upgrades. Interview feedback also points to a chicken-or-egg-challenge regarding slow infrastructure construction and BE-truck adoption, with competitiveness of BE-vehicles depending on how optimally vehicles can be used. External fast-charging is further considered expensive and entails time losses, detours, etc. In the context of electrifying construction work and related transports in urban areas, an important barrier pointed out in the interviews is that operators in practice bear responsibility for investigating and ensuring sufficient grid capacity and charging areas for charging electric machinery and vehicles. This is reported to entail uncertainty and potentially significant costs and project delays.

2.4 Incentives and framework conditions

All firms highlighted the importance of stable, predictable and long-term framework conditions and call for measures aimed at the many small market actors. Vehicle subsidies are considered essential, but much better solutions are required for charging infrastructure, alongside rapid construction of publicly available chargers. Maintaining road toll advantages, especially in cities, is considered crucial, as cost savings can be in the order of 80.000-120.000 NOK/year (~8-12 thousand EUR). These savings (in addition to (particularly) lower energy costs) are important when comparing BE- and ICE-trucks in terms of cost competitiveness and the payback of higher BE-truck investment costs. A possible (much-debated) introduction of toll road advantages also for biogas vehicles may cause a shift to those. Other (existing or potential) incentives mentioned include geographical/time differentiation (low-/zero-emission, low-noise, dedicated loading/unloading zones). Silent BE-trucks have a potential for night-time operation, improving their utilization/cost effectiveness, but not for construction trucks, due to dependency on inherently noisy activities. For these, particularly (smarter) tender design and conditions are considered crucial.

2.5 Electrification potential and other alternative technologies

Distributors are positive about the potential for electrification of their fleets. For much of local distribution, electrification is already feasible. The firms further report that fast charging and relatively small driving range improvements can make it feasible to also operate large shares of their regional transport electrically, provided that four-wheel drive and towbars become available. For construction trucks, vehicles with more axles and tow bars are needed, alongside driving range improvements to put more construction waste disposal sites within range. More generally, the vehicle manufacturer reports that developments are moving quickly and that larger technological developments are expected in the future. It is also expected that costs can become significantly lower once much of the large initial development costs has been recovered.

Of other low-/zero-emission alternatives, (liquid) biogas is considered the most promising alternative to battery-electric operation on (longer-haul) heavy trucks, while in urban settings, BE-trucks may face most competition from (compressed) biogas trucks, particularly if these are also treated advantageously (e.g. road toll exemptions).

Biodiesel/-ethanol have become less competitive after levy system changes, and has reportedly induced returns to (fossil) diesel operation in some market segments, instead of the use of pure biofuels. Biofuels are nevertheless used to some extent, because Norwegian regulation mandates that a certain percentage of all fuel sales shall be biofuel. In practice, this means that a biofuel share is mixed into fossil diesel and petrol. Hydrogen was not considered a realistic short- to medium-term alternative by the interviewed operators at the time of the interviews.

3 Conclusions and future work

The interviews of owners of series produced battery-electric trucks show that progress has been made since the previous interviews with adopters of converted diesel trucks. The quality of battery-electric vehicles has improved, and the service has become more accessible. Incentives, including government subsidies (from ENOVA) and exemptions from road tolls have made total costs of ownership more comparable to those of ICE vehicles, and public procurement initiatives have further tipped the scale towards the decision to adopt battery-electric vehicles. The users interviewed look forward to further technical progress that should enable more adoption in new use areas, and at lower costs once manufacturers' initial development costs have been recovered.

Further research is in particular required when it comes to policies and support schemes that can support broader adoption, evaluation of the impact of longer driving ranges on the operational potential of battery-electric trucks, and charging infrastructure deployment and operation. Other questions relate to which transportation segments can be covered with battery-electric trucks, and from what point in time, and which transportation segments will require other alternatives such as hydrogen or biogas operation, or may even need to remain based on fossil fuel operation.

Acknowledgments

This work was funded within MoZEES, a Norwegian Centre for Environment-friendly Energy Research (FME), co-sponsored by the Research Council of Norway (project_257653) and 40 research, industry and public sector partners.

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