Customer Magazine

SOLARIS

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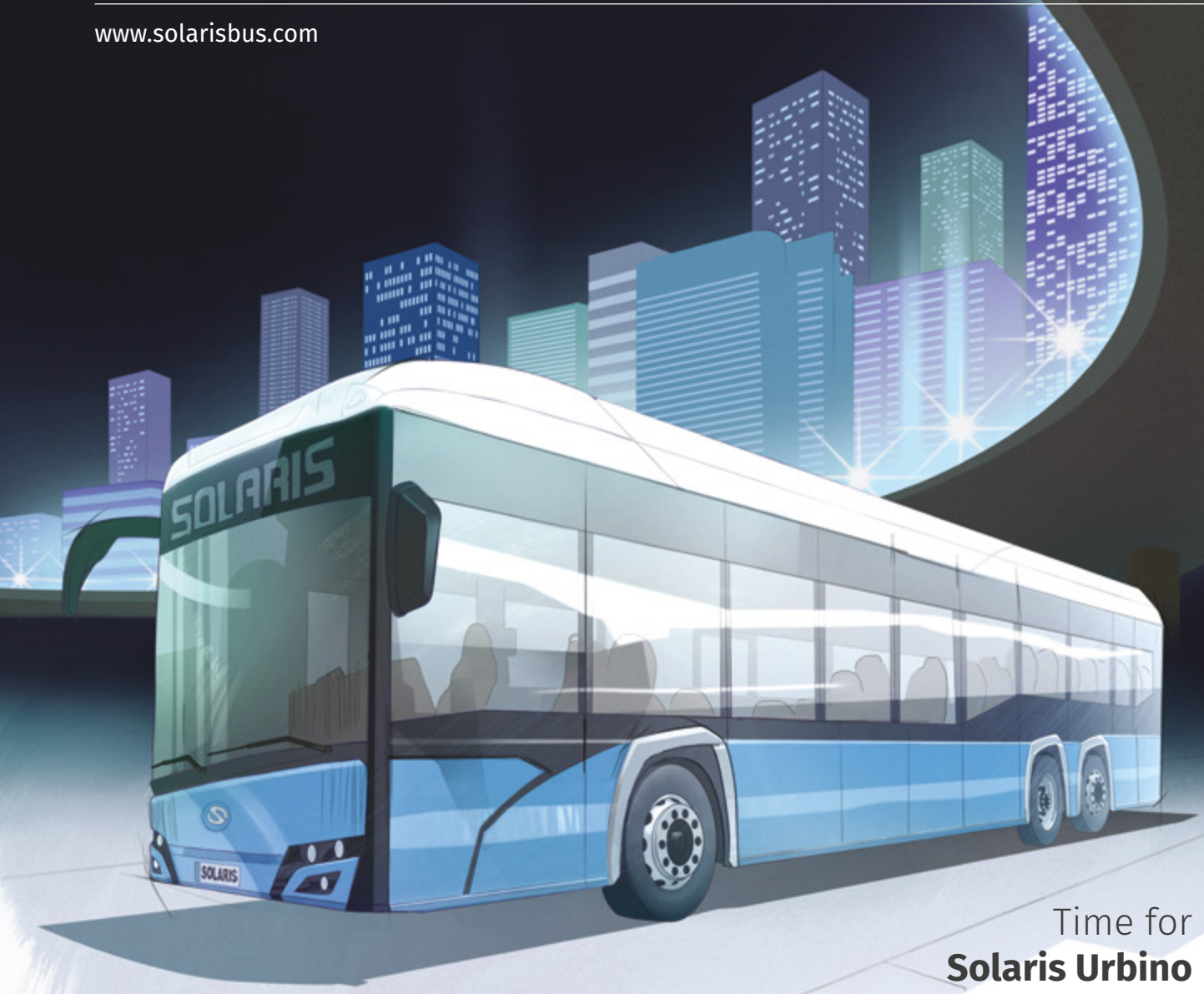

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Publisher: Solaris Bus & Coach S.A., ul. Obornicka 46, Bolechowo-Osiedle, 62-005 Owińska, Poland, tel.: +48 61 6672 333, faks: +48 61 6672 345, e-mail: solarisbus@solarisbus.com, www.solarisbus.com

Editorial team: Agata Barnaś, Mateusz Figaszewski, Anna Kordylas, Agnieszka Kubiak, Alicja Malewicz-Pełczyńska, Marcin Napierała, Maciej Sankowski, Grzegorz Świerniak

Photography: Solaris Bus & Coach S.A., PSPA, MPK Poznań

Layout, realisation: Weave Studio Dominika Banaszak.

As an introduction

Dear Readers, dear Friends,

We deliver this new issue of the Solaris Magazine to you at an extremely difficult time for Europe, as the world we know radically changes how it works in the face of the coronavirus epidemic. Today, we take on a huge challenge that is novel to all of us, one which renders our solidarity the most important value by far.

I would like to take this opportunity to thank everyone for their words of support and encouragement which have reached us from many corners across Europe – coming from our Clients, Suppliers and Friends. I want to stress that the feeling is mutual.

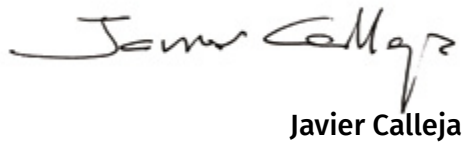
In these uncertain times, and as the CEO of Solaris, I would like to assure you that we do our utmost to build and deliver buses, as long as this is possible though only if it is safe – for our employers, customers and suppliers alike. At this point I would like to stress emphatically that the health of our workers and contractual partners is paramount to us.

I hereby hand over to you the latest edition of the Solaris Magazine in

which we sum up the intense year 2019. The hard work of each of our employees yielded record sales results and a significant hike of revenues. We have set the bar high for ourselves, aiming to become the European leader on the electric bus market, and we are going to boldly pursue that goal. Featured on the pages of this Magazine are two new models of our portfolio, ambitious ADAS-related projects, but much space is dedicated also to after-sales services, such as maintenance servicing custom-designed for buses with alternative drivelines. After all, the share of these vehicles in our sales is still rising.

I truly hope that the situation reverts to normal soon and that, together, we may enjoy everyday life and joint meetings. In the meantime, I ask you to take good care of yourselves and of your dear ones.

Happy reading and best regards to all of you,



Javier Calleja
CEO of Solaris Bus & Coach

First Solaris buses in Bonn will be electric

› Solaris will deliver buses to Bonn for the first time ever. The vehicles in question will be three articulated Urbino electric. Featuring the latest generation of batteries, the Solaris High Energy+, the electric buses will venture out onto the streets of Bonn this year.

The first contract of Solaris carried out for SWB in Bonn consists in the supply of 3 Urbino 18 electric buses. A key condition of the carrier was that the producer has to ensure a driving range of 200 km on a single charge of the vehicle, over a period of 12 years. In order to meet those terms, Solaris went for the latest High Energy+ battery generation.

The batteries with a total capacity of 553 kWh will be only plug-in charged.

The buses to roll out onto the streets of Beethoven's city will be equipped with an innovative drivers' assistance system called MobilEye Shield+ which allows the driver to see more and which will inform the driver of potential obstacles, thanks to cameras which detect pedestrians and cyclists. Envisioning an additional platform with a bench for three passengers in the rear of the vehicle, the completely new seat layout has allowed to raise the number of seats in the bus to 44. 12 of these are accessible directly from the low floor, which will ease travel for passengers with reduced mobility.

The point is that the electric buses will be fuelled only by so-called "green" energy, i.e. power derived from renewable sources.

Solaris buses in the picturesque **Dubrovnik**

› Solaris is going to deliver 11 Solaris Urbino 12 buses to the picturesque city of Dubrovnik in Croatia. Carrier Libertas Dubrovnik d.o.o. will receive the commissioned vehicles mid-2020. A four-year warranty will be issued for the vehicles.

Solaris will fit the buses ordered by the customer from Dubrovnik with engines meeting the strictest emission norm EURO 6D, and boasting a power of 270 kW. The driveline will be completed by an automatic transmission featuring an economy programme which will allow for a considerable reduction of fuel consumption. Of the 85

passengers the Bolechowo-made vehicles can carry at a time, 24 will travel seated. An efficient air conditioning system will provide comfort to all passengers. The vehicle will also comprise a passenger information system with internal LED displays. In line with the expectations of the contracting authority, the modern Solaris Urbino 12 will be also equipped with a video surveillance system with cameras monitoring the passenger compartment and the road in front of the bus.

Following the completion of the order, Solaris will deliver its first city buses of the Urbino family to Croatia. So far, there is only one vehicle made in Bolechowo which has driven along the roads of the country at the Adriatic Sea – that is the intercity Solaris InterUrbino 12.8 delivered to the city of Karlovac in 2014.

Huge order from Tallinn

› Solaris has won a tender held by Tallinn for 100 eco-friendly compressed natural gas (CNG) fuelled city buses. 60 of the buses commissioned by operator Tallinna Linnatranspordi AS are Solaris Urbino 12 vehicles, while the remaining 40 are articulated Urbino 18.

Both in the 12-metre and in the 18-metre version, the heart of the new vehicles will be a 239 kW engine able of using compressed natural gas (CNG) as fuel. Meanwhile, five tanks holding 315 litres each and containing compressed natural gas (CNG) will be placed on the vehicle roof.

Both versions of the environmentally friendly vehicles have been fitted with a series of solutions improving the travel comfort of passengers. The vehicle will feature among others efficient air conditioning and dual USB ports installed between the seats in each row. It will also be equipped with a passenger information system with external and internal voice announcement systems, as well as a video surveillance system comprising five interior CCTV cameras, one road-facing and one rear view camera.

The order placed by Tallinn is the second biggest one-off contract won by Solaris, for this type of vehicles. So far, nearly 1200 low-emission Urbinos running on fuel in the CNG form have already reached customers in 14 European countries.

Satu Mare gets innovative hybrid buses

› Representatives of the city council of Satu Mare in Romania have signed a contract with Solaris for the purchase of 11 low-emission Solaris Urbino 12 hybrid buses. The buses shall be delivered to the customer in the second half of 2020. Concurrently the parties signed a framework agreement which allows for the extension of collaboration in the future to cover six more hybrid buses, including two articulated ones.

The twelve-meter buses for Satu Mare will be fitted with a serial hybrid drive consisting of an electric motor and a diesel engine. They will also feature supercapacitors that make it possible to store and then use recuperated energy. The Stop & Go feature allows to control diesel engine operations: it turns off the engine when the bus halts at bus stops, and it turns it on again once the vehicle sets off. This allows for a considerable reduction of emissions and of fuel consumption. The Solaris Urbino 12 hybrids will be adapted to carry a maximum of 96 persons with seats available to 31 of them. The amenities installed in the vehicles include, among others, air conditioning of the passenger compartment, a surveillance system and a passenger counting system.

The cooperation between Solaris and operators from Romania dates back to 2002. Since then, Solaris has supplied nearly 250 buses and trolleybuses to Romanian cities, including over 40 electric buses now deployed in Cluj-Napoca.

Lublin opts for electric Solaris vehicles

› Lublin invests in further development of an emission-free fleet. Representatives of the public transport authority Zarząd Transportu Miejskiego (ZTM) in Lublin and of Solaris have signed a contract for the delivery of 35 electric buses and trolleybuses. Their total value exceeds PLN 106 million.

Among the new vehicles com--missioned by the public transport authority ZTM are 15 articulated trolleybuses of the Solaris Trollino 18 type and 20 electric buses Solaris Urbino 12 electric. The supplies will begin by the end of this year and are to end in September 2021.

The Solaris Urbino 12 electric will be fitted with 116 kWh Solaris High Power batteries adapted to frequent and fast charging. Apart from vehicles Solaris will also build and install infrastructure for supplementing electric energy: four pantograph chargers with a power of 450 kW each, ten stationary chargers enabling the concurrent recharging of two buses with a power of 40 kW, as well as two mobile chargers of 40 kW.

The trolleybuses will be equipped with 58 kWh Solaris High Power batteries. Through automatic current collectors, electric power will propel the trolleybus, and at the same time charge batteries using the In-Motion-Charging system.

Electric Solaris buses go all the way to **Paks in Hungary**

› The city of Paks in central Hungary has ordered six Solaris Urbino 12 electric and four electric 8.9 meter long buses, as well as five stationary chargers.

The emission-free Urbinos will be supplied to Hungary within 11 months of signing the contract. The total value of the contract, which covers also after-sales servicing apart from electric buses and chargers, settled at EUR 4.7 million.

The Solaris Urbino 12 buses will feature modern air conditioning with a roof heating function, among others. USB ports will be mounted in the passenger compartment, by means of which passengers will be able to charge their mobile devices. The ecological electric buses will be propelled by a 160 kW central traction motor. The energy needed to drive the vehicle will be stored in Solaris High Power batteries with a total capacity of 250 kWh. It will be supplemented via a plug-in connector. The shorter of the commissioned e-buses will share a similar equipment standard, although the batteries, which will be also plug-in charged, will have a capacity of 200 kWh.

These will be the first electric buses to be delivered to Hungary by Solaris. As a result of the signed contract, Hungary has become the 18th European country which has opted for battery buses made by Solaris.

Solaris **leader of electromobility**

› At the conference Global e-Mobility Forum in Warsaw, Solaris was awarded the Electromobility Leader prize for its contribution to the development of zero-emission transport in Poland.

The Global e-Mobility Forum in Warsaw is a high-ranking event which attracts representatives of states and governments, of international organisations and of chief companies with ties to electromobility. Warsaw turned into a space for debate on the future of electric transport and the best practices that contribute to development in that area.

As one of the most important producers of electric buses in Europe, Solaris has been bestowed upon with the Electromobility Leader Award – for its participation in the transformation of public urban transport in Poland.

As part of the conference, the organisers set up an exhibition zone where innovative solutions with regard to electromobility were on display. Solaris presented its flagship product: the electric Solaris Urbino 12 electric, which has been carrying passengers in Warsaw since 2018.

fot. PSPA

ElekBu – electromobility in Berlin for 11th time

› The ElekBu – the 11th edition of the conference organised by VDV Akademie, was held at the beginning of February. This unique event is a meeting place for the whole bus industry involved in electromobility. The ElekBu is a combination of theory and practical experience of operators. It is also a trade fair during which producers of vehicles and various components have the opportunity to exhibit their latest solutions.

Many speakers at this year's conference edition stressed that the current challenge faced by operators and cities is no longer the introduction of electric drive vehicles to fleets, because that process is already noticeable in many conurbations. The most important issue at hand today is adjusting the whole city infrastructure to the shift in municipal transport towards zero emission.

During the presentation block '*Boulevard of Ideas*', Alan Przyłębski, the Sales Director of Solaris in Germany, presented among others the new Solaris High Energy+ batteries which allow to achieve large ranges, and the concept and design of the hydrogen-fuelled bus Urbino 12 hydrogen which premièred in June last year. The Solaris Urbino 12 hydrogen was added to the portfolio of Solaris as a technology complementary to battery vehicles; it attracted huge interest at the ElekBu.

Solaris accelerates
on e-mobility market

Last year was record-breaking for Solaris in more than one way. First of all, the company has achieved its biggest ever sales volume. A total of 1487 buses and trolleybuses was delivered to customers. This resulted in sales revenues reaching PLN 2.6 billion, which marks a climb by nearly 40% year-on--year. In 2020, Solaris does not intend to slow down. It is already clear that this year, the firm will deliver over 500 electric buses.

In 2019, Solaris sold a record number of 1487 vehicles, which constitutes the best result ever for the company. The previous sales volume record was hit in 2017 and that figure was by nearly 100 buses lower (1397).

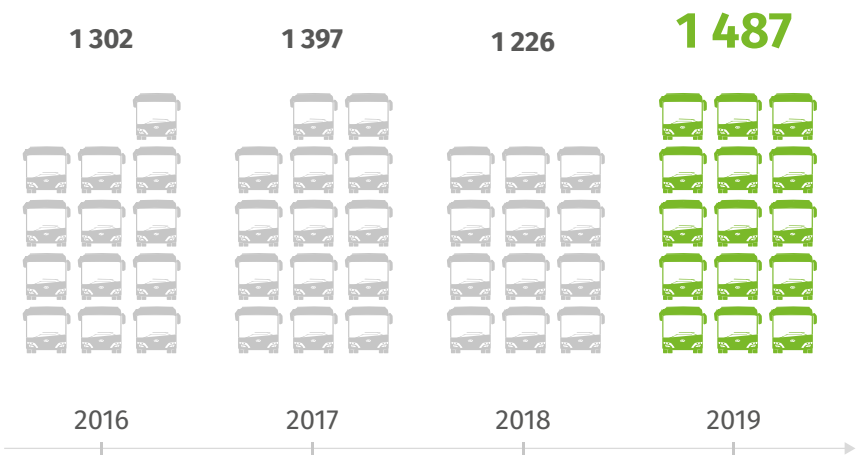


Chart: Sales volume of Solaris vehicles from 2016 to 2019, in units, Source: Solaris Bus & Coach


SOLARIS

In 2019, Poland (434 units), Germany (283 units), Belgium (160 units), Lithuania (106) and Italy (82) numbered among the biggest sales markets of Solaris. Products made by Solaris are currently found in 32 countries, in over 700 cities, and their total number comes to nearly 19,000 vehicles.

Most of the vehicles sold last year ended up in the hands of customers in Poland – 434 units in total. This number allowed Solaris to claim the leader position on the market of low-floor city buses in Poland, for the 17th time in a row, and to achieve a 42% share in this segment. Compared to 2018, Solaris has recorded a rise by 9 percentage points in this respect.

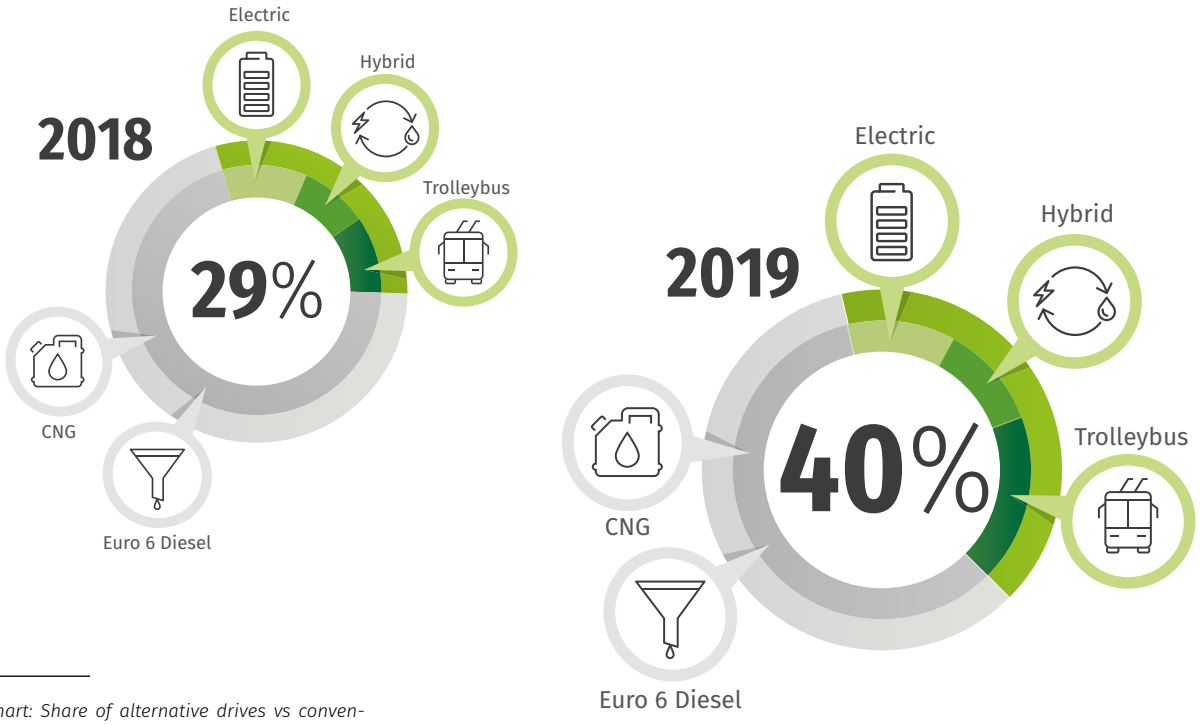


Chart: Share of alternative drives vs conventional ones in structure of sales of Solaris in 2018 and 2019, Source: Solaris Bus & Coach

It should be stressed that Solaris is very dynamically developing its sales position on European markets but it is also quickly re-orienting the organisation of production and after-sales servicing towards vehicles with alternative, low or zero-emission propulsions. In 2018, hybrid and electric buses as well as trolleybuses constituted in total 29% of all vehicles sold. In 2019, their share in sales increased by 11 percentage points to 40%.

The trend of a growing share of low or zero-emission drive vehicles in the company's sales and production structure will certainly carry on in 2020 and is consistent with tendencies observed for the whole EU and EFTA market. For a few years now, these states have noted an unusually dynamic climb of demand for alternative driveline vehicles, and these are what accounts for most of the commercial activity of Solaris. This trend is also reflected in the number of commissioned battery buses in EU and EFTA member states; the number settled at 2341 units in 2019, having surged by 78% compared to 2018!

One of the European leaders of e-mobility, Solaris is also among the top manufacturers responding to changing purchasing needs of public transport operators. This is clearly evident from the sales structure of the company – the number of sold and contracted Solaris-made electric buses has been growing dynamically for a few years now. In 2019, the manufacturer supplied in total 162 battery buses, which marks a rise by 51% versus 2018.

Based on the orders already secured, it is possible to assume sales of battery buses of Solaris at a level of at least 500 units in 2020. The contracts due to be performed this year include among others a gigantic order for 130 articulated Solaris Urbino 18 for operator MZA in Warsaw, or the framework agreement for the supply of 250 Solaris Urbino 12 electric buses for Milanese operator ATM. Since 2017, the number of electric buses for which orders were secured has increased over eight times!

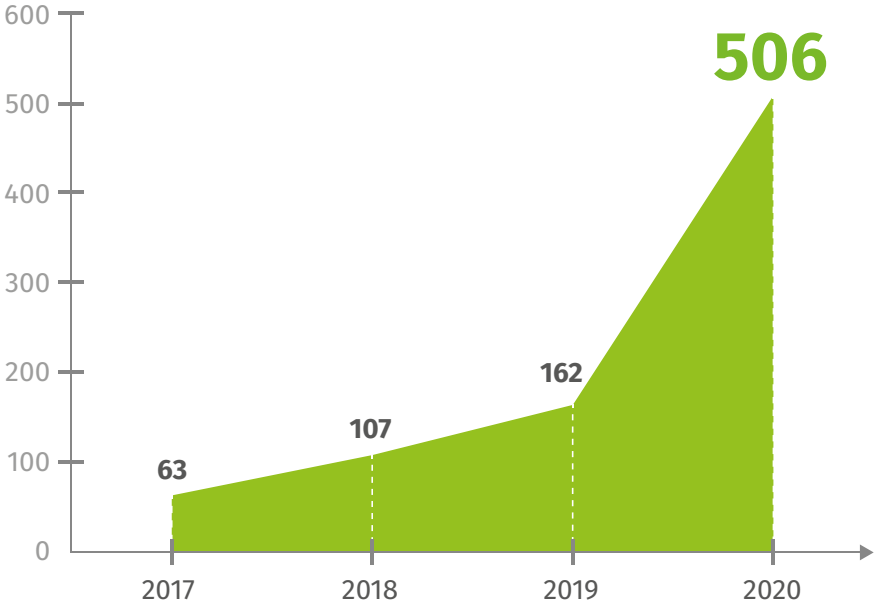


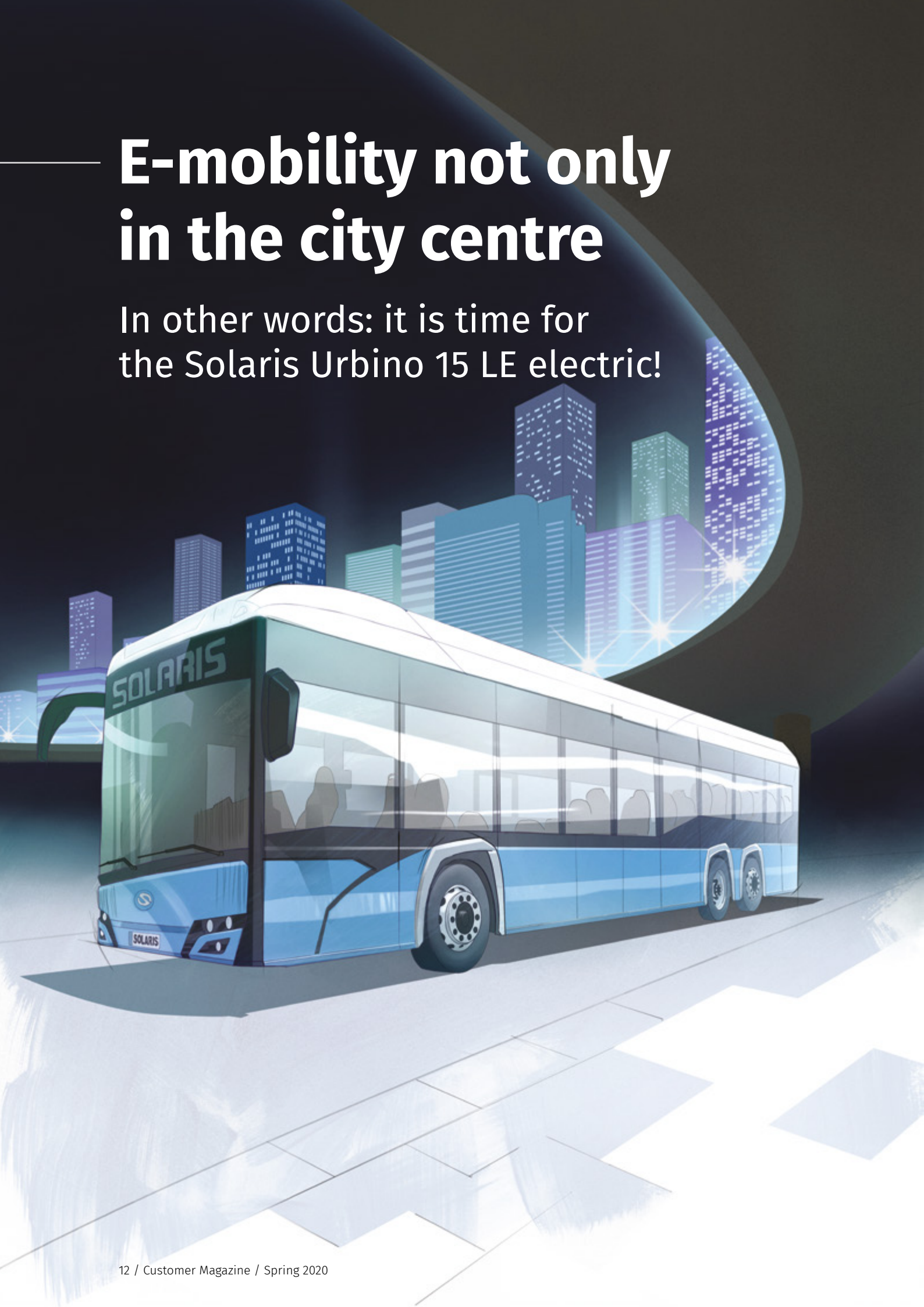
Chart: Number of electric buses of Solaris sold until 2019 and orders for battery buses in 2020, Source: Solaris Bus & Coach

„2019 was a record year for Solaris in many respects. It is fantastic what we managed to achieve thanks to our employees and thanks to the trust our customers put in us. This year, we will face new challenges, related above all to the continuous dynamic development of electromobility. We plan further increases of sales and output. In 2020, we assume the supply of over 500 electric buses. Of course, this entails further investments and the optimisation of maintenance service processes and structures, in order to ensure the highest possible service quality for all our clients from the moment the vehicles get delivered, throughout their whole service live."

Javier Calleja
CEO
Solaris Bus & Coach

E-mobility not only in the city centre

In other words: it is time for the Solaris Urbino 15 LE electric!



Up until now, the “electric offer” of Solaris encompassed only city buses. That will change this year, thanks to the 15-meter version of the Urbino which will also meet requirements of intercity transport.

The design itself of the tri-axle bus of 15 meters is nothing new for the company. Solaris made its first tri-axle vehicles back in 1999 and to-date it has supplied nearly 1300 of these vehicles to customers. However, these were models based on conventional diesel and on CNG engines.

This year will see the manufacture of a completely new generation of the Solaris Urbino 15 LE model, created solely with zero-emission drivelines in mind. The bus will be certified and offered with specs characteristic for class I vehicles – as a city bus, and for class II vehicles – as a bus for intercity transport.

“Even though we are building a new model of a low-entry electric bus, chiefly with Scandinavian markets in mind, we will certainly not limit our offer for that vehicle to those countries only. It will be available to all operators seeking a tri-axle LE bus for city and intercity transport. It will also be a completely zero-emission alternative in this class for CNG-fuelled buses,” says Petros Spinaris, Vice-President of Solaris, about the new product.

The decision to build a new bus was triggered not only by market interests, but also by the unprecedented technical progress with regard to electric buses, and in terms of energy storage in particular. The new battery solution which was presented by Solaris last year – the Solaris High Energy+ batteries – allows to offer a drive range on a single charging which will fulfil expectations of municipal and intercity carriers in any travel conditions.

And since it has been already mentioned above, energy storage in the SU14 LE electric buses will be covered by Solaris High Energy+ batteries of the latest generation. The first two pre-series vehicles will be fitted with 6 battery packs with a total capacity of over 470 kWh. Two will be roof-mounted, whereas four will be placed in the back of the bus. The batteries in this model can be recharged by means of a plug-in, or, at the customer’s request, also using a pantograph. The options available will be pantographs mounted on the vehicle roof or inverted ones. Everything will be consistent with customer preferences and compatible with the existing or planned charging infrastructure.

The drive unit of the tri-axle Urbino version is the liquid-cooled, 300 kW central electric motor CeTrax. The driveline is moved to the second (middle) axle of the vehicle. In order to reduce the use of energy to a minimum, the manufacturer will implement SiC technology in the bus propulsion area.

The first two Solaris Urbino 15 LE electric vehicles are made chiefly with Scandinavian operators in mind. That is also why the buses will feature special solutions complying with Bus Nordic standards and the so-called Scandinavian package. This entails, among others, unique equipment ensuring thermal comfort in the vehicle, lighting or a type of passenger seats dedicated to transport between cities. Interestingly enough, the bus will be also equipped with a solution familiar from the tram market mostly. Namely: a sander which enables movement even on the most icy or snowy of roads. In order to optimise the energy consumption, the Urbino 15 LE electric will be fitted with hybrid heating based on a heat pump, among others. What is more, the vehicle will contain solutions related to ADAS (Advanced Drivers Assistance Systems), i.e. automated systems of assistance for the driver, including the features MirrorEye or MobilEye Shield+.

The low-entry electric buses will be available with a two-door (2-2-0) or three-door (2-2-1) outlay. The passenger seating capacity will amount to 55 persons for class II vehicles.

“I am convinced that our latest, modern design will be a response to the needs of European carriers in this segment. The première of the bus is slated for this year,” announced Petros Spinaris, Vice-President of Solaris.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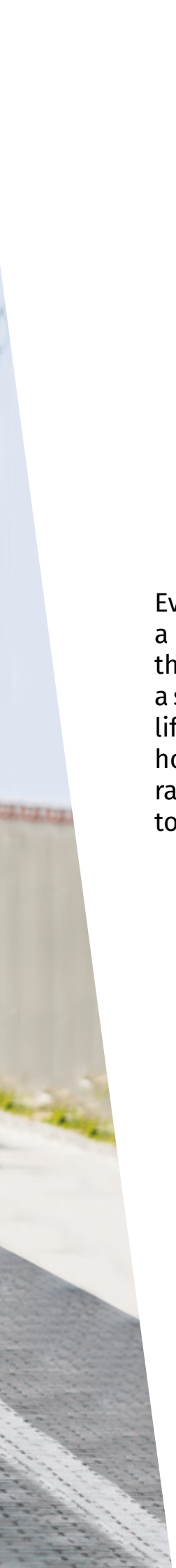


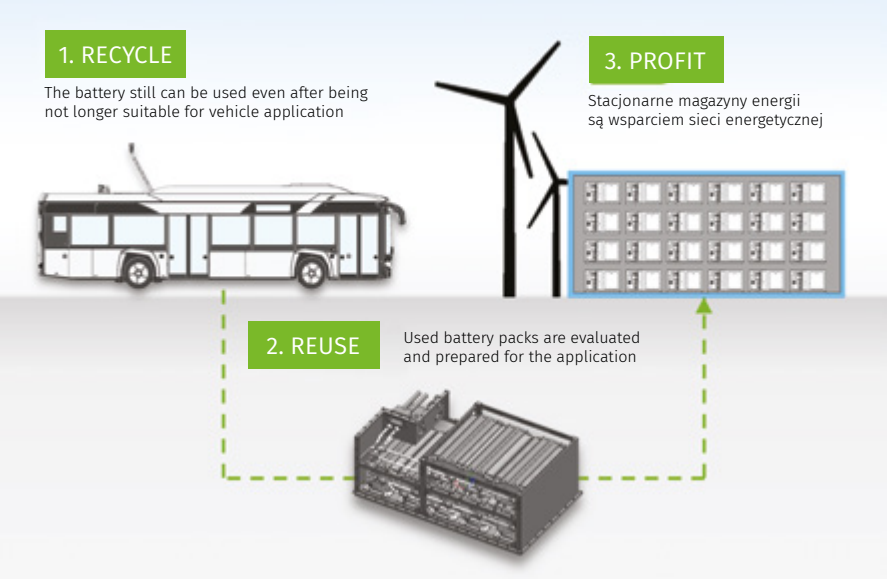
Let's give batteries a second life

Even when an electric bus battery gets decommissioned, it remains a valuable energy storage unit. It may be worthwhile to try using the battery in a different configuration where it will be able to enjoy a second life – one not necessarily related to public transport. Second-life projects considered by energy companies will allow firms to test how to tap into the full battery life cycle. They will also help us use rare and precious resources sustainably. This is especially important today, when we bear witness to a revolution in the e-mobility sector.

The introduction of electric vehicles to traffic progresses extremely fast. As the number of such vehicles on the roads rises, so does the number of batteries which are a crucial part of the electric driveline. In the case of electric buses that increase is even more dynamic. The share of e-buses in the global bus fleet currently stands at approximately 15%. It is predicted that by 2030 that share will have grown to 50%, and by the end of the subsequent decade – by 70%!

Meanwhile though, electric bus batteries have a tough life. They work in various, at times extreme, temperatures. They are discharged hundreds of times in a year, and sometimes recharged with power ratings exceeding 500 kW. They determine the drive range, the life cycle of the vehicle and the pace at which it is recharged. This heavy wear accounts for the lifespan of a traction battery being estimated at a 5 to 10 years on average, depending on the technology used – at least at the current stage of technological development. The energy storage used by the electric vehicle slowly loses its functionality – as the internal resistance of the battery increases, its usable capacity decreases. It is assumed that once the capacity drops below a value facilitating the regular use of a bus on a particular route, the battery should be replaced. Required by law to take back spent batteries if the client wishes to return them, the vehicle producer has two options: either have the battery recycled or give it a chance at a second life for other purposes, e.g. being used in a stationary energy storage unit.

Recycling allows to reclaim highly valuable metals, such as cobalt or nickel, which are finite resources. It is performed by specialised enterprises which handle the environmentally sustainable management of spent batteries. Existing technologies enable the practically complete recovery of resources from batteries, thus preventing additional waste from ending up in landfills. Establishing closed-loop resource management and maximum re-use of resources is particularly important in the case of rare and precious elements, such as lithium, cobalt, manganese or nickel. The world reserves of these elements are limited and their extraction is often challenging. In addition, as prices of resources hike, the development of electric drivelines progresses. Consequently, it is crucial to maintain these materials in market circulation and to re-use them in more production cycles.



It should be stressed that, as a leading European manufacturer of zero-emission vehicles, Solaris places strong emphasis on ethical business practices. The firm starts cooperation only with enterprises which can effectively demonstrate that they always implement a sustainable supply chain. This attitude applies also to the selection of battery fuel cells. The components for Solaris batteries are obtained only from reliable, certified producers aiming to minimize the impact on the environment and receiving their resources from sub-suppliers guaranteeing respect for human rights.

Yet another way to minimise the additional mining of resources is to use batteries in second-life projects. When it is no longer possible to effectively utilise a battery in a vehicle after very intensive use, it may be a great idea to employ the battery in the construction of a stationary energy storage. Normally, a stationary system will feature much bigger energy capacities, whereas single cells are targeted with smaller amperage than what is used in the case of mobile applications. As a result, they can work properly for a longer time.

The employ of such storages can be immensely versatile. They can serve as an emergency power supply, i.e. protective measure for firms which are bound by particular safety restrictions or which require constant availability of energy, e.g. manufacturing companies. Power banks can be also an invaluable support during peak energy demand

when the grid is overloaded. What is more, they can be applied in solutions that stabilise the power mains.

Stationary power storage units will ease the energy management while generating benefits, for instance they allow to store energy during off-peak hours, when a cheaper rate applies, or to store the surplus power generated by wind or solar power plants, as well as by photovoltaic cells installed around homes. Next, the energy can be utilised in times of increased demands, without generating additional costs.

One of the project assumptions for Solaris batteries was the possibility to re-use them in stationary devices. The cells are placed in casings of standard size and shape, which can be combined in various ways, without having to adjust them or to modify their design. The batteries can be built into standard shipping containers, which is a very common, practical and cheap solution. Around 30 batteries fit into a standard container of 20 feet, which, depending on the battery technology applied, translates to ca. 1-2 MWh of energy. Twice as many batteries can be installed into a larger, 40 feet long container. Of course, stacking batteries next to each other in a container is not enough to plug the device into the power mains, for instance. Once it has been established whether the batteries at hand are suitable for a particular application, it is always necessary to design fitting converters and systems for communicating with the external world. The operation of the storage device has to be controlled by a master management system which allows for the efficient and optimal utilisation of the components. For this purpose, such projects should be run primarily by companies which manage energy systems.

The exponentially surging number of electric vehicles entails many challenges, not only those related to the availability of charging stations or the range of electric vehicles. The processing of partially or fully spent batteries is turning into a burning issue right now, as the number of energy storage devices decommissioned after being employed in traffic and mobile applications starts growing dynamically. Market demand for stationary energy storages is soaring, too, in correlation with the growing number of electric vehicles on roads. Nonetheless, it has to be noted that batteries from vehicles will not always be suitable for a particular stationary device. Sometimes this is determined by technical limitations, at other times – by economic reasons. However, second-life projects have an enormous potential and are always justified on environmental grounds. The re-use of valuable resources needed for the construction of batteries and the battery second-life programme will facilitate sustainable energy management.

Product portfolio novelty

Solaris Urbino 18 plug-in hybrid

The array of hybrid vehicles offered by Solaris will grow by another option. In response to market needs, the firm is widening its portfolio of hybrid vehicles and is launching the Urbino 18 plug-in hybrid with the option of plug-in charging.

Solaris was the first producer in Europe in 2006 to launch a serially produced hybrid bus with a serial drive and since then, it has sold nearly 650 vehicles of that type. Now, responding to the needs of the market, the company is broadening its hybrid vehicle range and presenting an articulated Urbino 18 plug-in hybrid which will be able to cover up to 10 km in zero-emission mode.

The Urbino 18 plug-in hybrid is equipped with a 6.7 l and 300 hp diesel engine, as well as an electric traction motor made by BEA and with a power of 160 kW. In the new hybrid model, the supercapacitors used hitherto have been replaced with batteries. Thanks to the implementation of a battery with a capacity of approximately 30 kW, the bus will be able to drive for up to 10 km in zero-emission mode. This will be of significance on those routes in the centres of cities which possess emission-free transport zones. In those areas, vehicles can use only power stored in batteries.

The system applied is a serial hybrid. This means that there is no mechanical connection between the primary power source, which means the diesel engine, and the wheels. The diesel engine powers only the current generator which then feeds the electrical equipment, the energy storage, the electric traction motor and, finally, the wheels. The propulsion of the vehicle is partly electric, as a result of which it uses up less fuel and thus reduces the emission of noxious substances into the atmosphere. The electric traction motor converts electrical energy into mechanical output that is used to drive the vehicle in hybrid mode. When in hybrid mode, the energy stored in the batteries will merely support the electric motor, but in zero-emission mode, i.e. when the diesel engine is switched off, it turns into the sole power source for the traction motor. Since the driveline of the vehicle is partly electric, it is able to recuperate energy from braking. Consequently it uses less fuel and thus limits the release of noxious substances into the atmosphere.

The Urbino 18 plug-in hybrid features a CCS Combo 2 type charging socket, placed above the first, right-hand wheel arch. The batteries can be recharged in the same way as in electric buses.

The vehicle is already on offer.

Revolution before our eyes

It is not that long ago that projects of city bus fleet electrification were considered innovative ventures which only a select few cities would opt for. In the course of a few years the electromobility transition has clearly picked up the pace. Last year, electric bus registrations made up 11.6% of all new bus registrations in western Europe and Poland.

It is therefore fair to say that 2019 was a breakthrough year on the path to low-emission public transport. Orders placed in previous years, both for single electric buses as well as for 20 or more vehicles, have translated to deliveries impressive in number. Some cities are still taking their first steps in this regard, but many others are continuing the process of transport transformation, as they are consistently replacing their diesel fleet with eco-friendly alternatives.

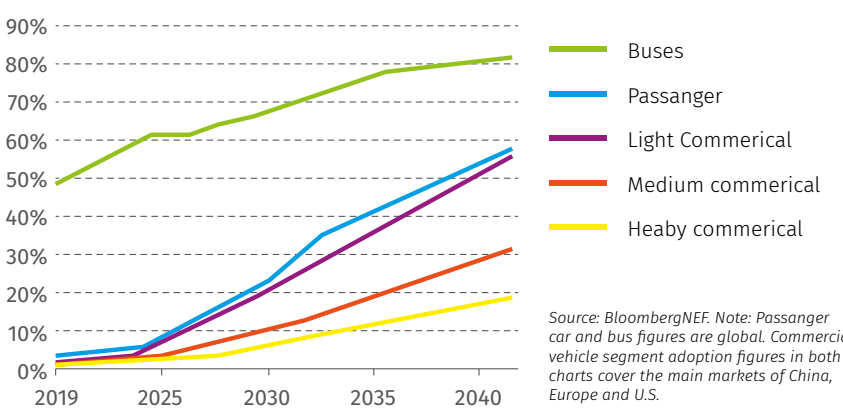
In 2015, a total of 101 battery buses were registered, while four years later that number soared to 1687 – a more than fifteenfold hike in number in barely four years. Compared to 2018 one may also notice a definite upward trend. Ca. 550 registered electric buses in western Europe and in Poland allowed to reach a market share of 4.6 percent in that period. Even though the total number of registered city buses increased to nearly 14,500, the share of new registrations of electric buses amounted to 11.6 percent.

The increasing interest in green transport is also noticeable in other segments of low-emission drives. In 2019, nearly 2000 of each, hybrid and CNG buses were registered. Owing to that, diesel-fuelled buses constituted 61% of all new registrations, compared to 72% in 2018.

How do electric buses fare compared to battery-powered passenger cars? Even though over 350,000 electric passenger cars were registered in the EU, their market share amounts to 2.2%. It is therefore evident that the electrification of the city bus segment is proceeding at a much faster pace. According to BloombergNEF, the share of sold battery buses in sales will reach 70% already in 2030.

Electric buses are becoming a part of our everyday life. Since recently, Solaris battery buses have been available for rides to residents of Poznań. Meanwhile, a delivery of 130 vehicles to Warsaw is under way (see also p. 22). This year, Urbino electric buses will make it also to Berlin, Hamburg, Venice, Paris, Barcelona and many other European metropolitan areas, as well as much smaller cities and towns. Electromobility is no longer a distant future – the revolution is happening before our eyes and Solaris has its share in it.

EV share of annual vehicle sales by segment



Source: BloombergNEF. Note: Passanger car and bus figures are global. Commercial vehicle segment adoption figures in both charts cover the main markets of China, Europe and U.S.


Linie Ziel Abfahrt in
300
M48 Busseallee
M85 S Lichterfelde Süd 2 min
200 Departure is delayed 6 min
M48 Busseallee
300 Philharmonie 11 min
13 min
Varian-Fry-Str./Potsdamer Platz
300 Tiergarten
Philharmonie
1804
1804
B V 1804

From Bolechowo to Warsaw

Konwiktorska – Natolin: that is the bus line 503 to which the first – of 130 ordered – zero-emission Solaris Urbino 18 electric bus has been deployed. Since the beginning of the year, Warsaw has been delivered electric buses under that contract.

Each of the 130 articulated, electric Urbinos is extremely quiet, a fully emission-free public transport bus with a capacity for 133 passengers. The vehicles feature a 150 kWh Solaris High Power battery with a warranty period of seven years. The batteries boast a high power density, which means they can be charged really fast using high current. Crucially, the batteries have a long life and a significant number of charging cycles. Similar battery solutions have been implemented by Solaris in electric buses operating in Brussels and in Barcelona, among others.

The batteries will be recharged by means of plug-in depot charging stations and by means of pantographs. The bus features two charging sockets: one above the right wheel arch and the other placed behind the last door, whereas the pantograph is mounted on the roof.

The cooperation between Solaris and MZA in Warsaw dates back to 1997. It is the company's biggest client to-date. Over the course of 23 years, the bus maker has supplied to Warsaw over 1100 vehicles, including 21 electrically propelled ones. In line with the agenda of MZA, by 2022 one third of the bus fleet in Warsaw will be made up of vehicles with alternative propulsion systems: electric, hybrid or gas.

"This is a huge step for the citizens of Warsaw towards improving the air quality in the capital city. It is also an excellent example of modern city transport management and of the transition towards sustainable urban transport."

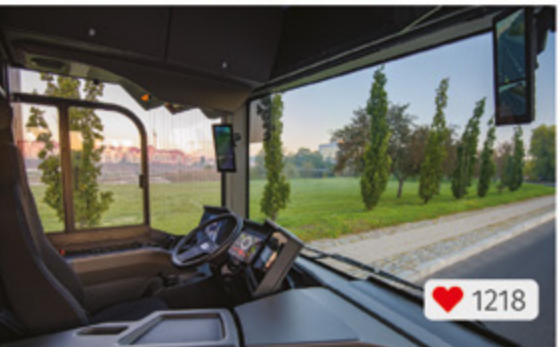
Javier Calleja,
CEO
Solaris Bus & Coach

„The purchase of 130 articulated electric buses made by Solaris is a big event for us. Thanks to this and to our other investments in the fleet we will soon be able to boast nearly 500 low- and zero emission vehicles. This is one of the best results Europe-wide and great news for Warsaw residents."

Jan Kuźmiński,
CEO
MZA Warszawa

solarisbus_official

Find us on
Instagram



2019
in Solaris Logistics Center

We enter the new decade with a sense that we are witnessing a great transformation on the public transport market. The huge climb in the share of low and completely emission-free vehicles has also considerably influenced the after-sales service market. The wide range of alternative drives in Solaris' offer means there is also more and more servicing to be done while they are in use. The Solaris Logistics Center plans its stocks of parts in an optimal way so as to ensure full operability both for older vehicle versions as well as those featuring the latest technologies.

WE SUPPLY PARTS **ALL OVER THE WORLD**

25 countries

that is to how many countries we delivered spare parts in 2019

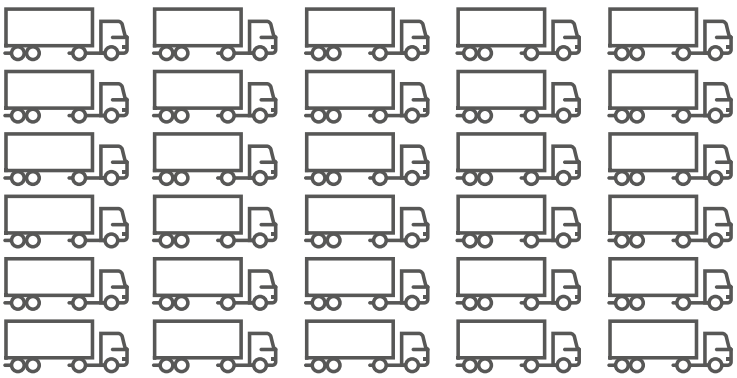
6,240

that is the length of the longest route in 2019 covered by spare parts dispatched from the Solaris Logistics Center. That was the journey the parts made to our contractual partner in Dubai

nearly

3,000

that many vans and trucks set off from the Solaris Logistics Center in 2019, to supply spare parts to clients around the world



Stacked one behind the other these cars would create a

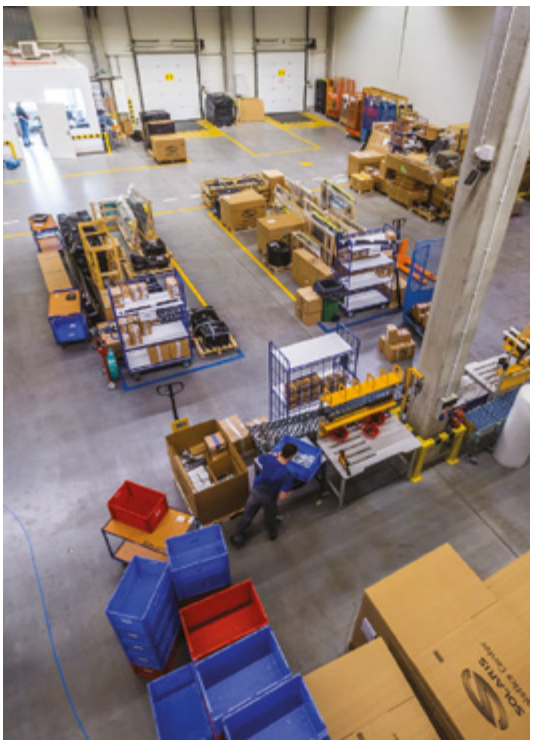
30-kilometre queue

WE ARE **EFFICIENT**

55,207
parcels

weighing nearly
2,000 tonnes
in total were dispatched from the Solaris Logistics Center. These made it to final customers in Poland as well as to our regional warehouses abroad

x 190
That is tantamount to the mass of nearly 190 twelve-meter buses

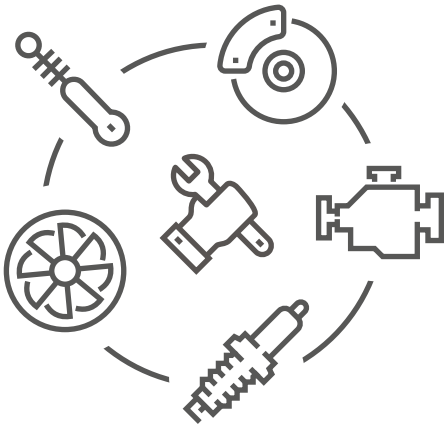


150,000

2018 **+10%** **2019**

that is how many order lines were carried out in 2019.
The result was by 10% higher than in the preceding year

WE HAVE A FANTASTICALLY **DESIGNED OFFER AND OPTIMISED STOCKS**



17,006

that is how many types of parts we delivered to customers around the world in 2019

In total, we dispatched nearly

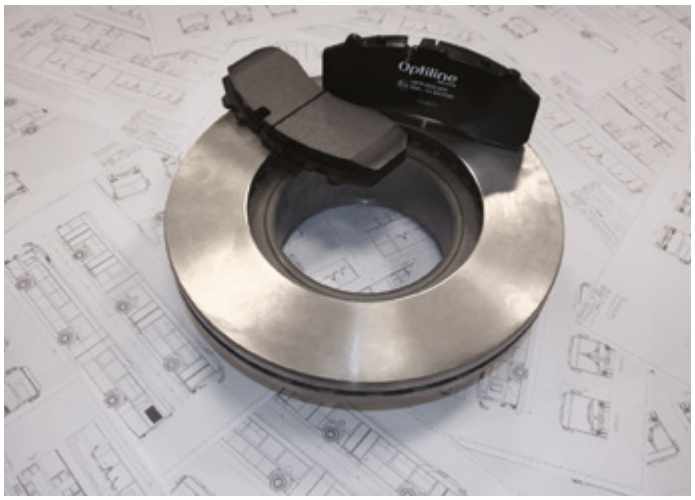
1,000,000

components to clients

We keep developing our own brand

The items ranking highest in terms of delivery volume were **Optiline brake pads.**

In 2019, they were the brake pads most frequently chosen by Solaris clients



2019 – a year marked by Optiline

The Solaris Optiline brand is increasingly recognisable on the market, chosen by more and more customers. 2019 was a record year for Optiline, and the number of products of that brand supplied to clients are proof that Optiline is gaining the trust of product users.

More and more clients are convinced by the quality of Optiline ware. Right after their launch, they were perceived by many as substitutes the likes of many others on the market. However, in the course of their use it was proven that these are not components with universal properties, but parts ideally matched to Solaris vehicles, and consequently these devices are more efficient. 2019 proved that customers have placed great confidence in that brand.

Last year, Optiline was the brand most often selected for brake pads by customers who got their supplies from Solaris. Compared to the previous year, Solaris brake pads recorded a sales hike by 60%. Nearly half of these went to clients in Poland, although export markets, too, opted for the own brand of the bus manufacturer. The leaders in this respect were clients from Italy, Sweden and France. All in all, over 23,000 brake pad sets of Optiline have been sold on the market so far. This means that they have already travelled billions of kilometres in vehicles, having accounted for countless braking motions.

Optiline filters, too, recorded a considerable increase, and we supplied a third more of them to customers year on year in 2019. Similarly to sales of the other product, Polish customers led in purchases, whereas the lead export markets were Italy and Scandinavian countries.

Such a diversity of customers indicates that the quality of Optiline proves efficient both in the frosty climates of northern Europe where salt spread on roads in winter puts a huge strain on components, as well as in seaside resorts where humidity and high temperatures can have a negative impact on the vehicle operation.

2019 was also significant for the Optiline line on account of the launch of completely new products – air bellows. These are products that can replace all kinds of bellows used in fourth generation Urbino buses during maintenance. Upon their official market launch, they found first users in Poland. In 2020, the product has been also introduced on foreign markets.

To the Polish manufacturer, the trust of clients constitutes the best justification for the marketing of the Optiline line. In the next few months, more, completely new parts will be added to the Optiline portfolio. These will be the company's response to the needs of customers and will help to improve the maintenance service of customers' fleets.

Solaris

after-sales support

Bespoke vehicles are the trademark of Solaris. The unique configuration of the vehicles often requires also custom-made service. Solaris ensures full after-sales support and comprehensive servicing over many years and hundreds of thousands of kilometres. All this to allow each customer to experience the full potential of their fleet.

Technical disposition and availability of buses is a key criterion for any carrier. They are what defines the ability to perform transports. Nonetheless, regardless of the brand, no vehicle runs failure-free and over time, every car needs at least a checkup or ongoing servicing. Support in this regard is indispensable. In addition, in the age of new technologies and of a rising share of vehicles with alternative drivelines, even the day-to-day maintenance may constitute a challenge for a user lacking established solutions and efficient know-how. When a customer decides in favour of a Solaris vehicle, they are provided with the knowledge of how to service a bus, but they also receive access to a range of tools which will accelerate that process.

Flexible servicing contracts

In order to allow the customer to fully benefit from all the vehicle servicing options specific under a given contract, Solaris offers flexible maintenance service contracts. These may vary in terms of authorisation scope. Starting with those where all vehicle repair options are available to the customer, up to the extreme opposite case when all repairs are done by Solaris. Thanks to its long-standing experience, Solaris is able to not only advise its customers as to the suitable solution but also helps prepare to the servicing of new vehicles, offering a wide array of trainings to both service workers and drivers.

Maintenance service offer

The ongoing servicing of a vehicle is usually scheduled and does not cause a temporary non-availability of the vehicle. However, it constitutes barely a small part of the whole process. Operators may face huge challenges in the case of an unexpected malfunction but whose identification is facilitated by the offered diagnostic service. It is efficiently executed thanks to the readiness of Solaris' Service. Owing to its extensive maintenance network and ability to do fieldwork, the company is able to offer a near instant response in case of breakdowns, which helps to make a vehicle fit for service again quickly. It works the same way in case of unexpected events, such as collisions or accidents, providing comprehensive service in case of accident damage rectification and repair of salvaged vehicles of all types.

Extensive maintenance service network

Assistance of all types is easily accessible for every client thanks to the extensive maintenance service network which is developed gradually, based on the needs of a particular market. The authorised servicing centre and wide array of services readily available to the customer enable the bus to resume operations swiftly and efficiently.

Spare parts distribution network

While widening its servicing network, the company also keeps expanding its spare parts distribution network. Each authorised servicing centre, but above all each individual client may rely on the supply of a part necessary for repair. The multi-stage distribution model ensures that the most needed and frequently demanded components are readily available on particular markets. As a result, clients can always turn to a trusted and certain source and purchase original parts, thanks to which they will see the potential of their Urbino undiminished.

Modern assistance portals

All maintenance service-related measures are supported by a range of applications. Accessible 24/7, the portals eSNote, eSClaim, eSConnect and Magbus ensure remote access to real-time and historical vehicle data, whereas the client may control the ongoing status of measures in each area.

The **eSNote** application is used to handle service reports for Solaris vehicles and it allows to not only verify defects in a vehicle, but also to plan and register regular technical maintenance.

The **eSClaim** enhances and shortens the time of processing and settling warranty claims.

Meanwhile, the **eSConnect** platform which is currently in development ensures remote access to real-time vehicle data, which allows for a quick response to potential malfunctions and better control of the driving range.

As for the spare parts segment, clients have been regularly using the **Magbus** platform which provides full access to the documentation and allows users to identify vehicle parts.

Solaris and Poznań University of Technology

work on advanced driver assistance system

In cooperation with Poznań University of Technology Solaris is developing an advanced system of assistance for drivers of city buses, mostly electric ones. Constituting part of the project, tests were run thanks to which the electric bus will be able to precisely show the driver how to dock the pantograph under the charging station.

Devised jointly by engineers of Solaris and of the University of Technology, the system will facilitate the performance of simple and complex manoeuvres, such as driving forward and backward, or parking, but it will also constitute an invaluable support when carrying out precise movements, for instance docking the pantograph to the charging station, which may prove quite tricky in the case of articulated vehicles. The goal of the project is to improve the safety of passengers and drivers of buses in urban traffic, and moreover, it will help public transport operators with manoeuvres at the bus depot. The new system will also ensure optimal energy consumption by the vehicles.

In the past weeks of 2019, project tests were performed in front of the Municipal Stadium in Poznań; these tests allowed to optimise the driver assistance system used in the Solaris bus. For research purposes, the Solaris Office of Development designed and installed a mobile pantograph charging mast set up on the square in front of the stadium. The firm also supplied a bus featuring a system designed and supplied by the Poznań University of Technology. Thanks to the advanced device, the bus is capable of recognising a charging mast, and consequently, it will be able to precisely show the driver where to dock the pantograph under the charging station.

Owing to the software which the consortium is developing, the vehicle will self-locate and at the same time create a map of the surroundings, in order to be able to detect other road users around it. What is more, the system is based on a neural network which enables the system to recognize specified objects in various weather conditions. Data transmitted from the ADAS sensors will be analysed so as to best use and fine-tune the operation of the software. The tests will also allow to check the operation of algorithms during the docking of vehicles under a station and to optimise their values.

The project “Advanced driver assistance system for precise manoeuvres of non-articulated and articulated city buses” (project acronym ADAS) is subsidised under Measure 4.2: “Sectoral R+D programmes” of the Operational Programme Smart Growth 2014-2020, co-financed by the European Regional Development Fund (ERDF) (POIR.04.01.02-00-0081/17).

“The Poznań University of Technology has been our long-standing partner for the development of drive technology and of various types of systems constituting the equipment of our buses. Thanks to our close collaboration, we are able to give our customers improved, more modern solutions, instrumental in the everyday use of vehicles. This project will considerably ease the daily work of bus drivers, and it will allow them to perform precise, but above all safe, manoeuvres.”

Michał Pikuła,
Director for Bus Development at
Solaris Bus & Coach S.A.

HYDROGEN tests

Having had its première in June this year at the Global Public Transport Summit UITP in Stockholm, the hydrogen-fuelled Solaris Urbino 12 hydrogen was tested by carriers in Austria, Germany, Poland and Italy over the past few months.

The latest, hydrogen-fuelled Solaris product has met with huge interest among potential customers, as evidenced by the demand for bus tests in several European cities. Right after its première at the Global Public Transport Summit UITP in Stockholm, the Solaris Urbino 12 hydrogen was showcased in the Austrian cities of Graz and Klagenfurt, following which it went on to the Italian city of Bolzano. In the next few weeks, the vehicle will move on for tests in Germany, to be conducted by public transport operators in Frankfurt, Cologne and Wuppertal. Meanwhile, in Poland the vehicle was presented in Poznań and Piła. RATP Paris (Régie Autonome des Transports Parisiens) is also interested in hydrogen technology. The capital carrier plans to test the capabilities of Urbino 12 hydrogen in regular Parisian passenger traffic.

What is more, the Urbino 12 hydrogen has already scored first buyers. At the end of May last year, transport firm SASA Bolzano ordered 12 units of the hydrogen bus model made by Solaris, to be delivered in 2021. In March this year, the Wuppertal-based operator WSW Mobil GmbH, which is an affiliated company of tran-sport association Verkehrsverbund Rhein-Ruhr (VRR), placed an order for 25 hydrogen-fuelled Solaris buses.

The Solaris Urbino 12 hydrogen has achieved its first distinction, too. It was awarded the title "I-Wielkopolska – innovative for Wielkopolska" (in the "H2 Wielkopolska" category) bestowed by the Marshal of the Greater Poland (Wielkopolska) province, Marek Woźniak.

Many European cities strive to make their municipal transport as environmentally friendly as possible. Solaris embraces customer expectations, adding hydrogen-fuelled buses to its low- and zero-emission vehicle portfolio. The sole "by-products" generated during the operation of the Solaris Urbino 12 hydrogen are heat and steam, which renders this vehicle one of the most ecological one on the market.

The Urbino 12 hydrogen is fitted with a cutting-edge fuel cell that acts as a miniature hydrogen power plant on board of the vehicle. Thanks to the advanced technology applied in it, the bus is capable of covering up to 350 km on a single refill. In a hydrogen fuel cell, electric power is generated in the process of reverse electrolysis and then transferred directly to the driveline.

Trustonomy

Last year Solaris made huge strides towards the implementation of driver assistance systems in its vehicles. A driver who, by virtue of many innovative solutions, sees more, responds faster and anticipates better, is a better driver, simply put. But how may one acquire those new habits at work? Should one trust new technologies without fail?

Various types of Advanced Driver Assistance Systems (ADAS) and Automated Driving Systems (ADS) are slowly becoming a staple in public transport. They are permeating from the world of passenger cars, trucks and coaches. In 2019, Solaris showed several innovations that allow drivers to see more and better. The used systems detect pedestrians or cyclists for the driver, or even initiate braking. Nonetheless, the success of new technologies depends on the level of trust placed in them. Even so, the driver remains crucial for the safety of passengers. The driver's trust in tools assisting his or her everyday life allows to take advantage of the full array of their functionalities.

Recognising the weight and importance of the cooperation of a driver with the increasingly common assistance systems, Solaris has got involved in an initiative implemented by a multinational consortium that works on a project dubbed Trustonomy (created from the combination of the words trust and autonomy). The intention of the creators is the maximisation of efforts aimed at improving the safety of automated vehicles, but also raising trust in and acceptance of them. The Trustonomy initiative covers among others research on how stimuli influence drivers and their reactions to these stimuli. Also analysed is the way drivers respond to information provided by on-board systems. What is more, part of the project involves defining the possible scope of cooperation between a driver and the ADAS/ADS system, and also specifying moments of interaction between devices and the driver. The data allow to devise the best – acoustic, visual or tactile – methods of how autonomous systems convey information to the driver. All this is supposed to make the driver trust not only his intuition and abilities, but also to make use of the support of ADAS and ADS systems.

The first project stage, during which it was analysed what the requirements and preferences of the potential system users, i.e. persons steering the vehicle, are with regard to the mode of communicating information, has been completed. As part of that task, Solaris and other consortium participants have carried out a number of interviews with drivers of vehicles of various categories; and preliminary proposals on the system operation have been formulated based on those interviews.

The architecture of system functionalities is being discussed now. The next stage will involve tests which are to confirm previous analyses in real-life conditions, namely during the driving of a bus. Solaris supports the project with its experience in the construction of city vehicles, and it offers help in the development of test procedures, as well as defines guidelines regarding the integration of systems into vehicles.

TOGETHER
we create great things!

According to OECD figures, a statistical European spends more than 200 days a year at work. That is over 1600 hours! . These valuable work hours of each of our 2600 employees contribute to the final success of our firm, meaning each of the over 19,000 vehicles that have rolled out of our factory so far. We, at Solaris, are fully aware of that. That is precisely why, in 2019, we initiated a campaign in which we have given the floor to our employees.

Dozens of people have applied to join our initiative, to share their Solaris story with us. During casting interviews, we managed to collect a multitude of exceptional memories and wonderful experiences. 20 employees have become the faces of the campaign. Their pictures have appeared on billboards on display in and around our home town Poznań. They played the lead roles in several films and it was their stories that were posted on our website.

We wanted to stress that employees are at the heart of every firm, and that **only together we are able to create truly great things.**

I appreaciate Solaris for the stability and the benefits system. We have private healthcare at work and I can provide more safety to my family.

Krzysztof Piasecki
– works in the department of final assembly of buses

I am responsible for the preparation of floors in our vehicles. When I see a Solaris on a street, I am proud of it.

Marcin Nowak
– works in the paint shop

I first heard of Solaris when I was in primary school. Now I install hydrogen and CNG installations at work.

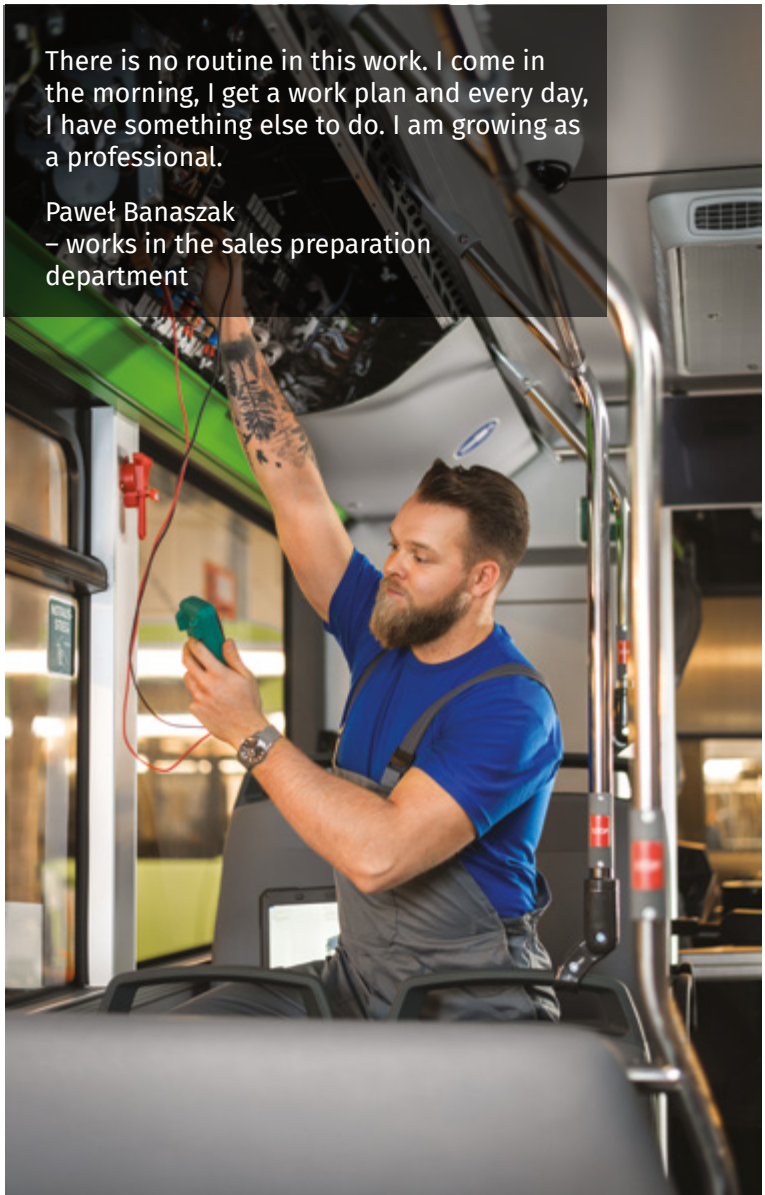
I never thought I would work here, but now I cannot imagine working anywhere else.

Sebastian Śmiełowski
– works in the department of final assembly of buses

Many friendships have been formed in our team, we enjoy working together. The Accounting Department at Solaris is made up of smiling people full of positive energy.

Weronika Grabowska
(second from the left in the first row)
– works in the accounting department

Different people, different tasks › common direction



There is no routine in this work. I come in the morning, I get a work plan and every day, I have something else to do. I am growing as a professional.

Paweł Banaszak
– works in the sales preparation department

I am proud of working here. But most of all when, as I walk down the street with my family and every time a bus drives past, my son asks me “Dad, Dad, did you build that bus?”

Participating in such a venture was a completely new experience for me, the day-long photo shoot and recordings were, contrary to what one might expect, really exhausting... Once our faces turned up on billboards, many of my friends sent me pictures from various parts of the city, congratulating me and asking about the campaign.

Łukasz Kończak (first from the left)
– works in the technical office

SOLARIS
A CAF GROUP COMPANY

DIRECTION ›
Optiline

Optiline
SOLARIS

Designed by those who brought your bus to life.

CAF GROUP