



SOLARIS

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Busworld 2019

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e-mobility offer
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Busworld 2019: Solaris widens e-mobility offer

At the largest bus exhibition in Europe, the Busworld 2019, Solaris unveils three product novelties. All buses feature electric drives which Solaris believes to be the future of city transport.

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Batteries in electric buses of Solaris

Today, Solaris offers the following batteries to its electric buses: Solaris High Power, Solaris High Energy and Solaris High Energy+. Over 20 million kilometres covered by the electric buses Urbino make it possible for Solaris today to offer the optimal battery solutions to its customers.

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Real zero-emission revolution

European cities which already have experience of using electric buses, are now proceeding to hold larger and larger tenders for more vehicles. In the first months of 2019, Solaris has landed gigantic deals with Berlin, Milan and Warsaw, for a total of up to 470 buses!

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eSConnect – bespoke solutions

Embracing the global development of the e-mobility market and the customer needs which we continuously monitor, Solaris engineers have ventured to design a modern system of remote diagnostics for electric buses.

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As an introduction

Dear Readers,
Dear Friends,

We are on a roll. We started the year 2019 with huge ambitions, and have fulfilled these to a large extent. Having landed multiple large and small tenders for electric buses, Solaris has now become the top producer in Europe in terms of contracted electric buses and our firm has turned into one of the chief agents of the transition of European urban transport to low-emission technologies.

And yet, we do not rest on our laurels, but do quite the opposite – we are accelerating. Our ambitions are not limited to succeeding in sales. Urban transport is undergoing enormous changes – regarding both the approach of passengers themselves, as well as technologies. We seek to respond to these and sometimes – to anticipate them. We complete our portfolio of eco-friendly buses with premières of other innovative vehicles, and we equip them with new technologies serving the safety of passengers and city dwellers.

June saw the début of the hydrogen-fuelled Urbino 12 hydrogen, and at



the Busworld 2019 we are going to unveil an articulated electric bus featuring the latest generation of batteries designed by Solaris engineers. Also in Brussels, we will show the Trollino 24 – the longest vehicle to have ever rolled out of the Bolechowo factory, and which crowns the list of this year’s premières. Many years ago our firm entered a course towards electric public transport. Today, all market players are heading for that same direction.

The issue of the Solaris Magazine I hereby hand over to You features articles and information about events that were of great importance to us in the past months, about this year’s débuts and the latest technological solutions, as well as the extensive after-sales offer of Solaris tailored to suit the needs of our Clients.

My warmest regards and happy reading!

Javier Calleja
CEO of Solaris Bus & Coach S.A.

Bolzano orders 12 Solaris hydrogen buses

➤ The Italian city of Bolzano is the first one to order Solaris Urbino 12 hydrogen buses. Twelve Solaris hydrogen buses will follow the last year's delivery of battery vehicles. The contract includes an 8 year-long service and maintenance package.

The energy stored in hydrogen is directly fed into the driveline of the vehicle. Thanks to the use of advanced technology, the bus will be capable of covering up to 350 km on a single refill. The sole products of the chemical reaction occurring in the fuel cell are heat and steam. Consequently, the vehicle does not

generate any noxious substances whatsoever. Hydrogen is stored in composite roof tanks. Part of the contract is also a special drivers' and workshop personnel's training emphasizing the safety aspects of using and servicing hydrogen vehicles.

Already in June, during the UITP Global Public Transport Summit, representatives of Solaris and Régie Autonome des Transports Parisiens (RATP) have signed a contract for lease and tests of the Urbino 12 hydrogen. The operator responsible for public transport in Paris for 10 weeks (April-June 2020) will test the Solaris hydrogen bus in regular passenger traffic. This is another step made by RATP in the preparations for transforming its fleet to completely zero emissions vehicles.



Cotral orders InterUrbino buses, again

➤ Cortal, the Rome-based carrier in charge of regional transport, has signed another framework contract with Solaris Bus & Coach S.A. for the supply of up to 300 intercity buses of the InterUrbino type. Covering also ten years' worth of maintenance services, the contract is worth EUR 117 million. The first order for 50 units is to be carried out in 2019. The vehicles will be put to use on bus routes connecting the towns of the Rome Province and of the whole Lazio Region.

It is yet another order of considerable size for that bus model of the Polish manufacturer. Having completed the agreement from 2016 for the delivery of 360 InterUrbino buses in total, the Italian operator decided in favour of more deliveries by Solaris.

The commissioned 12-metre Solaris InterUrbino are cutting-edge intercity buses specialising in the transport of passengers on longer distances, on routes reaching beyond city limits. 67 passengers can stay on board, with seats available to 55 of them. In addition, the vehicles will have a space dedicated to hand baggage

inside the bus (shelves above the seats), as well as a luggage compartment outside (electrically blocked luggage hold with a capacity

of 5.2 m³). The driveline in the intercity buses of Solaris consists of engines with a power of 251 kW, meeting the restrictive Euro 6 stage of emissions standards.

The recently signed deal is one of the biggest commissions in the history of the firm. Once the contract is performed, there might be up to 660 InterUrbino buses riding across Rome and its suburbs.



Modena and Parma opt for Solaris trolleybuses

➤ The companies SETA Modena and TEP Parma, both providing carrier services in the Emilia-Romagna region in the North of the country, have placed orders for altogether 18 modern Solaris Trollino 12 vehicles.

Eight of the trolleybuses commissioned will join the fleet of SETA Modena, the other ten will go to TEP Parma. The latest Solaris Trollino 12 ordered by the two carriers are twin structures. The first recipient will be transport firm SETA Modena. Eight vehicles adjusted to serving on a trolleybus route with an atypical voltage rate of 750V (usually 600-650V), meaning the rate used in Modena, will be delivered to the city lying at the foot of the Apennines by the end of 2020. Meanwhile, the delivery of 10 zero-emission Solaris vehicles for TEP Parma will be carried out in several batches, between April and July next year.

The vehicles will feature among others a central traction motor and

traction batteries with a capacity of 45 kWh and a cooling system, all of which will allow the vehicles to cover a much longer distance without the need to be attached to overhead wires. There will be room for nearly 80 passengers in the air-conditioned passenger compartment, and 24 of them will be seated. The seats, as well as internal walls, window pillars and the cover of the battery chamber will be given an anti-graffiti coating. The vehicle will also encompass a passenger information system with external and internal direction displays and voice announcement loudspeakers and energy-saving lighting in LED technology.

Solaris Bus & Coach added trolleybuses to its offer back in 2001. Since then, having supplied nearly 1500 vehicles of that type to customers in 16 countries, including 160 to Italy, the firm has become a leader in the segment among manufacturers in the EU.



Solaris electric buses are going to Bilbao

➤ Solaris Bus & Coach S.A. signed a contract with ALSA Group SLU for a delivery of two Urbino 12 electric buses and two stationary chargers. The vehicles will operate on routes of the biggest city of the Basque country – Bilbao.

The 'Bus of the Year 2017' award-winning Solaris Urbino 12 electric will feature an axle with two integrated traction engines of 125 kW each and a pack of 240 kWh Solaris High Energy batteries which will be recharged using a plug-in connector.

The passengers will benefit from air conditioning, passenger information system with voice announcement, video surveillance, as well as USB ports installed in handrails. The

Polish producer will also apply innovative thermal management solutions, whereby the vehicles will be automatically pre-conditioned to the desired temperature one hour before setting out – if the outside temperature drops below 15 degrees.

Nearly 200 vehicles from the Bolechow-based factory have to date made their way to Spain. Notable examples include 3 articulated electric buses supplied to Barcelona, and nearly 80 hybrid drive vehicles which can be encountered in Barcelona as well as the city of San Sebastian, located in the Basque Country.



Solaris the biggest manufacturer on electric bus market in Europe

► Thanks to three large orders placed by customers from Berlin, Warsaw and Milan, Solaris has claimed the lead spot in Europe in terms of contracts for electric buses in 2019. The electric revolution in the bus segment coincides with the company's long-term strategy which assumes investments in particular in the development of alternative drives.

The European electric bus fleet has increased a nearly 15-fold over the past 5 years. The rapid development of this sector serves as confirmation to Solaris that it was right in choosing this direction nearly a decade ago, and building its first electric bus. Today, several hundred Urbino electric buses keep carrying thousands of passengers every day, in 16 countries in Europe

and Solaris has taken the lead in Europe in terms of contracts landed for electric buses.

In the first months of 2019, Solaris secured three large orders for the supply of electric buses to Berlin (BVG), Milan (ATM) and

Warsaw (MZA). A total of up to 470 vehicles will roll off the assembly line in Bolechowo to these three metropolises alone. In addition, the producer has contracted 90 more electric buses that are to make its way to other European cities.



30 Urbino 12 electric to Venice

► The Solaris company has won another zero-emission order for its electric buses in Italy. ACTV SPA Venezia operator has placed an order at the Polish manufacturer for a delivery of 30 Solaris Urbino 12 electric buses and charging infrastructure. The total value of the contract exceeds 20 million euros.

The buses will be used on the Lido and Pellestrina islands and will replace 100% of the diesel vehicles currently operating on two islands. In addition to the vehicles, the Polish manufacturer will deliver nine fast pantograph battery chargers, six fixed plug-in battery chargers and a mobile plug-in charger.

Electric buses for Venice will be driven by a drive axle with integrated



electric motors of 2 x 125 kW. The energy needed to drive them will be stored in Solaris High Power batteries with 116 kWh of total capacity. The vehicles will be adapted for a plug-in and pantograph charging.

The Solaris Urbino 12 electric vehicles for the ACTV SPA operator

will be equipped with a number of amenities. These include efficient air conditioning, extensive passenger information and video monitoring system on board. All vehicles as well as the infrastructure will be delivered before the end of 2020.

Solaris joins ITxPT

► The main purpose of the ITxPT initiative is the standardisation of IT solutions in public transport. Solaris joined the organisation in the first half of 2019 and has since been actively collaborating with other component suppliers in order to ensure full compliance of IT systems and products in various transport areas, including in buses.

Over the past few decades, computerisation has asserted itself in public transport, which obviously also includes vehicles of the Solaris Urbino family. With every year, the buses have more and more IT systems installed in them – the systems ensure better operability of the vehicle, enhance safety and ease the drivers' job, thus contributing to the improvement of the passengers' travel experience.

The organisation ITxPT (Information Technology for Public Transport) promotes interoperability of IT systems in public transport. In order to achieve this goal, and to ensure a fully compatible cooperation of interfaces of various products, the ITxPT supports among others

the construction of IT architecture based on Plug&Play components. Joining the institution's member group will help Solaris actively participate in the process of standardisation of parts and systems,

and thus will allow the firm to offer products that are fully compatible with components available on the market.

From the perspective of the operator, this may prove an immense convenience. That is because the ITxPT label will warrant that systems built in compliance with the organisation's standards will communicate effortlessly with other systems.



„Safe road to school” with Solaris

► Solaris believes that the safety of all road users, in particular of the youngest ones, has always been and will always be an undeniable priority. In April, the firm became a partner of the event “Save road to school” in Ostrów Wielkopolski – a campaign aimed at promoting the knowledge of road traffic rules among primary school first-graders.

The competition “Safe road to school” was organised by the municipal transport operator MZK in Ostrów Wielkopolski under the auspices of the city's mayor. Its consecutive, fourth edition took place in April this year.

The initiative is addressed at primary school first graders of the Ostrów Wielkopolski region and

from neighbouring municipalities covered by a public transport agreement. The educational objective of the contest was to promote knowledge of road traffic rules and rules of using public transport infrastructure among primary school pupils of the first grade.

In this year's edition, of the 500 participants, the organisers selected 65 prizewinners whose works were then “made public” on the Solaris bus running in Ostrów Wielkopolski.





Busworld 2019:

Solaris widens its e-mobility offer.
New generation of batteries,
innovative hydrogen bus
and trolleybus première

At the largest bus exhibition in Europe, the Busworld 2019, Solaris unveils three product novelties. All buses feature electric drives which Solaris believes to be the future of city transport and in the development of which the company invests consistently. The electric bus fitted with new generation batteries, the bi-articulated trolleybus and the ingenious hydrogen bus represent the wide range of Solaris' e-mobility vehicles.

For many years, Solaris has been standing at the forefront of bus producers investing intensely in the development of alternative drives. The company is the biggest trolleybus manufacturer in the European Union and in 2019 it took the lead in terms of number of contracted electric buses. Today, barely a decade since its première in 2011, several hundred Urbino electric carry thousands of passengers every day, in 16 countries in Europe, whereas the odometer of electric kilometres has already exceeded 20 million km.

Following the path of progress, the producer has managed to create

a complementary emission-free vehicle portfolio – encompassing electric buses, trolleybuses and hydrogen-fuelled buses. Solaris believes that, in order to warrant sustainable transport of the future, it is necessary to foster various types of e-mobility solutions. The flexible offer of Solaris with regard to zero-emission vehicles is the firm's response to the rapid development of that sector, and the surging demand of clients who are preparing for a transition to emission-free transport.

During this year's exhibition Busworld 2019 in Brussels, Solaris showcases three ground-breaking

and completely emission-free buses, representing the broad offer of vehicles catering to the e-mobility concept. The first of these is the Solaris Urbino 18 electric bus, equipped with batteries of the latest generation. The one second is the longest, 24-meter Solaris vehicle – the trolleybus Trollino 24, on display in the new Metrostyle design. The last of the three is the highly technologically advanced Urbino 12 hydrogen whose big première took place a few months prior, at the UITP trade fair.



Solaris Urbino 18 electric

Nowadays, the distinctive line of the articulated Urbino 18 electric is known to many operators; over 200 models have been commissioned by clients so far. The bus displayed at the Busworld, however, has been uniquely equipped.

What is an absolute novelty is the new-generation batteries Solaris High Energy+ which the manufacturer is showing for the first time in Brussels. The batteries stand out on account of their high energy density, thanks to which the bus will easily be able to cover 200 km on a single charging session, irrespective of road and weather conditions. However, the perfected parameters of the energy storage tanks will also allow to maintain a still significant passenger load at a much increased range – there will be room for 120 people on the articulated electric bus, including 40 seated ones.

7 battery packs with a total capacity of 553 kWh have been installed in the Urbino 18 electric. 3 batteries have been stowed away in the rear end of the vehicle, and four – on the roof of the first section. The bus is charged via a plug-in connector, yet the new batteries also allow for pantograph charging (for more

details on the batteries, including the Solaris High Energy+, in the Urbino electric see pages 14-17).

The Solaris Urbino 18 electric on display has been equipped with advanced driver assistance systems (ADAS) which increase significantly both travel comfort and – above all – safety. The Mobileye Shield+ device remedies the risk of collisions with pedestrians or cyclists thanks to a system of smart cameras which constantly monitor the so-called blind spots in a vehicle. The driver is alerted to potential dangers with sound and visual signals.

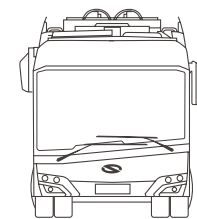
What is more, the electric Solaris will feature the system initiating automatic braking, i.e. the CMS (Collision Mitigation System). When a radar installed on top of the bus detects the risk of a potential head-on collision, the system goes into braking mode, reducing velocity and thus alleviating the consequences of a potential collision.

Where the side mirrors would be conventionally, the 18-meter Solaris features cameras that ensure improved visibility not only in bright sunlight, but also during rain or snowfall, as well as at night. What is more, the cameras increase

the field of view substantially and they improve the aerodynamics of the vehicle. This new solution is already available for the whole Urbino family.

In order to reduce the energy consumption as much as possible, the articulated Urbino electric features air conditioning with a heat pump which uses heat from the outside to generate an adequate temperature inside the vehicle. This device uses carbon dioxide as the working fluid which is currently considered the most environment-friendly solution. The implementation of the CO₂ heat pump is supposed to enhance the energy efficacy of the vehicle, and thus increase its drive range, but also to reduce noxiousness.

Yet another innovation applied in the vehicle is a traction inverter produced in the innovative SiC technology, i.e. using silicon carbide. Owing to this, the device can operate at higher voltage, frequencies and temperatures, which, in turn, results in a significant reduction of the mass and size of the power converter and in a general increase in efficiency of the whole system.



Solaris Trollino 24

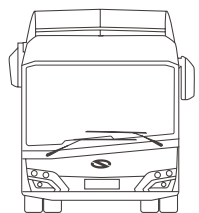
Presented to the public for the first time at the Busworld 2019, the bi-articulated Trollino 24 is the longest vehicle assembled by the Polish manufacturer so far. The idea behind the Trollino was to create a platform for the future, serial production of 24-metre vehicles with an electric or hybrid driveline and of trolleybuses. The Trollino 24 is a technically highly advanced model. Its driveline consists of two traction motors of 160 kW each, propelling two drive axles. A pack of 58 kWh batteries

installed in the bus is charged during the drive, collecting current from the overhead line via a bipolar pantograph traditionally in use in trolleybuses. What is more, the energy accumulated in the batteries will be used to fuel the trolleybus whenever it is detached from the electric traction line. In order to ease manoeuvres in urban traffic, the fourth axle of the vehicle has also been made the steering axle. Apart from featuring a unique door layout of 1-2-2-2-2, the vehicle has also been fitted with an electric

power steering (EPS) system, among others. Up to 215 persons will be able to hitch a ride on the trolleybus. This début model features cameras in lieu of side mirrors.

The Trollino 24 is also a first timer, built according to the new MetroStyle design form, adapted to the 4th generation Urbino (for more details on the MetroStyle design see pages 32-33).





Solaris Urbino 12 hydrogen

Also exhibited at the Solaris stand is the most novel product in Solaris' portfolio – the hydrogen-fuelled Urbino 12 hydrogen, which debuted in June 2019, at the UITP trade fair. It is a completely emission-free vehicle in which hydrogen is transformed in a fuel cell into electricity which, in turn, propels the driveline.

The Urbino 12 hydrogen is fitted with a state-of-the-art fuel cell of 60 kW which acts as a miniature hydrogen power plant on board of the vehicle. The sole "by-products" generated during the operation of the Solaris Urbino 12 hydrogen are heat and steam. Thanks to the use of advanced technology, the bus

will be capable of covering up to 350 km on a single refill.

As for the hydrogen storing technology, the Urbino 12 hydrogen features cutting-edge solutions. The fuel is stored in gaseous form in 5 new-generation composite tanks placed alongside on the bus roof. A multifunctional valve encompassing a range of safety measures is installed at the end of each cylinder.

The bus is equipped with a Solaris High Power battery whose role it is to support the fuel cell in moments of increased demand for electric power. The battery is recharged using energy derived from hydrogen

and energy recuperated during the braking process. Complementing the driveline is an axle with integrated electric motors.

Just like the Urbino 18 electric, the hydrogen vehicle also features a climate comfort system using a CO₂ heat pump. In this particular case, the pump additionally uses waste heat from the fuel cell. This solution guarantees very high efficiency and allows to increase the drive range of the vehicle even more.









#SolarisTalks >

Forum on modern public transportation

Let's talk about e-mobility



Solaris Stand, hall 5, nr 507
Every day at 1:00 pm

18/10/2019	19/10/2019	20/10/2019	21/10/2019	22/10/2019	23/10/2019
1:00-1:15 p.m. #SolarisTalks presentation + Q&A and networking					
					
The art of choosing the best e-mobility solution	Solaris battery solutions	Optiline. Genuine Solaris parts	Solaris goes hydrogen. Another option for zero emission buses	eSConnect. Remote diagnosis and predictive maintenance of e-buses	IMC, plug-in, pantograph? Which option to opt for?

#SolarisTalks

Every day at the Solaris stand the manufacturer holds the #SolarisTalks forum to share its experience and information about its products. The forum is also an invitation to talk about modern technologies used in the area of e-mobility and the changing image of public transport. The topics of short presentations opening the discussion concern, among others types and selection of batteries, charging systems for buses and trolleybuses, hydrogen vehicles or remote diagnosis for electric buses.

Batteries in electric buses of Solaris

The optimal solution for every customer!

Back in 2011, when Solaris unveiled its first electric bus, its offer included only one battery option. Over the next years the company has remarkably extended its technical competence in this area. Over 20 million kilometres covered by the electric buses Urbino and experience gathered from the operation of vehicles in dozens of cities in various climates make it possible for Solaris today to offer the optimal battery solutions to its customers.

When we talk of electric buses, sooner or later the discussion will turn to this question: "What is the range of the bus on a single charge"? Of course, this depends on a multitude of factors which boil down to two issues: the battery capacity and the energy consumption per 1 km.

Since the very beginning Solaris has turned the issue around, asking instead „What range is needed?"

And that is because what battery we offer for the electric bus, and what charging mode, and thus the range the vehicle will boast, depends on a slew of factors. This is related among others to the distance of the route, topography, climate or electric infrastructure on hand in a given city. Finally, what is extremely important are the preferences of future users and whether the clients prefer longer charging, but once a day – usually

in the night, or more frequent charging – throughout the day. That is precisely why Solaris has designed several types of batteries, in an attempt to meet all of these expectations. But first things first.

Today, Solaris offers the following batteries to its electric buses: Solaris High Power, Solaris High Energy and Solaris High Energy+.





Solaris High Power – meaning fast and often

Solaris High Power batteries are characterised by a high “power density”. In practice, this means that the batteries can be recharged with high current, and consequently we can recharge them very quickly. These batteries come in packs with a nominal capacity of 29 kWh each. We can install up to 7 packs in one bus, which sums up to a maximum total capacity of over 200 kWh. Crucially, the batteries have a long life and a significant number of charging cycles. The firm is able to ensure an unlimited number of cycles over a period of 7 years.

Generally, the Solaris High Power battery can be charged using electricity equivalent to four times

the capacity (4C). Thus, assuming that the bus features a battery of that type with a capacity of 116 kWh, then the maximum charging power for that battery will be 450 kW. Of course, engineers prefer to express the same parameter in ampere, because we do not use the same power throughout the whole battery charging process. So in fact we ought to say that the maximum current battery charging amperage amounts to 800 A. So far, Solaris has provided fast-charging pantograph stations for batteries of the High Power type with varying charging powers, reaching up to 560 kW!

The Solaris High Power batteries are used in circumstances when the frequent discharge and also recharge of batteries, usually using pantograph chargers, is assumed.

Of course, power can be replenished also using plug-in charging stations. This is a perfect solution for those transport systems where fast pantograph charging stations, deployed along the vehicle route or at line terminals, are used to recharge electric buses. This type of battery has been installed by Solaris in electric buses driving around in Brussels, Warsaw or Barcelona, for instance. It is worth noting that High Power batteries are also applied in the Trollino trolleybuses.

Solaris High Energy – we charge during sleep

The second type of batteries on offer are the Solaris High Energy. These have a relatively high capacity and are usually used in circumstances where a smaller number of “refills” during the day is assumed. The

maximum charging power of that battery in kW corresponds to its energy capacity expressed in kWh. The nominal capacity of packs in that battery totals 50 kWh. The maximum, standard number of Solaris High Energy packs amounts to six for a 12-metre bus and to seven for an 18-metre vehicle. When applying this type of battery, we have the possibility to reach a nominal capacity of 350 kWh.

This is a solid solution for those operators who prefer a smaller number of recharging sessions throughout the day. Most often though, the energy in this type of

battery is replenished at night, using chargers located at bus depots, i.e. when the buses are not running. This means that, just like people, buses “need to recharge during sleep”.

Of course, in the case of these batteries like in that of other battery types, it is possible to recharge them via a pantograph. Solaris High Energy batteries are installed among others in the Urbino electric buses that cruise around Cracow, Milan and Hamburg.

Solaris High Energy+ – or 200 km is not a problem

The firm’s latest development are Solaris High Energy+ batteries. These were designed by the Solaris Office of Development, bearing in mind the needs of carriers who want to cover at least 200 km on a single charge, regardless of the weather conditions, and thus regardless of air-conditioning or heating working.

The Solaris High Energy+ batteries are characterised by an extremely high energy density. Thanks to this feature, we manage to fit 79 kWh into one pack! This means that in the case of 7 packs – that is how many can be installed in an articulated bus at the most – we reach a nominal energy rate of 553 kWh! And 5 packs of that

battery will fit into a 12-metre bus. This battery type can be recharged using a power equalling its capacity.

The Solaris High Energy+ batteries will have their official première at the Busworld exhibition in Brussels, in October 2019. It may be worth underscoring that the solution is the result of cooperation between the Solaris and BZM Poland Research and Development Offices. Batteries of this type can be used only in vehicles bearing the Solaris trademark and as of today, no other producer in the electric bus market is offering them. The contractor executing the design initiated by Solaris is BMZ Poland, a leading European manufacturer of intelligent power supply and energy storage systems based on lithium-ion technology.



All of the above batteries, which are offered for electric buses of Solaris, boast a nominal voltage ranging between 600 and 700 V. The energy storage tanks used in the Urbino electric are capable of working in temperatures between -15 and +50 degrees Celsius. In order to optimise their efficiency, and to extend their service life, they are warmed up or cooled down. The battery cooling system is based on liquid-cooling.

Solaris draws a lot of attention to the issue of safety and environmental protection. That is why only the best components available on the market are used in the battery production process. The elements

used in the batteries undergo recycling processes implemented by producers of battery cells, and can thus be reused. The firm also works on a programme regarding the second battery service life. This means that the energy storage tanks whose capacity has fallen below customer expectations could serve as a stationary electric power storage facility.

“In the past nine years we have achieved inconceivable progress in terms of battery technology offered in our buses. That is why we are able to offer our customers tried and tested, reliable solutions which will make battery buses be

a dependable public transport mean, whereas operators will be able to perform their transport duties in all kinds of conditions,” reckons Michał Piłkuła, Director of the Office of Development at Solaris Bus & Coach S.A.



Solaris High Power

These batteries are characterised by high power density, which makes them perfect for trolleybuses, hydrogen-fuelled buses and for customers who decide in favour of fast charging.



Solaris High Energy

These are a great solution for customers seeking batteries that are able to ensure a big driving range on a single charge.



Solaris High Energy+

The latest option for electric buses of Solaris. Thanks to the extremely high energy density of the battery, a vehicle is able to cover a distance of up to 200 km on a single charge.





BERLIN

The biggest municipal operator in Europe, Berliner Verkehrsbetriebe (BVG) has been gradually transitioning to battery buses. After a pilot phase of several years, during which 4 Solaris Urbino 12 electric buses underwent tests, BVG ventured larger investments. Their goal was the complete replacement of existing diesel buses with new, ecological, emission-free electric vehicles by 2030.

Solaris is part of these revolutionary changes in the capital of Germany. In line with the recently signed contract, Berlin is to receive 90 electric Urbino buses of 12 meters by 2020. It is one of the biggest public tenders for battery buses in Europe. The driveline of these emission-free vehicles consists of a drive axle with integrated electric motors. The buses will also be equipped with batteries with a total nominal capacity of 300 kWh, and it will be possible to recharge them using a plug-in system.

From 2015 until 2019 the Polish manufacturer has been contracted to deliver 35 zero-emission buses for BVG. That number covers 20



twelve-metre Urbino 12 electric buses and 15 articulated Urbino 18 electric ones. Including the freshly signed contract, the number of Solaris-made electric vehicles used by BVG will amount to 125.

Each of the 90 buses commissioned by BVG will fit 70 passengers. For the passengers' travel convenience, the buses will have air conditioning, video surveillance, as well as USB

ports. What is more, a passenger information system with voice announcement of bus stops will be installed, too.



➤ By 2030, Berlin plans to completely replace diesel buses with emission-free electric vehicles.

Real zero-emission revolution

European cities which already have experience using electric buses, are now proceeding to hold larger and larger tenders for more vehicles. In the first months of 2019, Solaris has landed gigantic deals with Berlin, Milan and Warsaw, for a total number of up to 470 buses!

It is these huge tenders that will help transform public transport into one that is less environmentally intrusive. Large contracts will be crucial to reaching

the goal of reducing carbon dioxide emissions into the atmosphere. Solaris is a manufacturer which is one of the few able to perform large deliveries of battery buses, which is why it is the ideal partner in the process of making public transport emission-free.

Forecasts for public transport in Europe stipulate that in 2030 nearly half of all new city buses will feature an electric drive. The European Parliament went even

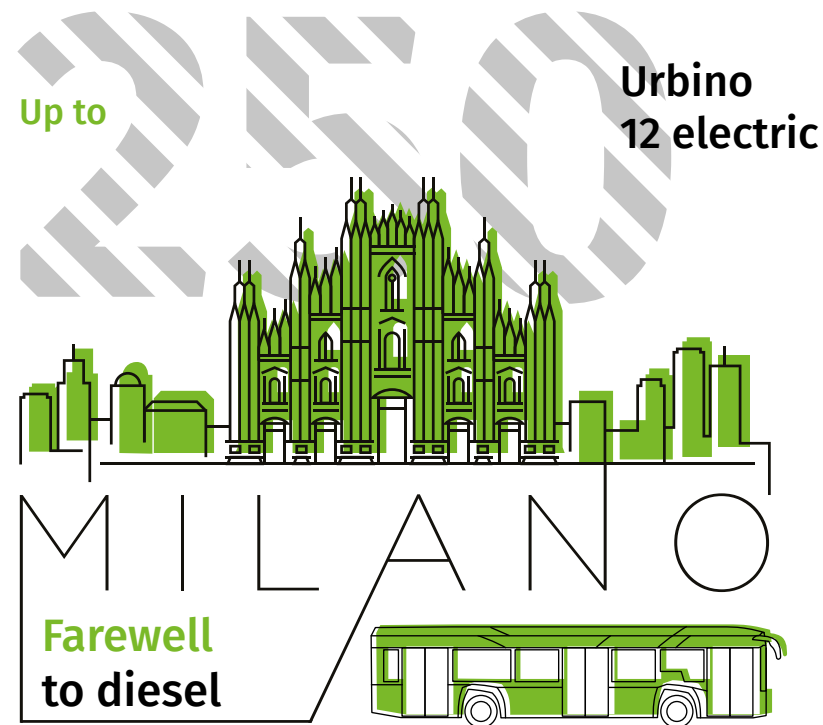
further, setting itself the goal to make that share climb to 75%. Considering that in 2018, electric buses made up barely 5% of the newly registered fleet, over the next decade we may expect to see a real zero-emission revolution.

MILAN

ATM Milano is a carrier with impressive plans – by 2030, it plans to forego diesel buses altogether. A milestone towards meeting that goal was concluding a framework agreement for the supply of 250 electric buses. Solaris may play a significant role in the transformation of Milanese transport. The first of the 40 contracted buses will venture out onto the streets of the metropolis in June 2020.

The buses Milan has chosen are the flagship product of Solaris: the Urbino 12 electric. The electric vehicles will be equipped with Solaris High Energy batteries with a capacity of 300 kWh, whereas recharging will be possible via pantograph or overnight using a plug-in outlet. The drive unit of the electric buses will consist of an electric axle with two integrated motors boasting a power of 125 kW each.

The comfortable, spacious vehicle interior will be complemented with a range of cutting-edge solutions



– USB ports for mobile device recharging, a passenger information system, and also video surveillance, which will enhance both pleasure of travelling and safety. Drivers will also have a view of the door and of pantograph on display, and a rear-view camera will be at their disposal.

The Urbino is known in Milan since 2014. Currently, some 150 Solaris vehicle drive around the capital of northern Italy, including 25 electric ones. As of next year, ATM plans to buy only electric buses.



➤ ATM would like for diesel buses to disappear from the streets of Milan and of the whole province by 2030. The whole fleet of 1200 buses is to be converted into battery vehicles.

➤ As of 2020, the operator will buy only electric buses.

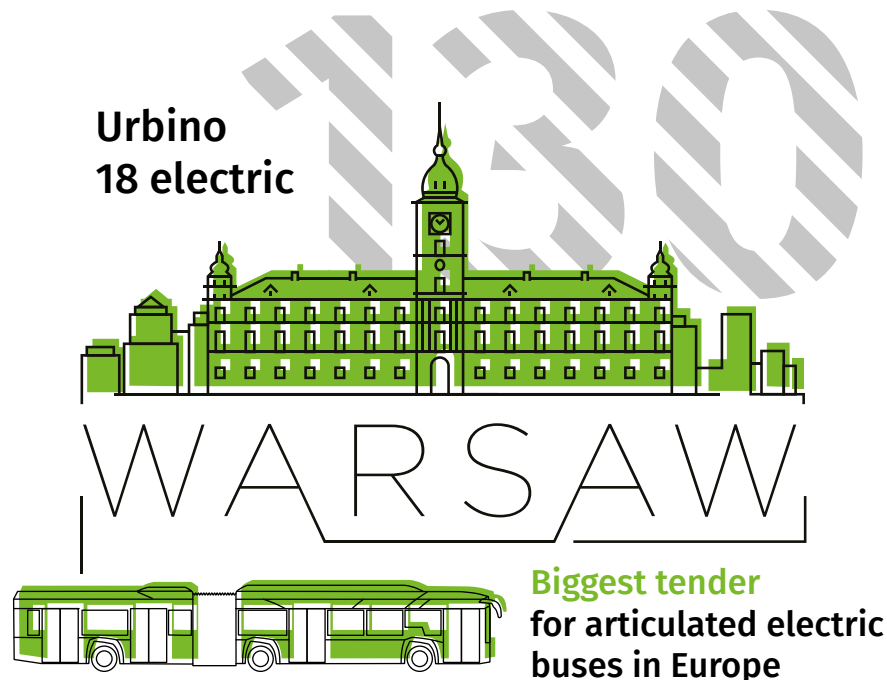
➤ Thanks to these ambitious plans, ATM will curb its CO₂ emissions by nearly 75%.

WARSAW

The gigantic order for 130 18-metre electric buses is the biggest ever tender for articulated electric buses in Europe. Over the next three years the carrier intends to carry out other investments, too, to ensure that by 2022, one third of the buses rolling out on the streets of the capital city of Poland every day will have an electric, hybrid or CNG drive.

The contract for 130 Urbino 18 electric is worth nearly PLN 400 million and pursuant to the contract it is to be performed in 2020. All electric buses for MZA will feature 150 kWh Solaris High Power batteries which will be recharged using depot-based plug-in chargers and pantograph chargers with a power of over 400 kW. Driveline of each of the electric articulated buses for Warsaw will consist of an axle with two electric engines of 125 kW each. What is more, the vehicles for operator MZA have been fitted with a traction motor voltage converter, produced in SiC technology, which will further help to reduce energy consumption.

The interior and equipment of the bus will be well-known to MZA



**Urbino
18 electric**

**Biggest tender
for articulated electric
buses in Europe**

passengers. The driver's cabin will be completely shut off, whereas the bus will be air-conditioned and will feature a comprehensive passenger information system. Furthermore, three double USB ports will be available to passengers, allowing for the recharge of mobile devices during a bus ride.

So far Solaris has delivered 20 electric buses to Warsaw. Thanks to the purchase of another

130 buses, in two years, the route running along the most prestigious roads of the capital – the Warsaw Royal Route – will be free of any diesel buses. All articulated battery buses will be delivered to Warsaw in 2020.



➤ In only two years, MZA Warszawa will own a fleet of nearly 400 zero- and low-emission buses, which will account for almost 1/3 of the fleet.

Hope for clean air in capital city

MZA started testing its first electric buses back in 2012 – and it used Solaris vehicles for that purpose. This type of bus fleet has been in regular operation for four years. So far, the fleet includes 30 12-metre electric buses. Subsidised by the EU, the purchase of 130 articulated electric buses is one of the biggest electromobility investments in Europe.

“We are glad to be one of the leaders in the implementation of environmentally sustainable transport solutions, and we would like to own a fleet of nearly 400 emission-free and low-emission buses in two years. The environmentally friendly buses of MZA give hope for cleaner air in the capital city,” notes Jan Kuźmiński, CEO of the municipal bus operator MZA Sp. z o.o.

“We have highly specialist knowledge and experience on the use of a fleet of electric buses, and we share that know-how with

representatives of firms and local governments from all over the world. We are satisfied with the operation of the Urbino electric we own. Their exploitation in everyday traffic in the city is cost-effective and does not create any bigger technical problems, whereas our passengers may enjoy ecological and low-noise transport,” Kuźmiński adds.

Obviously, in the first years when the electric buses were tested, the operator did encounter difficulties, too. The biggest challenge with regard to the operation of the first electric buses was their limited range on a single charge, which precluded whole-day journeys of the buses.

“Based on the experience we have gathered and on the new technological possibilities offered by producers, we already know how to use electric buses effectively. We have therefore decided to go for solutions that assume the setup of

fast charging outlets across town. In the first stage, Warsaw will get a network of twenty pantograph chargers which will enable the fast recharging of vehicles and thus ensure an optimal range,” MZA head Jan Kuźmiński elaborates.

Apart from the 30 electric buses already owned by MZA and the purchase of another 130, the operator intends to invest even more in the expansion of its fleet based on zero-emission technologies. Over the next three years alone the Polish carrier intends to acquire over 200 low and zero-emission vehicles, so that, by 2022, they make up one third of the buses regularly rolling out of the bus depot.



More safety

Over decades the impression arose that the only autonomous technology known from science-fiction films to actually work in our reality are automatically opening doors. In 2019, automated or autonomous solutions applied in everyday life are much more visible. In public transport, the benefits of such solutions are reaped not only by drivers and passengers, but all residents and road users.

In city buses, driver assistance and support functionalities (so-called ADAS, or *Advanced Driver Assistance Systems*) are an increasingly common feature. Casting aside illusions of vehicles driving wholly without drivers very soon, it is worth acquainting oneself with solutions that already serve bus drivers, and finding out, how these increase the safety of all road users.

Seeing more

The foundation for passive systems – meaning ones which do not take any actions autonomously – are appliances that allow the driver to see more. Cameras placed outside the vehicle detect pedestrians and cyclists who are not reflected in mirrors, especially during turns, even if it may seem to them that they must be visible to the driver. In order to solve this challenge, Solaris has availed itself of the MobilEye Shield+, a system warning the driver – with acoustic signals and visual alerts on the display

– also in cases when changing lanes without adequate signalling beforehand or when no appropriate distance to the vehicle in front is maintained. The system also alerts the driver to collision risks. The device detects every pedestrian and cyclist within 80 cm from the bus, alerting the driver to their presence – again, acoustically and visually on a display. What the driver does not see in the mirror is pointed out to them by the camera steering device. Thus only one thing disappears now, and that is doubts about the visibility on the road.

An enhanced visibility is ensured also by the completely re-designed mirrors, or rather cameras which project the image onto screens inside the vehicle. The ingenious design of the MirrorEye installed in lieu of regular rear-view mirrors corresponds to class 2 and 4 visibility (optionally class 5 in the right “mirror”) and this yields a whole range of advantages. Above all, there is no more need to reset

and adjust mirrors after a driver switch – the screens and cameras always display the optimal scope regardless of the driver’s height. The width of the vehicle is reduced – which is of great importance on narrower and tight urban streets, and which considerably reduces also the risk of collision or of snagging the mirror on infrastructure items. What is more, the cameras substantially widen the field of view and they improve the aerodynamics of the vehicle.

The lack of mirrors enhances the safety of passengers, pedestrians and those waiting at the bus stop. The device employed up until now protruded from the bus contours, which involved the risk of hitting a person standing too close to a bus passing or turning into a bus pullout. The warmed cameras do not freeze nor fog up and, owing to their reduced size, are easier to clean or wash during the daily cleanup of a bus. What is more, the screens can also show distance

thresholds of the various bus parts, such as its rear, particular doors or the axle. A horizontal line displayed on the screen eases manoeuvres and parking, and above all renders these procedures safer.

Gaining time

Active driver assistance systems help drivers by performing certain actions before them or in their stead, and thus provide them with invaluable seconds for a proper response. Solaris offers its clients the Collision Mitigation System (CMS) which initiates automatic braking. When a radar installed on top of the bus detects the risk of a potential head-on collision, the system goes into braking

mode, reducing velocity and thus alleviating the consequences of a potential collision. The solution is already used in coaches and has now been copied in city buses. The correct calibration and configuration is of great significance in city buses where – contrary to coaches – there are no safety belts and most passengers ride standing rather than on seats. Therefore the braking force is crucial for the passenger safety. It is an additional challenge that manufacturers had to take into account in designing city buses.





learning mechanisms. The 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 Smart Growth Operational Programme 2014-2020, co-financed by the European Regional Development Fund (ERDF) (POIR.04.01.02-00-0081/17).

Meanwhile, as part of the international project Trustonomy (an amalgamation of the words trust + economy; co-financed under the Horizon 2020 programme, GA no 815003), the Polish producer intends to maximise efforts focused on the safety of automated vehicles, but also on increasing trust in and acceptance of those. A well-integrated, interdisciplinary approach, connecting experts and everyday users will help us face the technical and the non-technical challenges. Solaris offers assistance in creating test procedures and with outlining the guidelines regarding the integration of systems in a vehicle, as well as with controlling autonomous systems on the test track in line with previously set out rules.

500 Solaris buses on Norwegian streets

Solaris has been present on the Norwegian market since 2006. Since then, a few hundred Urbino buses of different lengths and featuring a variety of drivelines are now in operation on the roads of the land of fjords. Including the recent supplies for operator Unibuss, the number of Solaris vehicles will exceed half a thousand. Regardless of their lengths and drivelines, all buses are adjusted to covering routes in the coldest of weathers.

Solaris kicked off supplies of 21 buses for its biggest client in Norway, the firm Unibuss AS. The carrier's fleet already encompasses more than 250 vehicles of the Urbino family and soon it will increase by 15 standard-length Solaris buses and 6 articulated ones. The newly delivered Urbinos included the 500th Solaris bus supplied to Norway.

All of the vehicles commissioned by the carrier will be propelled by eco-friendly Euro 6 motors meeting the most rigorous emission standard. Just like all of the other

Scandinavian Solaris buses, the new ones are equipped with a special Scandinavian thermal insulation package which improves the thermal comfort of passengers while reducing the energy consumption in the harsh weather.

"I am extremely happy to present more buses of our brand in the capital of Norway. The current delivery is particularly important because in its course Scandinavia will witness the long anticipated début of the latest version of the articulated city bus," said Sverre

Skaar, the Managing Director of Solaris Norge AS which is in charge of after-sales maintenance of the vehicles.

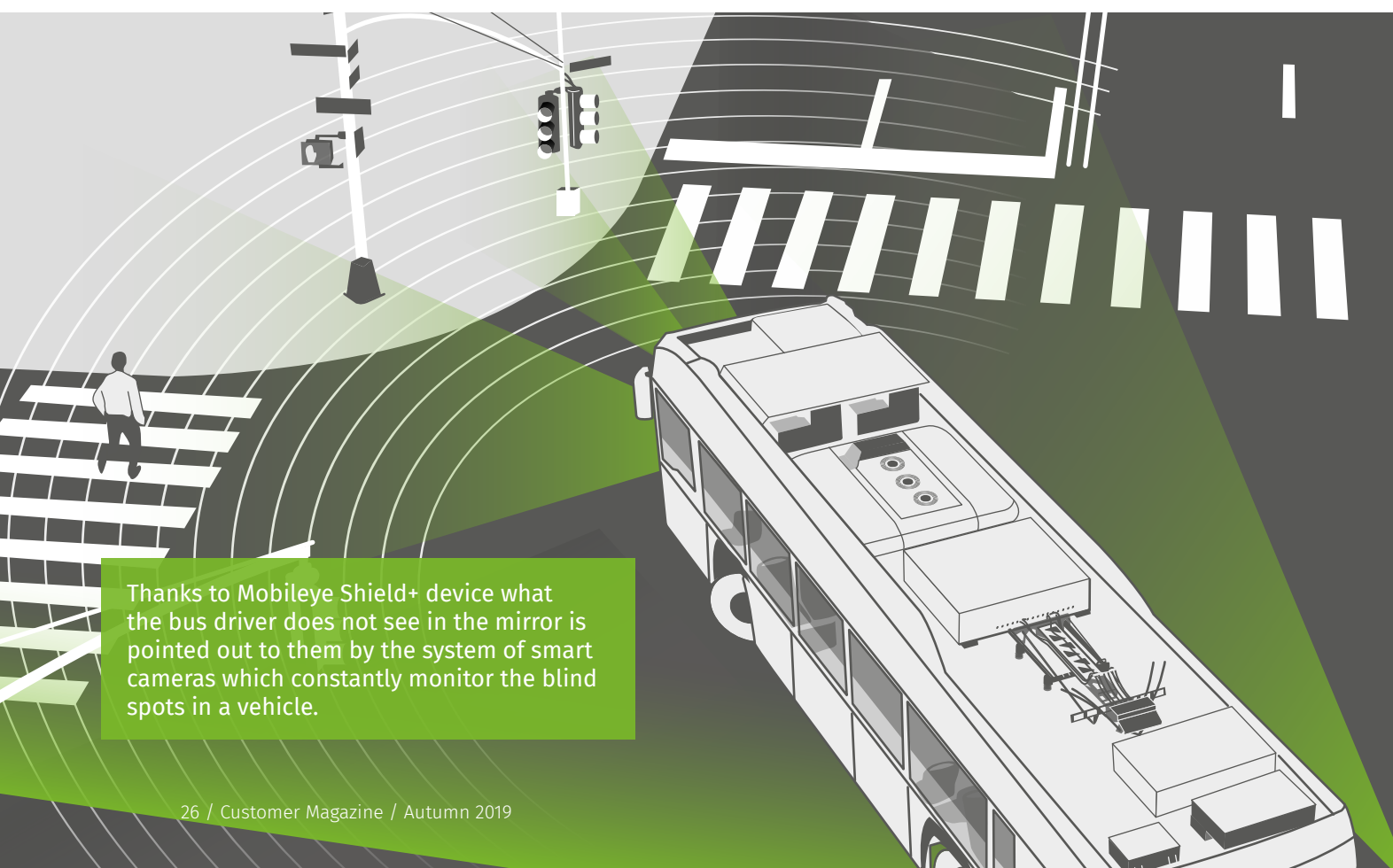
The first bus was delivered by Solaris to the Norwegian market 13 years ago. Today, there are several hundred of these driving around over a dozen cities in Norway. These include vehicles with a length ranging between 8.9 m and 18.75 m, propelled by eco-friendly diesel engines, low-emission vehicles with a hybrid and CNG drives, but also 14 Urbino electric buses.

Nearest future

Already available for buses, the ADAS equipment is only a small section of what the engineers and builders of Solaris are working on. Another solution to be introduced in the near future is the Driver State Monitoring system (DMS). The cameras analysing the driver's face will alert him or her, should the driver be distracted, keep looking around or show signs of drowsiness, and thus will substantially raise the

safety of passengers and the drivers themselves.

Another project conducted by Solaris in collaboration with the Poznań University of Technology, is work on an advanced system of supporting accurate manoeuvres for city bus drivers, above all those driving electric buses. It consists in the construction of a system of concurrent self-locating and map creation with detection of other road users, with the help of constant



Thanks to Mobileye Shield+ device what the bus driver does not see in the mirror is pointed out to them by the system of smart cameras which constantly monitor the blind spots in a vehicle.



In the picture: (from left) Javier Calleja, CEO of Solaris Bus & Coach; Knut Gunnar Dissen, Technical Director, Unibuss AS; Sverre Skaar, Managing Director, Solaris Norge

eSConnect

bespoke solutions

Embracing the global development of the e-mobility market and the customer needs which we continuously monitor, Solaris engineers have ventured to design a very special product.

Comprehensive e-mobility solutions

The eSConnect is a modern system of remote diagnostics for electric buses dedicated to those Solaris clients who have decided to purchase emission-free vehicles.

eSConnect constitutes the expansion of Solaris' existing offer of e-mobility solutions. The firm warrants a comprehensive offer in this regard, starting with the drafting of a feasibility study, through the supply of state-of-the-art Urbino electric buses including the complete charging infrastructure. The e-mobility service range is completed by a cutting-edge system of remote diagnostics offered to customers precisely in the form of the eSConnect.

Monitoring, diagnosis, maintenance, optimisation

Designed by an interdisciplinary team of Solaris experts, the up-to-date software represents a multifaceted tool that enables the efficient management of a fleet of electric buses and the optimal use thereof. The eSConnect is an accurate diagnostics instrument, facilitating and supporting maintenance capacities. The methodically constructed base of physical performance data allows for the conscious and economical use of the bus fleet by drivers and its management by operators. The collected data allow customers to accurately define the technical requirements for buses used on particular routes and lines. One tangible benefit of the data base

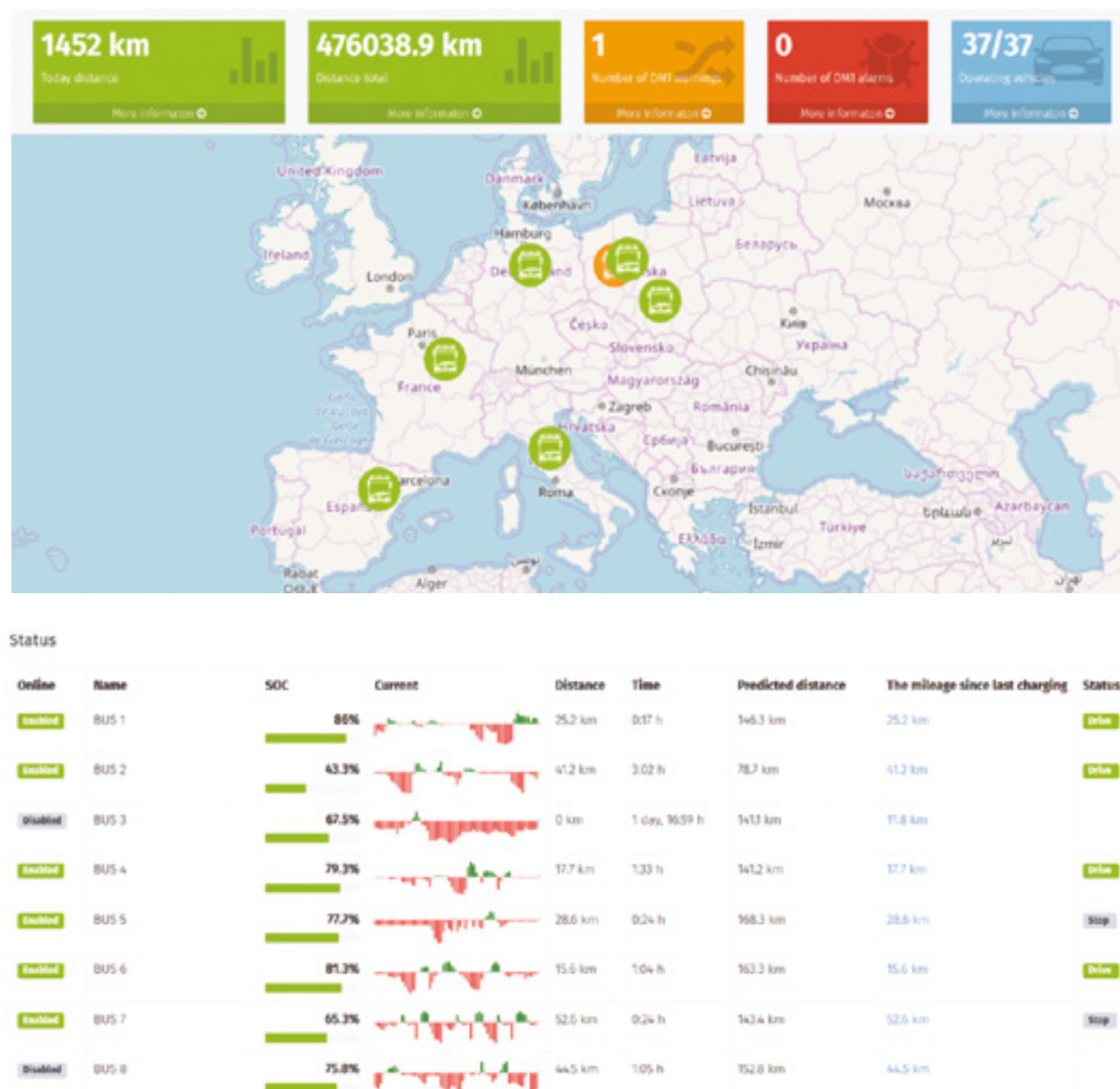
in development is the possibility of perfecting applied solutions by the producer itself.

Green, Silver, Gold

The eSConnect is a comprehensive service. As part of a monthly subscription, the user may take advantage of the connection to the system, the transfer and storage of data, the servicing system and the access to the remote maintenance service. Depending on the needs, the eSConnect service can be accessed by Solaris clients in three variants: Green, Silver and Gold.

eSConnect
SOLARIS





Pinpointing needs

Standing out among the many functionalities offered by the eSConnect system to users are:

- 01 access to vehicle data in real time
- 02 monitoring of up-to-date operating parameters of the vehicle, such as energy consumption, battery charging status, predicted range
- 03 real-time bus fleet location tracking
- 04 monitoring of routes of particular vehicles
- 05 generating statistics and reports on, i.a., the number of charging cycles and the time needed to recharge batteries
- 06 real-time identification of defects or alerts signalled by the vehicle on the driver's panel
- 07 identification and analysis of possible faults with notification of the operator
- 08 swift maintenance support – the Solaris service has remote access to diagnostic data which substantially shortens the repair time

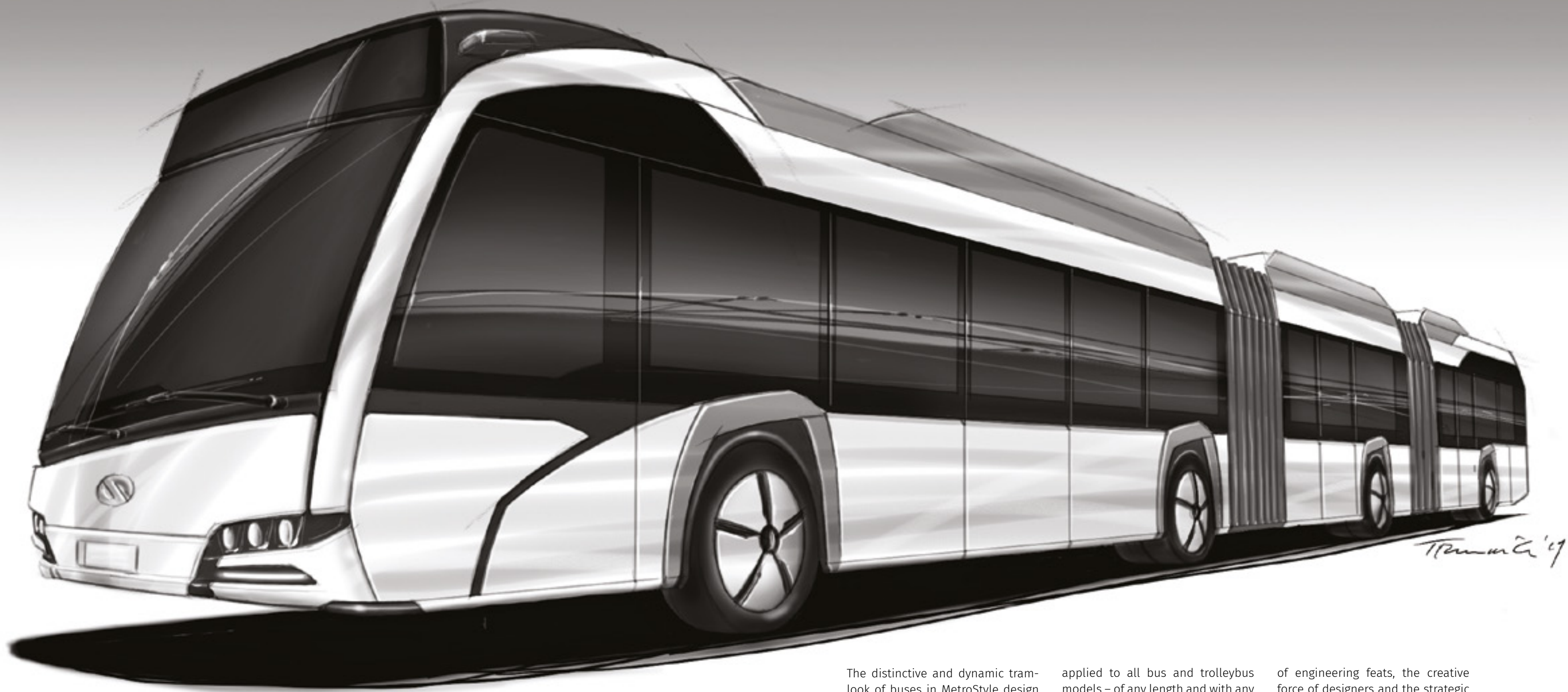
Technology of the future

The existing functionalities of the eSConnect do not determine the final shape of the application. The Solaris expert team is constantly developing new utilities, expanding among others the base of available overviews and statistics. The knowledge and experience of people involved in the development of this product directly affect its adjustment to the needs of both clients and the e-mobility market as such.

The data collected by the app are presented in a visually appealing form of charts and graphs. As the functionalities of the app get expanded, the current users will be guaranteed regular updates. It is worth noting that the eSConnect was fitted with an API interface that allows for its integration with external programmes.

➤ It is worth noting that the eSConnect system may be installed both in every newly produced electric bus, as well as in those already delivered to customers.





MetroStyle

anew

Solaris presented the new MetroStyle model, adapted to the fourth-generation Urbino. The special design is earmarked above all for metropolitan Bus Rapid Transit (BRT) routes. The premiere vehicle to be built in line with the new design is the Solaris Trollino 24, the longest trolleybus on offer at Solaris and presented to the public for the first time at the Busworld 2019 in Brussels.

The distinctive and dynamic tram-look of buses in MetroStyle design is a response to the latest trends in public transport. The vehicles in this design were specially developed to cater to BRT systems.

The intention behind the change of the former design was simple - to draw attention. The market calls for bus models boasting an ambitious design, and thanks to the new MetroStyle look operators will be able to clearly communicate to their customers that they are striving to ensure the best travel experience possible.

It was also important for the producer not to create a separate product dedicated solely to BRT routes, but to develop a new, metropolitan design that can be

applied to all bus and trolleybus models - of any length and with any kind of driveline. This broad range of options enables a much bigger configuration freedom to customers. Also importantly, Solaris is able to ensure the same passenger load for vehicles in the MetroStyle design, as for the standard edition ones.

In spite of the new front design of the bus, the producer will maintain the same work space comfort for drivers - in terms of seat position and driver cabin ergonomics. Instead of conventional mirrors, Solaris will offer innovative cameras which will surely enhance the drivers' comfort, but above all safety.

The new MetroStyle generation is the result of the deep integration

of engineering feats, the creative force of designers and the strategic goals of Management. The objective was to develop a bus model that would unquestionably embody the Solaris DNA but at the same time have their own unique character. In this regard, Solaris treats the new MetroStyle look as the premium design version within its product portfolio.

At the Busworld 2019 in Brussels, Solaris will present the new MetroStyle design on the bi-articulated Trollino 24 trolleybus. This particular bus length will be perfect for highly urbanised metropolises and for the busiest, special fast routes.

After the „Direction > E-mobility” conference in Gdynia

At the beginning of June, Solaris held its second conference titled “Direction > e-mobility”, and focusing on the company’s strategy, though above all – on the vehicles and technical solutions of the manufacturer related to electromobility. This time the conference guests – dozens of specialist journalists from all across Europe – were invited to Gdynia where Solaris and local operator PKT Gdynia presented the Trollino and the pertinent servicing infrastructure.

Solaris started its journey towards electromobility in 2001, when the firm produced its first trolleybus. That vehicle had been ordered by local operator Przedsiębiorstwo Komunikacji Trolejbusowej in Gdynia. Now, there are nearly 90 trolleybuses rambling across town; and next year, the PKT will receive a total novelty coming from Solaris – six Trollino super-trolleybuses. These novel vehicles represent the synergy of trolleybus and electric bus. By organising this year’s conference “Direction > e-mobility” Solaris decided to hark back to its experience in manufacturing trolleybuses – which are emission-free vehicles that have been around for decades – and to invite its guests to none other than Gdynia. This city possesses an intricate trolleybus-focused public transport grid and has been investing for years in its development, implementing cutting-edge solutions.

Solaris is currently the biggest producer of trolleybuses in the EU, and the meeting in Gdynia posed a unique opportunity to the firm to showcase its extensive experience in the production of the Trollino, as well as the advanced technologies, such as, for instance,

the use of batteries in trolleybuses or the recharging when vehicles are hooked up to the traction line, i.e. the so-called In-Motion-Charging (IMC). During the three-day conference, journalists had the opportunity to take a peek at the first trolleybus produced by Solaris and an absolute novelty in the Trollino family – a 24-metre, articulated trolleybus which was tested precisely there, on the streets of Gdynia.

The conference would have been incomplete if there had been no mention of Solaris’ achievements in the electromobility sector, or of premiere solutions and products – the hydrogen-fuelled Urbino 12 hydrogen, the new High Energy+ batteries, characterised by a large energy capacity, or of the electric bus fleet monitoring system eSConnect of Solaris’ own design.

The speakers at the event included: Marek Gucia – deputy mayor of

Gdynia, in charge of Innovations, Marcin Wołek – deputy chairman of the Gdynia City Council and Marta Woronowicz of PKT Gdynia, who all spoke about the plans of the city and of the operator to expand the trolleybus fleet in Gdynia. Thanks to this event, the audience were given a full set of information – ranging from the city strategy for electromobility, up to the actual implementation thereof. Also speaking at the conference was Jürgen Lehmann, an independent expert of the association Trolley-motion.eu who presented major data of the trolleybus market, in particular though the number of trolleybus systems around the world and in the EU, and the market shares of particular manufacturers.

During the first conference of the “Direction > e-mobility” cycle in 2018, Solaris presented its portfolio of electric buses of the Urbino electric family running on the streets of Cracow and of Jaworzno.

In the picture: Javier Calleja, CEO of Solaris Bus & Coach S.A.



We create great things together!*

Solaris is employer to nearly 2500 people. Having all of its production plants located in the Greater Poland province, the firm has strong ties to this region and ever since its establishment, it has been undertaking numerous measures for its employees so as to create an optimal working environment, development opportunities and a friendly atmosphere.

These measures include:



Trainings

- For over eight years the firm has provided its staff with the opportunity to attend trainings to raise their foreign language skills. At the moment, employees can choose between classes of English, German or Spanish, among others.
- Apart from language courses, employees can also take advantage of trainings for the development of managerial skills, products, soft skills or trainings that allow employees to obtain many different licences.
- The number of training man-hours in 2018 totalled **19 287**.

Dual education system

- Since 2007, Solaris has been pursuing its programme of Practical Vocational Training via sponsored classes in cooperation with schools from the Greater Poland region.
- In 2014, the company expanded its dual education system by taking up cooperation with the Poznań University of Technology (Politechnika Poznańska).
- So far, 43 persons have participated in the Dual Study programme, whereas the programme of sponsored classes has been completed by nearly 100 students so far.

***Slogan of the employer branding campaign on display among others on billboards, the website, social media, and which a dozen or so Solaris workers took part in.**

Promotion and career opportunities

- Solaris gives its employees the possibility of vertical promotion (related to the change of seniority in the organisational structure), as well as horizontal promotion (switching to a position in a different organisational area, while maintaining the same seniority in the organisational structure).
- **90%** of all managers have been chosen in the course of promotion from within the organisation.



Internal communication

- Solaris lays strong emphasis on all employees receiving news about the life and activities of the firm. That is why countless internal communication tools are in use (including): Intranet; meetings of all staffers with the Managing Board held a few times a year; the in-house news magazine "Przystanek" (Bus Stop), which has been published **for 16 years** now; the company Newsletter; mailing; telephone apps; numerous showcases and posters.



Retired Employees Club

- Since 2016, a Club for the Elderly has been operating in Solaris; it currently brings together 40 former employees of the firm who retired due to old age or disability. Thanks to this club, employees who have concluded their employment with Solaris can continue participating in the company's life.



Nursery

- Since 2012, Solaris has its own in-house nursery called "At the Green Dachshund" for the children of employees.
- Since its establishment, over 100 children have attended the nursery.



Fringe benefits

- The firm has launched a system of benefits where each employee can choose those benefits suiting them best, for instance private healthcare, sports discount cards, vouchers for many shops, cinemas or restaurants.
- Solaris has created its own programme, named "My Solaris", which allows company employees to benefit from many discounts for both products and services.
- Every employee is awarded a holiday bonus annually, in other words a holiday leave subsidy.
- In the company canteen, employees can eat lunch meals subsidized by the employer.



Diversity and equal opportunities

In 2018, Solaris held a recruitment campaign encouraging also women to participate in recruitments for production jobs, in particular jobs related to welding. As a result of the campaign, the factory in Środa Wielkopolska hired its first female welders. The campaign has also earned the firm a distinction in one of the most prestigious employer branding contests in Poland, the **"Employer Branding Excellence Award 2019"**, in the category "Innovation".

Integrating and identifying with the firm

- Currently, the firm is holding an EB campaign involving employees who promote Solaris as an employer on websites, in films, on billboards and social media. Solaris and its staffers are organising a slew of integrational activities, such as:
 - a Christmas contest with a New Year's Eve party being the main prize,
 - a soccer tournament,
 - an Open Door day during which employees can invite their families into the company,
 - a photo contest for the best snapshot featuring a Solaris bus. The company is currently holding the 26th edition of that contest.
- The firm has also earmarked a budget for integration within departments per employee.

Electric road towards the future

Solaris Sverige AB, the representative of the Polish company Solaris Bus & Coach on the Swedish market, participates in an innovative project titled „EVoLution Road” and concerning the construction of an electric road which automatically detects and charges electric vehicles. A Solaris-built trolleybus will be adapted for test drives on the ingenious road. The aim of the initiative is to test novel ways of electric vehicle charging and paving the way towards fossil-free transportation.

„EVoLution Road” is an electric road which will enable the battery charging of buses – and eventually of other electric vehicles – both during rides and in stationary mode. Initiated by the Swedish company Elonroad AB together with the Faculty of Engineering at the University of Lund, this cutting-edge research and development project will be carried out in cooperation with members of the industry, academia and public sector. The test vehicle used in the project is a Solaris trolleybus.

The demonstration site is to be situated in the city of Lund in southern Sweden, where a one kilometre long section of the road will be equipped with electric rails, each of them one meter long. A specially developed pick-up aggregate will be built into the chassis of the Solaris Trollino trolleybus selected for test drives. The traction batteries of the vehicle will be charged as the pick-up receiver under the trolleybus connects with the conductive rail installed in the road. Solaris will be responsible for developing the technical integration between the onboard charging systems and the

custom made conductive pick-up receiver installed under the vehicle. The construction of the demo site starts in the first quarter of 2020 and the entire project is scheduled to run for three years. The investment is worth EUR 9m in total and the procurer and main financier is the Swedish Transport Administration.

The road uses wireless communication to identify electric vehicles approaching and switches on power in the rail segments directly underneath the vehicle. Power can only be supplied through one concrete rail segment the pick-up receiver installed in the vehicle is able to connect with and through which it receives power. In all other segments in front and behind the moving vehicles, the power will be turned off, making it safe to install this type of charging both in cities and on highways.

Among the main advantages of this type of in-motion charging is the fact that it significantly reduces the need for a large number of traction batteries. This in turn results in reduced weight and cost

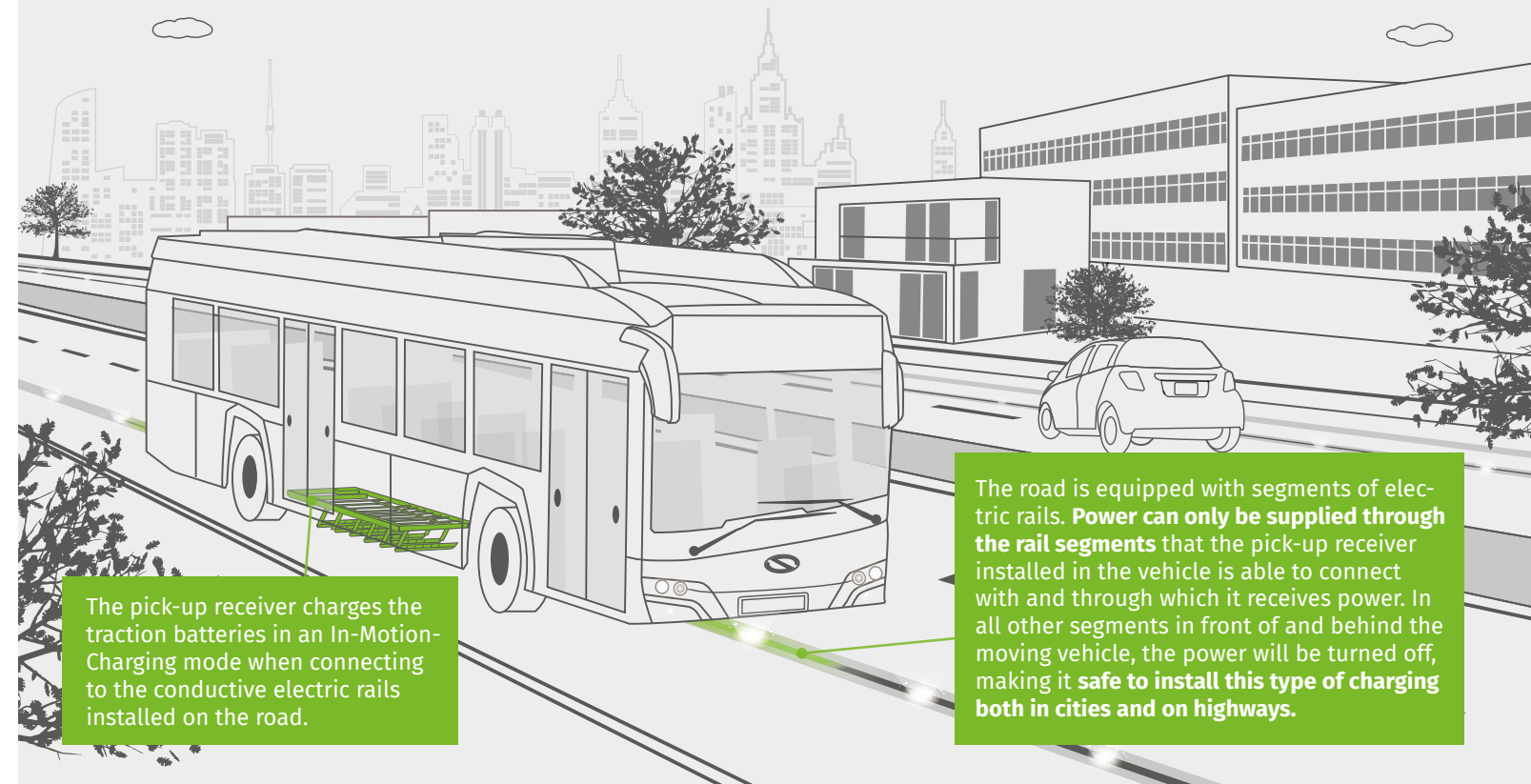
of the electric vehicle purchase and operation. It also allows to save time as it is no longer necessary to make regular stops to recharge the batteries.

The installation interferes very little with the existing urban infrastructure, since no masts or overhead wires are needed, and no side-rails will be necessary to protect from potential collisions with pantograph charger masts. The plans assume that charges for using the electric road will be made automatically thanks to wireless communication between the vehicle and the road.

Apart from Solaris, the partners of this project that is truly innovative on a global scale include the Faculty of Engineering at Lund University, the Swedish National Road and Transport Research Institute, Lund municipality, Elonroad, Innovation Skåne AB, Kraftringen Energi AB, Ramboll AB and Skånetrafiken.

EVoLution Road

The road uses **wireless communication** to identify electric vehicles approaching and switches the power on in the rail segments directly underneath the vehicle.



The pick-up receiver charges the traction batteries in an In-Motion-Charging mode when connecting to the conductive electric rails installed on the road.

The road is equipped with segments of electric rails. **Power can only be supplied through the rail segments** that the pick-up receiver installed in the vehicle is able to connect with and through which it receives power. In all other segments in front of and behind the moving vehicle, the power will be turned off, making it **safe to install this type of charging both in cities and on highways.**

ELONROAD



Solaris Optiline

Solaris original spare parts line

Extensive market experience

Nearly two years since its market launch, the Optiline spare parts line has established itself as a strong brand, enjoying the trust of customers. The products bearing the Solaris logo already account for millions of kilometres covered, billions of braking motions and countless litres of cleansed fluids and air.

So far, Solaris has supplied 19,000 brake pad sets and over 24,000 filters used for various purposes. They have ended up with customers all across, and even beyond, Europe. And it is precisely the customers on each of the markets Solaris operates on who test the efficiency of the Optiline gear. Therefore, they have proven their effectiveness in countries with radically different weather conditions, which considerably affects the performance of consumables.

MPK Kraków bets on Optiline

One of the customers banking on Optiline is operator MPK Kraków. With years of experience under its belt, the municipal carrier owns a fleet of 560 vehicles in total, including 400 Solaris buses in diverse configurations.

“Our first experience with Optiline products has shown that they meet the requirements set forth for them,” declares Krzysztof Wieczorek, who manages the bus depot in Cracow district Płaszów. “We have a full guarantee that these products fit the vehicle and can replace original assembly parts,” he adds.

MPK Kraków is one of the biggest public transport operators in Poland. Every day, a huge fleet of public transport vehicles roll out onto Cracow streets. It was in those challenging conditions that the real effectiveness of Optiline products was confirmed. Brake pads installed in vehicles of MPK Kraków have achieved mileages of up to 120,000 km.



➤ **Our first experience with Optiline products has shown that they meet the requirements set forth for them. We have a full guarantee that these products fit the vehicle and can replace original assembly parts.**

Krzysztof Wieczorek
managing the bus depot in Cracow
district Płaszów

Interestingly, they have been installed not only in Solaris buses but also in vehicles of other brands. MPK Kraków went for Solaris brake pads to begin with. Since then it has been gradually extending experiments to include other Optiline spare parts, testing also filters and air bellows in its vehicles. Thanks to the fact that the range of Optiline products is so diverse, it is possible to use them in vehicles with diverse equipment. This is particularly important since the fleets of most carriers encompass vehicles of varied configurations

"It has been a huge distinction for us that MPK Kraków went for products of the Optiline range. We are extremely glad we meet the expectations of that customer, also in terms of after-sales services,"

remarks Petros Spinaris, managing board member of Solaris Bus & Coach, in charge of Sales and After Sales.

More than servicing costs

"We notice increasingly that, apart from effectiveness and price, our customers also pay attention to the fact that it is the right selection of operating components that influences the travel comfort of passengers," Spinaris adds.

The brake pads, air bellows, air-conditioning filters or filters affecting the quality of exhaust gases, directly contribute to this. Thanks to extensive laboratory and field tests, products of the Optiline gamut have been refined to a point where they represent the highest

quality also during the process of vehicle operation. By providing stable rides even on the most bumpy of roads, noise-free operation of the brake system when approaching bus stops and thoroughly cleaned air in the passenger compartment, the producer aims to ensure the highest travel quality. In this way, together with carriers, Solaris seeks to convince city dwellers of the benefits of public transport.



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Servicing buses with alternative drivelines

As the market of alternative drive vehicles is developing, Solaris' sees more and more operators concerned with the well-being of the environment choose green technologies joining its circle of clients. However, new drivelines also mean new challenges. The maintenance of low- or zero-emission vehicles can differ strongly from the maintenance of diesel vehicles. That is precisely why Solaris offers extensive expert support in the area of alternative drivelines; these specialists help optimise maintenance service.

The maintenance of alternative drive vehicles is a complex process which Solaris learned step by step, just like other suppliers did. The producer has signed over 100 contracts with customers for the supply of electric vehicles, and dozens of contracts for the supply of hybrid vehicles. This experience allows the firm to realistically assess the possibilities of vehicle servicing, to advise clients and to help them prepare for the operation of new vehicles.

Solaris authorises its clients to perform repairs of buses based on a series of specific criteria. What is of importance is the scope of technical resources, the possessed

infrastructure, as well as certificates and experience of staffers. In the case of electric vehicles, these criteria are in practice much more restrictive than those regarding the servicing of diesel models. Often this is determined by occupational health and safety regulations, for instance provisions requiring adequate safety precautions when working on the roof, i.e. for work on heights of over 3 metres. Pursuant to binding regulations, the staff, too, has to be adequately trained and must possess respective certificates for work involving electrical appliances. All these issues determine the scope of the authorisation granted to customers to carry out repairs of electric

vehicles in the customer's in-house repair shops. Possible limitations to the authorisation are merely an expression of concern for the safety of the technical personnel carrying out maintenance and that of passengers.

All areas in which the customer may perform repairs are clearly specified in the maintenance contract. Solaris offers technical trainings, conducted by experienced specialists, for each of these fields. Other aspects of maintenance are fully covered by Solaris. In this respect, the firm offers full support and endeavours to see this support reach the customer as soon as possible. That is why the network of maintenance service providers is organised in such a way as to offer customers assistance on many levels. Obviously, first contact occurs through a local Solaris service point which is also supported by experienced, locally operating technicians. In complicated cases, reinforcement arrives in the form of mobile service workers (flying doctors).

Full Repair & Maintenance Contract

Owing to the complexity of the maintenance process, in particular for alternative drive vehicles, more and more customers decide to hand over the whole maintenance service to Solaris experts (under a so-called Repair & Maintenance Contract). This is a perfect solution for customers who lack adequately trained personnel or who are too inexperienced with regard to the latest technologies. Usually, adding an electric drive vehicle to one's fleet necessarily calls for the immediate restocking of the workshop with new infrastructure, which means

huge complications for the customer. This, too, can be avoided if one commissions the repair and maintenance of the vehicles to Solaris Service. Depending on the form of the contract and on the technical resources, these repairs are then performed either in the customer's repair shop or at a Solaris service point. In addition, the years of experience and direct contact with suppliers help shorten the response time and thus result in faster repairs.

eSConnect

The key to shortening the repair time is a correct diagnosis. Both

clients who do the maintenance of their vehicles themselves, and those who commission it to Solaris service workshops, can now take advantage of a new solution – the remote diagnostics system eSConnect. For more details on that product see pages 28-31.



Solaris' volunteers

helping again

The “Green Dachshund Foundation – for the rescue of the defenceless”, established and run by Solaris, is summing up the result of an in-house fundraiser for children and youths of the Sociotherapy Centre in Gołańcz.

Employees of Solaris had once again the opportunity to get involved in an employee volunteering project and they participated in a gig for the wards of the Sociotherapy Centre in Gołańcz. The theme of the fund-raising event was sports equipment, in an effort to pitch physical activity among the children under the care of the centre. Under the pretext of spring cleanups, employees of the firm were able to hand down their own contributions in kind. What is more, the foundation sponsored the purchase of bikes. The campaign met with huge interest, which is why, during the fund-raiser, the organisers collected bikes, roller blades, scooters and other sports gear worth in total nearly PLN 15,000.

“Employee voluntary service is an idea that is deeply ingrained in the DNA of Solaris. I am proud that there are so many among our staff willing to provide selfless help. I hope that the gear handed out will make it possible for the pupils to spend time actively,” notes Alicja Malewicz-Pelczyńska, Director of Marketing Communication and member of the Board of the Green Dachshund Foundation.

It is not the first time that Solaris employees have got involved in volunteering. Among the similar campaigns, one should mention participation in the programme “My Own Place” which involved the make-over of the room of an elderly resident of the Nursing Home in Poznań, humanitarian aid for Ukrainian citizens during the

armed conflict in 2015, as well as regular fund-raisers for employees in need and for the pupils of the Special School in Kowanówko. The fundraiser completed just now marks the announcement of further campaigns of the company regarding social corporate responsibility.



We work together – we train together – we win together!

Report on the Poznań Business Run 2019

On 8 September, at exactly 10.30 a.m., the Business Run 2019 kicked off in Poznań. Of the nearly 750 teams, each consisting of 5 persons, a total of four represented Solaris. Six women and 14 men were among the 20 Solaris runners representing various departments. Each of the representatives was to run a 3400 metres in the relay race.

Dressed in company caps and T-shirts of Solaris, the runners scored very well. The team ‘Solaris 01’ came seventh with a time of

01:02:02 – against nearly 750 teams taking part. As the participants said themselves, to them, the Business Run provided not only a chance to support a worthy goal and a reason to increase their physical activity, but also a great opportunity for inter-departmental integration.

The Business Run is a business charity relay race which is held in nine Polish cities on the same day and at the same time. The money raised in fees for start-up kits is spent on support for disabled

persons. The race route in Poznań ran along the right bank of the river Warta, whereas the start/finish line was located under the Roch bridge.

➤ The best Solaris team came 7th against nearly 750 teams taking part!



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