SIEMENS

Background information

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Sustainable, innovative solutions from Siemens Mobility for rail and road transport

As a consequence of the megatrends of urbanization, globalization and demographic change, demand for mobility is soaring worldwide. Passenger transport is expected to triple by the year 2050. * At the same time, climate change is underscoring the necessity and urgency of providing sustainable mobility.

Sustainable mobility systems are critically important for resource-saving economic development and the sustainable shaping of our societies. Sustainability is the key factor for enhancing the prosperity and quality of life for all people, while at the same time sensibly limiting the consumption of resources out of consideration of the environment and future generations.

To support sustainable development worldwide, 193 member states of the United Nations adopted the Agenda 2030 and its 17 Sustainable Development Goals (SDGs), and it took effect in January 2016. As declared in the Agenda, the transport of goods and people has a significant impact on the sustainability goals of industry, innovation and infrastructure (SDG 9), sustainable cities and communities (SDG 11), and climate protection (SDG 13). All in all, mobility accounts for over 23 percent of the global CO_2 emissions.

Siemens Mobility has committed to making a substantial contribution to the 17 SDGs and is developing sustainably designed trains, locomotives and intelligent traffic systems that help reduce environmental impact despite increasing mobility. We are addressing this challenge in three different ways: though the direct influence of the Siemens Mobility portfolio in the use phase of transport systems; through the active shaping of systemic changes such as with modal shift strategies; and through collaboration with partners along the entire mobility value chain. With our innovative

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service concepts, we enable transportation companies worldwide to reduce their CO_2 emissions by ensuring 100-percent availability of their fleets.

Innovative solutions increase the energy efficiency, service life and flexibility of rail vehicles dealing with changing demands and, together with predictive maintenance, ensure low-wear and safe operation over decades. From their very inception, our designs aim at efficient, resource-saving assembly and maintenance, and ensure high recycling rates at the end of their service life after 30 to 40 years.

Siemens Mobility also supports the sustainability of large cities and metropolitan areas by providing smart IT solutions that can, for example, effectively reduce CO_2 emissions produced by road traffic locally, regionally or at specific times of the day. Climate protection is a top priority at Siemens Mobility in all of its planning and solutions, and the company itself is aiming to achieve carbon neutrality by 2030.

Velaro Novo – the new high-speed train

The new high-speed train from Siemens Mobility, designed for top speeds of 250 km/h to 360 km/h, draws on the experience of three generations of Velaro trains that have accumulated over three billion kilometers of service since 2005. Thanks to further optimized aerodynamics, the Velaro Novo requires 30 percent less energy running at 300 km/h than previous Velaro models, thus saving 1,375 tons of CO_2 a year. The train's fully enclosed bogies lower energy consumption by around 15 percent and reduce noise emissions. The more steeply sloped front sections of the end cars, flush car transitions and fully enclosed high-voltage equipment on the roof also improve the aerodynamics and help lower energy consumption. Thanks to new production techniques and numerous innovations in the bogies and components, the train's weight was reduced by over 70 tons.

The Velaro Novo's maintenance requirements have also been significantly reduced: a continuous stream of transmitted condition data is analyzed to predict when maintenance is needed. The train's high-performance electric brakes enable virtually wear-free braking and reduce the use and wear of the pneumatic brake system.

The Velaro Novo's car bodies are designed as empty lightweight tubes, leaving the interior passenger space free of all technical equipment. Given this greater interior flexibility, passenger space, seating and services can easily be adapted to meet the respective needs of the customer.

With its numerous configuration options, the Velaro Novo is future-proof and can be flexibly adapted to meet changing operator requirements even after years of service. With this long-term adaptability, Siemens Mobility is setting new standards for sustainability in the high-speed rail sector.

Mireo Plus – the light rail train with hybrid drive

The electric Mireo light rail train from Siemens features a highly flexible interior thanks to its empty tube structure, and the lightweight construction and aerodynamic design ensure a high degree of efficiency and low energy consumption. The train's predictive energy management system saves an additional five to 15 percent energy. And the low maintenance costs also contribute to the Mireo's low lifecycle costs.

These Mireo platform features are also incorporated in the two new hybrid versions being marketed as the Mireo Plus. These trains are also designed to run on non-electrified routes yet operate emission-free locally. They replace diesel-powered trainsets and can be used seamlessly on branch routes without overhead lines as well as on electrified network sections. Such mixed rail networks are common in the vicinity of large cities and regional centers where traffic volumes are not yet sufficient to justify fully electrified light rail operation. The new hybrid trains make economic sense on routes where electrification is neither practical or possible due to profile restrictions or disproportionately high electrification costs.

Mireo Plus B – energy from overhead lines and batteries

The Mireo Plus B is an electric multiple-unit train for regional transport that draws its energy from the overhead line or battery systems housed in containers located beneath the floor. The train uses lithium-ion batteries with a long service life. Under real-life conditions while operating with batteries at speeds up to 160 km/h, the two-car, 120-seat train has a range of around 80 to 90 kilometers. The three-car version with 165 seats can even operate distances of 100 to 120 kilometers running on batteries at the same speeds.

Compared to a similar diesel-powered trainset, the Mireo Plus B saves an average of 24 tons of CO_2 per year. Despite the extra expense for the battery system, the break-even point for CO_2 savings is already reached within one-and-a-half years for trains averaging 200,000 kilometers a year.

The Landesanstalt Schienenfahrzeuge Baden-Württemberg (SFBW) ordered 20 Mireo Plus B trains from Siemens Mobility in March 2020, and plans to put these two-car, 120-seat electric units into regional service on the Ortenau Network 8 as of 2023. They will operate in the Offenburg area on several non-electrified lines branching off the electrified Rhine Valley and Black Forest route. Siemens Mobility will handle their maintenance for 29.5 years and also guarantee the specified energy costs over the entire term of the contract. This will ensure the sustainability of the trains for nearly 30 years, regardless of who is operating Network 8 in Baden Württemberg. In short: The operating costs of the battery-hybrid trains have been calculated and fixed for the entire term of the contract.

Desiro Cityjet eco – test runs on Austria's branch lines

The Mireo Plus B is based on the experience that Austrian Federal Railways (ÖBB) and Siemens Mobility have gained together since 2018 in the development of an electro-hybrid battery system. The three-car Cityjet eco prototype, based on the electric Desiro ML from Siemens Mobility and with a battery container installed on the roof, was premiered at the InnoTrans in September 2018. The prototype hybrid train was given unrestricted approval for passenger operation in August 2019 and has been since been running on various main and branch routes in Austria. Around one-quarter of the country's branch lines, totaling roughly 1,300 kilometers, are not electrified.

Drawing on energy from its batteries, the prototype reaches a top speed of 120 km/h (160 km/h operating with overhead lines) and has been a success with both ÖBB and its passengers. The goal of the project has been to gain extensive experience with the operation of alternative drive systems under all conditions in summer and winter. The Cityjet eco charges its batteries from overhead lines under way and during stops. The Cityjet eco has been in authorized service on suitable routes of the ÖBB network since January 2020 and is gathering further operating data. This information is flowing directly into the series production of the Mireo Plus hybrid trains.

Mireo Plus H – on the way to a fuel cell train

The new Mireo regional platform was developed for sustainable and flexible service and is thus predestined for testing alternative drive systems. Using this platform,

Siemens Mobility is pursuing a fundamentally new drive concept that can replace diesels.

Working together with the Canadian fuel cell producer Ballard Power Systems, Siemens Mobility is developing a fuel cell drive for the designated Mireo Plus H. The new hydrogen fuel cell is said to have a triple service life, 50-percent higher power density, and five percent better efficiency. The Rhine-Westphalian Technical University in Aachen (RWTH) is a partner in the research project. The project is being funded with around twelve million euros from Germany's Federal Ministry for Transport and Digital Infrastructure (BMVI) as part of its National Innovation Program for Hydrogen and Fuel Cell Technology. The program is being coordinated by NOW GmbH (National Organization for Hydrogen and Fuel Cell Technology).

The aim of the cooperation is to develop a modular fuel cell drive system for the Mireo platform. The system will then be integrated into other vehicle platforms.

The fuel cell drive is planned to be ready for use in 2021. The developers expect the system to have a range of 600 to 900 kilometers in two or three-car trains. The fuel cell trains should have the same performance characteristics of electric trains, emit no CO_2 emissions locally and, thanks to their durable components, have low maintenance costs. They would be used on existing diesel routes and in regions where hydrogen is cheaply available with wind energy and from the chemical industry.

Vectron Dual Mode – the electric and diesel locomotive for freight transport

Since Germany's rail network is only around 60 percent electrified and both starting points and destinations are often on non-electrified lines, freight trains either have to change locomotives along the way or be hauled the entire distance by diesel locomotives. Either way, this costs time and logistical efforts and pollutes the environment.

Siemens Mobility presented its concept of a diesel locomotive that can also be powered from overhead lines at the InnoTrans 2018. With the new Vectron Dual Mode, operators can close gaps in a rail network's electrification without having to change locomotives. At the same time, metropolitan areas and large cities where there is frequently a fully electrified system are spared emissions. In addition, the locomotive can be used for shunting when assembling trains at the start or

destination of a journey, such as at container terminals, ports and factories where the line is not electrified.

The Vectron Dual Mode locomotive is based on proven components used in the electric version sold over a thousand times. The 90-ton, dual-power locomotive is designed to operate on the 15-kV, 16.7 Hz AC voltage system commonly used in Central Europe and is equipped with the PZB train control system. Regardless of its operating mode, power at the wheel is 2,000 kW, which corresponds to the full power of a conventional diesel locomotive. The locomotive's top speed is 160 km/h, and its diesel tank hold 2,600 liters of fuel.

The Vectron Dual Mode enables freight transport operators to increase sustainable added value over the locomotive's entire lifecycle.

Railsystems RP GmbH ordered two Vectron Dual Mode locomotives from Siemens Mobility in November 2019, marking the first order for the new, highly flexible locomotive. The locomotives will be delivered at the end of 2020.

Additive manufacturing reduces spare part inventories

The 3D printing of plastic and metal parts is enabling greater freedom in 3D design and a more sustainable production of spare parts. This is opening up completely new opportunities for increasing material efficiency, saving weight and integrating recycling concepts. Backed by its worldwide network of additive manufacturing (AM) facilities, Siemens Mobility Customer Services helps customers reduce their spare part inventories and use of their own workshops to manufacture frequently needed parts. This eliminates local emissions and time/cost-intensive shipping, since the spare parts can be manufactured quickly at the eleven locations currently operated by Siemens Mobility worldwide. The company's AM experts in Germany, the United Kingdom and Russia are also able to scan parts that are no longer available – even when broken – and rework their design in 3D CAD. As a result, the redesigned 3D-printed parts are often more stable than the originals. This technology can also be used to test new ideas before they go into series production. Stadtwerke Ulm, for example, uses the company's AM service to print front aprons for trams involved in accidents. The Swiss Federal Railways has also been using plastic and metal spare parts produced with additive manufacturing since 2019.

Improving energy efficiency by connecting signaling and power supply systems

By coupling train signaling systems with a SCADA system for monitoring and controlling power supplies, Siemens Mobility makes the energy-optimized operation of public transport systems more transparent and can forecast energy consumption. Analysis of the data clearly shows, for example, the relationships and dependencies between consumption and metro operations. As a result, metro operators can optimally adjust their timetables based on actual mileage and energy consumption data. This reduces initial investment costs in the power supply infrastructure and, with guaranteed availability, lowers the operating costs. Energy peaks and restrictions in the energy supply during operation can also be taken into account in order to achieve energy-optimized operation and avoid failures due to overloads.

Thameslink – the world's first commercial long-distance ATO application with ETCS

Automation systems significantly increase the energy efficiency and capacity of rail operations. The Automatic Train Operation (ATO) system developed by Siemens Mobility operates with the European Train Control System ETCS to ensure that safe distances between trains are maintained and permissible speeds are closely monitored. Rail systems that are already partly automated now provide an excellent basis for adding new solutions – such as automated driving systems. For the north-south rail route through the heart of London (Thameslink project), Siemens Mobility is supplying a combination of trains, ETCS equipment and an ATO system to enable automated driving along the most heavily used core route. By using the ATO system, operators can optimize headway along the line. All trains move exactly according to the same optimal speed profiles. This is the only way the required line capacity of 24 trains per hour, track and direction can be maintained.

Low emission zone, clean air zone and environmental zone – solutions for achieving low-emission urban road traffic

Siemens Mobility is not only pursuing the goal of reducing emissions through smart and efficient rail solutions, but also offers ways to ensure sustainable, lower-emission road traffic in large cities and metropolitan regions.

The low emission zone, clean air zone and environmental zone solutions improve the air in cities where quality is especially critical due dense populations. By implementing these solutions, municipalities can reduce pollutant emissions as well as traffic jams and traffic-related noise.

A low emission zone is a flexible solution that automatically monitors environmental zoning compliance with camera-based license plate recognition (ANPR = Automatic Number Plate Recognition). The system records and controls the use of vehicles that are particularly harmful for the environment and that require special municipal licensing. It’s an innovative, modular, highly secure and efficient solution for improving urban air quality.

A low emission zone or environmental zone solution doesn’t require the customer to install an IT infrastructure, since Siemens Mobility hosts and operates the solution. Visually unobtrusive devices on the side of the streets collect data on vehicles and air quality and transmit the data to the municipal authority and back-office system via highly secure and encrypted technologies. Billing for zone licensing can be integrated into the municipal systems.

Municipal traffic managers can determine the routes and zones that require pollutant controls as well as the class of vehicles they want to charge or possibly even ban from selected areas. The fees for entering a low emission zone can be set for each route, zone and vehicle class on a daily basis depending, for example, on the forecast air quality and expected traffic volume.

In consultation with the customer, Siemens Mobility installs signage, inconspicuous Sicore ANPR cameras and air quality measuring devices, using existing site furnishings wherever possible. Since this installed roadside equipment communicates directly with the cloud-based IT infrastructure from Siemens Mobility, there is no need for cabling or construction work.

The solution provides historical, real-time and forecast data for traffic and pollution, supporting decision-makers in implementing the most effective air quality strategy for reducing pollution.

Transport for London, the government body responsible for transport systems in Greater London, commissioned Siemens Mobility in March 2018 to develop the software for implementing an ultra-low emission zone in London. The software is integrated into the existing network of sensors and cameras provided by Siemens for automatic license plate recognition. It monitors and controls pollutant-intensive

vehicles when they enter a defined zone, quickly delivers comprehensive data, and reliably identifies vehicles that fail to comply with the strict pollutant regulations for the low emission zone.

Setting incentives for sustainable intermodal transport: Mobility as a Service

Many major cities are struggling to cope with traffic congestion despite their expanded public transport systems. To promote more intermodal passenger transport, HaCon, a subsidiary of Siemens Mobility, has developed the Mobility as a Service (MaaS) platform mobiliteit.lu for the Verkéiersverbond Luxembourg. By integrating park-and-ride zones and the carpool provider CoPilote, the Verkéiersverbond wants to encourage commuters to switch to public transport that has been free since March 2020. If using a private car is unavoidable, the app takes into account the real-time traffic situation, construction sites and road closures and adjusts the route accordingly. The total journey time by car even includes searching for a parking spot, giving the user a realistic comparison of all traffic modes. Cyclists can also define their individual routes based on personal preferences. Route suggestions are evaluated on the basis of CO_2 emissions, and green leaf symbols indicate the most environmentally friendly choices.

*Source: International Transport Forum

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This background information, a press picture and other material are available at:
www.siemens.com/press/innotrans2018

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Siemens Mobility is a separately managed company of Siemens AG. As a leader in transport solutions for more than 160 years, Siemens Mobility is constantly innovating its portfolio in its core areas of rolling stock, rail automation and electrification, turnkey systems, intelligent traffic systems as well as related services. With digitalization, Siemens Mobility is enabling mobility operators worldwide to make infrastructure intelligent, increase value sustainably over the entire lifecycle, enhance passenger experience and guarantee availability. In fiscal year 2019, which ended on September 30, 2019, the former Siemens Mobility Division posted revenue of €8.9 billion and had around 36,800 employees worldwide. Further information is available at: www.siemens.com/mobility.