LNG BINNENVAART
Deployment in Inland Waterway Transport

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Breakthrough LNG deployment in Inland Waterway Transport

Activity 2.3 Evaluation pilot test results

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Revision History

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V1	*18-09-2020*	*Salih Karaarslan*	*EICB*	*Processing draft document*
V2	*19-09-2020*	*Salih Karaarslan*	*EICB*	*Final document*

Table of Contents

1 Introduction

This document contains a brief evaluation of the pilot test results of the three pilot vessels deployed in the Action “Breakthrough LNG deployment in Inland Waterway Transport”. These are the following vessels:

- **De Werkendam** – inland crane vessel
- **Somtrans LNG** – inland tank vessel
- **Argonon** – inland tank vessel

All three vessels were deployed during a pilot test period of 6 months. The pilot test period was used to collect data, this data can be grouped into three categories:

- 7 parameter measurements:
  1. Running Hours of engine
  2. Engine Speed
  3. Load of engine
  4. LNG and Diesel consumption
  5. Water depth, position, speed
  6. Overall LNG and diesel bunkering figures
  7. Gas Ventilation Events
- E2/E3 test Cycle Data of Test Bed Trials
- On Board Emission Monitoring

The collected data was used to analyse the variance in:

- emissions as a result of the LNG technology
- fuel consumption as a result of the LNG technology
- operational costs as a result of the LNG technology

The corresponding pilot test reports of the vessels can be found on the project website.1

This evaluation report will primarily focus on a comparison between the vessels as regards the variance in emissions, fuel consumption and operational costs.

It should be noted that this evaluation concerns a comparison between the pilot test results of the three vessels and that these results are only a snapshot and reflect a particular point in time. These results may vary depending on the operational area of the vessel, carried cargo, waterway conditions, etc. This also means that the results cannot be a performance indicator for the powertrain on board of the vessels. The powertrain can perform better or worse in another ship under different circumstances.

[1] https://lngbinnenvaart.eu/downloads/

2 Emissions

Emissions were measured on board of all three pilot vessels during the pilot test period. The result of these on-board emission measurements can be found in table 1 below.

Table 1: on-board emission measurement results

Pilot vessel	Engine	Nox (g/kWh)	CO (g/kWh)	CH4 (g/kWh)	PM (g/kWh)
Werkendam	Portside	1.3	1.9	5.5	0.02
	Center	1.5	1.9	2.2	0.01
	Starboard	2.0	1.8	1.7	0.02
Somtrans LNG	Portside	1.5	2.6	8.6	0.1
	Starboard	1.6	2.4	7.4	0.1
Argonon	Starboard	0.42	0.00	4.83	0.01

As indicated, it is difficult to make a fair comparison between the vessels, given the differences in vessel characteristics, type of operations, operational profile, etc. Furthermore, the results represent a particular point in time. However, given the results as presented in table 1, it appears that there are both some similarities as well as differences.

CH4 is the emission category in which all vessels emitted the most, whereas PM is the category in which all vessels emitted the least. The vessel Werkendam emitted, on average, the least CH4 emissions during the on-board measurements. This can partly be explained by the fact that the Werkendam is equipped with pure gas engines, whereas the other two vessels have a dual-fuel installation. Pure gas engines perform in general better in terms of CH4 emissions as compared to dual-fuel engines applied in IWT.

The retrofitted vessel Argonon performs considerably well based on the on-board measurement results. This offers prospects for retrofitting existing vessels, certainly because the emission problem mainly applies to the existing fleet.

Table 2 below provides a simplified overview of three emission standards for IWT. This overview focuses on the emission categories as measured during the pilot tests (Nox, CO, CH4, and PM) and applies to the larger power ranges (>300 kW) installed in inland vessels. NRMM Stage V is the current emission standard for new inland vessels and new engines, the successor to the CCR I and II standards.

Table 2: CCR I, II and Stage V emission standards

	Nox (g/kWh)	CO (g/kWh)	CH4 (g/kWh)	PM (g/kWh)
CCR I	9.745	5.0	1.3	0.540
CCR II	6.745	3.5	1.0	0.200

Stage V	1.8	3.5	0.19 / 6.19	0.015

Note: 6.19 g/kWh applies to gas engines

It is relevant to present the limits of the CCR I and II standards since a significant share (~70%) of the European Inland Waterway Transport (IWT) fleet still operates on CCR I and even unregulated (pre-CCR) engines. Only a relatively small part of the fleet sails on CCR II type-approved engines. As regards Stage V, there are currently no engines (>300kW) which are type approved for specific use in IWT.

When both tables are compared to each other, it appears that all three vessels perform significantly well as compared to the CCR I and II standards. The gap would be even larger with vessels sailing on unregulated engines. This is an important finding since a large part of the European fleet still operates with CCR I and unregulated engines. Hence, by using LNG and even more bio-LNG, emissions in IWT can be lowered significantly.

As regards Stage V, the on-board measurement results show that the three vessels were performing either just below or above the Stage V limits during the test.

The measurement results also show that there are differences in the emission performance between engines of the same vessel. There are no clear reasons for this, this may be due to the set-up and the performance could be equalized with some fine-tuning.

3 Fuel consumption and operational costs

Throughout the pilot period, all three vessels saved on fuel consumption as compared to the benchmark, i.e. sailing on 100% diesel fuel. On average, the LNG bunker price was lower last year as compared to the bunker price of diesel. This enabled lower fuel costs in all three cases. Table 3 provides a short overview of the fuel cost savings in a 6-month period:

Table 3: fuel savings in 6-month period

	Fuel savings
Werkendam	€5,506
Somtrans LNG	€20,820
Argonon	€10,000

Fuel savings depend on factors as operating hours and the price difference between LNG and diesel. Depending on the operations and the price gap, savings may lie considerably higher or lower as compared to the figures presented in table 3. The difference in fuel savings between the three vessels can be partly explained. The vessel Werkendam is a crane vessel and is in an idle situation during crane operations. Hence, this vessel consumes significantly less fuel as compared to the other two vessels. The Somtrans LNG on the other hand is the largest vessel among the three vessels and is probably operated the most intensively in terms of sailing hours. This results in more fuel consumption and consequently in larger fuel savings.

As opposed to savings on fuel costs, all three cases also experienced higher operational costs. This was mainly due to significantly longer bunkering times. Bunkering LNG results in extra circumnavigation, longer bunkering time and longer time spent to administrative processes (filling in checklists, planning of bunkering, etc.). In case of the extreme example of the Werkendam, the additional circumnavigation resulted in €8,400 of additional costs throughout the pilot period.

In all three cases, checks executed by class societies and regular maintenance also relatively increased the costs of the LNG installation as compared to the diesel installation.

Taking into account both the savings and additional costs, there was either a slight reduction or increase in the costs throughout a 6-month period. This is presented in table 4 below.

Table 4: overall cost balance

	Overall cost balance
Werkendam	€8,632 increase in costs
Somtrans LNG	€6,060 reduction of costs
Argonon	€10,100 reduction of costs

It should be noted though, that not all possible cost aspects could be taken in to account in this simplified cost balance. Moreover, it remains to be seen how this cost balance will develop throughout the years. For example, an LNG installation should on the long term wear out less as compared to a conventional diesel installation. This should enable future savings on, among others, spare parts and equipment.

4 Conclusion

This report provided a brief evaluation of the pilot test results of the three pilot vessels (Werkendam, Somtrans LNG and Argonon) deployed in the Action “Breakthrough LNG deployment in Inland Waterway Transport”.

The pilot test results indicate that all three vessels perform considerably well in terms of emission performance once compared to the current fleet average. As regards Stage V though, the current emissions standard, on-board measurement results show that the three vessels were performing either just below or above the Stage V limits during the test.

All three vessels saved on fuel costs, other operational costs increased though. This is mainly due to extra costs related to the bunkering operations. The further development of the LNG bunkering infrastructure is necessary to bring down costs related to bunkering LNG.