Reader

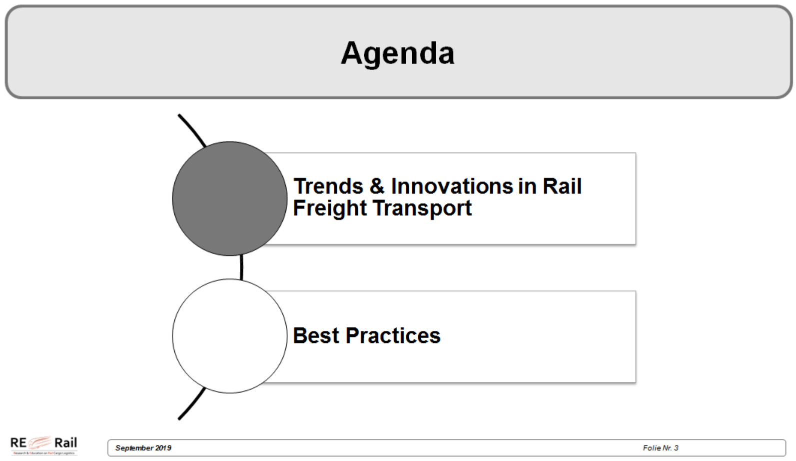
Trends & Innovations in Rail Freight Transport

This reader supplements the ppt presentation on this topic and doubles as a script if necessary.

A project in cooperation with the University of Applied Sciences BFI Vienna, Logistikum, Schieneninfrastruktur-Dienstleistungsgesellschaft mbH and the Federal Ministry of Transport, Innovation and Technology

Introduction

The ppt presentation "Trends & Innovations in Rail Freight Transport" and the accompanying reader are structured as follows:



A brief history of the railway introduces the topic trends and innovations in rail freight transport. Here is a summary: https://www.youtube.com/watch?v=y76kBUzSV4M.[1]

The economic upturn of the industrial revolution in the second half of the 18th century, caused a huge lack of efficient transport systems for transport of raw materials and end products. Growing goods flows could no longer be handled by horse-drawn carriages. Rapid population growth in the cities also called for fast and cost-effective transport of goods. Cost reductions in coal and iron ore transport reduced prices for iron, making it possible to lay the long iron rails for rail transport. In 1795 the first horse-drawn railway was opened in England. At the same time, the idea of using a stationary steam engine as a drive came up, but this still caused some problems for the time being. In 1825 the first public railway on the Stockton - Darlington line was put into operation which was still operated in mixed operation with carts. The first pure railway line (Manchester - Liverpool) opened in 1828 with the "railway virus" also spreading to continental Europe and the USA from 1830.[2]

In 1836, the ground-breaking ceremony for the ”Emperor Ferdinand Northern Railway”, which opened in 1838, marked the birth of railway with locomotive operation in Austria. This project became a success story: Until its nationalization in 1906, the economically highly successful Nordbahn company built a very extensive

[1] Einfach Geschichte (2015), online.
[2] See Zukunft Mobilität (2019), online.

rail network. The Nordbahn became the most important railway line of the Habsburg Monarchy.

Austria is currently the leading country in the EU in terms of rail transport. On average, each Austrian covers 2.255 kilometres per year by train, tram or underground - more than twice the EU average of 1.090 kilometres and about 45 per cent more than in other European countries. Every year, the Austrian Federal Railways (ÖBB) alone transport 459 million passengers and 115 million tons of goods.[3]

Trends & Innovations in Rail Freight Transport

Innovations include ideas and inventions that are translated into new products and services for the market. Here are some selected trends and innovations in rail transport.

Innovative Drives

Hybrid Drive

In order to make the drive systems of rail vehicles more flexible and environmentally friendly, hybrid drives have been increasingly developed in the recent past. Hybrid rail vehicles are to be powered by two different energy sources. In rail transport, both the conventional drive systems diesel traction and electric traction are combined and the coupling with innovative storage and drive systems is tested.[4]

Examples of hybrid drives:[5]

The RegioCitadis, which connects Kassel with the surrounding area, is equipped with a combination of electric and diesel power units. These so-called RegioTram vehicles are the world's first series-produced hybrid suburban railways. They operate in the city using tram overhead lines. The diesel engine is used on non-electrified routes in the surrounding area.

[3] See bmvit (2018), online.
[4] Cf. o.V. (2017), online.
[5] Cf. o.V. (2017), online.

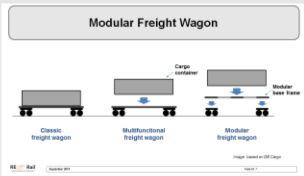
In North America and Europe, hybrid solutions are used in shunting locomotives. The fuel efficiency of a shunting locomotive equipped with hybrid technology proves to be a significant advantage compared to a diesel locomotive. Corresponding consumption reductions of 35 - 60% are possible under everyday operating conditions.

Battery Multiple Unit

Like a conventional electric multiple unit, the battery-powered multiple unit draws its traction current from the overhead line. In addition, there are batteries on board which are recharged on overhead lines, necessary on sections without external power supply.[6]

Hydrogen Multiple Unit

In the hydrogen multiple-unit train, a fuel cell generates electricity from hydrogen which is stored in batteries. Driven by electric motors the vehicle can thus run completely independently of the overhead line, but requires a hydrogen tank infrastructure.[7]



Modular Freight Wagons

The focus of interest is not on the classic wagon, but on its cargo container. The cargo container corresponds technically and constructively to a typical truck body. Like this one, it has stanchions that can be moved instead of fixed side walls with individually opening sliding tarpaulin systems. These enable fast loading and unloading, customised for its load. In contrast to classic freight wagons, these cargo containers can flexibly be adjusted to special customer requirements and, once the transport order has been carried out, can be tailored to the next freight again.[8]

The modular vehicle concept is based on the carrying wagon, which can multifunctionally cover all the requirements of rail freight transport. An innovative feature is the base frame, which forms the rolling and load-bearing system for transporting goods. In order to achieve cost advantages through higher quantities in procurement, a far-reaching standardization of the vehicle body must be planned.[9]

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[6] See Allianz pro Schiene (2019a), online.
[7] See Allianz pro Schiene (2019a), online.
[8] See DB Cargo (2019), online; see Bobsien et al. (2018), online.
[9] See DB Cargo (2019), online.

Intelligent Freight Trains

In order to keep up with digitisation, existing freight wagons must now also be upgraded. A large number of freight wagons are travelling on rail infrastructure without telematics. A freight car 4.0 is therefore equipped with sensors, e.g. for train testing, brake testing or an automatic clutch. This sensor technology facilitates and shortens train preparation and formation. Another point is communication between wagons and locomotive which is currently non-existent. The sensor technology can not only be used for the aforementioned purposes, but also enables predictive maintenance systems. These, in turn, allow improved use of the wagons, as maintenance can be better planned and surprising wagon breaks can be avoided. Telematics can also guarantee the connection to existing logistics systems.[10]

Figure 1: Freight wagon 4.0[11]

Autonomous Driving in Rail Traffic

Automation is becoming increasingly important not only in the automotive industry, but also in rail transport. All processes that a locomotive driver performs during the journey are taken over by the technology in fully automatic operation. Accordingly, lines, railway installations and vehicles must be equipped with special technical

[10] See Clausen (2017), online.
[11] SBB Cargo (2019), online.

components.[12] In the course of digitalization, increasingly powerful systems are being used. The various degrees of automation range from brake and travel control to speed control, from travel control and door control at the stopping point to potential remote control for driverless operation. Until the classic railway runs without a driver, however, there are still a few hurdles to overcome. These include customer acceptance, the handling of external faults and, last but not least, the approval of autonomous trains.[13]

According to "Siemens," fully automated trains also have several advantages: They can travel faster in a row because braking distance and speed are constantly calculated. In addition, the technology saves electricity and can be used with high passenger volumes - without a train driver having to stand by - without any problems.[14]

Advantages of autonomous driving in rail transport:[15]

- greater safety
- increasing efficiency
- capacities are fully utilised
- human errors can be minimized
- calculable => better planning, more reliable driving times

Disadvantages of autonomous driving in rail transport:[16]

- sensors may fail
- situations can be misinterpreted
- bugs can lead to malfunctions
- accident liability: who is responsible?
- customer acceptance not a reality yet
- job cuts

Development of Rail Infrastructure

Austria is the leading country for rail transport in the EU. On average, each Austrian covers 2.255 kilometres per year by train, tram or underground - more than twice the

[12] See Allianz pro Schiene (2019b), online.
[13] See Gaisch-Faustmann (2018), online.
[14] See Die Welt (2016) online.
[15] Cf. Gaisch-Faustmann (2018), online; Cf. Die Welt (2016) online.
[16] Cf. Gaisch-Faustmann (2018), online; Cf. Die Welt (2016) online.

EU average of 1.090 kilometres and about 45 per cent more than in other European countries. Every year, the Austrian Federal Railways (ÖBB) alone transport 459 million passengers and 115 million tons of goods.[17]

In the coming years, billions will be invested in the new construction and expansion of rail infrastructure in order to further enhance the competitiveness of rail transport and continue the positive trend of recent years.

Below the Brenner Pass, the world's longest underground rail link for freight and passenger traffic is being built. The Brenner Base Tunnel improves travel and transport possibilities by rail in the heart of Europe and, with a length of 64 kilometres, is the longest underground railway connection in the world. It is a flat railway tunnel between Innsbruck and Franzensfeste in Italy. The Brenner Base Tunnel is a part of the European Scandinavian-Mediterranean core network corridor, where about 110 million people live between Helsinki and Valletta. The Brenner Base Tunnel thus enables a rapid and safe connection between population centres north and south of the Alps and links important European economic centres with each other. Cross-national projects are subsidised to an extent of up to 40 percent. The project will be implemented by Brenner Base Tunnel SE, a European public limited company working on behalf of the Republic of Austria, the Republic of Italy and the EU.[18]

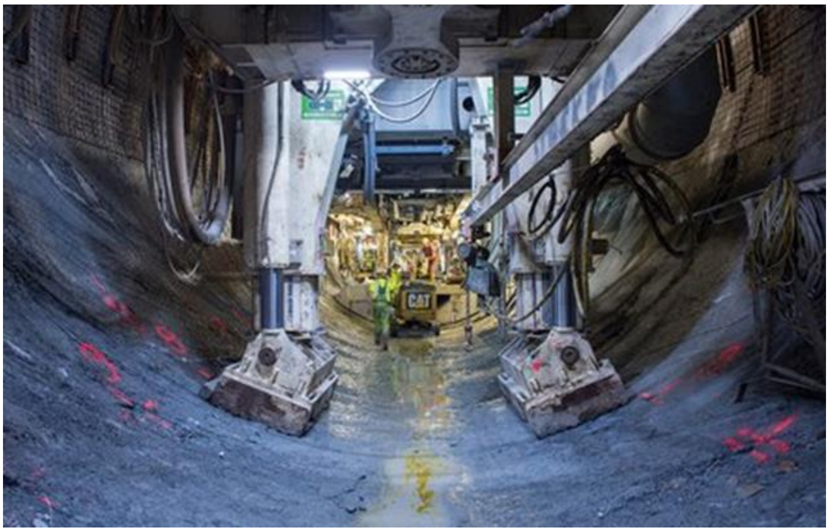
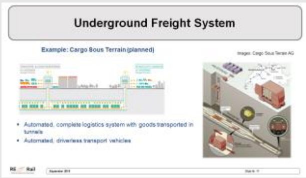


Figure 2: Brenner Base Tunnel[19]

The Brenner base tunnel is to be completed in 2028, with a mere construction time of about 20 years. In the future, freight trains will be able to travel through the tunnel at speeds of up to 120 km/h and passenger trains at speeds of up to 250 km/h. The tunnel will also be used for goods transport. Altogether there will be 4 accessed

[17] See bmvit (2018), online.
[18] See ÖBB Infrastuktur (2018), online.
[19] BBT (2018), online.

tunnels, in Ampass, Ahrental, Wolf near Steinach am Brenner and in Mauls. In Innsbruck, the Brenner Base Tunnel then leads into the existing railway bypass. A special feature of the tunnel is the continuous exploratory tunnel. This runs centrally between the two main tunnel tubes and is 12 metres below. Current excavation work on the exploration tunnel should provide information on the rock condition and thus minimise construction times and costs. Once the tunnel is operational, the exploratory tunnel will be important for drainage.[20]



Underground Freight System

Cargo sous terrain is a complete logistics system for the flexible transport of small-component goods. Tunnels connect production and logistics sites with urban centres. Overground, CST distributes the transported goods in environmentally-friendly vehicles, contributing to the reduction of traffic and noise emissions..[21]

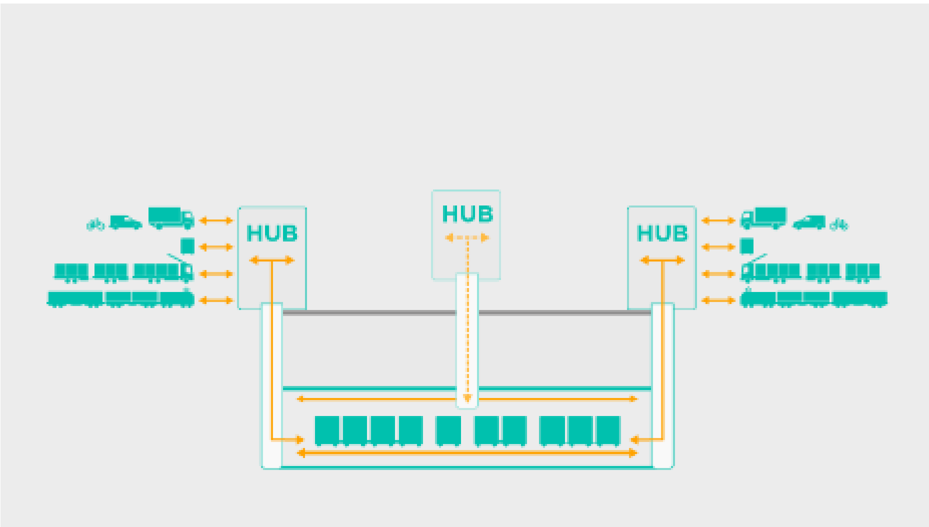


Figure 3: Cargo Sous Terrain[22]

Cargo sous terrain follows a similar principle to that of an automatic conveyor system. Automated, driverless transport vehicles which are able to pick up and deposit loads automatically from the designated ramps and lifts travel around the clock in the tunnels. The vehicles, which travel on wheels and have an electric drive with induction rails, operate in three-track tunnels with a constant speed of around 30 kilometres per hour. The goods are transported on pallets or in modified containers.

[20] See BBT (2018), online
[21] See Cargo sous Terrain (2019), online.
[22] Cargo sous Terrain (2019), online.

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Magnetic Levitation Train (Maglev)

In contrast to the conventional railway, the magnetic levitation train can accelerate to speeds of over 400 km/h without touching the rails. This is made possible by electromagnetic travelling fields that make the train float, control, drive and brake. [24] China has already shown the prototype of a magnetic levitation train that can travel 600 km/h in Qingdao in the eastern province of Shandong.[25]

The realisation of magnetic levitation trains is associated with high investment costs, as it cannot use the existing railway infrastructure and requires a new infrastructure. For this reason, the planning of a magnetic levitation train should be based on structured, credible analyses and facts. Only then can such planning as a whole be socially meaningful and beneficial for the future.[26] The top speed of the magnetic levitation train closes the gap between railway and aircraft and is particularly suitable for longer distances.

Advantages of magnetic levitation trains:[27]

- requires less space for routing than conventional railways9
- lower energy consumption
- less noisy than railways at high speeds
- high accelerations possible
- shorter travel times

[23] See Cargo sous Terrain (2019), online.
[24] See Uhlenbrock/Nordmeier/Schlichting (2000), p.1.
[25] See Stern (2019), online.
[26] See The International Maglev Board e.V. (2018) online.
[27] See The International Maglev Board e.V. (2018) online; see Uhlenbrock/Nordmeier/Schlichting (2000).

Disadvantages of magnetic levitation trains:[28]

- unsuitable for heavy goods traffic
- cannot be used on existing railway infrastructure
- no intermodality possible
- high investment costs 12-55 million/km (comparison: high speed rail 6-25 million/km)

Enhanced Customer Service

A modern infrastructure is a prerequisite for more efficient rail transport. The traffic forecast for 2025+ anticipates an increase in traffic volume in Austria. This forecast growth in traffic should primarily be handled by rail. An efficient railway is therefore of central importance for the transport system. More trains, shorter journey times and more modern stations and terminals should strengthen the market position of the railways. Investments in the rail network create the conditions for regular passenger traffic with stable and punctual travel times, support the transfer of freight traffic to rail and thus contribute to the reduction of CO_2 emissions. This should make the railways more attractive and efficient and ensure that they can cope with the forecast demand for freight and passenger transport.[29]

Improved customer service adds to attractiveness and competitiveness of the railways. The following two examples from freight and passenger traffic illustrate this.

Capacity Booking System for Rail Freight Transport of the Rail Cargo Group

This is a project for the development of a booking system for Rail Cargo's freight traffic with a focus on transports in single wagonload traffic. The customer can accessed route and date-specific transport information in real time through the web-based portal. The Rail Cargo Group benefits from the optimisation of planning and better capacity utilisation through timely customer booking of the required volume. So the company increases transport flexibility and quality to create added benefit for its customers. The[30] objective of the capacity booking system is clear: reforming the existing rail production system in terms of quality, punctuality and cost-effectiveness with a view to giving the attractiveness of rail freight transport a boost which will transfer more freight transport from road to rail.[31]

[28] Vgl. Vuchic/Casello (2002) S.45.; Vgl. The International Maglev Board e.V. (2018) online.
[29] See ÖBB Infrastruktur (2019), online.
[30] See Österreichische Verkehrszeitung (2013) online.
[31] See Rail Cargo Logistics - Austria GmbH (2013) online.

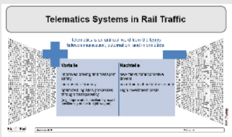
wegfinder - the Navigation App for more Intermodality

Transport choices in Austria cover a broad spectrum from public transport and taxis to car sharing and bicycles. The "wegfinder" app makes optimum use of these services facilitating route planning with a variety of transport opportunities. Customers can buy ÖBB and VOR (Traffic Region East for Vienna, Lower Austria and Burgenland) tickets directly via the application. The purchase process is handled via a chatbot and payment is currently made by credit card. Further payment options such as PayPal or immediate transfer will be available in the future.[32]

Wegfinder at a glance thus offers the best opportunities to get from door to door in your own city or throughout Austria. The means of transport and information are displayed in real time and, in addition, users can find city bikes and book car2go or call a taxi directly. The app processes the data of all transport associations in Austria and integrates other mobility providers such as ÖBB, Westbahn and Flixbus.[33]

Figure 4: wegfinder[34]

The app's merits are several: you can find alternatives to previously used transport means, leave your own car or motorbike at home more often and thus relieve and protect the environment and the road network.[35]



Telematics Systems in Rail Traffic

Telematics systems usually describe self-sufficient systems that operate over a longer period of time without energy replenishment, communicate with the outside world and can locate themselves via GPS.[36] Telematics enables customised solutions and customer requirements to be reliably met. This allows real time tracking

[32] See Wegfinder (2017), online.
[33] See Weitze (2017), online.
[34] wegfinder (2018), online.
[35] See VCÖ (2017), online.
[36] See Bergaus/Stottok (2010) p.28.

of freight wagons or containers with high-quality goods. Solar-powered locating devices are mounted on and provide position data via satellite (GPS). At the same time, modern diagnostic systems measure parameters such as schedule deviations. Individually desired sensor data on charge status, temperature, door openings or vibrations can also be linked to the GPS position data and transmitted telematically. The data can be retrieved from any Internet-capable PC or mobile phone. The automated deviation management and early problem detection enable logistics specialists to take short-term measures.[37]

With telematics systems, locomotive drivers perform a multitude of supervisory and management tasks. These range from direct manual operation of the train to largely autonomous operations management, where the active role of the driver is minimal.[38]

Advantages:[39]

- improved driving and transport safety
- enhanced attractiveness of rail transport
- energy self-sufficient through solar operation
- increased efficiency
- optimized logistics processes through transparency
- improved disposition by exact positioning of the freight wagon

Disadvantages:

- new tasks for locomotive drivers from operating to managing the trains
- uncertainty about data security
- high investment costs

Interoperability

European rail transport is still hampered by historically evolved national systems. This puts international rail transport at a competitive disadvantage compared with contending modes of transport. Different energy supplies in different countries often require time-consuming locomotive changes at border stations. In addition, some countries, such as Russia, Ukraine, Kazakhstan and Spain, have broad gauge tracks. Such deviating track gauges make reloading of the goods or a gauge change of the entire train necessary. In addition, there are different train protection systems.[40]

[37] Cf. VCÖ – Mobilität mit Zukunft (2010) online.
[38] See Bergaus/Stottok (2010) p.200.
[39] See Ebeling et al. (2005) p. 17.
[40] See Rail Cargo Group (2018), online; Stoll et al. (2017), p. 36ff.

The removal of obstacles in cross-border traffic and further harmonisation of national requirements are among the main transport policy objectives of the European Union. This means that infrastructure, train protection and signalling systems as well as the technical equipment of locomotives are to be standardised.[41]

One step towards harmonisation is the European Train Control System (ETCS). ETCS monitors the locally permitted maximum speed, the correct route and direction as well as the suitability of the train for the route and is intended to harmonise a large number of train control systems in Europe.[42]

Best Practices

Here are some selected best practices in rail freight transport.

Cityjet Eco - ÖBB's New Hybrid Train

Several diesel locomotives are still running on Austria's rail network, as part of the network has not been electrified yet. However, a large part of this is being electrified within the framework of the bmvit in order to minimise the number of diesel trains for more environmentally friendly transport throughout Austria. Siemens is already taking action with its newly developed train - the Cityjet Eco. This is the world's first battery-powered electric hybrid train which absorbs energy on the electrified line via the pantograph and then stores it in batteries. This energy is then used on non-electrified lines, where the batteries feed the entire energy supply system of the train. The Cityjet Eco has a range of about 80 kilometres before it has to go back under the power line.[43]

A special cooling system for the batteries is necessary in order to reach the maximum speed of 140 km/h. The drive does not need so much energy, because most of the electricity goes into lighting, air conditioning, Wi-Fi etc. Cooling is also vital for prolonged battery life to 15 years, as this means that they would only have to be changed once during the entire service life of the train.[44]

[41] See Rail Cargo Group (2018), online; Stoll et al. (2017), p. 36ff.
[42] See Rail Cargo Group (2018), online
[43] See Leadersnet (2018), online.
[44] See Leadersnet (2018), online.

Figure 5: Cityjet Eco[45]

Currently there is only a prototype, and in the coming months the train will be tested and further developed to series production. The first passenger operation is expected for the second half of 2019.[46]

TransANT – the voestalpine and Rail Cargo Group Pioneering Lightweight Wagon

Rail Cargo Group and voestalpine are setting new standards in rail logistics with the innovation of the modular and flexible freight wagon TransANT. Its modular lightweight construction concept and its universal applicability make the innovative platform trolley unique.[47]

TransANT consists of a standardized platform available in seven different lengths - from 33 to 70 feet. A modular structure is placed on the platform, which is interchangeable and available in numerous industry-specific versions. This modular system increases structure flexibility, usability and maintenance. Lightweight construction lends a weight advantage of around 20%, enabling increased payload. In addition, manufacturing costs can be saved[48] through reduction of traction costs for energy and the infrastructure usage fee (IBE).

[45] Railway Technology (2018), online.
[46] See Leadersnet (2018), online.
[47] See Steininger (2018), online.
[48] See Steininger (2018), online.

Figure 6: TransANT[49]

According to forecasts, European freight traffic is expected to increase by around 30% by 2030, which means that there is great potential for the modes of transport - but above all for rail.[50]

Modular structures are the flat box with stanchions for transporting wood, for example, the cover box for palletized goods, the multi box for bulk goods of all kinds and the bulk box for bulk goods such as ores.[51]

From autumn 2019, the first 60 freight wagons will carry domestic ores to voestalpine in Linz, operated by CargoServ - a subsidiary of LogServ.[52]

MOBILER - The Innovative Wagonload Concept of Rail Cargo Group

The name MOBILER stands for a wagonload system that combines the advantages of rail and road freight transport in one system. The MOBILER enables direct connection to the customer, regardless of whether a siding is available. A special MOBILER truck picks up the goods to bring them to the next loading point, from where they are transported by rail.[53]

[49] Rail Cargo Group (2019a), online.
[50] See Rieder (2018), online.
[51] See Rail Cargo Austria (2018), online.
[52] See LogServ (2018), online.
[53] See Rail Cargo Logistics Austria (2018), online.

Figure 7: MOBILER[54]

MOBILER's faster, safer and more economical technology means that more goods can be transported by rail in a more environmentally friendly way, without foregoing the advantages of more flexible and faster truck delivery. In addition to just-in-time deliveries, the monitoring of the progress of each individual shipment and the electronic arrival notification by SMS or e-mail are also part of the service portfolio.[55]

MOBILER enables the truck driver to handle MOBILER containers and WABs at any time and place in just a few minutes. Handling takes place laterally on each loading track. The MOBILER is particularly suitable for dangerous goods of all kinds. MOBILER is mainly used for FMCG (fast moving consumer goods) incl. beverage logistics for the transport of bottles and drums as well as heavy bulk goods and residual materials such as slag, scrap, waste paper and building products. Palletized goods, industrial products and liquids are also transported in tank containers.[56]

The MOBILER vehicle is equipped with a hydraulic lifting device for uncomplicated and fast transhipment between wagon and truck without a crane. This means that door-to-door deliveries are possible throughout Europe and a wide variety of goods can be transported along the supply chain.[57]

Coradia iLint – Alstom's Fuel Cell Train

The French Alstom Group has developed a fuel cell-powered train for mass transit, revolutionizing the international rail market. The so-called Coradia iLint is a fuel cell train that runs on electricity but does not get its electricity from the overhead line, but

[54] See Rail Cargo Group (2019b), online.
[55] See Rail Cargo Group (2019c), online.
[56] See Rail Cargo Group (2019c), online.
[57] See Rail Cargo Group (2019c), online.

produces it itself using fuel cell technology. The Coradia iLint is conceived as an alternative to diesel trains in local rail transport, as there are still many diesel trains in use in rural areas.[58]

Two fuel cells are installed in the railcar train, which, together with a large hydrogen tank, are located on the roof of the train. Each fuel cell delivers an output of 200 kilowatts (kW), but 800 kW is needed to start the engine. The remaining power comes from a so-called lithium-ion battery which is installed in the train floor. Excess power not needed while driving is stored in the battery. If more energy is needed, e.g. on a gradient, it is supplied by the battery. The kinetic energy from braking is also converted into electrical energy and stored in the battery. With a top speed of 140 km/h, the Coradia iLint is just as fast as a diesel train. The big difference to the diesel train, however, is the environmentally friendly operation and the significantly lower noise emissions. The train developed by Alstom is a pioneer in its niche with a ready market for such a model.[59]

Figure 8: Coradia iLint[60]

Coradia iLint is the world's first hydrogen fuel cell train that has been running regularly to a fixed schedule on public transport services in Lower Saxony (Germany) from autumn 2018.[61]

[58] Cf. Pluta (2018), online.
[59] Cf. Pluta (2018), online.
[60] Alstom (2019), online.
[61] See Alstom (2018), online.

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