Photo by Michael Dziedzic

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Free and Hanseatic City of Hamburg

# Recent e-bus developments in and around Hamburg: Autonomous driving

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*Figure 1: HEAT bus in Hamburg, © Hamburger Hochbahn AG*

**HEAT – Hamburg Electric Autonomous Transportation**

The HEAT bus is a unique research and development project in Germany and one of the first pilots in the world, funded by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). The objective is to showcase how electric autonomous mini-buses can be used for passenger transportation in urban environments.

A unique feature of the HEAT bus system are the additional poles, equipped with cameras, sensors and lidars (laser-based distance measurement systems) positioned alongside the test track in Hamburg's HafenCity. This infrastructure, which was developed by SIEMENS in cooperation with Hamburg Verkehrsanlagen (HHVA), complement the integrated sensors of the vehicle, allowing for a better overview of the surroundings, thus enabling higher velocities. Information about cyclists or pedestrians, who are outside the reach of the integrated sensors can be communicated to the bus. As a second external data source, the bus has access to a high-definition map of the route with centimetre-accuracy. This enables very precise positioning and steering of the bus.

The vehicle itself has been developed by IAV Automotive Engineering and is a 5-metre electric mini-bus designed to take seven passengers on board – five seated and two standing. A wheelchair on the bus reduces the maximum number of passengers to three.

HafenCity has been chosen as the location as it is considered most suitable, fulfilling the needs, i.e. electricity supply is taken care of by Wärme Hamburg – the local district heat provider.

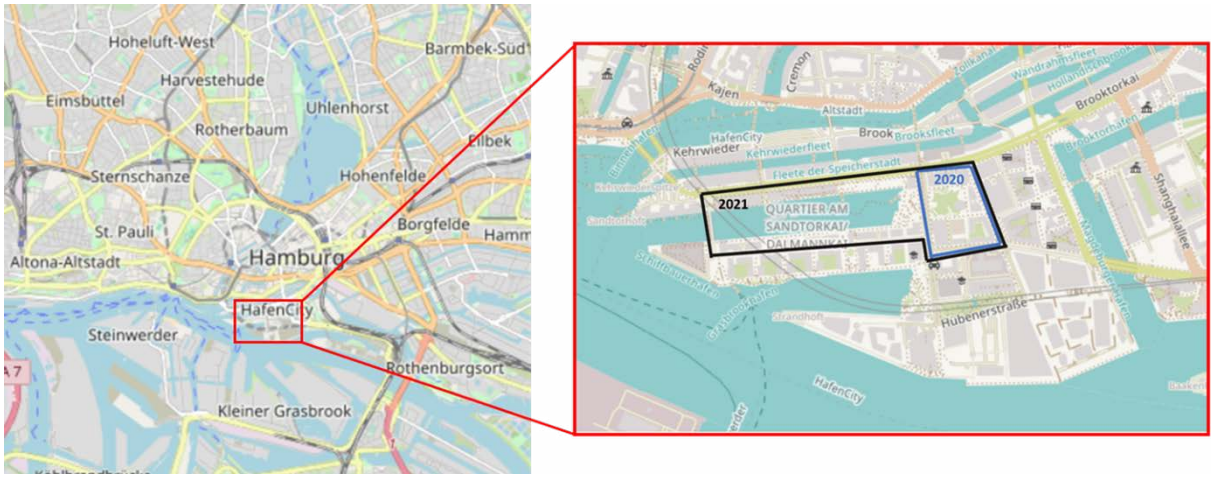

*Figure 2: Test routes of the HEAT bus (maps made with openstreetmap.org)*

HEAT is part of the ITS strategy (Intelligent Transport Systems) and will be one of the flagship projects for the ITS World Congress to which the City of Hamburg is the host from 11-15 October 2021 (https://itsworldcongress.com/).

In the first phase of the pilot, the 5-meter e-bus from IAV Automotive Engineering was allowed to drive a maximum velocity of 15 km/h over a route of 800 meters. The only passenger on board was an attendant who supervised the tests. This phase was mainly for gathering operational experience and data and improve the hardware and software components.

During the second phase of pilot operations – from October to November 2020 – the focus was on interconnecting the shuttle with the control room (at Hamburger Hochbahn AG) and improving the interactions with the regular traffic. An attendant, as well as technical support, were still onboard the vehicle to take over control or resolve technical problems, should the need arise. The improvements of the system enabled safe operation up to a maximum speed of 25 km/h. The test track included two fixed bus stops. Interested passengers had the opportunity to register via an app for free rides. Almost 600 people made use of this offer. All trips have been monitored by the control centre. In December 2020 the bus has been taken out of service for further development.

In the third and last project phase, beginning in spring 2021, the e-bus will be transporting the passengers along an extended test route of 1.8 km including five bus stops.

Matthias Kratzsch, Managing Director Technology of IAV (Automotive Engineering) said: "We are confident that the shuttle will cope with much longer distances compared to last year and have no problems merging with the flow of traffic with other road users. We expect to achieve clear progress in the technological development of autonomous driving."

Another aspect of the project is the acceptance by and needs of passengers and other road users which is being assessed by the DLR (German Aerospace Center). The shuttle bus has also been equipped with a passenger information system. Two monitors in the vehicle display the stops and show the targeted and actual arrival times as well as information about the route.

While technological implementation is challenging, one of the biggest obstacles is the legal framework. Autonomous driving is still not reflected in the regulations. Hopes of a permit for automated driving without a vehicle attendant before the ITS World Congress takes place in Hamburg in October 2021 are high. However, the legal framework does not yet meet the "SAE Level 4 Autonomous Driving" requirements for driving without a vehicle attendant and remains one of the most pressing challenges.

**TaBuLa Shuttle (Test centre for autonomous buses in the county of Lauenburg)**

Another project to advance autonomous e-buses is being operated by VHH in Lauenburg, a small town close to Hamburg. In the frame of the programme for automated and connected driving by the Federal Ministry of Transport and Digital Infrastructure, a shuttle by manufacturer NAVYA started regular operation in 2019. The project has the aim to demonstrate the feasibility of automated vehicles for the first and last mile in small towns, which are difficult to access for regular busses. Further goals are to assess opportunities and hurdles of the implementation of autonomous and connected vehicles in public transport.


*Figure 3: Route of the TaBuLa shuttle, ©TaBuLa*

Up to 10 passengers can use free-of-charge transport until 2021. An especially interesting aspect of the project is that the e-bus is driving in a normal traffic environment, rather than a controlled test environment, like most other autonomous driving projects. During operation, the e-bus follows its pre-programmed tour along a “digital railway” with a maximum velocity of 18 km/h. The test route is designed to include various challenges for the e-bus such as steep and narrow roads and cobblestone in the historic centre.


*Figure 4: TaBuLa shuttle in downtowon Lauenburg © TaBuLa*

**RealLab HH**

In the Hamburg Borough of Bergedorf, an on-demand-service with autonomous vehicles is being tested. The pilot is part of the RealLab HH, a programme of the Federal Ministry of Transport and Digital Infrastructure. From August to October 2021 in the run-up to the ITS World Congress up to three autonomous vehicles from the manufacturer EasyMile with a capacity of up to 12 passengers will be available for the public. The focus is on better connecting to the commuter train.