Institute of Transport Economics
Norwegian Centre for Transport Research

ENGLISH Summary

Progress and future prospects for the adoption of battery-electric trucks in Norway

User experiences, developments, barriers and needs

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Main findings:

- Battery-electric trucks (BETs) are the market's main focus, and range increases, faster charging, improved reliability and robustness, and gradually decreasing prices allow new use cases for BETs.
- Investment subsidies, tender requirements, road toll benefits and measures for charging infrastructure construction have been central to BET adoption. Achieving 2030 objectives, however, requires strong additional measures, and likely a role also for biogas trucks.
- Improved predictability, longer-term perspectives and more comprehensive policy design are critical for Norway's green transition going forward, including regarding investment subsidies, electricity access, road toll benefits, tenders, technology choices and transport contracts.
- Challenges related to charging infrastructure construction at depots and along public roads have been major barriers. This is due to cost implications of high power requirements, long case-handling processes, risks of power and grid deficits, and systemic challenges.
- There is a need for policies that allow transitions also for smaller transport firms, where transitioning poses larger challenges. Risks regarding implications for competition should also be considered.

Background

Achieving Norwegian climate objectives for 2030 requires large emission cuts from the transport sector. Although road transport emissions have shown a downward trend from around 2015, there is still a long way to go when considering a 55% reduction in 2030 (vs. 1990) in accordance with Norway's overall objective under the Paris Agreement. Emission cuts thus far have further largely been driven by passenger transport, whilst for (smaller) emissions cuts from heavy-duty transport, increased biofuel blending has so far been the main driver.

To reduce emissions also from heavy-duty transport, Norway has a strong focus on the adoption of new technologies, with an increasing number of battery-electric (BET) and biogas

trucks. Achieving 2030 objectives, however, requires similar adoption rates for zero-emission or biogas trucks as Norway previously had for battery-electric passenger cars. This has to be achieved despite the fact that the policy toolbox is more limited for trucks than for passenger cars, and despite barriers in the truck segment being larger.

This report provides an updated overview of experiences, barriers, drivers and lessons for further adoption of BETs in light of fast developments in recent years, including increased focus on charging needs and barriers and changes in policies, incentives and framework conditions. The work is based on interviews with early adopters of series-produced BETs, truck suppliers and public authorities, and on perspectives from major leasing and financing firms. This is supplemented with analyses of developments in BET prices and investment cost premiums, based on data from applications for investment subsidies from government agency ENOVA. Even though also the number of biogas trucks is increasing and hydrogen vehicles are being developed, this report focuses on BETs. These have been the market's main focus, but remain less mature solutions than gas trucks and face larger challenges for adoption going forward. So far, only a handful of hydrogen trucks have been tested in Norway, and transport firms call for significant technological, price and infrastructure developments before they considered hydrogen-based solutions a viable alternative.

Experiences from early adopters

Background and drivers for investments

So far, the demand for BETs is mainly driven by larger firms, although some medium-sized and small firms have also made smaller-scale investments in BETs. Overall, our interviews suggests that the larger firms will transition anyway, and do so primarily for strategic reasons, and to a lesser extent for other reasons. Medium-sized firms transition partially for strategic reasons and partially because of a market demand, e.g. in tenders or assignments from key customers. BET investments by small firms have so far primarily been driven by market demand through tender requirements or larger long-term assignments from key customers. For all types of firms, use cases are also relevant for BET investments, even though this varies depending on whether investments are mostly strategic or BETs also have to be profitable. Transport firms investing in BETs are for example often actors with much driving in urban areas, because of the availability of charging opportunities and road toll advantages. Other examples include transport firms with repetitive transport assignments on routes where they have control over charging opportunities. The choice of BETs over other propulsion technologies is related to firms' preferences, perceptions of future developments, or that alternative solutions did not fit as well. The timing of BET investments, in turn, has been related to strategic considerations, to sufficient decreases in vehicle prices, and to the fact that available models increasingly meet transport firms' needs.

Purchase process and vehicle availability

Previously, both the choice of supplier and models was limited for BETs. This has improved considerably, even though transport firms report that in practice, choice alternatives have still been limited in some segments. Amongst others, this has been due to a demand for 3-axled tractors, which is specific for Norway and differs from most other countries. Generally, purchasing processes for BETs are more extensive than for diesel trucks. Suppliers want customers to succeed and spend time going through their customers' needs, intended use and operation, charging strategy and construction of charging infrastructure, vehicle specifications, price, and financing. There has also been a need for increased knowledge and training among both suppliers and transport firms. In recent years, delivery times for BETs have varied,

amongst others due to pandemic-related backlogs (especially for superstructures/bodywork, which also affected delivery times for diesel trucks), but also because production still takes place in relatively small series and because developments are going so fast that not everything has been standardized yet. This is expected to improve going forward.

Capital costs

Rapid technological developments and more standardized production at larger scale has resulted in somewhat lower purchase prices for BETs. Despite this, BETs remain at a large cost premium compared to diesel trucks. Newer models have come with steadily increasing battery capacities and other improvements, which have partially 'eaten up' price reductions, e.g. for batteries. Cost premiums are also a result of suppliers attempting to recoup high R&D-costs by setting high prices in early market stages.

So far, essentially all BETs in Norway have been bought with an investment subsidy from ENOVA, usually ca. 40% of the cost difference compared to similar diesel trucks. With regard to costs, a challenge has been that residual or second-hand values remain very uncertain and are generally set very conservatively. This yields high capital costs and affects profitability negatively. The reason for this uncertainty is that one lacks a second-hand market and that residual values are affected by the uncertain speed of technological and price developments for new models. Some transport firms plan with shorter use periods for BETs than diesel trucks because of large technological developments during these early phases. For several firms, tying up capital is a challenge for buying BETs. Some firms choose to own their BETs, whilst others opt for leasing, partly out of common practice and partly out of capital considerations. There are also some developments towards financing concepts that are more similar to renting.

Operating schemes and considerations

Apart from capital costs, profitability is strongly affected by operation and charging schemes. The availability of charging opportunities affects both the routes and areas that BETs are used on. It is usually favourable to do most charging 'at home' and using slow charging, as this yields relatively low energy costs and because trucks are standing still anyway. Similarly, there is much focus on timing any fast charging en-route to drivers' mandatory brakes and on avoiding detours for such charging.

Transitioning to BETs has increased firms' focus on route planning and possible adaptions of route structures and fleet disposition. Transport firms report that suppliers provide good support in the dimensioning of BETs and of routes. BET routes generally appear to be carefully planned in terms of access to charging, charging needs, and at what time of day. Several transport firms have also made structural changes to their operating schemes.

Payload challenges have become smaller, but transporters still report that BETs in practice have given payload reductions for some segments. Examples include driving with trailer (due to the need for larger batteries) or that larger batteries, especially for 2-axled trucks intended for longer routes, have implications for axle load and payload, and sometimes lead to transport firms choosing 3-axled BETs instead. It is further reported that BETs with long driving ranges are so heavy that payloads are reduced even despite increased vehicle weight allowances. Technological developments towards (heavier) lithium-iron-phosphate batteries may increase this challenge, even though they might make BETs more affordable.

Charging needs and strategies

The charging strategies and operating schemes of transport firms are carefully aligned with their needs, e.g. with regard to the number of chargers, locations, power capacity, and rules

for when vehicles are charged and how much. So far, transport firms have focused on charging as much as possible 'at home', mostly at night (slow charging), but often with the possibility of fast charging during daytime. Such strategies work well for distribution transports, particularly when vehicles can be charged when they stand still anyway. At the same time, good charging opportunities at customer facilities or whilst loading/unloading other places than the transport firms' own depots, have so far been rare. Especially within construction transport, there appears to be a need for daytime fast charging. Here, transporters have much focus on planning such charging to drivers' breaks. On long routes, charging is one of the biggest challenges on many routes, both in terms of costs and availability.

Many BET owners have invested in their own charging infrastructure because availability of charging opportunities en-route is limited and such charging is expensive and provides less control and predictability. Several firms also express that they do not rely on political promises regarding the rollout of publicly available charging. Suppliers tend to take an active stance with regard to transporters' charging strategies to ensure that these are feasible. Here, suppliers provide input to charging strategies and choice of technological solution, or contribute with ready-made solutions and contact with partner firms.

Although transport firms use different charging infrastructure solutions, their choices have in common that construction is expensive, despite investment subsidies that most have received. Costs are particularly high in cases with high power needs or when construction requires network reinforcements. For fast charging, transporters have so far used chargers from 150-360 kW, where 150 is said to be a little too slow for some applications. Developments towards megawatt-charging are mentioned, although 350 kW is reported to be sufficient for many transport firms. The choice of charging solution has so far partly been based on trial and error, and partly on solutions having worked elsewhere. More recently, focus on charging management and flexibility has been increasing, although this marked is still considered to be rather immature.

Operating costs, total costs of ownership (TCO) and profitability

BETs have high capital costs, but can yield large operational savings compared to diesel trucks, depending on the operating scheme and use case. Here, it is particularly important how much BETs are used, how charging needs affect energy costs, and how incentives such as road toll benefits work out. Some firms for example try to use their BETs more than they do diesel trucks. However, operating schemes also affect charging needs, where costs depend on the need for fast charging during daytime, the extent of external charging, whether one has access to own chargers, their construction cost, and the number of trucks such costs are divided over.

So far, most operating schemes have not been profitable, and transport firms report that ownership costs are difficult to calculate. These costs differ strongly between the routes and assignments that are compared, and whether road toll benefits, tender requirements, etc., are included. Access to public transport lanes for BETs could in future provide advantages in areas prone to congestion, whilst payload challenges have a negative effect on profitability. Profitable use cases have mostly been seen at firms who manage to utilize their BETs effectively or for assignments involving shorter distribution routes and city-trucks and tipper trucks in use cases where zero-emission transport pays better, provided these cases entail favourable charging opportunities and road toll exemptions. At the same time, developments are going fast. Several analyses suggest that BETs will become profitable in a 2030 perspective, and for some distribution transport segments already by 2025, subject to continued ENOVA subsidies and road toll advantages.

Minimum requirements and increased environmental weighting in tenders have resulted in a certain willingness to pay for emission-free transport for the public sector. Private customers

are also starting to request quotes for zero-emission transport, but their willingness to pay lags behind. Although some customers have become willing to pay more, even these frontrunners are rarely willing to pay the full additional costs of emission-free transports. This entails that the transition of Norway's truck fleet will take time.

Regarding service and maintenance, firms report that costs were previously higher for BETs than for diesel trucks, but that this difference has become smaller or that prices have become comparable. Based on the interviews, insurance costs do not appear to be a large challenge: Some transporters report hardly any difference in costs between BETs and diesel trucks, whilst others report that insurance costs are somewhat higher, but that this is due to BETs being more expensive generally, not because BETs have a different technology than diesel trucks.

Experiences with technology and vehicle performance

Early adopters of first-generation BETs faced a range of challenges. Several firms experienced significant trial and error, as well as considerable downtime due to various maintenance needs. In addition to challenges with vehicles for early-generation BETs, there have been various challenges related to charging. Here, particularly early adopters experienced many pitfalls and steep learning curves. Not all challenges have disappeared, but much has been improved with newer BET generations. Also levels of expertise have increased among all parties, and troubleshooting processes have become faster. Most challenges from recent times concerned problems that were often resolved relatively quickly, or were challenges that were also experienced with newer diesel trucks.

Although driving ranges have steadily increased during the last years, transport firms still assume sizable margins compared to supplier specifications. Generally, topography and payload are important for driving range, whilst also weather and road conditions play a role. Several transport firms actively pursue eco-driving and report that driving styles are important for BET range. Transport firms further state that they steadily encounter new things along the way and learn quickly. At the same time, they point out that there is generally still little experience with e.g. different configurations of extra equipment, even though several firms report positive first impressions.

During the interview period, Norway experienced several cold waves, which, amongst others, caused large challenges for electric buses in Oslo. For electric trucks, experiences vary. Several firms state that their vehicles handled even very low temperatures well. Others experienced that driving ranges could suddenly drop significantly or had individual trucks that experienced problems during the coldest weeks, although they point out that also newer diesel trucks experienced major problems during this period.

Overall, driver experience has been very positive as long as charging and operating schedules functioned. Amongst others, BETs are perceived to be quiet, provide better acceleration and comfort, yield good and smooth driving, and are powerful. Gear shifting and responses to gas pedal inputs are also perceived to be good. Several firms highlight that employees are proud to drive electrically. At the same time, it is critical that operating schedules work, because range anxiety can be a challenge on assignments where route and payload characteristics make it difficult to estimate actual driving ranges.

Charging infrastructure: Needs and barriers

Access to charging is considered one of the largest challenges going forward. So far, publicly available charging in Norway has been limited, particularly in some geographical areas. This has affected where BETs are used and led to many transport firms opting for using own chargers. The interviews indicate that the first priority for many transport firms will remain to

charge mostly 'at home', in order to achieve low charging costs and predictable operating schedules and costs. At the same time, there are many reasons for Norway's vehicle fleet transition requiring rapid and large-scale development of charging infrastructure en-route and alongside public roads. For example, charging facilities will be necessary for long-distance transport and to avoid that BETs require huge and expensive batteries. Better charging access also increases available applications for BETs and yields sufficient control of charging needs and access for transport firms. Furthermore, there are transport firms that, for various reasons, do not have the option of home or depot charging (e.g. because they lack land or a terminal, sufficient grid or electricity access, sufficient finances, or have too few vehicles to divide construction costs over).

The development of publicly available charging infrastructure has, amongst others, been driven by Norway's National Charging Strategy, a follow-up plan for construction roll-out, investment subsidies, and developments at the EU level. Throughout 2024/2025, significant construction developments are therefore expected along important road stretches in parts of Norway. Both for depot charging and publicly available fast charging, however, a range of challenges are pointed out. This includes grid capacity limitations, which can entail large cost differences between actors, depending on their grid situation. Further, case handling times are often long both for the construction of charging infrastructure or network reinforcements, but also for simple clarifications on available grid capacity. In the interviews, actors also point to systemic challenges, e.g. how electricity and grid capacity are reserved and divided. Charging for heavy -duty vehicles is not prioritized in grid application queues because applications are small and fragmented and have relatively short time horizons compared to applications from e.g. industry. Finding sufficiently large areas for charging infrastructure construction, sufficiently close to main roads and with sufficient grid and electricity capacity is also difficult, and such land is often expensive.

To achieve green transitions in all trucking segments, interviewees state that it is crucial to have dedicated charging facilities alongside public roads, with sufficient capacity, acceptable prices, without queues or major detours, and with good predictability. Despite considerable developments in the construction of public charging facilities, one still knows little what such charging will cost and how it will function in practice, e.g. with regard to booking systems. At the same time, some transport firms have started to consider opening up their charging facilities for others, albeit for the time being at a small scale, and with restrictions.

Future prospects and framework conditions

Technology, prices and availability

For BETs, rapid developments are expected with regard to technology, performance, price, availability and increases in production capacity. This will yield a large increase in possible applications and improved profitability for users. At the same time, several actors expect that also biogas and potentially hydrogen might gain a role, and that there will still be several buying cycluses with a large share of diesel trucks. This is due to a combination of transport needs, BET prices, and availability of charging facilities. For the time being, import and export over longer distances is considered too difficult to be carried out with alternative propulsion solutions, at least when considering full transport chains.

For BETs, there is also significant uncertainty about the pace of developments. Vehicle prices have for example fallen somewhat more slowly than expected. Continued battery development, increased competition and more standardized and larger-scale production are expected to result in reduced prices, dependent on framework conditions and how BET demand com-

pares to suppliers' production capacity. In this regard, the Norwegian market has both advantages and disadvantages. Norway is for example a small market, which despite relatively favourable support schemes can lose priority for suppliers when BET demand loosens on the European mainland. The Norwegian market further has several special characteristics which do not necessarily trigger prioritization by suppliers, e.g. vehicle configurations highly specific to Norway.

Measures and incentives

So far, main measures for the adoption of zero- and low-emission trucks have been investment subsidies for vehicles and charging infrastructure, environmental requirements and weighting in public tenders, road toll advantages, and measures related to increased construction of charging infrastructure. At the same time, there is a large need for additional measures and incentives if climate and transport-political objectives for 2030 are to be achieved.

Previously, firms could receive investment subsidies of up to 40% of BETs' cost premium compared to diesel trucks. In February 2024, this support scheme was replaced by a new scheme with a higher maximum (up to 60% of BETs' cost premium), but where applications compete and subsidies are given to those demanding least financial support. The new support scheme has strong focus on both CO_2-reductions and cost efficiency, and rewards firms that require little financial support per unit of CO_2-reduction (with some adjustments for hydrogen vehicles (both with internal combustion engines and fuel cells) to reflect their lagging market maturity). Although details of the new support scheme had not been finalized at the time our interviews were held, most actors were somewhat sceptical to the above change in ENOVA's support scheme. The reason for this scepticism was that the new scheme was perceived to give poor predictability, which is generally a large barrier for BET investments, and which is increased with the new support scheme because firms don't know *whether* they will receive financial support or *how much* support they will get. In addition, some actors believe that ENOVA's assessment criteria yield unfortunate results, e.g. with regard to which segments will attain favourable results and which sectors will not.

In recent years, there has been a trend towards minimum environmental requirements or an increased weighting of the environment in public tenders, first with the municipality of Oslo as frontrunner, and later also in many other tenders. In and around Oslo, these requirements have been a major driver for the adoption of new BETs, particularly for construction transport and goods delivery transport. The requirements also led to transport firms calling for specially designed BETs from suppliers. Increased use of environmental requirements in tenders in the future requires knowledge developments at public authorities. It is also mentioned that such requirements can favour larger firms and that although tender requirements have been important for BET adoption, many transport assignments are still not lucrative, despite zero-emission solutions often involving additional risk. Several actors therefore posit that it is important that contracts with zero-emission trucks also entail improved payment.

For many transport firms, road toll advantages for BETs have been an incentive, although the significance has depended on which routes and assignments are compared, and on transport contracts (whether advantages accrue to the transport firm or the final transport customer). Toll benefits have been most important in urban areas and on some selected routes outside cities. Toll benefits for biogas trucks, which were gradually introduced in several places, have had an impact on transport costs and the choice between BET and biogas trucks.

Regarding other existing or potential incentives and measures, the report discusses perspectives regarding the "Klimasats" scheme, several direct economic incentives (such as more favourable treatment of zero-emission trucks or increased taxation of diesel operation, e.g. through CO_2-levy increases or road pricing), regulatory changes and use benefits for zero-

emission solutions or restrictions on diesel operation (e.g. through weight allowances, dedicated loading/unloading zones and parking spaces, access to public transport lanes and zero-emission zones). Further, the report discusses barriers and potential improvements to the organization of electricity and grid access, e.g. through better financial incentives, but also improvements in case handling, where resources for an important agency (NVE) have been increased, alongside some regulatory changes. A change in the definition of 'alminnelig forbruk' (ordinary consumption) means that the establishment of charging infrastructure for heavy-duty vehicles has become easier.

Achievement of objectives, predictability, small actors and competition implications

The interviewees have different views on whether Norway's climate and vehicle-adoption objectives for 2030 will be achieved. Most actors believe that this will be difficult, or possible only with a mix of BETs and biogas trucks, and possibly hydrogen. It is particularly pointed out that many framework conditions remain uncertain. Although many transport firms show an interest in zero-emission solutions, a much smaller share of transport customers has so far been willing to pay more. This means that fleet transitions will take time, whilst freight transport demand, and thereby also the size of environmental challenges, keeps increasing. At the same time, trucks have shorter lifespans than passenger cars, so that even if BET adoption is too low to reach 2030 targets, large emission cuts can still be expected between 2030-2035.

Interviewees consistently state that increased predictability and longer-term perspectives for investment subsidies (vehicles and charging infrastructure), but also regarding electricity and grid access and capacity, road toll advantages, public tenders, technology choices, contracts, etc., are critical. Several actors point out that this predictability is lacking, including for key incentives such as investment subsidies from ENOVA and toll benefits[2]. Transport contracts, both private and public, are relatively short compared to the time horizon for truck investments. Actors therefore call for policies and measures with longer time perspectives, to achieve predictability for at least an investment cycle. Not least, this applies to how charging infrastructure (and possibly filling infrastructure for biogas and hydrogen) is constructed and will work in practice, and how much charging will cost.

BET investments have thus far been driven by large and medium-large firms, whilst a large part of Norway's transport sector consists of small actors operating with low financial margins. Several actors are therefore afraid that the green transition will halt. Investments in BETs or other alternatives are particularly challenging for smaller transport firms due to their financial situation, the large consequences of failed investments, challenging conditions for achieving profitable operation both with regard to purchasing terms for BETs, vehicle utilization, lack of depot charging facilities, the division of charging infrastructure costs over fewer vehicles, and generally larger vulnerability. Several actors believe that the design of existing policies only to a small extent takes into account transitioning needs for smaller transport firms. In addition to risks of competitive distortions between small and large firms, electrification of Norway's trucking fleet can entail wholly different situations for some firms than others, e.g. depending on the electricity and grid capacity that is available for them or whether or not the construction of charging infrastructure requires expensive grid reinforcements.

[2] In Norway's National Transport Plan for 2025-2036, which was released after interviews had been held, the Norwegian government announced that it would not open for road toll payments for zero-emission heavy-duty vehicles before 2030.

Perspectives from leasing and financing firms

Both in previous and recent interviews, leasing and financing of BETs were themes brought up by market actors. We therefore contacted a selection of leasing and financing firms involved in the financing of BETs and asked for their perspectives on several themes. These firms report that residual values for BETs are very uncertain, amongst others because lifespans of batteries are uncertain. Repurchase values and warranty (as indications of life expectancy) are set by suppliers, who have varying risk appetites. There is also uncertainty related to how current BETs can be used in 5 years' time, given developments in technology, driving ranges, prices and alternative propulsion technologies. The lack of a second-hand market and lack of experience from BET sales in connection with transport firm bankruptcies also mean that residual values remain uncertain. So long, leasing and financing firms have therefore taken conservative approaches by setting low residual values for BETs, although this could change in the future, as it previously did for electric passenger cars.

Even though charging infrastructure and charging needs are considered important, most leasing and financing views primarily consider this a responsibility of transport firms and society. Charging needs are seen as something that 'requires financing'. Some leasing and financing firms offer such financing, whilst others deliberately do not, and some offer own charging solutions, whilst others can offer this though partner firms.

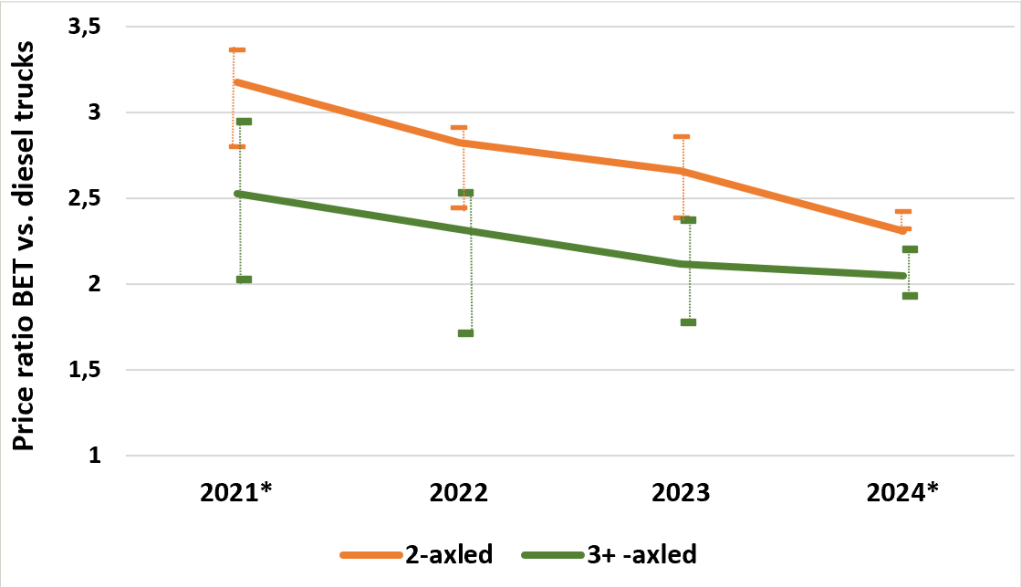
Leasing and financing contracts for BET differ little from contracts for diesel trucks, other than that minimum contract periods are longer because ENOVA sets restrictions on the export or sale of subsidized BETs in the first years. BET contracts are more expensive than for diesel trucks because the vehicles are more expensive, and contracts can also be somewhat longer. Here, it is reported that transport firms often lack long-term perspectives in the assignments they get, which reduces their willingness to take risks. This has also led to several leasing firms working on concepts with shorter durations and contracts that are more similar to renting.

Interviewed actors report that ENOVA subsidies have been and remain absolutely crucial, and that predictability is especially critical. Mere mentions of changes in framework conditions can be enough to cause large market changes. Sudden changes in ENOVA's support schemes have proven to be challenging, e.g. discontinuation of investment subsidies for gas vehicles. For trucks, long delivery times make changes in framework conditions particularly challenging. Changes in ENOVA's support schemes in 2024 create unpredictability and similar changes have previously led to challenges in the market for construction machinery. Several actors also point to potential challenges for how subsidy applications from different truck segments are ranked.

Developments in BET purchase prices and cost premiums based on data from ENOVA

Detailed data from applications for investment subsidies from ENOVA (for 981 BETs between September 2021-early January 2024) indicates that most BETs have so far been 3-axled (ca. 60%), whilst around a third have been 2-axled and about 7% have had 4 axles. The majority of 2-/3-axled BETs have been equipped with 2WD, whilst nearly all 4-axled BETs and a minority of 3-axled BETs have had 4WD. Several models have come in different configurations, e.g. both in 2- and 3-axled models.

With some assumptions on actual subsidy rates, we were able to estimate both *cost premiums* for BETs and prices for 'reference trucks'. Based on this, Figure S.1 illustrates developments in cost premiums for BETs and diesel-based 'reference trucks' in recent years.



**For 2021, the figure covers September-end of year. For 2024, the figure is based on fewer observations, only at the start of the year, and must be interpreted with caution.*

Figure S.1: Development in price ratio between BETs and (diesel-based) 'reference trucks': Yearly averages and spread (25^{th}-75^{th} percentile).

The figure shows a decrease in relative cost premiums for BETs over time, and that relative cost premiums – as expected – on average are higher for smaller trucks (fewer axles). At the same time, some variation is visible in cost rations. Amongst others, this is because the figure presents yearly averages, while there have also been price developments within years, but also because almost all trucks have slightly different specifications and because some buyers may have obtained better prices.

The reasons for price reductions for BETs and differences between truck segments are complex. Likely explanations include reductions in battery prices and developments towards larger-scale and more standardized production. Price ratios may also be affected by increased competition and suppliers' different strategies for recouping large development costs. Not least, developments in relative cost premiums are affected by the fact that part of the reductions in battery prices are counteracted by new models being bought with better driving ranges and other specifications. Further, the cost ratio between BETs and diesel trucks is affected by developments in underlying prices. Our data suggest that there might have been some differences in price developments for diesel trucks between segments. Statistics Norway's cost index for truck transport also shows unusually large increases in capital costs between 2021-2023. Because ENOVA's database lacks information on BETs' battery capacity, it has unfortunately not been possible to carry out more detailed analyses of dynamics between battery size and developments in vehicle prices and cost premiums.

Main conclusions

Our interviews indicate that BETs are currently the market's main focus, but that market actors also envision roles for biogas and potentially hydrogen in the green transition of Norway's trucking fleet going forward, especially for the longest and heaviest applications. BETs are steadily improving in terms of driving range and faster charging. They have become reliable and robust, work in cold climates, and purchase prices are gradually decreasing. This opens for the use of BETs in new types of applications. Investment subsidies from ENOVA, both towards

vehicle purchases and the establishment of charging infrastructure have been crucial for the economic feasibility of BET investments. Transport firms that have purchased BETs have thus far done so mostly to reduce climate emissions from their own activities and to win tenders that include minimum environmental requirements or high weighting of environmental performance. Operators have so far employed conservative use strategies for which they know that BETs will work. Improved fleet management and experience-building will enable more use applications and improve BETs' financial competitiveness. One of the biggest barriers for BET adoption has been related to the establishment of charging infrastructure, both at depots and alongside public roads. High power capacity requirements trigger considerable costs for grid reinforcement, even with investment subsidies. Available grid capacity has to be clarified with grid operators that have limited resources for case handling, delaying charging infrastructure construction. Risks of possible power deficits and insufficient grid capacity are causing concern for future developments and BET adoption. Good and long-term incentives, increased knowledge, better trucks, increases in the number of available BET models, improved processes with grid operators, and increased construction of charging infrastructure will facilitate further adoption of BETs towards 2030. Interviewees believe that biogas trucks will also be needed to achieve 2030 objectives that require 100% of new truck sales to be zero-emission *or biogas*. For the time being, market actors follow developments also for hydrogen-based solutions, but report that there is still much uncertainty about how the operation of hydrogen trucks will cost, be it hydrogen trucks with internal combustion engines or fuel cell technology.