Introduction

This document describes the results of the tests done with Eco-Cars in two different cities in Poland: Szczecin and Bialystok.

The tests were done using city busses from the local transportation companies. Contacts with the companies responsible are available for reference on request.

The busses we used were MAN City Lion busses and some Solaris. In total more than 30 busses implemented the solution in both cities.

"The goal of this document is to show the benefits of Eco-Cars using only CAN-bus data from the busses and comparing different scenarios"

All the collected data is available upon request and we are open to repeat the same tests at any company with busses or trucks.

Test Equipment

The test equipment consists of two components working sometimes together and sometimes not. The reason to mix the equipment were to rule out any "placebo" effects like in medical studies.

"We wanted to make sure that the Eco-Cars benefits as described below can be demonstrated and shown with and without the electrical Eco-Driving assistant"

The way to secure this conclusion is to compare some busses with Eco-Cars and some without but all of them with the assistant. The results showed that the fuel ionization really makes a difference in the consumption and behavior of the engine. But is clear from our tests that by combining the two components and have them working together will create the maximum benefits.

The two components of the test equipment were: the fuel ionizers for fuel consumption reduction (Eco-Cars), as well as a driver assistant that informs the driver the most efficient use of the engine.

The fuel ionizers: Eco-Cars product is the one taking care of the ionization of the fuel trough physical reaction once in contact with the mineral composition of the device.

This process facilitates the mixing and absorption of oxygen resulting in a better and purer combustion.

The resulting treated fuel is then burned in the engine compartment in

a more efficient manner. This action reduces actual fuel consumption and the engine becomes "more flexible".

This also results in a "more complete burning of the fuel molecules", which reduce the amount of pollutant gases going into the atmosphere.

To achieve the ionization effect, the fuel ionizers are connected in series to the fuel in an amount proportional to the engine size.

The second unit, **the driver assistant**, monitors key engine parameters such as torque, engine speed, frequency of depressing the accelerator pedal, fuel delivery etc. gathering real-time data from CAN-bus.

Based on the developed algorithm the assistant driver creates a visual message indicator to the driver, supported by an acoustic signal at the moment exceeding defined thresholds of parameters considered as economical.

Driving style, in which the vehicle has reached the full torque and the driver presses the accelerator pedal, only results in higher fuel consumption and is considered as uneconomical drive state.

Each time the assistant has been activated by one of those parameters the information is kept in a database so it can be used for analyzing the driving style afterwards in order to compare right information.

"All data used for this document has been gathered in real-time from CAN-bus and therefore can their authenticity be guaranteed"

Benefits

The Installation of Eco-Cars together with the Eco-Driving electronic assistant showed following benefits:

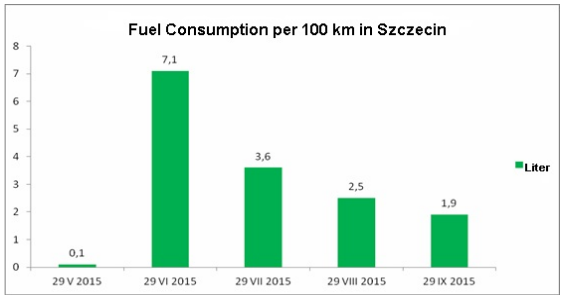
- **Economical** - Huge savings resulting in a fuel consumption reduction in the range of 10 - 18%
- **Ecological** - Large reduction of pollutants due to the fuel consumption reduction, and (to a greater extent of) due to the process of ionized fuel in our devices. Reduction of CO2 emissions, nitrogen oxides and hydrocarbons CH4 NOx by up to 50%.
- **Education** – **Eco Driving**. The electronic assistant recommends the driver on how to drive more economical.
- **Safety** - involving driving patterns while reducing accelerations, engine RPM and speed. This results in a better passenger comfort, less risks of injuries due to sudden maneuvers.
- **Technical** - due to the ionizing effect of the Eco-Cars. The vehicle runs more smoothly and

with greater flexibility, and the engine reaches the required speed in less time. This leads to less wear on the brakes, transmission and other vehicle components.

Tests

In previous tests at other companies we made some unexpected observations. So for this test we wanted to confirm the reason behind them:

1. In the previous tests we observed that after installing Eco-Cars a huge saving in the fuel consumption was observed but more important the drivers told that they could feel like the engine has more power or responded better and faster.
2. After some few weeks the savings achieved were getting lower and lower as if the positive effect of Eco-Cars was being reduced over time.

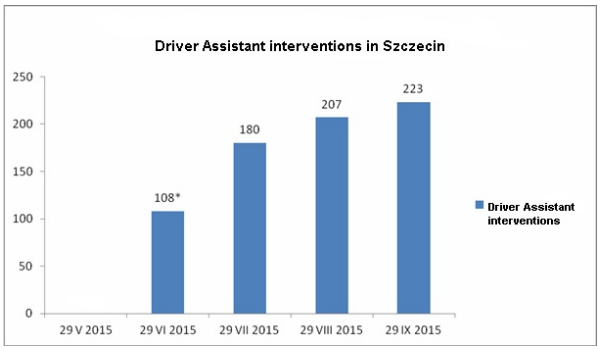


As you can see in the picture the fuel reductions become less and less after installation: going from 7,1 liter/100km to 1,9 liter/10 km. This is a good saving but we couldn't really understand why this happens.

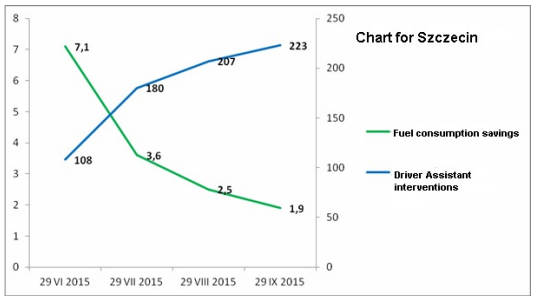
"Our theory: We do believe that the bad driving behavior adapt to the new reaction of the engine after a few weeks"

To show this a Driver assistant was installed and recording the number of times the driver assistant warned the driver before and after installing Eco-Cars. We wanted to see if the number of warnings increased after installing Eco-cars and when the driver adapts to the new behavior of the engine.

As you can see in the following picture the driver assistants shows an increase of the number of warnings over time the bus in Szczecin. This indicates that the driving style was getting worse and more uneconomical over time.

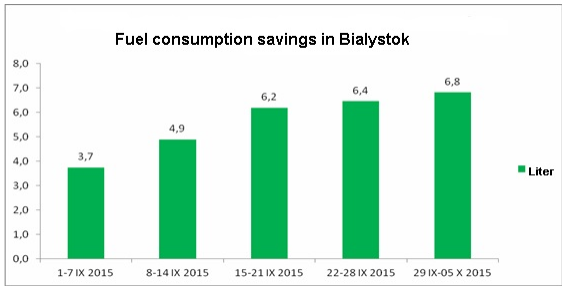


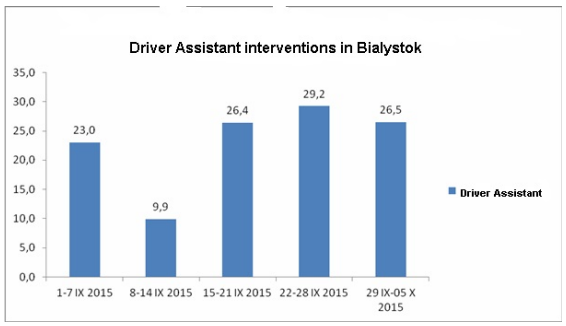
The chart below shows the correlation of the same vehicle between the fuel savings and the Driver Assistant interventions per 100 km. A threefold decline in fuel savings can be seen as a result of a more uneconomical driving style. When the Driver Assistant intervenes more often over the course of the test fuel savings decreases significantly. Despite of this worse driving style the ionization of the fuel by ECO-CARS will give a lower but still a positive fuel savings at 1.9 l/100km



"We can easily say as it has been shown that he uneconomical driving style of the drivers "eats up" the savings achieved by Eco-cars after just a few weeks"

The vehicle in Bialystok on the other hand kept and even improved the fuel consumption savings by strictly following the recommendations given by the Driver assistant and thus getting a more economical driving style achieving fuel savings up to 6.8 l/100km with the Eco-Bus solution.





By combining Eco-Cars and educate the drivers to follow the recommendations of the Driver assistant a better fuels savings can be achieved and maintained.

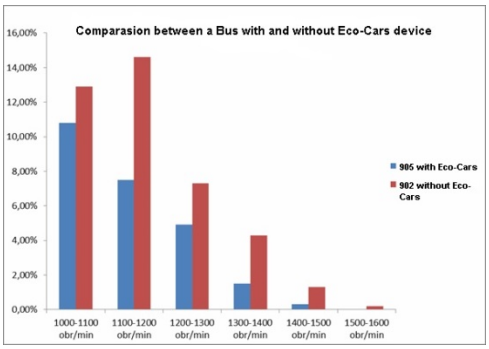
Conclusions

The total driven distance was of 25799 km and the real fuel savings resulted with an average of over 4 l/100

The driving style affects considerable the fuel savings negatively, but despite of this fuel savings was still observed. By combining the Driver assistant together with Eco-Cars the fuel savings is improved further more as in the case of Bialystok.

"The best way to keep the benefits of Eco-Cars is with Eco-Driving and the electronic assistant is a very good way to educate drivers in eco-driving"

Another observation made is how more efficient the engine works at lower RPMs. The following chart is of two MAN buses, belonging to KPKM in Bialystok. Both vehicles are equipped with Driver Assistant, but only one of them has a mounted Eco-Cars. It is shown that the vehicle's engine 905 with Eco-Cars system (blue) runs the test at a lower engine RPM.



The tests continue and currently ECO-BUS is installed in 10 buses belonging to the Municipal Public Transport Company in Bialystok and the savings achieved are in the average range of 4 - 6 liters per 100 km.

"The best way to keep the benefits of Eco-Cars is with Eco-Driving and the electronic assistant is a very good way to educate drivers in eco-driving"