Summary of previous activities and results of the ALBERO project

current status: 20.09.2019

Activities

Date	Event
22.08.2018	Meeting at the ferry terminal of company Scandlines at Rostock port
01./02.10.2018	Kick-Off-Meeting for the projekt ALBERO at Warnemünde
08./09.10.2018	Kick-off event "Civil Security - Transport Infrastructures" at Frankfurt/M.
04.12.2018	Inspection voyage with hybrid ferry "Berlin" of company Scandlines
15.01.2019	Joint Workshop with SUVEREN project at Berlin (similar topic for the protection of underground garages)
26./27.03.2019	Inspection voyage and test trial with FS "Peter Pan" of company TT-Line
09./10.04.2019	Project Meeting at Rheinbach (Hochschule Bonn Rhein-Sieg)

Also on different dates:

- Interviews with representatives of the shipping companies Scandlines, TT-Line and STENA, visits to the harbor grounds at Rostock and at Travemünde
- Interview with the responsible department at the Ministry of Energy, Infrastructure and Digitalization Schwerin
- Interview with Verification Authority North Rostock
- Interview with Technical Monitoring Rostock GmbH
- Interviews with various car dealers offering electric vehicles
- Interview with sales manager and head of development of the company Mennekes (manufacturer of charging stations and plugs) at Kirchhundem
- Fire experiments with Li-Ion-Batteries in Trauen in May 2019
- Workshop “car position concept” at Hamburg
- Interview with CEO of Company Ellermann – Producer of container systems for extinguishing electric cars after accidents

Results

Following below is a rough summary of the previous insights. These insights are provided in the most understandable form and therefore may not always be presented in a scientifically correct form.

Vehicle stock (circa) currently in Baltic Sea states (as of 2018)

country	authorized cars in total	electrical cars absolutely/%	plug-in cars absolutely/%	CNG cars absolutely/%	LPG cars absolutely/%
Norway	3 Mio	160.000 / 6%	90.000 / 3%	< 1000 /< 0,2%	< 5000 / < 1%

Sweden	5 Mio	20.000 / < 1%	60.000 / 1,5%	50.000 / 1,2%	< 5000 / < 1%
Danmark	3 Mio	10.000 / < 1%	< 5000 / < 1%	< 1000 / < 0,2%	< 5000 / < 1%
Finland	4 Mio	< 5000 / < 1%	10.000 / 1 %	< 1000 / < 0,2%	< 5000 / < 1%
Latvia	< 1 Mio	< 5000 / < 1%	< 5000 / < 1%	< 1000/ < 0,2%	15000 / 8%
Estonia	< 1 Mio	< 5000 / < 1%	< 5000 / < 1%	< 1000 / < 0,2%	< 5000 / < 1%
Lithuania	1,5 Mio	< 5000 / < 1%	< 5000 / < 1%	< 1000 / < 0,2%	100.000 / 6%
Poland	23 Mio	< 5000 / < 1%	< 5000 / < 1%	5.000 / < 0,2%	3.000.000 / 14%
Germany	45 Mio	100.000 / < 1%	100.000 /<1%	70.000 / 0,2 %	470.000 / 1 %

electrical cars are meant as purely battery-powered vehicles + plug-in hybrid

Forecast vehicle development for Germany

year	battery-powered vehicle	plug-in hybrid	natural gas (CNG/ LNG)	liquefied gas (LPG)
2030	925.000	3.980.000	430.000	565.000
2040	3.065.000	10.515.000	535.000	530.000

Labelling of alternatively operated vehicles (AOV)

There is no single European regulation for the labelling of AOV.

For holders of electrically powered vehicles registered in Germany, the holder may apply for an E-mark (E as last letter on the license plate), but this is not mandatory. Gas-powered vehicles are not recognizable in Germany via the license plate.

In Norway, alternatively powered vehicles have special letter combinations (which otherwise indicate the registration area) on the license plate: Electric vehicles: EL, EK or EV, Hydrogen: HY, Gas vehicles GA

Austria: Electric vehicles have license plates with green instead of black letters.

France, Belgium and Denmark have environmental stickers in different colors. However, some of them are also vehicles that are operated with gasoline but run in a special clean mode.

Dangers due to alternatively operated vehicles

All in all, there is still an insufficient number of data to produce meaningful statistics on the accident behavior of alternatively powered vehicles. However, an impending statement is that such vehicles do not more frequently get damaged than conventional gasoline or diesel vehicles, but in the event of an accident, there may be special dangers to which there is no sufficient preparation yet.

Gas-powered vehicles

In the case of overheating, the tanks of gas vehicles are designed in such a way that the gas is blown out of the tank intermittently or completely. What can be a good solution ashore to protect against a bursting of the tank that may be a special source of danger at a (closed) vehicle deck of a RORO ferry. There may be fires and explosions. Gas fires can, if environment permits, burn off in a controlled manner or be extinguished with the extinguishing agents for gas fires known to date. The main

problem appears then at the car deck to get access to a vehicle - a problem that applies to all other vehicles too.

Electrical cars

According to an extensive study carried out within the ALBERO project, electric vehicles do not show a higher fire risk, obviously the risk of fire is even lower than for conventionally operated vehicles. Nevertheless – if there occurs a fire at an electric car, the risks are different. First of all the fire will last for a longer time, because extinguishing is difficult and re-ignition occurs even after ours. During the fire single Li-Ion cells can be ejected from the vehicle battery at high speed and fly around. For all these reasons the risk of fire spreading to neighboring vehicles is higher. In addition, particularly corrosive and toxic fluorine-containing gases can be released during the fire. At the moment a lot of water is considered as a means of choice - especially for cooling and thus to control the fire. The use of much water on a ship is only possible if sufficient drainage can be guaranteed at the same time. As a rule, seawater is used on board for extinguishing or cooling. Depending on the salinity, however, this may possibly have an unfavorable effect on the course of the fire, since seawater can act as an electrolyte and possibly short circuits in a battery pack are promoted.

Car position concept

The dangers mentioned have shown that it could be meaningful to transport alternatively operated vehicles on separated positions on board. Since the problem is not the more frequent occurrence but the more serious effects of a fire of an electric vehicle, safety measures should focus primarily on an effective firefighting. A special structural fire protection, such as (mobile) partition walls between AOV and other vehicles could be meaningful. The ALBERO project will develop concepts for such parking spaces in the coming months. Separate parking positions on board require in the current opinion of the consortium, a pre-sorting in the port to guarantee a fast loading. A recording of alternatively operated vehicles already in the booking system would help for good planning. Proposals are also being prepared for this.

Fire experiments

The ALBERO consortium performed fire tests with Li-Ion batteries. Within this tests E-bike batteries were heated slowly and the effects to the battery and the gas development was observed and measured. In all cases there was a strong release of smoke and gases, especially of H_2. In some cases there was an ignition of the gases and a fire. Nevertheless it could also be observed that despite the strong development of smoke an ignition will not take place necessarily, possibly because of the addition of flame retardants to the electrolyte within the Li-Ion cells. Therefore, a fire within a closed batterie is very unlikely. The hazard starts when the thermal runaway reaction caused by a battery failure leads to the bursting of the complete battery module and oxygen can come in contact with the free gases. A research for scientific results regarding the starting of a thermal runaway in a battery resulted in the finding, that a thermal runaway of a Lithium-Ion -Battery can start from temperatures at around 80°C. Within the ALBERO fire experiments these values were confirmed. So detection systems using temperature detection should have appropriate alarm settings.

Regulation for charging stations

For the construction of charging stations a regulation applies in Germany (Ladesäulenverordnung LSV). It only applies to publicly accessible charging points. Charging points are open to the public if

the associated parking spot is either at a public place or on private land which nevertheless can be entered by an indefinite group of people. The extent to which the LSV applies to a ferry (under German flag), i.e. if the circle of users is an indeterminated group of people or not, has not yet been clearly clarified according to current knowledge of the ALBERO consortium. We stick to it. Starting with the 01.04.2019 installed charging points have to be calibrated if they sell the current according to the actually charged kWh. Without calibration the charging can only be offered via using a lump-sum or as an all-inclusive-price for instance for parking or transporting.

Selection of charging station for on-bord-operation

The installation of a charging station is recommended for security reasons. Charging an electric vehicle is theoretically also possible simply by plugging it into a socket, which is otherwise e.g. used for the cooling units of refrigerated trucks (possibly with plug adapters). However, a charging station can communicate with the battery management system of the vehicle, which cannot be done by a simple power socket. The charging station may therefore recognize certain problems during the charging process and may interrupt it if necessary.

Whether a standard charging station or a fast charging station should be installed depends primarily on the amount of electricity still available on board. For this purpose, calculations for selected ferries have already taken place in the project. Vehicle batteries must always be charged with direct current. Standard charging stations supply the alternating current coming from the grid to the vehicle. The conversion into direct current takes place in the charging cable or in the vehicle. Fast charging stations convert the alternating current into direct current already in the charging station and deliver direct current to the vehicle. They need more electricity. How many and what kind of charging stations are possible, therefore, depends first on the overall energy balance of the particular ship and must be calculated exactly. Another, but subsequently criterion is the time available. For short crossings (less than 2 hours), fast-charging stations seem more appropriate than standard charging stations.

As of today, there is still no charging station that is suitable for the special conditions on a car deck. This concerns in particular with the following aspects:

- In contrast to the batteries, which must pass safety tests for movements, vibrations, impact, etc., there are no such test procedures for charging stations and plug connections between vehicle and charging station, as in shore operation, where the charging station is fixed. The location ship where charging station has to follow the ship movements and where the station is also exposed to vibrations has not been considered so far, there are no corresponding approval procedures.
- Electrical installations on closed car decks must be explosion-proof up to a certain height. The previously contacted charging station manufacturers do not offer explosion-proof charging stations.
- The current parameters on board (voltage, frequency) are often different from those on land. To what extent the charging station can cope with this is not really clear.
- The power grid on board is different compared to the typical ashore. This concerns in particular the layout of the zero conductor, hence a corresponding adjustment would be necessary for the charging station.