HORIZON EUROPE PROGRAMME
TOPIC HORIZON-CL5-2022-D5-01-08
Clean and competitive solutions for all transport modes
GA No. 101084046

Zero Emission flexible vehicle platform with modular powertrains serving the long-haul Freight Eco System

ZEFES - Deliverable report

D2.6
Design of the interface between b-trailer and prime mover

Funded by
the European Union

Deliverable No.	ZEFES D2.6	
Related WP	WP2	
Deliverable Title	Design of the interface between b-trailer and prime mover	
Deliverable Date	2024-05-28	
Deliverable Type	REPORT	
Dissemination level	Public (PU)	
Author(s)	Christer Thoren (SCA) Gerd Schünemann (ZF) Reinhard Schmid (AVL) Henning Wittig (FHG)	
Checked by	Jordi Plana (IDI)	2024-05-28
Reviewed by (if applicable)	Aykut Caglayan (VET)	2024-05-17
Approved by	Omar Hegazy (VUB) – Project coordinator	2024-05-28
Status	Final	2024-05-28

Publishable summary

Bringing long-haul zero emission vehicles (ZEV) to the next level to meet the needs of the freight eco system is the main objective of ZEFES. Therefore, requirements and needs are identified, and ZEV powertrains optimized. Including infrastructure considerations for electric fast charging concepts and hydrogen refueling stations (HRS) as well as usage of digital twins in the logistic operations completing the holistic approach. The further developed battery electric vehicles (BEV) as well as fuel cell electric vehicles (FCEV) in different vehicle combinations demonstrate their ability in real world logistic missions cross over Europe. An impact assessment and evaluation will elaborate the improvements.
The use of truck-trailer-combinations with distributed powertrains, meaning different parts of the combination contain single powertrains or range extenders in terms of additional energy storage units, is one potential solution to reach the objectives stated above.
This deliverable briefly reports on the analysis of energy needs and battery integration for truck trailer (VC8), focussing on the integration of a battery in the trailer, directly connected to the powertrain of the truck. The battery-trailer (b-trailer) itself consequently has no propelled axles or wheels.
The analysis of needs, concepts and solutions for battery integration and interfacing (power and signals) between truck and trailer was evaluated on a higher level. This allows a commercial evaluation as well as an assessment on the respective ZEFES practical use case, to decide whether to realize it with a b-trailer or with an e-trailer,

The conclusion in this report is that the e-trailer is a more cost-efficient solution than the b-trailer. More background is given in the following report.

Please complete the table below which will be removed from the report but included in the EC submission system.

Contents

List of Figures

List of Tables

Abbreviations & Definitions

Table 1-1: Abbreviations

Abbreviation	Explanation
BEV	Battery electric vehicle
CAN	Control area network
EBS	Electronic braking system
FCEV	Fuel cell electric vehicle
HRS	Hydrogen refueling station
ICE	Internal combustion engine
LV	Low voltage
OEM	Original equipment manufacturer
PDU	Power distribution unit
SOC	State-of-charge
VC	Valuation criterion
VCB	Voltage class B (According to ISO 6469-3:2021 working voltage between 60 Vdc and 1500 Vdc or between 30 Vac and 1000 Vac)
ZEV	Long-haul zero emission vehicles

Table 1-2: Definitions

Item	Definition
b-trailer	Trailer with no driveable wheels but a traction battery which can be coupled to the towing vehicle.
e-trailer	Trailer with at least partial driveable wheels powered by a traction battery located in the trailer

1 Introduction

Distributed powertrains in truck-trailer vehicle combinations are one possible solution to fulfil the needs of ZEV in the freight eco system. Next to the solution to distribute the power over the vehicle combination, like in an e –trailer, also the battery capacity can be distributed. The b-trailer extends the range of a vehicle combination by delivering extra energy capacity.

1.1 A survey through previous investigations of the market characteristics

In order to evaluate feasible solutions for the integration of batteries in trailers and their market potential, the main characteristics of the European road freight transport market and the most relevant vehicle concepts were compiled. The AEROFLEX project provided a comprehensive literature analysis [1]. The main findings and conclusions based on the analysis of literature and reports of European projects like TRANSFORMERS, FALCON or ALICE supplemented by current statistics are presented in this section.

In 2020, the total amount of goods transported in the EU-27 was estimated to amount to 3,272 billion tonne-kilometres (tkm). This includes the transport of goods via road, rail, water, air and pipeline. The average annual growth rate between the years 2000 and 2020 was 0,9% [2]. The International Transport Forum (ITS) expects a doubling in European freight volumes by 2050. On a global scale the demand for transport it is even expected to triple by 2050 [3]. Within the transport activities of the EU-27, road freight transport is the most important transport mode with a share of 53,0 % in 2020 [2]. This share in general is predicted to remain constant.

According to EUROSTAT [4], in 2022 78,6 % of the EU-27 road freight transport in million tonne-kilometres was performed by vehicles with a maximum permissible laden weight of more than 30 tonnes. This is linked to the fact that 75,3 % of the road freight transport were carried by vehicles with a load capacity of more than 20,6 tonnes. The most common vehicle configuration used in road freight transport in 2022 was the road tractor attached to a semitrailer with a share of 77,8 % of the total tonne-kilometres. Considering the maximum authorized vehicle combination weight of 40 tonnes in most EU countries, the semitrailer can carry a maximum payload of 26 tonnes or between 85 and 90 m^3 of volume.

Looking at the transport performance by distance class, about 79,0 % of the goods were carried over more than 150 km (60,2% more than 300 km, 41,2% between 150 km and 999 km) and thus are realized on long-haul [5].

Finally, the main type of cargo of most EU-27 countries is palletized goods. It represents 47,2 % of the road freight transport in tonne-kilometres [6]. Since palletized goods are a lot used for transport over distances of more than 50 km, they are a relevant segment to be supported by vehicle combinations with semitrailers.

Conclusions for the market segmentation for electrified trailers:

The characteristics that emphasize the need for electrified semitrailers like e-trailer/b-trailer/e-reefer to enter the market can be summarized as follows.

- Global transport demand is expected to triple by 2050 but at least doubled.
- The current share of road freight transport in EU-27 is 53,0 % and the share will remain the same in the coming years.
- The tractor – semitrailer combination is estimated to be the most common vehicle combination used intra EU freight transport. This vehicle combination can carry a maximum payload of 26 tonnes or between 85 and 90 m^3 of volume.
- About 80 % of all freight transport is realised on long haul. The distance of 60 % of road freight transport is more than 300 km, which is beneficial for an electrified trailer with a big battery.
- The most common type of loading devices of cargo for land transport is palletised goods which recorded 47,2 % of the EU-27 road freight transport in tonne-kilometres. 70% from the palletised goods have transport distances from more than 300 km.

The improvement of efficiency is the most important driver of European freight transport market. Flexibility and modularity of the vehicle concepts are the keywords for an efficient freight transport market. The typical range of a battery electric heavy-duty vehicle (BEV) is between 300 and 400 km. For fuel cell electric heavy-duty vehicles (FCEV), the range is given between 400 and 800 km. **To make electrification possible for all market segments, BEV and FCEV have to be combined with electrified trailer solutions, which might be e-trailers, b-trailers or e-reefers.**

1.2 Rationale for batteries on trailer used for range extension

Driving distance is key to operate long haulage vehicles. Normally there is a rest after 4,5 hours when also the vehicle can be charged. The trucks from different OEMs that will be delivered in the short future will have the range required for these operations. However, there will be instances where the range should be longer; for example, if you have two drivers the truck can continue after 4,5 hours. Also, the charger might be missing, occupied or out of operation where you stop to rest. For these cases a longer range could be profitable. Finally, if you can extend your range and only charge at your own depots where the cost is lower, this might justify the extra cost for the trailer.

2 Solutions for electrified trailers

2.1 e-trailer

An e-trailer is a trailer with at least partial propelled wheels. It is equipped with a drivetrain including an e-axle that consists of an inverter, an electric motor/generator and a (switchable) transmission, high voltage batteries serving as energy storage system and a thermal system. The powertrain is equipped with an electronic control unit to ensure the operation of the e-trailer. Figure 2-1 shows the main components of the powertrain of the e-trailer.

Figure 2-1: Illustration of the main powertrain components of the e-trailer and the interfaces to the prime mover

The e-trailer can be used in combination with a zero-emission truck but also an ICE truck can use this trailer as the present trailer interface can be used without alterations.

2.1.1 Vehicle-to-vehicle interface

An interface refers to a point of interaction or communication between different systems. In terms of a vehicle-to-vehicle interface the following interfaces can be distinguished:

- Mechanical interface like saddle plate and kingpin for semi-trailers or trailer-coupling for standard trailers
- Pneumatic interface for supplying and activating the pneumatic brakes of the trailer from the towing vehicle.
- Low Voltage (LV) & Communication interface as standard in truck-trailer-combinations as needed for lights of the trailer or trailer electronic braking system (EBS).
- E-trailer communication interface

Beside the physical interfaces there is also a logical interface between the vehicle units. This logical interface describes the interplay between the prime mover and the e-trailer due to the kinematic characteristics of the vehicle combination.

Figure 2-1 shows the subsystems and interfaces of a tractor-trailer combination with different colours. Yellow for the towing vehicle, green for the basic trailer, red for items specific for e-trailers and blue indicating the e-trailer interface. Mechanical and pneumatic interfaces are not illustrated. The mechanical, pneumatic, and low voltage & communication interfaces are standardized interfaces that are well established in existing prime movers and trailers. The e-trailer interface guaranties a proper operation of the e-trailer in combination with different types of prime movers. It is restricted to communication tasks. In deliverable D2.7 of the ZEFES project the vehicle-to-vehicle interface of an e-trailer is described in more details. The functions of the vehicle-to-vehicle interface depend on the level of integration of the powertrain management in the vehicle control system of the prime mover.

This ranges from a pure logical interface for an e-trailer with stand-alone powertrain management to a sophisticated communication interface for an e-trailer with a powertrain that is controlled by an overall powertrain management located in the prime mover. In general, the e-trailer communication interface requires no additional hardware connection between the vehicle units. The signals can be transmitted via the existing standardized ISO 11992-2 CAN connection and the ISO 7638-1 connector.

2.2 b-trailer

A b-trailer is a trailer with high voltage batteries serving as an energy storage system that is connected to the high voltage system of the prime mover to use its energy content for propulsion purposes. The energy is transferred through a specific interface with high voltage cables going from the truck to the b-trailer. As there are batteries both in the truck and the trailer with different characteristics and SOC levels, a DC/DC converter is needed between these batteries. The DC/DC converter can be placed both in the trailer and the truck but most likely will be a part of the high voltage system in the b-trailer.
The batteries of the b-trailer can be charged via an external charging interface.
Because of the reasons above, the b-trailer can only be used by an electric prime mover with a dedicated interface.

Figure 2-2 shows the main components of the b-trailer. The b-trailer could also be equipped with an electric axle to be used for recouperation of brake energy. However, the electric axle would in this case not be used for propulsion.

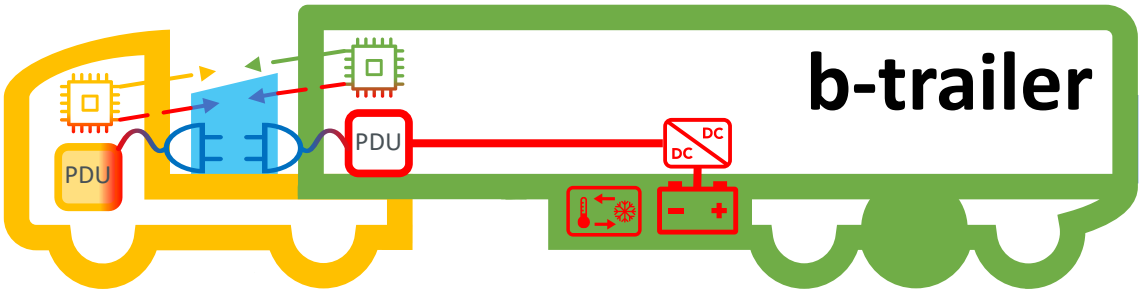

Figure 2-2: Illustration of the main components of the b-trailer and the interfaces to the prime mover

2.2.1 Vehicle-to-vehicle interface

In terms of a vehicle-to-vehicle interface the following interfaces between the b-trailer and the prime mover can be distinguished:

- Mechanical interface like saddle plate and kingpin for semi-trailers or trailer-coupling for standard trailers
- Pneumatic interface for supplying and activating the pneumatic brakes of the trailer from the towing vehicle.
- Low Voltage (LV) & Communication interface as standard in truck-trailer-combinations as needed for lights of the trailer or trailer electronic braking system (EBS).
- B-trailer communication interface
- High voltage interface

Similar to the e-trailer interfaces, the mechanical, pneumatic and low voltage & communication interfaces are standardized interfaces that are well established in existing prime movers and trailers.

The b-trailer communication interface is a signal connection and controls the energy flow between the b-trailer and the prime mover (charging and discharging of the energy storage unit in the b-trailer), transmits the electric capabilities of the energy storage unit and status information from the b-trailer to the prime mover. It requires an integrated energy management in the prime mover.
Like the e-trailer, the b-trailer communication interface requires no additional hardware connection between the vehicle units. The signals can be transmitted via the existing standardized ISO 11992-2 CAN connection and the ISO 7638-1 connector.

The high voltage interface must be realized via a Voltage Class B (VCB) connection. The VCB connector should be chosen regarding the current and voltage requirements and to sustain the harsh environment between tractor and trailer concerning temperature, vibration and particles. The VCB harness have to handle the movement between the tractor and trailer that mostly is seen when making sharp turns. All aspects that must be considered regarding the development of the communication interface and the high voltage interface between the prime mover and the b-trailer can be derived from the comparable interface that was designed for agricultural applications and is defined in the ISO 23316 series of standards . This high voltage interface enables the transmission of electric power up to 150 kW between tractors and machinery. It cannot be used for a b-trailer application, since, amongst others, the standard does not define a bidirectional energy flow or a control strategy that enables the connection and interoperability of two energy storage units. The series of standards consists of the following parts:

- ISO 23316 Part 1: General description
- ISO 23316 Part 2: Physical interface
- ISO 23316 Part 3: Safety requirements
- ISO 23316 Part 4: AC operation mode
- ISO 23316 Part 5: DC operation mode
- ISO 23316 Part 6: Controls communication
- ISO 23316 Part 7: Mechanical integration

2.3 Overview of trailer solutions

Basically, three types of electrified trailers can be distinguished:
Besides the already described e-trailer and b-trailer the e-reefer has to be mentioned.
Figure 2-3 shows the characteristics of the different types. Challenges for the realisation are listed.

Principally the functionality of an e-reefer can be combined with that of a b-trailer as well as an e-trailer.

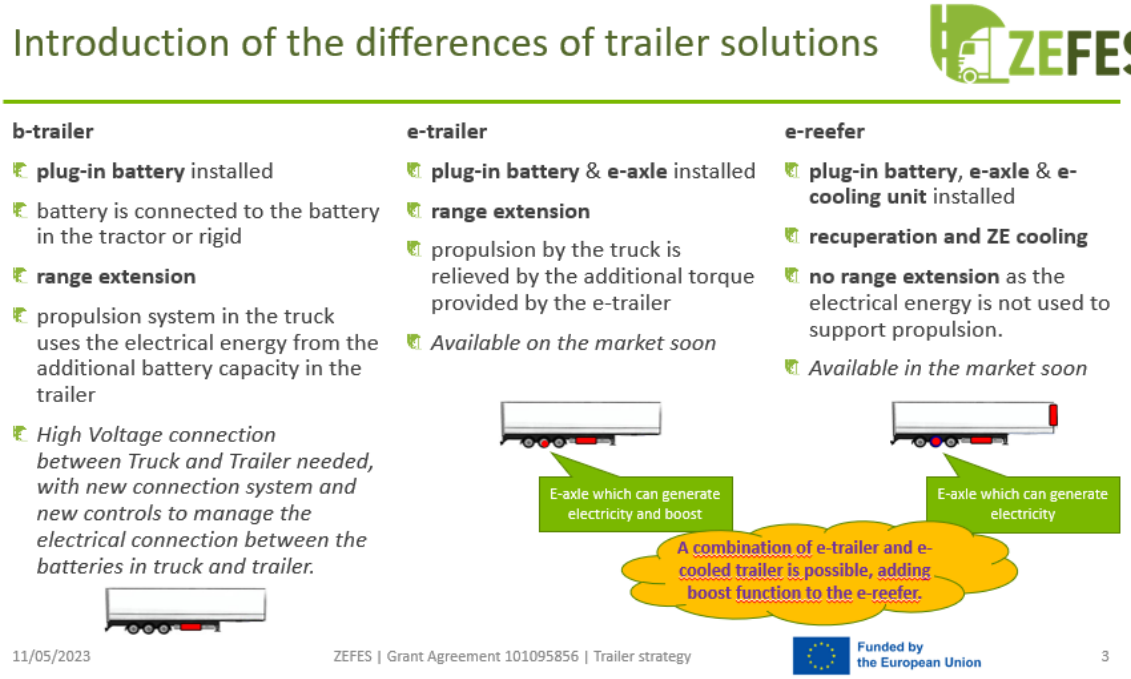

Figure 2-3: different types of electrified trailers.

2.4 Market segments served by e-trailer solutions

Figure 2-4 shows the different types of electrified trailers in different combinations with diverse characteristics of battery capacity.
The mapping shows that not all configurations and combinations make sense in combination with ICE truck and BEV/FCEV truck equally. Especially the pure recuperation solution of e-trailer with small battery (B) does only make sense to transform an ICE-truck to a hybrid, preferably in delivery application. The pure e-reefer solution D with relatively small battery size suites more to delivery application. On long haul missions it does not support the towing vehicle, moreover it may reduce the range when the generator axle becomes active. The b-trailer can only be assigned to the BEV/FCEV-long-haul segment.

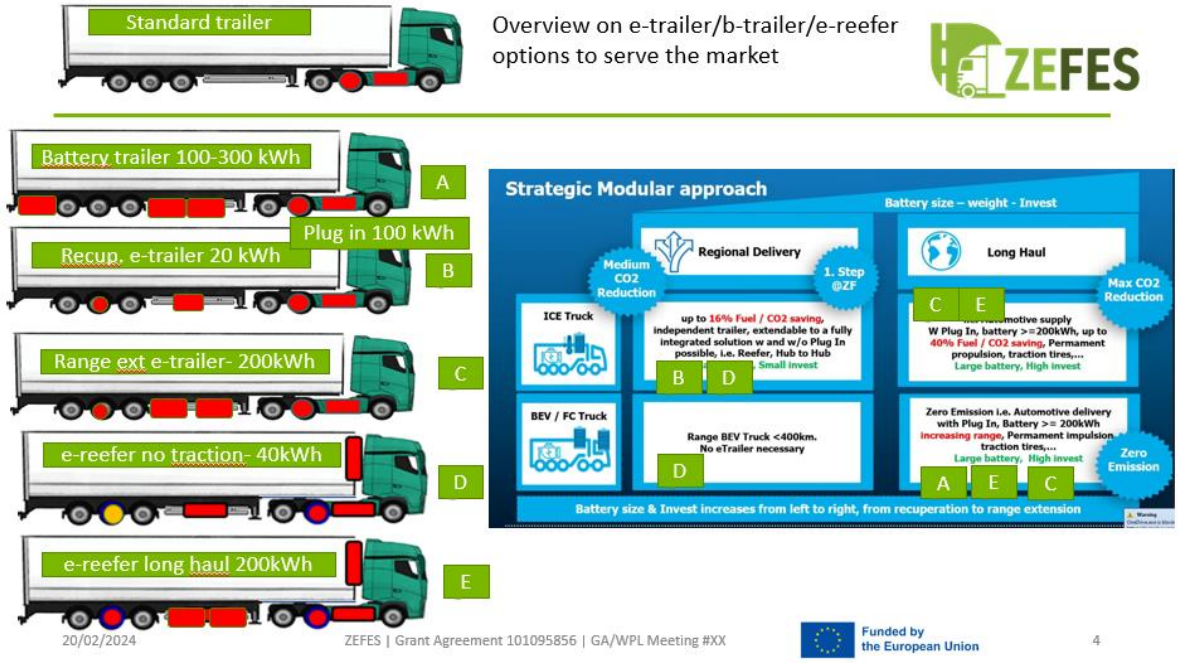

Figure 2-4: mapping of solutions for electrified trailers to market segments

2.5 Comparison of trailer solutions

To be able to compare b-trailer and e-trailer, a structured list of properties is made.

Table 2-1: Comparison of trailer solutions

	e-trailer	b-trailer
Range	Energy used in trailer	Somewhat lower as energy is used in truck, - Losses in DC/DC converter between truck and trailer. - No brake recovery in trailer
Trailer cost	Inverter and e-axle added	DC/DC converter and interface to truck added
Truck cost	No change	Interface to trailer added including main contactor and connector
Compatibility	Can be used by any truck including ICE	Requires specific interface in truck. Can not be used by ICE
Weight	E-axle and drive inverter	DC/DC converter
Road performance	Possible to improve handling using the trailer drive axle	
Charging	Separate chargers for truck and trailer	Possible to use truck charger for trailer

	e-trailer	b-trailer
Market	Available (not homologated)	No indication at this point from any supplier that they will introduce this trailer
Standard for CAN communication	Available standard released	No standard work ongoing. (Agricultural standard could be used as inspiration)
Standard for VCB connector	N.A.	No standard work ongoing
Regulatory framework	Necessary regulation is under preparation and on a clear path	No work ongoing
Type approval	Work in progress. Difficult as trailer includes drive train	Not as difficult but no work is ongoing. Trailer does not include drive train.
Safety	System has to avoid that the trailer axle could cause an unwanted situation at a fault	System has to avoid that handling of high voltage connector could be a safety issue

Conclusions are drawn in chapter 3.

3 Results & Discussion

3.1 Conclusion on b-trailer development

The Market assessment in section 1.1 together with the assessment of pro and cons for b-trailer and e-trailer in section 2.5 have shown that b-trailer will not enter the market in predictable future.
E-trailer will be the market solution for range extension for commercial BEV and FCEV as well as for fuel reduction and CO_2 reduction for combustion engine driven trucks.

Along with creating this document a trailer working group invested in the market view and in the b-trailer e-trailer benchmark. This investigation concluded that an e-trailer, a trailer with an energy storage unit and an electric axle for propulsion and recuperation, will serve the market best in terms of

- Maximizing the possible CO_2 reduction by recuperation of brake energy with the electric axle of the e-trailer and the towing vehicle
- Flexibility in applying the e-trailer in different vehicle combinations with ICE or ZE towing vehicles,
- Flexibility of applying the e-trailer in different areas reaching from regional delivery to long haul routes,
- Flexibility in applying the e-trailer concept in different trailer types up to electric reefer trailers,
- Possibility of using the e-trailer with conventional towing vehicles without the need of technical changes,
- A short time to market due to available standards and the market maturity of the technical components,
- A short time to market since regulations for type approval and road permits are already under discussion.

In ZEFES General Assembly meeting in October 2023 the ZEFES group accepted the proposal to change the b-trailer use case to an e-trailer use case instead. The resources and development will be shifted from b-trailer to e-trailer.

As the b-trailer solution neither will be realized in ZEFES nor is expected to enter the market, the depth of investigation of this document is limited. Technical solution for the b-trailer is only described as detailed as needed for comparison and conclusion with e-trailer.

3.2 Contribution to project (linked) objectives

The main contribution to the project is to show that there is much more potential for the e-trailer than the b-trailer. With this knowledge we also were able to shift focus in one of the use cases from b- to e-trailer. The experience from the e-trailer application will give very important insights for future work.

3.3 Contribution to major project exploitable result

With the decision to shift to e-trailer, this application will be tested in more use cases which will give us extended knowledge about the e-trailer application.

Nevertheless, the experience and data from the use cases with e-trailer can also be transferred to a virtual b-trailer use case. Battery size and use of the amount of energy in the battery is similar, independent whether the energy is used by the electric drivetrain of the truck or by a local electric axle in the trailer. The potential of range extension is the same for an e-trailer or for a b-trailer with similar battery capacity.

Also, for charging, the challenges are equivalent, as there is no difference in amount of energy which has to be recharged to a b- or e-trailer in the same use-case. Consequently, timing of the charging process and the needed power for charging do not differ.

4 Risks and interconnections

4.1 Risks/problems encountered

Since the battery trailer will not be realized in the ZEFES project the work presented in this deliverable reflects theoretical considerations. The b-trailer will be replaced in use case UC 7.3.1 by an e-trailer that also adds the required range to the capabilities of the prime mover.

Thus, there were no risks or problems for the ZEFES project encountered during the work presented in this deliverable.

4.2 Interconnections with other deliverables

The ZEFES deliverable D2.7 presents the design of the interface between an e-trailer and the prime mover. Within the recommendations and outlook of this deliverable it is described that the standardized interfaces, especially the communication interface described in the ISO 11992, are continuously developed. The introduction of future developments in these standards and the adoption by the OEMs will also enable the integration of energy storage units of the trailer in the overall vehicle energy management, if applicable in the future.

The investigation of an interoperable vehicle-to-trailer interface for b-trailers was done on a theoretical level to identify the requirements of a future development. It was decided by the involved partners SCA, VET, KAE, ZF and FHG and confirmed by the ZEFES project consortium, that instead of the b-trailers an additional e-trailer shall be built and demonstrated. This affects especially the realization of vehicles in WP5 and the demonstration in WP7. The simulation-based verification of vehicle concepts in task 5.1 as well as all other simulation tasks in the ZEFES project will consider the change from b-trailer to e-trailer in the simulation models. In subtask ST5.4.1 the partners VET, KAE and ZF consider the requirements of the SCA BEV that will be used with the second e-trailer. In subtask ST5.4.2 the developments regarding the b-trailer will not be conducted within the ZEFES project. Instead, a second e-trailer will be prepared by VET, KAE and ZF. In subtask ST5.5.1 KAE and VET will not integrate the concept of a battery trailer into a standard/mega trailer and an ultra-low version of the mega trailer. Instead VET, KAE and ZF will manufacture and commission the second e-trailer. SCA, VET, KAE and ZF will commission the SCA BEV tractor in combination with the second e-trailer and demonstrate the vehicle combination in WP7.

Since both the b-trailer and the e-trailer need charging infrastructure along the route, this topic is already considered in WP3 and is not affected by the change from b-trailer to e-trailer.

5 Deviations from Annex 1

Based on the work presented in this deliverable the ZEFES consortium concluded not to realize a battery trailer for the demonstration in the use cases. Instead, an additional e-trailer will be built to support the prime movers in the respective use cases and gain deeper knowledge about the performance of vehicle combinations with modular, distributed powertrains under real world conditions. This deviation has no effect on the characteristics of the use cases and the objectives to be fulfilled.

All other effects and the resulting deviations in work packages and tasks of the ZEFES project are described in section 4.2.

6 References

[1] A. Lobig, S. Seidel, A. Lischke und T. Breemersch, „AEROFLEX D1.1 - Transport market and its drivers with respect to new vehicle concepts," Brussels, 2018.

[2] D.-G. f. M. a. T. European Commission, „EU transport in figures – Statistical pocketbook 2022," Publications Office of the European Union, https://data.europa.eu/doi/10.2832/216553, 2022.

[3] O. International Transport Forum, „"International freight and CO2 emissions to 2050", in ITF Transport Outlook 2015," OECD Publishing, https://doi.org/10.1787/9789282107782-7-en, Paris, 2015.

[4] EUROSTAT, „Road freight transport by vehicle characteristics," 2023.

[5] EUROSTAT, „Road freight transport by journey characteristics," EUROSTAT, 2023.

[6] EUROSTAT, „Road freight transport by type of goods," EUROSTAT, 2023.

[7] *ISO 23316 Tractors and machinery for agriculture and forestry - Electrical high-power interface 700 V DC / 480 V AC,* DIN Media, 2023.

7 Acknowledgement

The author(s) would like to thank the partners in the project for their valuable comments on previous drafts and for performing the review.

Project partners:

#	Partner short name	Partner Full Name
1	VUB	VRIJE UNIVERSITEIT BRUSSEL
2	FRD	FORD OTOMOTIV SANAYI ANONIM SIRKETI
4	KAE	KASSBOHRER FAHRZEUGWERKE GMBH
5	REN	RENAULT TRUCKS SAS
6	SCA	SCANIA CV AB
7	VET	VAN ECK TRAILERS BV
8	VOL	VOLVO TECHNOLOGY AB
9	ABB	ABB E-MOBILITY BV
9.1	ABP	ABB E-MOBILITY SPOLKA Z OGRANICZONAODPOWIEDZIALNOSCIA
10	AVL	AVL LIST GMBH
11	CM	SOCIEDAD ESPANOLA DE CARBUROS METALICOS SA
11.1	APG	AIR PRODUCTS GMBH
12	HEPL	HITACHI ENERGY POLAND SPOLKA Z OGRANICZONA ODPOWIEDZIALNOSCIA
13	MIC	MANUFACTURE FRANCAISE DES PNEUMATIQUES MICHELIN
14	POW	PLASTIC OMNIUM NEW ENERGIES WELS GMBH
15	RIC-CZ	RICARDO PRAGUE S.R.O.
15.1	RIC-DE	RICARDO GMBH
16	UNR	UNIRESEARCH BV
17	ZF	ZF CV SYSTEMS HANNOVER GMBH
18	ALI	ALLIANCE FOR LOGISTICS INNOVATION THROUGH COLLABORATION IN EUROPE
19	DPD	DPD (NEDERLAND) B.V.
20	COL	ETABLISSEMENTEN FRANZ COLRUYT NV
21	GRU	GRUBER LOGISTICS S.P.A.
22	GBW	GEBRUEDER WEISS GESELLSCHAFT M.B.H.
23	PG	PROCTER & GAMBLE SERVICES COMPANY NV
23.1	PGP	PROCTER AND GAMBLE POLSKA SPOLKA Z OGRANICZONA ODPOWIEDZIALNOSCIA
23.2	PGA	PROCTER & GAMBLE AMIENS
24	PRI	PRIMAFRIO CORPORACION, S.A.
25	PTV	PTV PLANUNG TRANSPORT VERKEHR GmbH
26	Fraunhofer	FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG EV

27	HAN	STICHTING HOGESCHOOL VAN ARNHEM ENNIJMEGEN HAN
28	IDI	IDIADA AUTOMOTIVE TECHNOLOGY SA
29	TNO	NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK TNO
30	UIC	UNION INTERNATIONALE DES CHEMINS DE FER
31	CFL	CFL MULTIMODAL S.A.
32	GSS	Grupo Logistico Sese
33	HIT	Hitachi ABB Power Grids Ltd.
34	IRU	UNION INTERNATIONALE DES TRANSPORTS ROUTIERS (IRU)
35	RIC-UK	RICARDO CONSULTING ENGINEERS LIMITED

Disclaimer/ Acknowledgment

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Commission. Neither the European Union nor the granting authority can be held responsible for them.