



Two years of electric buses operation in the City Bus Plant (MZA)

New quality on the capital city streets

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Diesel died, long live electricity – announced in 2006 Mr Krzysztof Olszewski, at that time the president and owner of Solaris Bus & Coach. Few persons considered then the words of the biggest Polish bus manufacturer seriously, while it has turned out that they were visionary. Only eleven years later the number of electric buses on Polish roads reached a hundred, and during the nearest years it can exceed even one thousand.

► Streszczenie

Miejskie Zakłady Autobusowe w Warszawie już od roku 2012 prowadzą testy eksploatacyjne autobusów elektrycznych. Jako pierwsze miasto w Polsce wprowadziły do ruchu w roku 2015 większą partię fabrycznie nowego i jednolitego taboru elektrycznego. W artykule opisane zostały doświadczenia warszawskiego przewoźnika z eksploatacji tego typu pojazdów oraz plany związane z rozbudową tego typu taboru.

► **Słowa kluczowe:** elektromobilność, Miejskie Zakłady Autobusowe w Warszawie, ekologia

► Summary

Two years of electric buses operation in the City Bus Plant (MZA)

The City Bus Plant (MZA) in Warsaw have been carrying out operational tests of electric buses already from 2012. As the first city in Poland they have started to operate in 2015 a larger part of brand new and uniform electric buses. The paper describes the experience of the Warsaw carrier from such vehicles operation and the plans related to the expansion of such vehicles.

► **Keywords:** electromobility, City Bus Plant (MZA) in Warsaw, ecology



Electromobility plans of Polish and European cities are to a large extent the consequences of the European Commission White Paper, according to which by 2030 a half of, and after 20 years all the urban transport fleets shall comprise only low- or zero-emission vehicles.

The City Bus Plant (MZA) in Warsaw is now the source of experience for many domestic and foreign partners, because as the first city in Poland in 2015 it started on a larger scale the operation of a big batch of brand new and uniform electric vehicles. That decision was preceded by previous tests of buses equipped with innovative ecological drive types. They were started in 2008, trying in practice bioethanol-driven and hybrid vehicles, later on also supplied with LNG. The purchase of four Solaris Urbino 18 hybrid vehicles, which the company wanted to check during a longer period, was also an element of broadly planned tests.

To begin with – tests

The next stage of ecological activity of MZA consisted of tests of various makes of electric buses, started in 2012. The trials were carried out on various models – of both Polish and foreign manufacturers.

2012 – two-week tests of Polish Solaris Urbino Electric 8,9 bus on line 222 (range with one charging – 100 kilometres).

2013 – two-week tests of twelve-metre long Chinese bus BYD K-9 on line 222 (range with one charging – approx. 250 kilometres).

2013 – tests of AMZ CitySmile 10E bus on line 222.

As you can see all buses were operated on line 222. The point was to obtain reliable results of individual vehicle types operation comparison. Line 222 was selected for tests as a normal line, stopping at each stop, with heavy passenger traffic load, and at the same time passing through the most attractive, from tourist point of view, areas of Warsaw. The insufficient level of vehicles heating under the Polish winter conditions was one of more important conclusions resulting from the carried out tests. In addition, the vehicle



Ursus and Solaris electric buses in the 'Woronicza' depot

On the left

Solaris Urbino 12 electric bus on the Spartańska terminus

heating by means of an electric motor substantially reduced the vehicles range. So a decision was made to apply in the operated electric buses the passenger space heating by means of diesel fuel.

In 2014 an invitation for bids was announced for the delivery of ten twelve-metre long electric buses, which in July 2015 were acquired by the R-1 'Woronicza' Transport Section. Ten SU12E vehicles were delivered by Polish Solaris Bus & Coach manufacturer. Beforehand, during a few months four test BYD K-9 vehicles were operated, stationed in the 'Woronicza' Transport Section and servicing line 222. A few months long tests of electric buses under various weather and traffic conditions (weekdays, holidays, school holidays) were to prepare the technical staff and drivers of the section for permanent operation of a brand new type of vehicles.

The first MZA electric buses

Solaris Urbino 12 Electric are the vehicles delivered in July to Warsaw. The vehicles are equipped with TSA TMF-35-28-4 four-pole asynchronous electric motors of 160 kW power. The vehicle battery capacity is 208 kW. Solaris buses have a standard 2-2-2 door arrangement, typical of MAXI class vehicles operated by the MZA. Together with vehicles the manufacturer delivered chargers with a plug-in connection, produced by the Eko Energetyka company. The power of *plug-in* chargers at quick charging is 70 kW, and at slow (night) charging – 40 kW. During the operation vehicles were additionally equipped with the Schunk system roof pantographs, used for street charging. In July this year at the Spartańska terminus of line 222 the first of planned 19 street chargers was started. Because of that it was possible to charge additionally the line buses at the terminus, without the need for their return to the depot.



Street charging station on the Spartańska terminus

◆ The range of Solaris Urbino 12 Electric assumed by the company is approx. 150 kilometres. Till the time of starting the street charger the vehicle timetables were arranged in such a way, that after travelling approx. 130 kilometres vehicles were returning to the depot to fill in the electricity. That meant an incomplete use of vehicles, assuming that the mileage of all-day teams in Warsaw exceed 250 kilometres. The introduction of a possibility to charge from the pantograph eliminates those inconveniences. During a 20-minute stop at the terminus a vehicle can fill in 20% of its batteries capacity (charging approx. 1% per minute). Even assuming shorter times of possible charging, due to traffic jams and reduced time of stop, the solution allows to keep the vehicle moving all day long. After a change of timetables the buses are used at their full capability.

The vehicle charging at the terminus is simplified to the maximum for the driver. An appropriate approach to the charger is enabled by the guides on the right side of vehicle, and by the kerb on the left. In addition, the driver knows that he must stop the vehicle between two speed humps. After raising the pantograph adapts its position to the charger socket. And after charging the vehicle to the maximum the pantograph automatically lowers down to the bus roof and the driver receives a message about the end of charging. The charger and the pantograph are protected against any inconveniences resulting from the weather conditions (hoarfrost, rain, snow, frost).

In the case of electric buses a number of solutions were applied, which are to protect the vehicle against being excluded from traffic due to the shortage of electricity:

- the state of battery charging in percent displayed on the dashboard;
- possible range of bus in kilometres displayed on the dashboard;

- immediate information about the range decreasing below 25 kilometres;
- after connecting to a charger through the plug-in connection, relevant information is transmitted to the master's or dispatcher's computer and to the chargers service;
- sending remote information about a sudden charging stop to relevant services.

Impressions from the operation

And how the vehicles are perceived by drivers? Can an electric bus create additional difficulties and are special qualifications required to drive electric buses? These questions will be answered by Mr Antoni Mroczek, the manager of 'Woronicza' Transport Section, operating electric buses.

– From a formal point of view to drive an electric bus the same qualifications will be enough, which are required to drive a conventional bus. Driving it practically does not differ from driving a bus equipped with a combustion engine – he says. – Even the driving direction controller is the same, as a controller of an automatic gearbox in a traditional bus. However, the City Bus Plant carries out an additional internal training for drivers, who later on drive such vehicles. The idea is that every driver (irrespective of the fact, whether (s)he drives an electric bus every day) has received such training. The driving of an 'electric' is pleasant for the driver. The electric motor has this feature, that its maximum torque is available 'right now'. There is no need for higher motor rotations. This characteristic makes that the vehicle is more dynamic, which under city conditions is more important than, say, a higher speed, which is not to be obtained in the city. Drivers feel a greater vehicle's weight (increased by the



battery), but the vehicle itself is designed in such a way that the increased weight would not create additional problems. So far no drivers were encountered, who after driving an electric bus would be unwilling to get on it. Sometimes it is just opposite, there are such drivers, who drive 'electrics' permanently.

The information about the operating cost could be extremely important. This is very positive. A high cost of purchase as compared with diesel driven buses can be economically compensated due to extremely low cost of electricity supply. To travel one kilometre the electric bus requires only 1.0-1.1 kWh, which means a few times lower expenses as compared with the purchase of traditional fuel. The simplicity of technical solutions reduces also the cost of daily maintenance.

The next investments in electricity

In September this year the City Bus Plant (MZA) received the next contracted batch of electric buses. This time this is ten CitySmile 12E vehicles, manufactured by the Ursus plant in Lublin. They are driven by electric synchronous Ursus TM4 Sumo HD motors of 170 kW power. The power of lithium batteries is 200 kW, and the assumed vehicle's range is 150 kilometres. Ultimately, after starting the next street chargers at Konwiktorska street, Ursus buses will be servicing line 178. This integrates with the city authorities philosophy, which assumed that by 2020 all lines servicing the Royal Route, that is the most representative area of Warsaw, will be equipped only with electric buses.

Solaris Urbino 18 Electric is another purchase this year, which will service the city centre fast line 503. A three-year lease of such vehicle type will be the preparation to a great contract for deliveries of alto-



Pantograph charging of a Solaris bus

On the left

Plug-in charging stations in the 'Woronicza' depot

gether 130 electric articulated buses, which around 2020 are to be operated and stationed in a new Redutowa depot. The plant will be equipped especially for that with 160 *plug-in* chargers.

The company has already contracted another batch of MAXI class electric buses. Ten vehicles are manufactured by the Solaris Bus & Coach company, and they will appear on Warsaw streets in spring next year. Overall, the company will then have 30 electric vehicles and all of them will be serviced by the 'Woronicza' Transport Section. In this context altogether 30 charging positions have already been prepared, also appropriate investments were carried out to ensure appropriate electricity supply to charge the electric buses.

The experience with the electric buses operation is extremely valuable for many partners from Poland and from abroad. The first 'electric' depot at Woronicza street was already visited by delegations of the global UITP association, and also of urban transport companies and local governments from Lithuania, Albania, France (Paris, RATP), India, Sweden, Denmark, and Finland. In November we expect the next guests, this time from the USA, Republic of South Africa, Chile, and New Zealand. ■



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