

RAMPINI HYDRON: World Premiere at Busworld Brussels

- Italian company first time at Busworld Europe with new management
- Full range of Mini and Midi e-Buses displayed in Hall 6, booth 606a
- Modern Italian styling (“Stile Energetico”) by Studio Vernacchia
- World Premiere of the Hydrogen Range Extender Midibus HYDRON
- Range of more than 400 kilometres with capacity of up to 48 passengers by flexible **Hy4Drive-System**, nominated for Busworld “Digital Award”

Brussels / Passignano sul Trasimeno, Perugia, October 6th 2023. The medium-sized Italian bus builder RAMPINI spa in Passignano sul Trasimeno (IT) participates for the first time in its history in Busworld Europe in Brussels and shows its full portfolio of Zero Emission buses in a compact size. The highlight will be the presentation of the new Hydrogen Range Extender Midibus HYDRON, that goes into production in 2024. Also the electric version of the eight meter Midibus ELTRON is featured with a new Design called “Stile Energetico”, made by the prestigious Italian Design Studio Vernacchia. Last but not least the smallest family member with six meters length joins the show: the SIXTRON for up to 28 passengers – also fully electric.

The company: almost 80 years of automotive craftsmanship

Founded in 1945, the company, which has today a great industrial tradition, started off with the maintenance and development of common and special vehicles. During the time other fields of expertise like industrial machinery and process competences extended the portfolio of the company, which has grown quickly in turnover and size. Today Hi-Tech equipment like Iron Rollers for the famous “Pistenbullis” preparing skiing areas in the alps are produced from RAMPINI as well as diverse equipment like Energy Stations and other Hi-Tech special equipments for the defense sector. The industrial portfolio is therefore very diversified.

RAMPINI has been committed to the theme of decarbonisation of municipal transport and waste disposal as well as the electrification of commercial vehicles since the early 2000s. Since then, around 200 electric buses have left the factory halls in Passignano and have been delivered to six European countries - Germany, France, Austria, Spain and Greece in addition to Italy. In May 2023, the company won part of the large Consip tender one of the company's biggest sales successes to date. Since 2022, the next generation of the family has joined the management: Caterina Rampini as CEO and Vice President, and Andrea Rampini as CEO and R&D Manager. This also marks the beginning of a new era for the company, which employs around 100 people.

World Premiere: Hydrogen Midibus HYDRON

Sometimes it appears in the bus and coach industry, that there is the salient question of “Battery versus Hydrogen” as a means of energy-storage and provision. But in fact it is not the question to say A or B, but sometimes both! RAMPINI is therefore the first manufacturer to offer a compact Midibus with a well-sized battery and a hydrogen range extender to combine the best of both worlds. Basically, every hydrogen bus is a electric bus – the defining question is just, how big are battery and fuel cell and their relevance for the Traction System. This is also the reason, why the models ELTRON (see below) and HYDRON are not completely different models, but rather “two sides of the green Zero Emission Coin”, with most parts and concepts shared among each other: body concept, Stile Energetico-Design, Driveline, Interior design etc. The advantage for the customer: no complex spare parts handling, when both models

should be in the fleet. Out of conceptual reasons, the HYDRON is offered only in a two-door-version unlike the ELTRON, which is also available with three doors.

The concept is easy: the somewhat smaller sized battery pack (175 kWh net instead of 270 kWh) is supported by a compact 30 kW fuel cell by the Canadian manufacturer Loop Energy. Due to the innovative eFlow™ architecture of the company, the fuel cells offer a 16 percent lower consumption of precious hydrogen while at the same time boasting up to 90 percent higher peak power and ten times better current density uniformity with the same stack size. The superfluous heat of the fuel cell as well as the traction is harvested efficiently and supports the heating for the drivers or even the passengers area.

The fuel cell is managed by the RAMPINI own “**Hy4Drive**”-System, which is explained below in detail. The fuel cell has a very conservatively estimated, 10.000 hours lifespan and so matches the intermittent usage of the cell. It has a preheating for winter, and can be started even in very cold weather after a short waiting time. The three Luxfer Type 3 flasks with 350 bar pressure hold ca. 15 kg of hydrogen in a modular frame, that is also interchangeable with the ELTRON roof installations. With this amount of Grade D Hydrogen, the HYDRON is able to extend its range to more than 400 kilometers in E-SORT 1 and almost over 500 kilometers in E-SORT 2 without heating or A/C. With Hydrogen alone the range can reach also 250 kilometers, what should be enough for a days service in most cases. Due to a partnership with the Italian gas supplier Sappio, RAMPINI is also able to support customers in the setup of their own hydrogen fuel station. The manufacturer has installed such a filling station on its factory premises in Passignano himself recently.

The “**Hy4Drive**”-System is a electronic Drive Management System for the Hydrogen Bus HYDRON, completely developed in-house by the technicians of RAMPINI. Basically the vehicle functions like a Battery Electric Vehicle (BEV) with a 170 kWh LFP-battery (the mostly identical designed ELTRON offers a 210 resp. 281 kWh battery), but it is coupled with a 30 kW fuel cell. In order to accomplish the most flexible and most efficient way to integrate the fuel cell into the Drive System, the “**Hy4Drive**-System” offers four different modes of usage of the fuel cell and thus of the

whole Drive System. The modes can be individually chosen by the driver in the vehicle System or the systems chooses them automatically in case of a malfunction or of low battery energy. Generally, the fuel cell can be activated only under 90 percent E-SOC and runs with low power between 90 and 93 percent E-SOC.

The four modes of **Hy4Drive** are defined as such:

Range Extender: Designed to maximize daily mileage using energy normally in proportion 40 percent battery and 60 percent Hydrogen energy, which equals the proportion of total on-board energy. Also is it possible to activate a “Pulse-Mode” of the fuel cell with given time slots, when it working or not. This is the ideal mode of driving to reach the best possible range, using battery as well as fuel cell Energy. The fuel cell alone can fill the battery up to 80 percent E-SOC (Electric State of Charge) in about 4 hours and 40 minutes, compared to 7 hours with a 22 kW external charger. In case of high power demand or when the E-SOC falls below 20 percent, the fuel cell is set into a boost mode to deliver maximum power. Thus the Range of the HYDRON is minimum 100 km higher than that of the BEV ELTRON in E-Sort 1.

Pure Hydrogen: In this mode all energy comes from the stored Hydrogen (stored gaseous at 350 bar pressure). The LFP-batteries have only a peek shaving function during acceleration and also a buffer function for storing regenerative braking (recuperation). State of Charge of Battery (E-SOC) is always kept around 90 percent and the fuel cell power can be manually adjusted between 50 and 100 percent. This mode is ideal, if the vehicle is supposed to run on the Batteries in the next service cycle.

Pure Electric: In this Mode all energy comes from the 170 kWh-Traction battery only. The fuel cell is kept always offline and the vehicle is operated like a normal BEV. This mode is ideal, when the Hydrogen storage is empty or other reasons are there, not to fill up the Hydrogen tanks. Also in winter this mode is ideal, as the emitted water of the fuel cell could freeze on the street or in a bus stop, where the vehicle is idling for some time.

Hybrid Custom: In this mode it is possible to customize exactly how much energy is drawn from the 170 kWh Traction-battery respectively from the 30 kW-fuel cell to allow adapting the usage according to the actual depot- and infrastructure-capability. In this way the service and range of the HYDRON can be adjusted tailormade to the daily service needs. This is the most sophisticated mode of the System and needs some skills and close consideration of the depot management.

RAMPINI ELTRON: The new concept for the Midi Class

The ELTRON is a classic full low-floor midibus in integral design, available as a two- or three-door version with barrier-free wheelchair space. Thanks to its length and width (only 2.20 metres) as well as the small wheelbase and a record-breaking turning circle of only 14.8 metres, the minibus is ideally suited for narrow city centres and historic old towns, where large buses, most of which are also 2.55 metres wide, can hardly enter. In addition, the lack of analogue exterior mirrors, which are replaced in series production by a camera system, promotes the vehicle's maneuverability in curves. At the same time, all batteries and most electrical components are installed on the roof, so there is no classic power unit tower in the rear that costs seats. Therefore, the bus can accommodate ten (three-door) or 13 (two-door) seated passengers, for a total of 46/48 without wheelchair space, 43/45 with wheelchair space. Like a full low-floor city bus, the ELTRON is of course barrier-free and equipped with a manual folding ramp. An optimal midibus concept that no other Central European busbuilder has in its programme in this form.

The new RAMPINI ELTRON (as well as the HYDRON) has been given a completely new design that makes it instantly recognizable as a high-quality low-floor city bus "Made in Europe". In contrast to the rather rounded design of its predecessor, the E80, the world-renowned design studio VERNACCHIA DESIGN from Ariano Irpino, Italy, has developed a clear and precise design language that clearly stands out from arbitrary curves. Particularly striking about the so-called "*Stile Energetico*" is the three-dimensionally shaped roof cladding, which emphasizes rather than hides the neuralgic energy components on the roof. Equally self-confident are the wheel arches

of the compact 17.5-inch wheels, which accelerate the stationary vehicle with a dynamic line. They correlate with the clear and symmetrical edges of the side panel, such as those of the upwardly strutting design badge behind the driver's window in the shape of a fin. Front and rear are clearly drawn and full of character, without appearing fashionably playful. The friendly "smile" of the front end is underlined by a three-dimensionally shaped diffuser below. The driver's high seating position, the low-slung windscreen and the destination display integrated into the roof ensure transparency and a high safety potential. The mirror cams, fitted as standard, further emphasize the clear lines and give the front view an unmistakable recognition feature. The bisection of the rear, on the other hand, makes the small bus look grown-up and arouses interest - not least thanks to the energetically shaped LED rear lights and the black diffuser quoted from the front.

The high quality processed interior is also designed to be transparent and airy, with large windows and bright surfaces that immediately welcome passengers. The 10 respectively 13 comfortable seats can of course be individually selected and are optimally upholstered for typical city lines. Special attention deserves the separate passenger compartment air conditioning that incorporates an infrared heating system "TopHeat" in the interior ceiling, which quickly and efficiently supplies radiant heat (max. 800 watts) to passengers who spend only a short time in the standing platform, but without escaping again through the large swinging doors at each stop. An important component of the ELTRON's efficiency strategy to realize an optimal range.

The VDV compliant (for Germany) cockpit of the bus is very clearly laid out and functional, the dashboard by the Swiss manufacturer TEQ is the defining element and stands out as a solitaire. TEQ also supplies the electronic multiplex system as well as the full telematics connectivity ("Teq Monitoring") of the bus.

Instead of many other hardkeys in the side panel, there is a modern rotary pushbutton ("iDrive"-style), which makes all bus functions very easy to operate. This reduced HMI concept provides the driver with excellent all-round visibility and ergonomics, which are complemented by the optimally positioned camera monitors. The dashboard displays are already fully digital, and work is already underway on more advanced models that will further increase comfort and functionality for the driver. Different cab doors can be

ordered as well as cash register systems, and sufficient storage space for the driver is also provided.

Even a compact e-midibus needs a powerful drive, especially in the premium segment. For the new ELTRON, RAMPINI has therefore opted for a vehicle-mounted central motor that operates for the first time according to the highly efficient permanent-magnet synchronous principle (PSM) with three phases, which transmits its power to a conventional axle differential via a matching gearbox that was developed in-house and is also new - all of this continuously variable and up to 7,000 revolutions per minute. The peak power of the compact, water-cooled engine from Dana (TM4) is 235 kW/320 hp, the continuous power 133 kW/180 hp. The maximum torque is available from the first revolution of the copper coils with up to 950 Newton metres (directly at the engine, but not at the wheel). With a permissible total weight of 12,000 kg, this engine is by far sufficient and can meet all the requirements of city traffic. Of course, the engine's possibilities as a generator are optimally utilized in overrun phases during deceleration, so that energy can be optimally recuperated, i.e. recovered. This is done conveniently via a lever on the steering wheel in three stages. The ELTRON drive concept speaks for high robustness and long service life of the components.

The ELTRON's chassis is also beyond reproach, relying on European and tried-and-tested components. The independent suspension of the front axle is based on the ZF RL 55 EC and was specially adapted for this application. For the driver in particular, this type of suspension is very comfortable and is part of the stationary wheel repertoire of a premium bus in Europe. In combination with the sensitive electro-hydraulic steering from Elica, the result is a superior driving experience that would also suit many a large bus. The compact and inexpensive 17.5-inch wheels contribute to the high rolling comfort and the sensational turning circle of 14.8 metres. The rear axle is engineered in-house, designed according to the hypoid principle and adapted in dimension to that of the bus. It is available in a standard ratio, optimal for most applications for the bus. The modern ECAS 3.0 levelling system is also installed on board, as is the new EBS 3 electronic braking system, which fully integrates all electronic braking systems and is also prepared for future functions.

Energy storage is at least as essential for a high-quality electric bus as the drive. With its maximum 280 kWh (alternatively 210 kWh, if charging pantographs are fitted) of battery capacity (80 percent of which can be used and is distributed over eight modules on the roof) and a range of up to 300 kilometers (e-SORT 2 without heating or air conditioning), the ELTRON offers more than any other supplier on the European market. In the "worst case" with e-SORT 1 and heating or air conditioning, the range is still at least 200 kilometers. For the mostly short lines in narrow inner cities, this is often enough for a whole day's circulation. As before, the company relies on the robust and largely fire-safe lithium iron phosphate cell chemistry (LiFePO₄), which is used hundreds of thousands of times in China and is also becoming more and more popular in Europe - mainly because of its robustness and fire safety. The argument of the slightly higher weight hardly plays a significant role any more, as the power density of the batteries, which are now supplied by world market leader CATL from China completely as finished modules, has been increased from 100 to 180 Wh/kg compared to the predecessor. In case of installation of vehicle-mounted or infrastructure-mounted pantographs, the battery capacity is reduced to 210 kWh in six modules. RAMPINI assumes a battery life of six to eight years (depending on use and maintenance) and therefore provides a warranty of at least five years.

The ELTRON can be charged with all conventional chargers of the Combo-CCS2 standard with a standard 22 kilowatts DC current in just over ten hours, with 40 kilowatts in about five hours and 40 minutes, and via quick charging with up to 120 kilowatts direct current in about two hours. The position of the charging socket can be chosen in the rear on the left or right - according to the customer's wishes. Of course, RAMPINI can offer both pantographs and the appropriate charging infrastructure for the ELTRON through its suppliers.

RAMPINI SIXTRON: Smaller is Smarter

The smallest product of the company is the six meter long and only 2,1 meter wide Minibus SIXTRON, that is suited perfectly for small inner cities or historic centres. The vehicle is designed with an integral bus body, what makes it robust as well as flexible in

its set up. The maximum of 28 passengers (without wheelchair space) can enter via a big sliding door of 1,34 m width with an entrance height of 340 mm, the standard for low floor buses. Thanks to a wheelbase of 3,7 meter the turning circle is a astonishing 14 meters small – optimal for the most densely built cities and corners. In the interior the passengers find a easy to clean low floor design, the drivers compartment is separated with a door and therefore resistant to every kind of vandalism. In the passenger area there are ten comfortable city seats, up to 17 people can be standees (without wheelchair, for which a manual ramp would be installed). The driveline of the vehicle with a total permissive mass of 8,8 tons equals that of bigger models with its central synchronous PSM e-Motor with a peak power of 230 kW and a peak torque of 950 Nm. The robust and safe LFP-battery pack on the roof with a massive 210 kWh of capacity is good for a range of up to 250 kilometers in E-SORT1, the charging of the bus at 22 kW takes around 4,5 hours. The safety of the SIXTRON is also at par with its bigger brothers: the comfortable independent ZF front suspension is as self-evident as ESP and optional MirrorView Cams. Also all regulations of the new European General Safety Regulation (GSR) will be naturally fulfilled when the regulation becomes mandatory mid 2024.

Safety and Service

Today, electric and hydrogen buses are just as safe as conventionally powered buses. This starts with the proven concept of the integral frame, which, in combination with the high-quality chassis and low weight, enables a confident and safe ride. Modern electronic safety systems such as ABS/ASR, ESP and EBS 3 also ensure optimal deceleration at all times. The requirements of the new EU "General Safety Regulation" directives are of course met, for example with sophisticated assistance systems such as front collision warning, turn-off assistant, traffic sign recognition and much more. In particular, the good all-round visibility for the driver and the modern camera-mirror replacement system from Orilaco or Brigade optimally support the driver in his daily work. The robust LFP batteries and also the other electrical systems are fire-monitored at all times and are read out electronically/telematically should important values deviate from the target - some components are also equipped with a fire extinguishing system.

Of course, all cyber security requirements are met and the ITxPT standards are applied for data exchange with the customer's own IT systems.

The service for RAMPINI buses is mainly provided by the team of highly specialised experts on site in Italy, who are also used as "flying doctors" in Europe. For customers who use and purchase RAMPINI buses, workshop staff are trained accordingly so that necessary warranty work can also be carried out at the customer's premises. Spare parts are currently delivered directly from Passignano in a 24-hour service. Service contracts are also available upon customer request.

About RAMPINI

RAMPINI S.p.a designs, manufactures, and markets the most innovative range of zero-emission buses throughout Europe in the Mini- and Midi-segment. The wide product offering includes six- and eight-meter electric buses with unique range and passenger capacity. At Passignano sul Trasimeno (PG) plant, RAMPINI S.p.a. employs approximately 100 people on an 80,000-square-meter area, generating a turnover of over 25 million euros per year. Founded in 1945, thanks to its strong innovative approach, RAMPINI S.p.a has made sustainability a fundamental value, aiming to produce completely "green" transport and communal disposal solutions as well as civilian products for the defense industry. In 2022 the Company incorporated the next generation of family members (Caterina Rampini, Andrea Rampini, Nicoletta Rampini) in the management board to adjust for the future.

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