

## M9 Annex I information on H2NODES associated partner Tallinna Linnatranspordi Aktsiaselts

### 1. Introduction



Tallinna Linnatranspordi Aktsiaselts (TLT) is a public transportation company owned by the city of Tallinn (Estonia). The main activity of TLT is providing bus, tram and trolleybus services, on the basis of a contract with the Tallinn Transport Department.

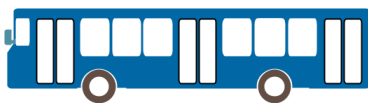
TLT started its operations on 18th July 2012, when the merger of Tallinn Bus Company and Tallinn Tram and Trolleybus Company took place. TLT is also an associated partner of action H2NODES. Within this annex the Fuel cell electric bus (FCE-bus) deployment for TLT will be assessed.

### 2. TLT existing transport fleet

Presently, TLT is servicing 73 bus routes, 4 trolleybus routes and 4 tram routes in Tallinn, which make up the major part of the whole volume of Tallinn's public transportation service. In 2019, 142,2 M passengers were carried, and 32,5 Million km were ran by buses, trams and trolleybuses. The TLT fleet consists of:

#### 546 buses:

- 360 (12m) units;
- 186 (18m) units;



The average annual mileage of one bus is around 50 000 - 60 000 km.

#### 49 trolleybuses:

- 30 (12m) units;
- 19 (18m) units;



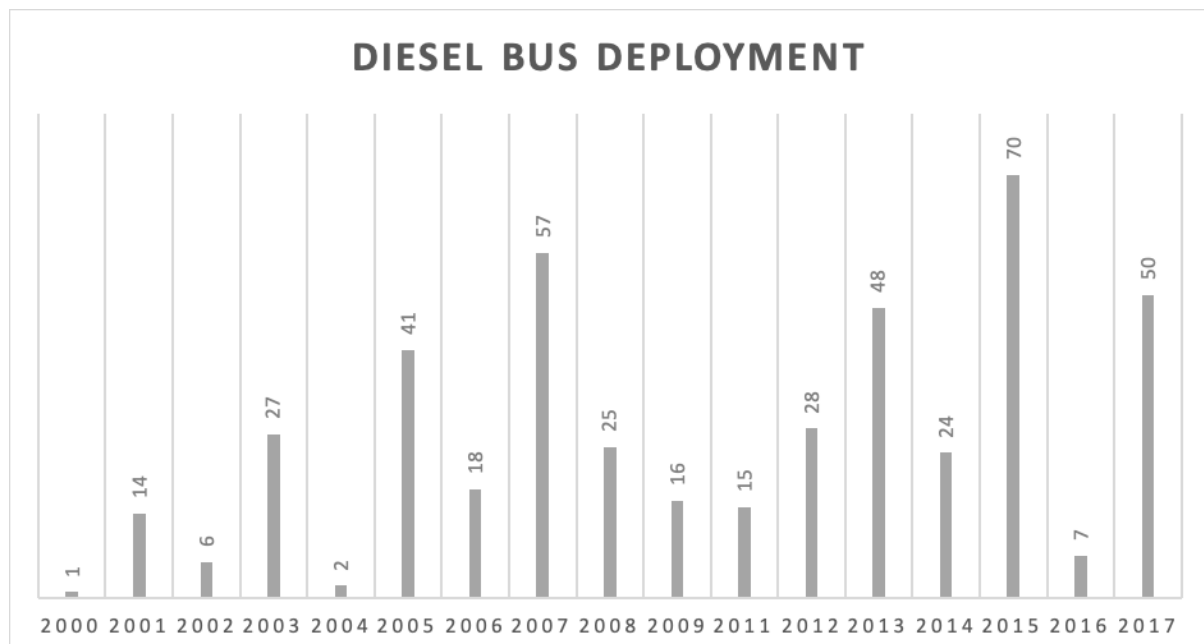
The average mileage per vehicle is 40 000 - 45 000 km. The average annual energy consumption per vehicle is 97 MWh.

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TLT is also operating 65 trams and the average energy consumption per vehicle is 161 MWh and average annual mileage per tram is around 40 000 km.

### 3. TLT bus fleet

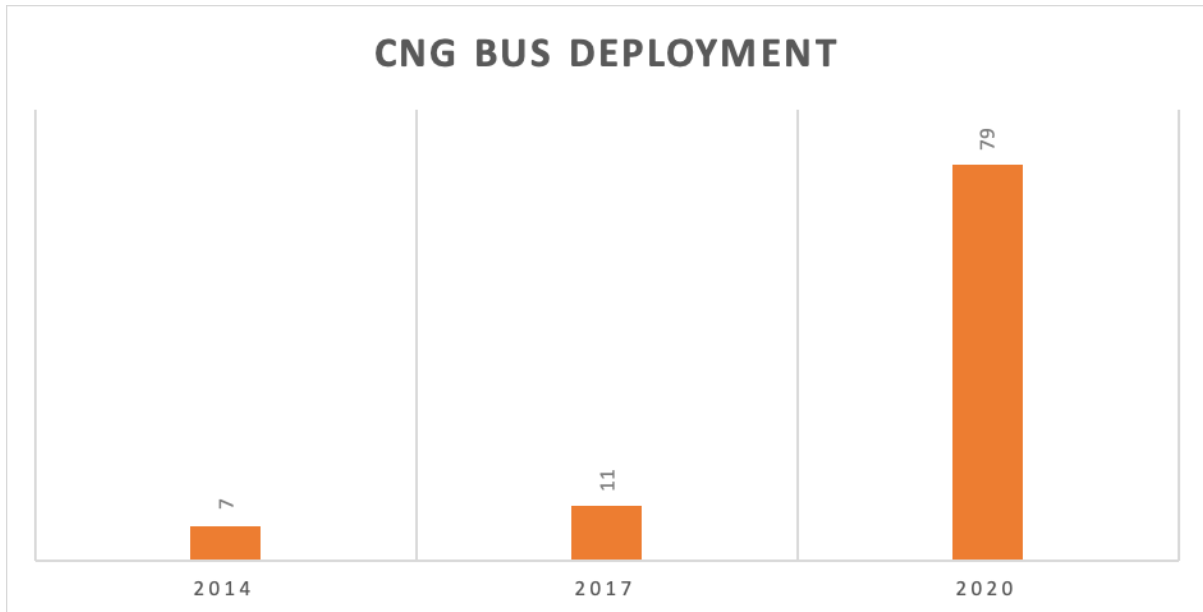
TLT is using 546 buses for public transport operations of whom 97 are CNG buses. According to the provided information the TLT vision on bus fleet renewal includes deployment of different fuel powered bus units that will substitute the existing diesel bus fleet.



*Figure 1 TLT diesel bus deployment per year.*

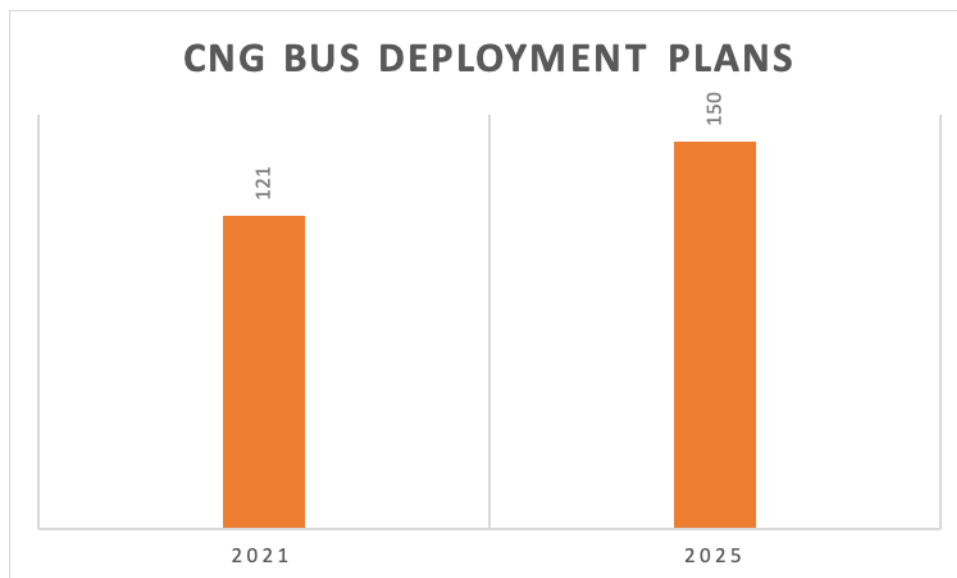
According to the available data, 40% of TLT diesel bus units are older than 10 years and the renewal of the fleet has to be made in the near term. Currently TLT is mainly focusing on CNG bus deployment. The first phase is already ongoing and the first batch of 100 CNG buses is almost delivered.

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*Figure 2 TLT CNG bus deployment.*

According to TLT projections the diesel buses will be replaced by clean and zero-emission buses till the 2025. The projection foresees that the next 100 CNG buses will be deployed in 2021 and the total number of CNG buses till 2025 will reach 350 units.



*Figure 3 TLT CNG bus deployment projection till 2025.*

In order to ensure the best possible CO<sub>2</sub> reduction, the buses will consume primarily biomethane, but in its absence, the buses will be refueled with natural gas.

TLT indicates that there are no definite decisions on the usable technology for the rest of the fleet. As mentioned earlier TLT uses 546 bus units of whom 350 units will be CNG buses till

M9 Annex I information on H2NODES associated partner Tallinna Linnatranspordi Aktsiaselts the 2025. As result, TLT has yet to decide on the usable technology for replacing the 196 diesel bus units.

As there are 3 possible technologies including BEV, FCEV, and CNG-buses, within the Action H2NODES the possibility to replace the 196 diesel bus units with FCE-buses will be assessed.

#### 4. TLT potential FCE-Bus fleet:

TLT has a potential to deploy 196 FCE-buses. These buses would replace the rest of the diesel bus fleet and could secure to reach the aim of TLT to operate clean or zero-emission fleet from 2025. Within this chapter the potential hydrogen demand of the FCE-buses will be assessed. According to provided data, TLT average annual mileage of one bus is around 50 000 - 60 000 km. By assuming that the yearly availability of bus is around 90%, the potential daily range of diesel bus is from 161 to 193km.

Hydrogen consumption per bus <sup>1</sup>	
Average range per unit 161km “low mileage”	Average range per unit 193km “high mileage”
12,9kg	15,5kg

*Figure 4 TLT potential hydrogen consumption per FCE-bus*

To reach the clean and zero emission fleet by 2025 TLT has to deploy around 49 FCE-buses per year starting from the 2021. Corresponding to the FCE-bus fleet deployment the potential hydrogen demand can be assessed.

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<sup>1</sup> Based on assumption that average FCE-bus H<sub>2</sub> consumption per 100km is 8kg.

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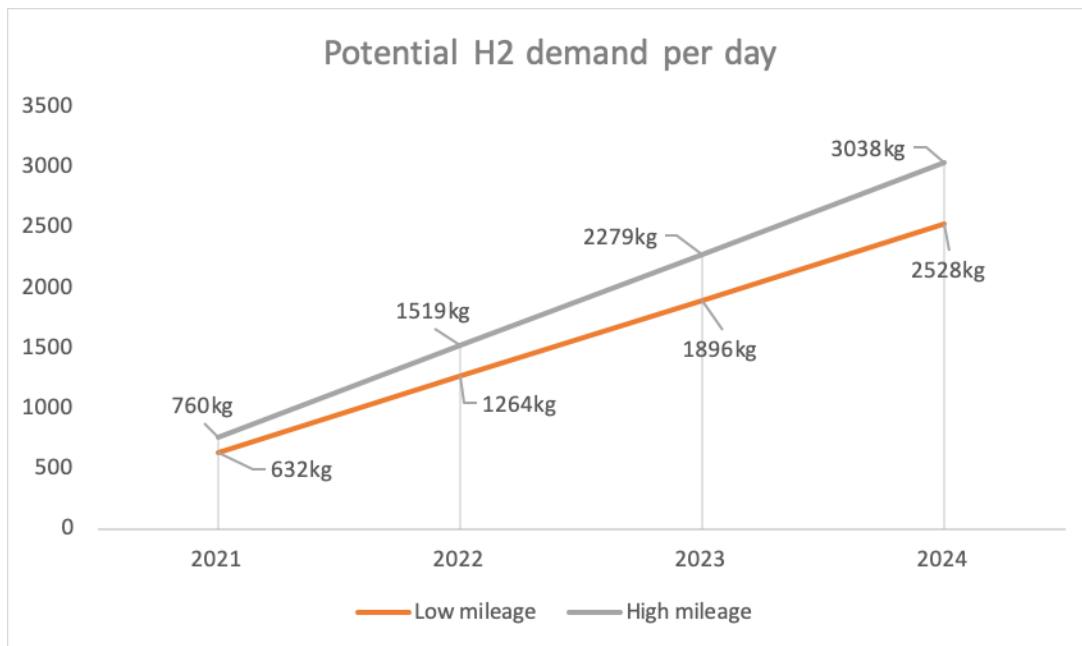


Figure 5 TLT hydrogen demand.

The Figure 5 indicates the TLT hydrogen demand assuming that 49 FCE-bus units are deployed per year starting from 2021. According to calculations in 2025 if 196 FCE-bus units are deployed by TLT, the potential hydrogen demand reaches is from 2528 up to 3038 kg of hydrogen per day. In order to specify exact amounts of hydrogen for potential FCE-bus fleet additional data, that includes specific characteristics of bus routes and bus availabilities should be used.

## 5. Bus/trolleybus depots

TLT has in total 5 depots and 3 of them are related to the operation of buses and trolleybuses. In order to reduce the potential distance of FCE-buses, it would be useful to evaluate the possibility to deploy hydrogen refueling station on-site.

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**Kadaka tee 62 depot**



Units deployed:	385 buses.
Refuelling possibilities:	Diesel refuelling station on-site and CNG refuelling station is under development.
Size of depot	104 144 m <sup>2</sup>



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**Peterbure tee 73 depot**



Units deployed:	161 buses
Refuelling possibilities:	On-site diesel refuelling station. CNG refuelling station is under development.
Size of depot	69 194 m <sup>2</sup>

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**Paldiski mnt 48c depot.**



Units deployed:	49 trolleybuses
Refuelling possibilities:	n/a
Size of depot	33 143 m <sup>2</sup>

## 6. Hydrogen refuelling station for TLT.

As the potential for the large-scale FCE-bus deployment for TLT can be seen, a large scale HRS deployment should be assessed. In order to achieve the hydrogen availability and considering the Figure 5, the total hydrogen production for TLT HRS should reach 3000kg/H<sub>2</sub> per day. The refueling capacity must be ensured in the same amount.

It is projected that the HRS would be used to refuel 196 FCE-buses that are used for public transport operations. Considering that the buses must be refueled in 6 hours, the equipment is modulated to ensure this aspect.

The concept of the TLT HRS is included in Figure 6. Whereas the potential hydrogen production would be performed via water-electrolysis process.



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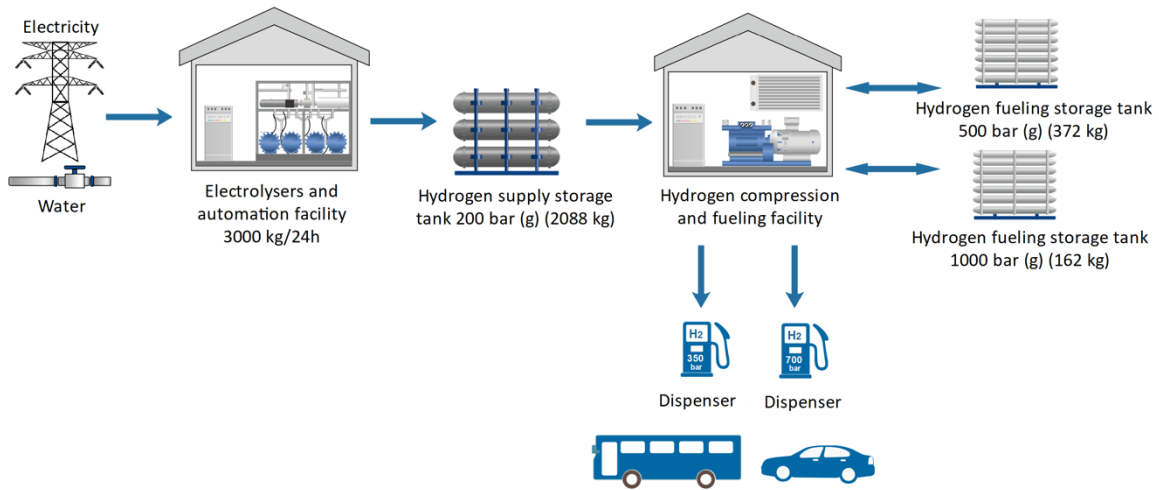


Figure 6 Concept of TLT HRS

For the storage it would be necessary to deploy 4 separate hydrogen supply storage units with 522kg each. In order to provide the significant amount of hydrogen for refueling the Hydrogen compressor and fueling facility would consist of 2 separate compressor modules that would increase the pressure of hydrogen for different levels. The Hydrogen fueling storage consist of 6 units with various pressures and capacities. In total to secure the 6-hour refueling window for FCE-buses it is necessary to deploy six 350bar dispensers.

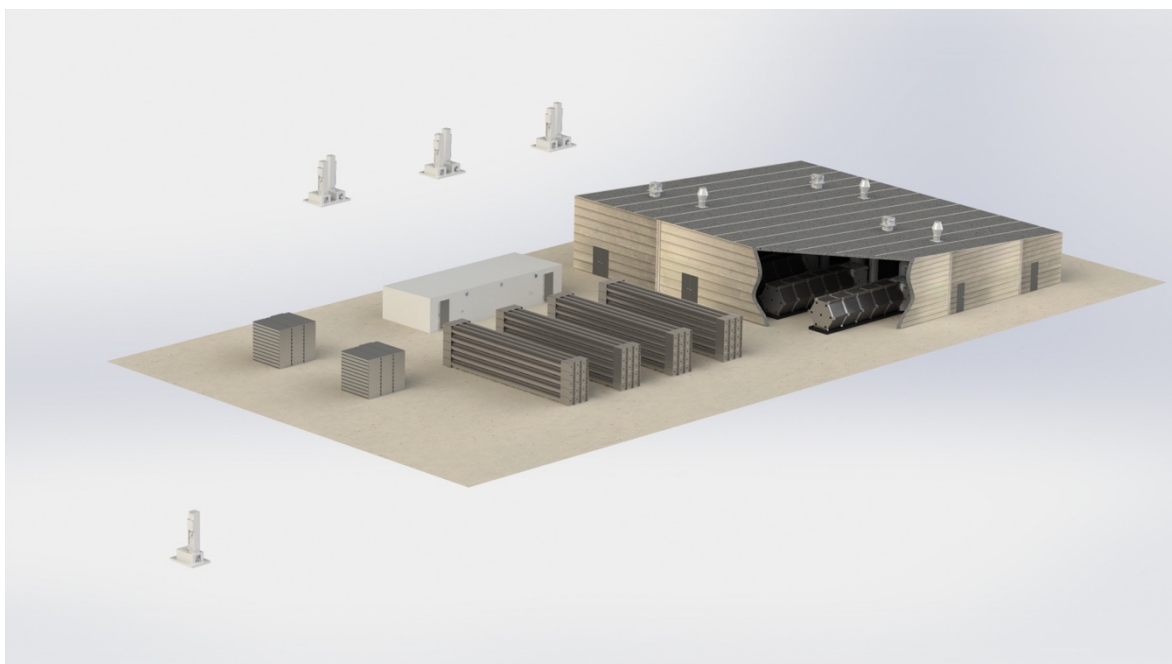


Figure 7 Visualization of TLT Hydrogen production and refueling facility

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## 7. Announced TLT plans and Conclusions

TLT has announced the possibility to deploy 650 electric buses by 2035. As result TLT would quickly perform a transition to a fully electric bus fleet. According to available information, the plan would reportedly include to abandon not only of the internal combustion engine buses (some gas buses are yet to be delivered) but also of the trolleybus network.<sup>2</sup>

It can be seen that for TLT the transition period from conventional fueled buses includes the already ongoing CNG-bus deployment and the zero-emission bus fleet is set as long-term goal. FCE-bus wise, for TLT it would be necessary to achieve the hydrogen availability with 3000 H<sub>2</sub>/kg/per day in order to operate the 196 FCE-bus fleet.

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<sup>2</sup> <https://www.sustainable-bus.com/news/tallin-electric-plans-full-bus-fleet-transition/>