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Solaris Urbino 12 LE lite hybrid is one of three buses presented at the Transexpo fair. The two other products are well-known on the market: the Solaris Urbino 12 electric and the Solaris Urbino 12 hybrid. All the buses will debut in new versions, which received an automotive "facelift".

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As an introduction

Dear Readers,

Autumn is, invariably, for our industry a time of exhibitions and specialist conferences. At that time of the year Solaris always tries to present its product novelties which embrace customer expectations. This autumn will be no different in this respect.

We will begin by showcasing, for the first time ever, the 12-metre version of the new generation of Solaris Trollino. Then, a month later, at the Transexpo in Kielce, a completely new addition to our product range will have its premiere: the Solaris Urbino 12 LE lite hybrid. The lighter-than-standard structure of the bus ensures low operating costs for its users. The trained eye of aficionados of our brand will surely notice the new design of that model. At the beginning of 2019, this design will become the standard for all the Urbino and Trollino types of vehicles produced by our company. Apart from an updated look, this design will involve many functional advantages for the users of buses and trolleybuses (for more details see pages 14-19).

Our firm's Research and Development Department is working intensively on new solutions in other areas, too. One of these areas is the management of an electric bus fleet. It is those very buses



that the programme eSConnect of our design was made for; it will enable the remote diagnostics of the Urbino electric model (for more check pages 28-29). Moreover, we have launched a line of dedicated service products, called Optiline, for users of all our vehicles, not only the electric ones. The product line is garnering more and more praise from service workshops and we will certainly expand its range in the future (for more see pages 30-31).

Concluding this issue of the Solaris Magazine, we would like to share news on our activities regarding CSR, i.e. corporate social responsibility,

as CSR is particularly important to us. Since the very establishment of our company, assistance provided to people and animals in need has constituted an important motive of our actions.

Last but not least, you will be able to read about and see for yourself what kind of extraordinary things the fans of our brand are able to create from the love of buses.

I truly hope that these and numerous other features on Solaris' activities will entice you to read this latest edition of our Magazine.

My warmest regards and enjoy the latest edition of our "Solaris Magazine".

Solange Olszewska

Solaris Bus & Coach S.A.



Polska
Publisher: Solaris Bus & Coach S.A., ul. Obornicka 46, Bolechowo-Osiedle, 62-005 Owińska, Poland, tel.: +48 61 6672 333, fax: +48 61 6672 345, e-mail: solarisbus@solarisbus.com, www.solarisbus.com
Editorial staff: Karolina Sarmow, Mateusz Figaszewski, Marcin Napierata, Anna Kozłowska, Maciej Sankowski
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Trollino in Milan

➤ Solaris has sold articulated Trollino 18 trolleybuses to Milan. Signed in May, the framework contract stipulates the supply of 80 vehicles in total. The first of these will be delivered mid-2019. Public transport operator ATM has been offered the option to order another 50 vehicles. The contract value amounts to 61,5 million euro.

The Milanese Trollino 18 will be fitted with two traction motors with a power of 160 kW each. 45 kWh batteries allow the trolleybuses to continue driving for up to 15 km even when they are detached from the traction line. They will ensure e.g. further travel in case of a power supply failure or on route stretches devoid of power lines (for instance



in the historical parts of the city). The trolleybuses can carry up to 135 passengers, 31 seated.

The receipt of 10 Solaris Urbino 12 electric buses was completed in Milan in May. ATM ordered another 15 vehicles. The Polish producer has already supplied nearly 150 buses to Milan. Next year, the articulated Trollino

18 trolleybuses will join that fleet. Even though these will be the first Polish trolleybuses in the capital of Lombardy, there are actually over 80 cruising in Italy, for instance in the cities of Bologna, Cagliari, Naples and Rome. Solaris has been present in Italy since 2003, having supplied over 900 buses and trolleybuses so far.

Urbino electric powers in more Polish cities



➤ More Polish cities have joined the prestigious group of municipalities that have added electric buses to their bus fleets. Following the execution of contracts, environment-friendly Solaris buses will soon arrive in Katowice, Łomianki and Bełchatów.

By the end of this year, the factory located close to Poznań will manufacture five 18-metre Solaris Urbino vehicles for operator PKM Katowice. Thus, Katowice will become the fourth city in Poland (after Cracow, Jaworzno and Warsaw) to have the new-generation articulated electric buses with the green dachshund logo running along the city streets. The buses will be equipped with 116 kWh Solaris High Power batteries and a traction motor with a power of 240 kW; they will allow for both pantograph (reversed version) and plug-in charging. The contract also covers the supply of bus depot ▶

chargers with powers of 40 and 80 kW (the latter ensures full recharge of batteries within 1.5 hours).

The 12-metre version of the Urbino electric was chosen by Łomianki and Bełchatów (2 and 3 vehicles respectively) - for both cities these

➤ The welding facility of Solaris Bus & Coach S.A. in Środa Wielkopolska began operation on 1 April 1998. In the beginning, 5 bodyframes would roll out of the Środa Wielkopolska-based site every month - now, it is 8 bodyframes per day. Back then the production hall of 4,500 square metres accommodated 30 welders; in 2018, the factory has a crew of 360 experts of whom 2/3 have worked for the company for over 10 years, whereas the production process involves a modern machine park.

In the first years, for each bus model, the manufacturer would have to design completely new welding devices which the employees had to make themselves. Next, the company purchased welders, guillotines, press brakes and it kicked off infrastructure investments. At the moment the production process uses a state-of-the-art machine park which consists also of

will be the first vehicles of this type. The newly signed contracts guarantee the delivery of buses within a year from contract signing. All in all, 15 Polish cities have already commissioned electric buses of Solaris; these include Warsaw with 20 Urbino electrics cruising its streets. As of recently,

the buses can also be seen driving across Stalowa Wola (10 x Urbino 8,9 LE). Also Rzeszów is waiting for the delivery of ten twelve-metre ecological vehicles and the complete charging infrastructure.

20 years of the welding facility in Środa Wielkopolska

a welding robot and laser cutting machine for profiles.

In 2013 the company expanded the factory, increasing its floor space to 7,100 square meters. It is also when the specialist work stations for practical vocational training were set up (Solaris collaborates with vocational schools that offer locksmith training). Thanks to this investment the firm was able to provide, for students, workbenches fitted with modern welding machinery. Over the next years the company extended the warehouse, whereas last year it renovated the office building façade.

"We work in several factories, but we are one company. All employees are equally important. We have a common goal and head in one

common direction. We congratulate our co-workers from Środa Wielkopolska on their exceptional jubilee: twenty years of mutual successes. We thank You very much for Your contribution and engagement," said Paweł Kaczalski, Eng. PhD, Vice-president of the Board, in charge of production.

However, this is not the only facility of Solaris in this town in Greater Poland. In June the company bought 9 hectares of land on which its third factory in Środa Wielkopolska will be set up. The decision to launch the factory is the consequence of plans for further development of output capacities. This, in turn, is the result of a rising number of orders, both on the Polish market as well as - or above all else - on export markets.



New contracts in Czech Republic

› The first Solaris buses produced for a foreign customer made it to the Czech Republic in 2000. Today, 18 years later, the firm is executing a large commissions for České Budějovice and other Czech cities, thanks to which the number of buses with the green dachshund logo will exceed 1000 in that country. The contract signed with Dopravní podnik města České Budějovice, a.s., is extremely diversified in terms of the drives applied in the commissioned vehicles.



The city upon the Vltava has ordered 46 vehicles in total, which constitutes nearly half of its existing fleet. České Budějovice and 15 neighbouring municipalities will soon be serviced by brand-new: 5 articulated Urbino 18 CNG, 19 Urbino 12 CNG and, constituting a complete novelty for this operator - 11 Solaris Urbino 8,9 LE electric buses for which Skoda Electric will supply the drive. On the other hand, the 11 ordered articulated Trollino 18 trolleybuses, also to be assembled in collaboration with Skoda, will end up servicing one of eight municipal trolleybus lines of 72 km in total.

Thanks to the implementation of this comprehensive order, Solaris' vehicle fleet in the Czech city has already increased to over 60.

Hamburg goes electric

› Ten electric Solaris Urbino 12 buses will enlarge the fleet of Hamburg public transport operator HOCHBAHN. In line with the agreement two of the commissioned vehicles shall be supplied in autumn this year. The remaining ones will be handed over in September 2019.

The Senate of Hamburg has decided that, as of 2020, all buses bought by local carriers should be electric zero-emission vehicles. Thus the latest order for the battery buses Solaris Urbino 12 electric converges with the city hall's policy and constitutes a milestone on its path to building an eco-friendly bus fleet.

Hamburg inhabitants are well acquainted with the buses fea-

turing the green dachshund logo. At the moment a total of 30 buses produced in Bolechowo, including five electric ones, cruise along the Hamburg streets. The ordered 12-metre vehicles will carry up to 70 passengers, of whom 25 can be seated. The buses will be recharged at the bus depot, using

a plug-in charger. The vehicles shall feature Solaris High Energy batteries boasting a total capacity of 240 kWh. An axle with integrated electric motors will constitute the drive unit. The bus will be fitted with LED lighting, both inside as well as outside.



› Emerging Europe, a London-based think-tank committed to boosting social and economic development of countries in Central and South-Eastern Europe, has awarded Solaris Bus & Coach company prestigious award "Global Market Champion of the Year 2018".

As the organiser of the contest assures, Emerging Europe Awards are awarded so as to give recognition to those enterprises and organizations which contribute to further development of Central and South-Eastern Europe, as a region with outstanding social and economic potential. "If emerging Europe



Photo: Emerging Europe

› The first buses completed under the record-breaking contract for the supply of 150 Solaris Urbino vehicles have reached the capital of Lithuania. To celebrate this occasion, and to highlight the ongoing revolution in public city transport, Vilnius authorities have combined the presentation of the vehicles with a happening - a bus labyrinth was set up in the city centre.

Of the 150 ordered buses, 50 constitute articulated vehicles. It is the biggest contract for a one-off delivery of buses in Lithuania since 1990. In the course of modernising its diesel fleet, municipal operator UAB „Vilniaus viešasis transportas", supplemented the fleet with environment-friendly vehicles – all of the commissioned Solaris bu-

ses meet EURO 6 standards. So far Vilnius inhabitants had the opportunity to ride on the fifteen-metre Trollino trolleybuses and the CNG-version of the Urbino 12. The whole delivery of the first, in the city's



Fot. vilnius.lt

Solaris - Global Market Champion of the Year 2018

is to truly reach its full potential, the region needs strong companies which are not only pre-eminent in their local markets, but are also strong on the international scene, selling or distributing their products to markets across the world", said Richard Stephens, director of the Awards Programme.

Solaris Bus & Coach received a prize in the "category Global Market Champion of the Year 2018"

for its "successful operation and significant influence on the Polish and international scene". When selecting the winner, the jury of the contest took into account such aspects as the employed numbers, the size of business, or the volume of production.

"We are very glad to receive such a prestigious award. We are proud that Solaris is a brand enjoying global recognition and appreciation. The statuette "Global Champion of the Year" is a wonderful confirmation of that fact, placing us in the elite group of top European enterprises, which includes such brands as Amazon or Siemens. This is an exceptional year for our company, which has become the European leader on the market of e-mobility and low- and zero-emission vehicles. In 2017, we exported more than 70% of our total sales", Dariusz Michalak, Vice-CEO of Solaris Bus & Coach S.A. said while accepting the prize

Bus labyrinth in Vilnius

history, Solaris buses with conventional drive is to be completed by the end of this year. In 2018, these will be joined by 41 twelve-metre trolleybuses ordered by the carrier at the beginning of this year.

Direction › E-mobility

Solaris takes things one step further

In April, May and June, Solaris organised a series of conferences for journalists and clients in Cracow and Jaworzno during which guests were shown not only the electric bus fleet with the green dachshund logo but also the infrastructure for charging the vehicles both at the bus depot and the centres of the two cities. The conference organised in cooperation with MPK Kraków i PKM Jaworzno has provided the participants with the opportunity to hear about their experience regarding the operation of electric buses as well as the charging infrastructure.

Since 2011, when the company's first electric bus - the Urbino LE 8,9 electric - had its debut, Solaris has been progressively developing its line of battery buses. At the moment customers may choose from several length options (8.9 m, 12m, 18 to 18.75 metres) and from several charging modes (plug-in, pantograph and fuel cells as range extenders). The Bolechowo producer offers also two types of batteries in its eco-friendly vehicles: the Solaris High Power and Solaris High Energy, as well as two types of power transmission; this can be achieved by means of an

electric axle with integrated motors or a central traction motor. Apart from the broad range of technical solutions from which clients can choose those that match their individual needs best, Solaris has yet another advantage over its competition, namely the experience gathered since the premiere of its Urbino LE 8,9 electric. Solaris has considerable experience in the operation of electric buses, as all of the electric buses built in Bolechowo (over 180 vehicles riding in 36 cities) have jointly covered over 8 million kilometres so far. Importantly though, these ▶





Based on route requirements and taking into account countless factors, such as temperature range in a city, the average speed of a bus or the heating system the bus was equipped with, the Office of Research and Development (BBiR) drafts recommendations regarding, for instance, the charging infrastructure, as well as adjusts the battery size and type for particular bus lines

Solaris offers comprehensive solutions, not only in terms of vehicle production but also when supplying and installing the charging system, as is the case, at the moment, in Brussels and Rzeszów.

► kilometres have been covered in varying weather conditions, ranging from freezing Scandinavia to hot Catalonia. The firm also offers comprehensive solutions, not only in terms of vehicle production but also when supplying and installing the charging system, as is the case, at the moment, in Brussels and Rzeszów. The crowning achievement in electromobility was the Solaris Urbino 12 electric winning the most prestigious award in bus history - the "Bus of the Year 2017" award which, for the first time ever, went to the Polish producer and, also for the first time in history, was granted to an electric bus.

Having such notable achievements, Solaris decided to take a step further and present not only single vehicles but whole electric fleets owned by cities including the charging infrastructure. For that reason, in May and June, the Bolechowo-based producer invited guests to Cracow and Jaworzno: first journalists and foreign customers and then Polish customers to the conference "Direction > E-mobility" which was combined with a display of the electric fleets of both cities. Operators PKM Jaworzno and MPK Kraków are among Europe's leaders in the use of zero-emission buses. There are currently 23 electric

buses in use in Jaworzno, which constitutes 40% of the whole bus fleet of that city. Cracow, in turn, owns 25 electric buses and intends to purchase another 160 vehicles of this type soon. Both municipal carriers also boast a full range of Solaris electric bus models.

The itinerary of all meetings was similar. The conference started with a presentation of existing solutions for electric buses and those in development, as well as announcements of new vehicles. One of the chief issues at hand was the development of batteries and the extension of the driving range.

Solaris is introducing changes to its Solaris High Energy batteries, declaring that as of 2019 the driving range of the bus will reach up to 200 km regardless of the operating conditions. During the conference Michał Piłkuła, Director for Bus Development, also presented the "Feasibility study" feature - yet another solution which Solaris uses to answer customer needs. Based on route requirements and taking into account countless factors, such as temperature range

in a city, the average speed of a bus or the heating system the bus was equipped with, the Office of Research and Development (BBiR) drafts recommendations regarding, for instance, the charging infrastructure, as well as adjusts the battery size and type for particular bus lines. Solaris has already conducted 1500 studies of this type. Another issue addressed during the conference was the heating and air conditioning options available for electric buses, the charging

In order to provide the guests with a comprehensive data pack, representatives of MPK Kraków and PKM Jaworzno have shared their experience in using electric buses and preparing, as well as building, the charging infrastructure. Kazimierz Fudala, Technical Director of MPK Kraków, talked among others about the city's plans for expanding the electric fleet, the costs of power used when driving battery buses and he also shed light on the basic assumptions regarding the construction of charging infrastructure. Next, Danuta Walas, Head of the Infrastructure Department of MPK Kraków, listed measures required to take when creating charging stations for electric buses, informed the audience about necessary investments and permits and particular stages of construction works.

The next item on the agenda were visits to the bus depots in Cracow and Jaworzno. First, the guests were

shown the infrastructure of Cracow-based bus depot Wola Duchacka, where Tomasz Moździerz, Head of the Bus Servicing Station of MPK Kraków, demonstrated details of the station, and then the pantograph charging at Pawia street, where the first pantograph charging station in Cracow was set up. Next, the conference participants had the opportunity to learn more about charging at the bus depot and in the city centre of Jaworzno. The electrification of the PKM Jaworzno fleet and future plans were explained to the audience by Paweł Silbert, mayor of Jaworzno, while Adrian Stupski of PKM Jaworzno presented the management system for the electric bus fleet and the charging infrastructure for those buses. All electric Solaris buses acquired by Cracow and Jaworzno are equipped with a pantograph charging system by means of which batteries can be charged both en route and at the bus depot. In standard issue the vehicles are also fitted with a plug-in connector for

modes for these vehicles and remote diagnostics. The remote diagnostic system offered by Solaris provides a range of benefits for buyers of vehicles made in Bolechowo, because it constitutes an improved use of the fleet and control over the technical condition of particular components. Created for the purpose of supporting maintenance, the system may be installed in every electric vehicle made by Solaris, also those already delivered to customers; in fact, some of these have already decided to apply the pilot scheme to their fleets (see pages 28-29 for more details). At the end of the event the organiser presented design concepts for three new vehicles - the bi-articulated trolleybus Trollino 24, the light low-entry Urbino 12 LE lite hybrid and the zero-emission Urbino 12 hydrogen bus (see pages 26-27 for more details on this model).

overnight charging of the battery using a stationary charger located at the bus depot. The participants of the event were also offered a ride onboard of the battery buses of both operators, so as to witness the bus charging process for themselves, both at the bus depot and in the city centre.

Thanks to the conference "Direction > E-mobility" both journalists and customers learned more about the experience with electromobility based on the examples of two cities with completely different needs and city transport systems. For Solaris, on the other hand, the event provided an opportunity to show a comprehensive offer regarding both electric vehicles and the charging infrastructure.

8 million kilometers of Solaris electric buses

Benefits of using electric buses

- Lower operating costs** - electric power is cheaper than diesel
- High efficiency of electric drive**
- Zero emissions** at the place of the use of the vehicle
- Lower noise level**



Our first electric bus was presented in **2011**.

Since 2011 we have produced **183 Urbino electric buses**.

They have already covered a total distance of **8 million kilometres**.

This number corresponds to **200** zero-emission travels around the world.

Where can you travel Solaris electric buses?

- | | | | |
|--------------|------------|----------------|--------------|
| Klagenfurt | Inowroclaw | Nürnberg | Lahr |
| Plzen | Jaworzno | Sète | Bergamo |
| Braunschweig | Cracow | Bergamo | Milan |
| Düsseldorf | Ostrołęka | Oslo | Kristiansand |
| Vasteras | Warsaw | Ostrów Wlkp. | Chodzież |
| Berlin | Třinec | Września | Katowice |
| Dresden | Hamburg | Nove Zamky | Sosnowiec |
| Oberhausen | Hannover | Brussels | Cluj-Napoca |
| Barcelona | Tampere | Cz. Budejovice | Ystad |
| | Heidenheim | Fürth | |

COMMON DIRECTION >

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TRANSEXPO 2018 - Kielce

Solaris

in a new design

Solaris **Urbino 12 LE lite hybrid** is one of three buses presented at the Transexpo fair in Kielce. The two other products are well-known on the market: the Solaris Urbino 12 electric and the Solaris **Urbino 12 hybrid**. All the buses will debut in new versions, which received an automotive “facelift”. Starting from 2019 a new design will become a standard in all Solaris vehicles from Urbino and Trollino family.





„The new Solaris Urbino 12 LE lite hybrid is specifically for bus operators who see high value in low fuel emission with preservation of as much comfort as possible for passengers and drivers. Our clients receive the quality and durability guarantee to which the Solaris brand obliges”



Zbigniew Palenica

Deputy CEO of Solaris Bus & Coach S.A. responsible for Rolling Stock and Sales

The “low-calorie” name of the vehicle refers to its biggest advantage: low fuel consumption reducing the costs of exploitation in comparison to similar products available on the market. The main objective of the engineers of the Solaris Research and Development Office who developed the Urbino lite hybrid was to create a bus, which would consume less than 30 litres of fuel per 100 km in the SORT 2 test.

The engineering work was focused on multiple areas in order to accomplish the above, but one of the main factors was reduction of the vehicle’s weight. The curb weight of the Solaris Urbino 12 LE lite hybrid is under 9 tonnes and its weight with passengers is 15 tonnes.

The heart of the drive system in the new Urbino model is the Cummins ISBE6 engine with the capacity of only 4.5 litres. The unit, which fulfils the restrictive EURO 6 exhaust emission standard, has 210 HP and torque of 850 Nm. The drive system of the Urbino LE lite hybrid is also equipped with an electrical machine with nominal power of 11.5 kW, which is tasked with recuperating energy during the braking process and supporting the combustion engine when the vehicle starts moving, which consequentially leads to it consuming less fuel.

“The new Solaris Urbino 12 LE lite hybrid is specifically for bus operators who see high value in low fuel emission with preservation of as much comfort as possible for

passengers and drivers. Our clients receive the quality and durability guarantee to which the Solaris brand obliges,” said Zbigniew Palenica, Vice President of Solaris in charge of Sales, Marketing, After Sales, and the Department of Rail Vehicles.

The Solaris Urbino 12 LE lite hybrid will be available in version with two door in the 2-2-0 arrangement. The bus will be able to take up to 85 passengers, 41 of them seated. The front axle of the vehicle is provided by ZF RL55 and the drive axle is DANA type G150. The size of the wheels used in the vehicle differs from the standard solutions applied in Solaris city buses. This vehicle will be equipped with wheels of a smaller diameter: 19.5 inches. The wheelbase of the Solaris Urbino LE lite hybrid is 5900 mm with front overhang of 2550 mm and rear overhang of 3240 mm.

Despite having a “slimmed-down” build and several new components, the Solaris Urbino 12 LE lite hybrid, is uncompromising when it comes to the safety and comfort of both the passengers and the drivers, which is true for all Solaris products. The safety standards fulfilled by the vehicle include those specified in provisions R29 and R66. Urbino lite in hybrid version will be available for customers as soon as next year.



**Urbino 12 LE
lite hybrid**

Solaris Urbino 12 electric



Solaris Urbino 12 hybrid



Dariusz Michalak, PhD, Eng

Deputy CEO of Solaris Bus & Coach S.A. responsible for in charge of Research and Development and Quality Assurance

„The facelift is evolutionary and optimises the current solutions. We are certain that we have discovered the right combination of style and function to increase the attractiveness and pleasure from using our vehicles even more”

The Solaris Urbino 12 LE lite hybrid will be accompanied at the Transexpo fair by two other buses: the Solaris Urbino 12 electric and the Solaris Urbino 12 hybrid with serial hybrid system, which are already well-known on the market but will debut with a new design, which will become the standard for all Urbino and Trollino city vehicles as of January 2019.

The current generation of Solaris city buses debuted in 2014. Over the past four years on the market, these buses have gained tremendous recognition, which is evidenced in awards like the prestigious 2017 “Bus of The Year” for the Solaris Urbino 12 electric.

“The endless changes on the automotive market, specifically the ones in the field of buses, force continuous development

of new products in order to meet the growing expectations of our clients: drivers, passengers, and buyers of the vehicles we design and make. Due to the above, we are currently introducing further improvements in Solaris city buses, four years after releasing the current generation to the market. The facelift is evolutionary and optimises the current solutions. We are certain that we have discovered the right combination of style and function to increase the attractiveness and pleasure from using our vehicles even more,” explains Dariusz Michalak, PhD, Eng, Vice President of the Solaris Management Board in charge of Research and Development, and Quality Assurance.

Apart from the designer conditions, the changes in the external appearance of the Urbino also

have a pragmatic side as they were correlated with work on the Solaris Urbino LE lite hybrid. Consequentially, starting from January of 2019 all new Solaris vehicles will have a coherent look.

“Just like our clients have grown to love the new Solaris Urbino generation, I am sure that they will be fond of the designing changes in the presented buses. They will definitely be appreciated by the drivers, who will have an even more comfortable workplace, and the passengers, who will have the opportunity to take an even more innovative vehicle and thus be more willing to take public transit,” says Zbigniew Palenica, Vice President of the Solaris Management Board.

› **The new shape of the roof covers** means easier installation, maintenance, and discharge of water from the bus roof

› **The new design of the front of the bus** provides the driver with greater visibility

› **The new shape of the front wall** makes the bus more aerodynamic

› **The visibility of the front destination sign for passengers is improved**

› **New front light system composed in 100% of LED technology** instead of the previous 5 reflectors, all lights (low beam, high beam, fog, running, and turn signals) are now replaced with 3 reflectors





Direction > no emissions

This year's Solaris vehicle premieres focus on zero emission vehicles. The InnoTrans trade fair in Berlin (18-21 September) is a stage to the premiere of the new **Trollino 12 trolleybus** and the **electric Urbino 12** with the latest solutions in e-mobility.

Solaris Trollino 12

Solaris has been offering its customers low-noise and environment-friendly trolleybuses for nearly twenty years. In this time the Polish producer has turned into one of the biggest suppliers in the EU. The InnoTrans 2018 trade fair will see the début of the Solaris Trollino 12 in a new design. All solutions that make up the force and innovation of the new Solaris have been combined with the established and popular construction of the Trollino trolleybus. Therefore, just like other vehicles of the Urbino family, they contain:

- a lighter and more rigid, but equally durable body frame, made of material extremely resistant to corrosion;
- a reduced vehicle weight as a result of the shaping and location of steel components;
- joints reinforcing the area where vertical profiles of the body frame come into contact with the horizontal ones and which braces the metal floor plate structure. Owing to this new solution, the trolleybus floor is not only more durable but also better protected against weathering.

At the moment the product range of Solaris encompasses three models of the Trollino family. These are the 12-metre Trollino, the 18-metre articulated Trollino and the 24-metre bi-articulated Trollino 24. All are based on the so-called new generation chassis. The 12-metre Trollino is propelled by one electric motor, boasting a power of 160 kW to 175 kW (depending on the producer and customer requirements). The 18-metre Trollino can be powered by one or two electric engines. When the single engine option is

chosen, the engine is installed on the left side before the second axle. Depending on the manufacturer the vehicle will feature an engine with a power rating between 240 and 251 kW. When two engines are used, depending on which manufacturer is chosen, the vehicle will feature 160 to 175 kW engines. The 24-metre Trollino is powered by two electric engines of 160 kW each.

Regardless of the length of the vehicle, the maximum speed of the trolleybus will be 70 km/h. The vehicles are equipped with air conditioning with an electric 3 x 400 V compressor. The trolleybuses are heated electrically, using an electric boiler, similarly to what is used in battery buses of the Urbino electric family. An option available for the vehicle is fitting it with traction batteries that facilitate zero-emission driving without a connection to traction wires. The Polish producer offers energy storage in the form of Solaris High Power batteries with a capacity tailored to customer requirements. The traction batteries can be charged in two ways: first by collecting current from the overhead line in motion, i.e. in-motion-charging. In this case electricity accumulated in the batteries is derived through a current collector from an overhead line. The second mode available is the plug-in charging known from Urbino electric buses, which allows for the recharging of a battery while the vehicle is parked at the depot. Another means of providing energy for the vehicle beyond the traction line is the installation of hydrogen fuel cells.

The Solaris Trollino 12 presented in Berlin is one of 14 trolleybuses of standard length commissioned in 2018 by the City Hall of Gdynia. It is equipped with a 175 kW engine and 58 kWh batteries. The air-conditioned interior of the trolleybus accommodates 30 passenger seats. A separate air conditioning caters for the driver's needs. A CCTV cameras recording the vehicle's interior, as well as

what is in front and behind it, has been installed to improve safety. A separate camera has been dedicated for a continuous monitoring of the pantograph. All of the lighting is made in LED technology. Four double USB charging ports are available to passengers.

Solaris presented its first trolleybus in 2001. Since then it has delivered

over 1200 vehicles of this type to customers in sixteen countries. Solaris trolleybuses can be encountered in nearly 50 cities all across Europe, for instance in Bologna, Budapest, Esslingen, Gdynia, Ostrava, Pilzno, Riga, Rome, Salzburg, Sofia, Tallinn, Tychy or Vilnius.

e-mobility, based on customer requirements and a range of input data, such as: the temperature range in a given city, average speed, the topography of the area the bus line will serve, the number of stops, the passenger streams, the timetables and many other.

The outcome of the feasibility study will be a report listing recommendations of the best technical solutions with regard to electric buses. The study takes into consideration such factors as the place of operation of the electric bus and the carrier's requirements. In practice, this means the document will name among others the size and type of batteries, the recommended charging infrastructure, predicted energy use and the battery service life. By sharing best practices and its know-how Solaris supports municipal transport operators in their efforts to develop electromobility.

The drive unit of the Solaris Urbino 12 electric presented at the InnoTrans fair is an electric drive axle with two 125 kW integrated electric engines. The energy needed to propel those is stored in Solaris High Power batteries with a total capacity of 240 kWh. The vehicle is recharged by means of a 40 kW charger. It is one of five electric buses ordered by the operator from Frankfurt/Main.

Apart from many technological novelties applied to the drive construction of the buses for Frankfurt, the Bolechowo-based manufacturer has also used numerous solutions aimed at improving the comfort and safety of passengers on board the vehicle. The Solaris Urbino 12 electric vehicles are being fitted among others with an efficient air conditioning system regulating the temperature of the whole vehicle, as well as energy-saving LED lighting

of the interior and a comprehensive passenger information system comprising 3 LCD screens. The producer has also installed USB ports which will enable passengers to recharge their mobile devices mid-ride. Interestingly, these ports are located at each row of seats. The vehicles for In Der City Bus GmbH from Frankfurt also provide access to wireless Internet using Wi-Fi technology. The electric bus of Solaris to be used in Frankfurt will be able to carry up to 70 passengers at a time, 28 of whom travel seated. Two additional folding seats have been installed in the space reserved for wheelchair-bound disabled persons and prams or pushchairs.

Solaris Urbino 12 electric

In barely seven years since the première of its first electric bus Solaris has supplied to or secured orders for over 330 such vehicles from customers in fourteen countries. At the InnoTrans 2018 trade fair the Polish producer is showing zero-emission vehicles

that draw from the experience of over 8 million kilometres (read more about Remote diagnostics on page 28).

To most municipalities and transport operators, electric drives represent a novel solution. At the

request of the interested party, and in order to help them prepare for the electrification of bus lines, Solaris can draft an individual feasibility study. The Office of Research and Development of the Polish manufacturer will devise the optimal solution in terms of



A future fuelled with hydrogen

product novelty of Solaris

The group of Solaris vehicles with alternative drives will be extended by the Solaris Urbino 12 hydrogen, a new generation vehicle fuelled with hydrogen energy. The official première is slated for 2019.



Undoubtedly, the following years on the European market will belong to public transport vehicles with alternative drivelines. According to a study commissioned by UITP, in 2030 buses with diesel engines will be a minority. Apart from electric, hybrid or bio-gas-fuelled vehicles, hydrogen buses will attract an increasing interest. As the lead producer of zero-emission vehicles in Europe, Solaris is prepared for this need and it has teased the début of yet another green bus.

It is worth noting that the Bolechowo-based producer has already gathered experience regarding the production of hydrogen buses. The new generation Solaris Urbino 12 hydrogen constitutes the continuation and extension of a concept which first came to light in 2014, when two articulated electric buses (Solaris Urbino 18,75) powered with hydrogen fuel cells as range extenders, were delivered to Hamburg. Energy needed to power the vehicle will be derived from hydrogen which, in turn, will be converted into electric power in a fuel cell. The battery will only serve as an auxiliary power source.

Thanks to the technology used in the hydrogen buses, (of all the firm's electric buses) these will be able to cover a record-long distance on a single refuelling – over 350 km. The vehicle will be also fitted with one of Solaris' small High Power

traction battery of 29.2 kWh which is to support the fuel cell when the demand for energy is biggest. The battery will be charged with hydrogen energy. In addition, it will be possible to recharge it by means of a plug-in charging outlet (as is the case in standard electric buses). On the other hand, an axle with integrated electric motors, with a nominal power of 60 kW each, will constitute the drive unit.

This is not the only state-of-the-art solution available in the new vehicle. The twelve-metre Solaris Urbino hydrogen will be equipped with cutting-edge fuel cells of the latest generation, boasting a power of 60 kW. The producer is using also the latest hydrogen storing technologies, by installing hydrogen tanks made of composites on the vehicle roof – thanks to this step the mass of the tanks will be reduced by about 20% compared to previous models. In order to optimally reduce energy use in the vehicle, it will feature a climate comfort system with a CO₂ heat pump; the system will allow to use waste heat from the fuel cell. This is a completely novel proposition that is to guarantee extraordinary efficiency while significantly improving the driving range of the bus.

“The revolution in terms of green public transport has become a fact. Hydrogen buses have the potential

to be very popular on the market: they are cheap in use, lighter than electric buses, can cover a distance of 350 km on a single hydrogen refuelling (that is also the average daily range of a city bus) and they are completely emission-free – the only substance emitted while the bus is driving is steam,” declares Dariusz Michalak, vice-CEO of Solaris Bus & Coach, in charge of the research and development division.

It appears that the market of hydrogen buses will develop dynamically. According to the authors of the “Fuel Cell Technology Market Research Report – Global Forecast to 2024”, Europe is one of the fastest developing regions of the fuel cell technology market. The EU is carrying on with its emission reduction plan (over 80% by 2050) and it is devoting substantial financial resources for this purpose. The authors of the report anticipate that, in the long term, hydrogen buses will constitute a tempting alternative for other zero-emission drivelines. An improved operating efficiency will plead in their favour: at driving ranges spanning 300-450 kilometres and refuelling times of less than 10 minutes and with no en-route infrastructure requirements, hydrogen buses may be operated just like conventional diesel engine buses, while at the same time they offer all the advantages of electric vehicles (including low noise emission and vibration level).



Dariusz Michalak, PhD, Eng

Deputy CEO of Solaris Bus & Coach S.A. responsible for Research and Development and Quality Assurance

„The revolution in terms of green public transport has become a fact. Hydrogen buses have the potential to be very popular on the market: they are cheap in use, lighter than electric buses, can cover a distance of 350 km on a single hydrogen refuelling (that is also the average daily range of a city bus) and they are completely emission-free – the only substance emitted while the bus is driving is steam”

Remote diagnostics of electric buses

The engineers from the Research and Development Department of Solaris Bus & Coach has created a system to streamline and support diagnostic solutions, improve maintenance options and to facilitate the analysis of specialist data derived from vehicles produced in Bolechowo. Vehicles fitted with a remote diagnostic system called **eSConnect** will enable the producer to establish a database of real performance information that will make it possible to perfect solutions applied by the manufacturer.

Created for the purpose of supporting maintenance, the eSConnect system may be installed in every electric vehicle made by Solaris, also those already delivered to customers; in fact, some of these have already decided to apply the pilot scheme to their fleets. Most importantly though, the remote eSConnect system gives customers the opportunity to work with basic information that allow to optimise fleet usage. It will also enable the Polish producer - a European leader in the production of electric vehicles - to further refine its vehicle designs which have already

garnered the firm a major award - the title of city bus of the year 2017.

The data thus collected include among others information on the bus fleet position in terms of time and location, updated battery status, the mileage covered by any given bus in a given time, energy use or even notifications about all batteries being fully charged. The eSConnect will help in the remote identification of potential errors notified by the vehicle on the driver's panel, the monitoring of operating parameters of the system and the generation of statistics, for

instance the number of charging cycles and the time needed to recharge batteries.

The eSConnect system proposed by Solaris entails quite a few advantages for its customers. For the buyers of vehicles from Bolechowo the system means a better use of the vehicle fleet and a confirmation of a bus being properly managed by the drivers. What is more, it gives clients the possibility to collect and analyse data that simplify a precise identification of technical requirement for buses serving on particular routes.



Optiline

Genuine Solaris Parts

One of the features distinguishing the firm and its vehicles is the flexible adjustment to customer expectations. Each vehicle that has left the Bolechowo-based factory is unique in its own way. Therefore it requires adequately tailored servicing. In response to this need the company has designed its own line of spare parts which fully relates to the unique usage conditions.

On average, each city bus of Solaris covers up to 100,000 kilometres per year. In that time the bus brakes and accelerates millions of times. Such intense usage makes the time between vehicle planned inspections go by quickly. How then should one choose consumables in order to ensure the effective use of the bus? The customisation of consumables directly affects further vehicle operation. Of the wide array of parts available on the market one ought to choose those that are not only easy to install but also ensure highest efficiency and quality.

Buses of the Urbino family are equipped with a range of components generally available on the market. However, it is their unique configuration that defines the singular character of the vehicles and their use. **Based on long-standing experience in after-sales, the Solaris designer team has devised the component line Optiline which fully corresponds to the particular features of vehicles of the Urbino family.**

These products represent not only the same high quality as those originally installed in the vehicle, but they also guarantee the highest efficiency, thus ensuring quantifiable benefits in the course of vehicle operation.

The quality of components has a tremendous significance in the context of road safety. It is particularly important in the case of the brake system. Thanks to the unique mix of friction material used in Optiline brake pads it was possible to achieve a reliable braking effect, confirmed by numerous tests. Optiline brake pads scored best in all conditions, in terms of braking distance and smooth stops of the vehicle. Maximum safety goes also hand in hand with the durability of brake pads. This has been appreciated by customers from all across Europe, including carrier MPK Wrocław. – „The Optiline brake pads are installed in practically all Solaris buses in our bus fleet. At the moment the highest kilometre reading recorded for these buses

is 125,000 km and they are still in use. For us, this is the best proof of highest quality,” ensures Piotr Urbaczewski, Technical Director of MPK Wrocław.

Optiline brake pads are fully compatible with other elements of the brake system and their ideal customisation helps to avoid wear and tear of the brake disks, too. The whole construction was devised in such a way as to minimise material tension, which, in return, reduces the risk of surface cracks. All pollution generated during the use of the vehicle is discharged outside of the brake system through diagonal edges of the brake pad. Thanks to this solution, the surface has an even wear pattern and damage to the disc can be avoided. Next to brake pads, the Optiline product line encompasses also engine filters and air conditioning. The filtering material used therein was selected taking into account the specific features of oil and fuel flows and the circulation of air in Solaris Urbino vehicles. Thus, it is possible to stop the entry of

all kinds of pollution which could result in serious, and expensive to mend, failures of the driveline and air conditioning system. Filter material is placed in casings and reinforcements perfectly matched to the vehicle design solutions. This ensures an optimal degree of imperviousness, preventing dust and humidity from permeating into the vehicle interior. “I have worked at the Solaris’ bus repair shop for 18 years, so I know our vehicles inside

out. I have to admit that every time I install Optiline filters I can see that, in terms of quality, they are just as good as the factory-fitted ones. What is more, their installation is simple because they are made to ideally match the vehicle design,” relates Przemysław Kiszka, Foreman in the Solaris Central Service Workshop.

Ever since their market launch, Solaris Optiline products have

travelled to dozens of customers of the firm in all of Europe and the producer receives new orders on a regular basis. The product range encompasses filters and brake pads, though this is only the beginning of a brand which is gradually developing.

Optiline parts have already been chosen by nearly **100 customers** all across Europe and beyond it; in the meantime the producer is regularly receiving new orders.



One of a kind Solaris electric bus for **blood donation**

Unique on a global scale, fuelled with electric power, and designed as a blood donation station, the Solaris Urbino 8,9 LE electric is the latest model in Solaris' line of special purpose vehicles. It is the first of two vehicles of this type, ordered by the Regional Blood Donation Centre (RCKiK) in Katowice.

On the outside, the Solaris Urbino 8,9 LE electric resembles a standard bus, however, it has hardly anything in common with a classic public transport vehicle. The bus was adapted to the purpose of blood donation and storage. In line with the requests of RCKiK in Katowice, the manufacturer has equipped the bus with two specialist mobile blood donor lounges, a doctor's surgery, a reception area as well as a small catering area. What is more, the vehicles are also fitted with, among others, shutters and external awnings as well as an LED-technology lighting. Thanks to its air-conditioned passenger compartment, Wi-Fi access and USB ports installed near the lounges, anyone willing will be able to donate blood in a comfortable setting.

The worldwide first electric bloodmobile was designed and built in a way that allows to run blood donation campaigns without any trouble in city centres, shopping malls, sports halls, i.e. in venues where conventionally fuelled vehicles intended for blood donation, i.e. those with combustion engines, cannot be used. Boasting an electric drive of 160 kW and

batteries with a capacity of 160 kWh, the bus ensures a fully emission-free operation mode when using heating or air-conditioning, as well when all devices on-board are working.

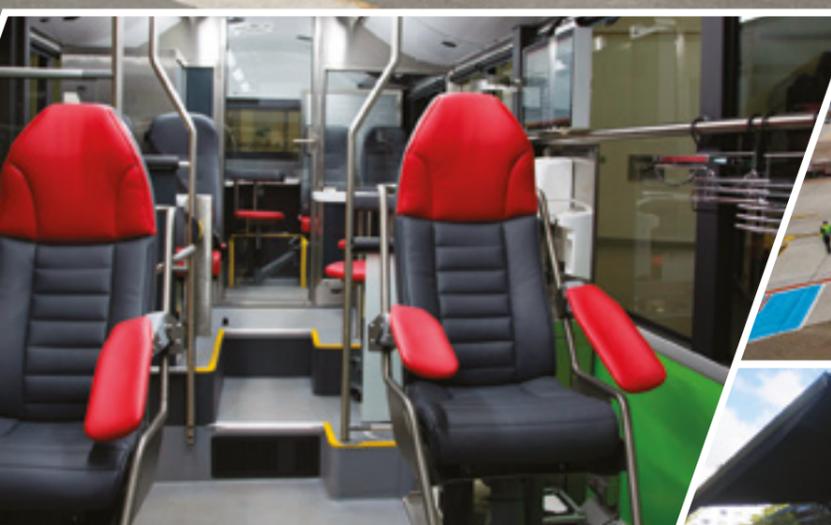
The less-than-nine-metre long Solaris Urbino electric made in Bolechowo meets all standards and regulations applicable to blood donation centres, but it also enables the remote transmission of data to the Blood Bank computer system. It is among others those very features that convinced the jury of the International Invention and Innovation Show INTARG 2018 to honor the producer of the bus with an award. The makers have also filed a patent application for the design of the electric ambulance for blood donation with the Patent Office, which is now being verified

Custom-built buses are our speciality

The history of co-operation between Solaris and the Regional Blood Donation and Hemotherapy Centre in Katowice dates back 20 years. The first special purpose vehicle made in Bolechowo – a mobile blood donation station,

built on the basis of the Vacanza model coach – left the factory gate in 1996. However, bloodmobiles are not the only exceptional vehicles produced in Bolechowo; in fact, the company's special bus portfolio is quite diversified.

Apart from vehicles commissioned by the fire service, driving instruction centres or a mobile beauty parlour, one of the most popular special purpose models are airport buses based on the design of the Urbino or the Urbino LE. These can be found among others in Madrid, Paris, Düsseldorf, Warsaw or Poznań. In 2016, Solaris even created a ... mobile film studio, commissioned by the Polish Film Institute (PISF). Based on the InterUrbino model, the vehicle can be used to serve at filming locations, as it even offers space for director previews and make-up stations, it allows to assemble, archive material and do basic editing work on the film as well as sound production for the finished picture. The tent that comes with the bus provides space for screenings and lectures (and doubles as a small blue-screen studio), which allows to present and promote the films created in this bus.



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CSR

Nowadays activities pertaining to corporate social responsibility constitute an inherent part of the strategy of every larger company, serving as an evidence of its maturity and its focus on things other than profit alone, namely on sustainable development. For Solaris, CSR is an inseparable part of its corporate philosophy, ingrained in its DNA and defining its operation in times when CSR-related activities were not commonly practiced in Poland yet. Below you will find a list of endeavours, defined in line with the 7 areas under norm PN-ISO-26000 that sets out standards for CSR.



ORGANIZATIONAL GOVERNANCE

Promoting participation of employees of all levels in corporate activities - "I Have an Idea"

In 2007 we created the programme "I Have an Idea" at Solaris; it promotes employee involvement in in-house efficiency-raising plans. Nearly 3500 ideas were submitted in the course of this programme. The implemented ideas generate benefits for the firm and the staff alike because every time a motioned improvement results in savings for Solaris, we share the profits with the author of the idea.

HUMAN RIGHTS

Discrimination and particularly vulnerable groups - mobilisation of women

In Poland, good practices regarding this aspect of life should result from, for instance, the need to counteract all kinds of discrimination or to enhance the protection of employee rights. At the moment we are running a campaign online, in the local press and the local job centre, looking for female workers for the position of welder in our factory in Środa Wielkopolska.

FAIR OPERATING PRACTICES

Ethical treatment of stakeholders - "Code of Good Practices"

Each employer of our firm is obliged to comply with the Code of Good Practices - a document created for in-house use. In line with the Code of Good Practices we commit, among others, to observing the law, ethical standards binding in countries where we do business, competition laws and also to caring for the quality of our products.

THE ENVIRONMENT

Waste management - Recycling

In 2017, 75% of waste produced in the course of our production process was recycled, whereas the remaining 25% was processed into alternative fuel. Hence, none of the waste generated by Solaris ended up on a landfill!

CONSUMER ISSUES

Customer satisfaction survey

The objective of the survey is to improve the company performance and to eliminate critical events in each of the four areas of customer care: purchases, transfer, vehicle usage and spare parts. The survey from last year covered 62 firms in Poland and indicated a high degree of customer satisfaction with Solaris, since the individual customer satisfaction index came to 77%.

Awards won in 2018

Our efforts have not gone unnoticed and thus, in May 2018, they won the company the **Silver Leaf of CSR** awarded by weekly Polityka. A month later the Solaris initiative "At the Green Dachshund" was awarded the **Ace of Responsible Business** prize.

COMMUNITY INVOLVEMENT AND DEVELOPMENT

"Green Dachshund Foundation"

In 2012 Solaris established the Green Dachshund Foundation - for the rescue of the defenceless, which supports employees of Solaris, inhabitants of the Greater Poland province as well as organisations providing emergency assistance. The foundation's agenda also includes aiding animals.

Road safety - Programme "Safe Driver"

In order to improve safety for all road users, Solaris has devised a training programme dedicated to drivers of city buses and named it "Safe Driver". Over 1000 people have so far completed the driver training programme launched by Solaris in 2005.

Collaboration with schools and universities - Vocational School Training and Dual Study System

Solaris is one of the first firms in Poland which, as early as 2007, committed to the cause of vocational training in collaboration with schools in the province of Greater Poland. Encouraged by the positive effects of that programme, we have extended the dual education project establishing a co-operation with the Technical University of Poznań. Not only does the project give young people a great professional head start, but it also supports local education and constitutes an investment in the local labour market.

LABOUR PRACTICES

Employee trainings

2 132 212,58 PLN - that is how much Solaris spent in 2017 so that our employees could receive licences to carry out works on gas installations and welding work, category D driving licences, attend technical trainings, language courses, conferences and seminars. In 2017 we also carried out a training programme of our own design, titled "The Power of Knowledge" addressed to managers of all levels in our company - starting with foremen and ending with top level managers.

Parent-friendly firm - Nursery

In 2012 Solaris created company's nursery "At the Green Dachshund". The mission of the nursery is to create a unique space that ensures the safety and versatile development of the company employees' children, and which, thanks to its location close to the company's headquarters, allows parents to visit children even during breaks at work.

Employee volunteering

Volunteers - Employees of Solaris got involved in a Poland-wide innovative project titled "My Own Place". Its objective is to turn the dwellings of senior citizens who live in public nursing homes, into rooms that are cosy and give a home-like feeling.



SOLARIS

DIRECTION

CSR >

Socially responsible

www.solarisbus.com

According to 7 areas defined in PN-ISO 26000

PURSUING ONE'S PASSION FOR BUSES

▶ “The Solaris Urbino made of LEGO bricks is the result of a slightly less than a year’s work. It was conceived of a passion for LEGO and fascination with Solaris buses. The construction of the bodyframe and the chassis were simple compared to the reconstruction of the design or of the door arrangement. With a lot of effort I managed to not only recreate the shape of the vehicle but also many details, such as: the engine, an opening roof hatch and the fuel filler neck. Consequently I built a model that is 320 mm long, 70 mm wide and 75 mm tall. The Urbino accommodates 8 seated and 11 standing passengers, though the standing space can be reduced making room for a bike. Apart from this, the bus also contains ticket validating machines and a driver’s compartment, separated with a door from the passenger compartment.”

▶ **Mateusz Brodowiak**, employee of Solaris Bus & Coach S.A.

▼ “My interests in transport date back to pre-school years in my home town of Scarborough, the largest seaside resort on the Yorkshire coast and a favourite of Queen Victoria. My Granddad would take me for walks around the town, encouraging my interest in transport in general and buses in particular.”

▶ **Phillip Barlow**, Yorkshire Solaris fan

It turns out that Urbino vehicles are assembled not only in the factory near Poznań. A bipolar transmission, opening doors, a pneumatic kneeling function or even 7 working engines - fans of the bus industry prove that there is no limit to creativity and bus models can be built even from... LEGO bricks.

▼ „The completion of the remote-controlled bus model at a scale of 1:15 took about 8 months. The bus consists of a bipolar transmission, opening doors, a realistic suspension, pneumatic kneeling function and 7 engines. It consists of over 5000 parts and weighs over 5 kg.”

▶ **Michał Wolski**, employee of Solaris Bus & Coach S.A.





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