

Always in the fast lane

Voith DIWA in BRT Systems





Sustainable solution for urban mobility

Bus Rapid Transit (BRT)

Road congestion, environmental pollution, budget restrictions for public transport, access to affordable and convenient mobility and a sustainable urban development are the worldwide challenges for urban mobility. Bus Rapid Transit (BRT) is their sustainable solution. Fast, reliable – and cost-effective!

Bus Rapid Transit (BRT) is a high-quality bus-based mass transit system that delivers fast, comfortable and cost-effective urban mobility. Vehicles in BRT Systems run on separate lanes with high service frequency, allowing them free and unrestricted travel.

Low costs – high availability. We are the correct choice.

Our local BRT specialists are always available to provide immediate support throughout the entire life cycle of a bus. Ranging from the support for the optimal driveline configuration to the setup of an individual maintenance plan – to reduce costs and to maximize vehicle availability.

Advantages of cost and time

Voith BRT solutions and driveline design

BRT Systems offer the same system capacity as other mass transit modes, but significantly shorter implementation periods – and at a fraction of the costs! Further benefits such as low operating costs, high availability, positive ecological impacts and short travel times also favor BRT. Advantages which will be maximized by integration of Voith DIWA technology and services for BRT Systems.

Further benefits of BRT

- + Easy integration with existing transit systems
- + High flexibility for further system expansion
- + Travel time savings for passengers
- + Positive ecological and urban development impacts

Less capital cost and implementation time

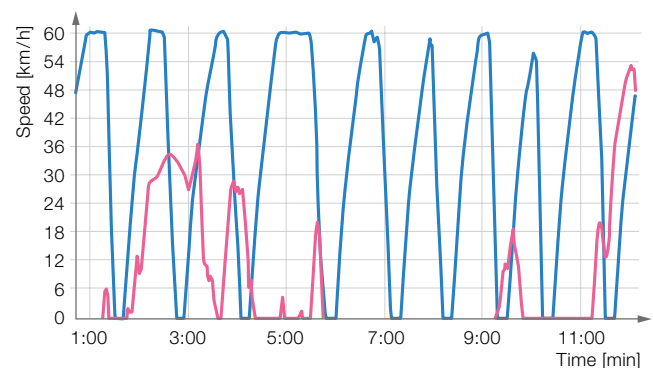
System comparison	Bus service	BRT	Light Rail Transit	Metro
Criteria considered				
Max. passengers per vehicle	80 – 180	80 – 240	100 – 720	720 – 2 500
System capacity (pphpd)	3 000 – 6 000	6 000 – 40 000	10 000 – 24 000	25 000 – 70 000
Average speed (km/h)	< 12	17 – 25	~ 20	30 – 40
Ø infrastructure costs (US\$ mn/km)	n.a.	1 – 8	13 – 40	40 – 140
Ø implementation time	n.a.	1 year	3 years	4 – 8 years

Voith BRT bus driveline design. Proven reliability for demanding operation.

BRT Systems demand a great deal from the driveline due to higher average speed, higher acceleration and braking levels and also passenger load. The whole driveline has to be specially designed to fulfill the demanding heavy-duty cycle of a BRT System.

Voith DIWA transmissions offer the ideal solution by a combination of technical features and DIWA Excellence services to ensure an economical and reliable operation: With maximum driving comfort and safety for drivers and passengers in every condition.

Comparison of BRT and typical urban duty cycle



- BRT profile with high acceleration and braking levels
- Typical heavy urban traffic with high standstill time



Lower fuel consumption

Key fact in reducing operating costs

Fuel costs account for approximately 30 % of vehicle life-cycle costs. Voith offers a wide-ranging combination of technical features and DIWA Excellence services to ensure optimum fuel-efficient vehicle operation at any time.

Optimum fuel efficiency with SensoTop

The topography-dependent gear-shifting strategy SensoTop automatically adapts all gear-shifting points to the optimum – for maximum fuel efficiency. Depending on the topography and vehicle operation, SensoTop reduces fuel consumption by up to 7 % – beside even more SensoTop advantages.

Fuel consumption reduction through

Products and components

DIWA transmission
Automatic Neutral Shift (ANS)
SensoTop and HTSD

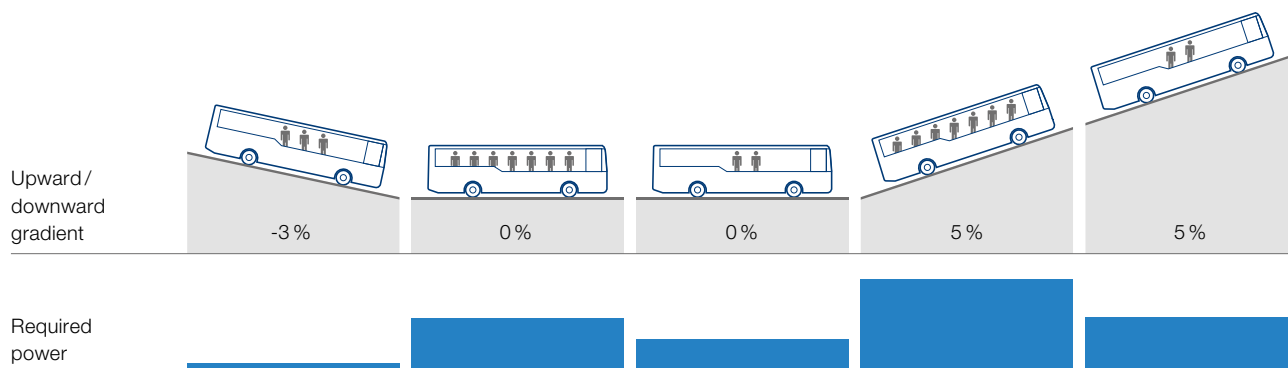
DIWA Excellence services

Driveline configuration
DIWA driver training
Operating data analysis

Advantages for fuel consumption

- + **DIWA: 50 % fewer gear shifts in lower speed range**
- + **Automatic Neutral Shift (ANS): Disconnects engine and transmission at vehicle standstill**
- + **Hydraulic Torsional Vibration Damper (HTSD): Allows shifting to a higher gear at lower engine speed**

Lower fuel consumption with SensoTop – Adaptation to topography and vehicle dynamics





Predictable costs

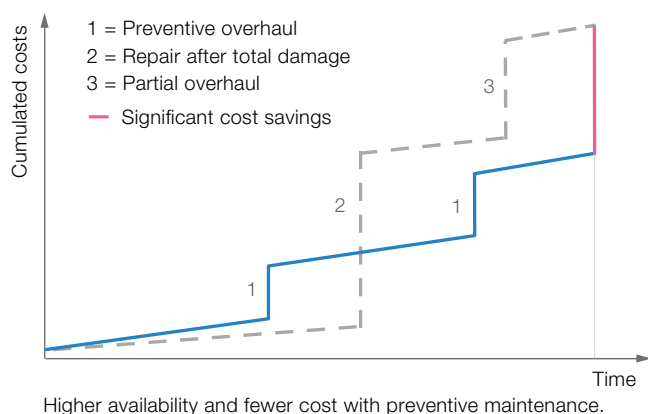
Preventive maintenance for BRT operation

Innovative preventive maintenance by Voith leads to significant cost savings throughout the entire vehicle lifecycle. The early-warning functionality of DIWA software enables permanent control of the shifting elements to detect problems at an early stage and to avoid costly consequential damages. Furthermore, the telemetric system DIWA SmartNet allows continuous and automated transmission condition monitoring that guarantees maximum vehicle availability while reducing the operating costs. Your advantage: Predictable costs with maximum planning reliability.

TransMilenio counts on preventive maintenance

TransMilenio in Bogotá, one of the world's most efficient BRT Systems, counts on innovative preventive maintenance by Voith. Exchange transmissions and continuous transmission monitoring in combination with immediate local support from Voith BRT specialists lead to over 98 % vehicle availability. Maintenance times can be scheduled – for maximum cost efficiency with predictable costs.

Significant cost savings





We keep our customers on the road With maximum availability

High vehicle availability is a precondition for an economical and reliable BRT operation. Because bus breakdowns on BRT routes have severe consequences on the system performance and its attractiveness. They affect the operators' economical position negatively by unplanned costs – often including penalties for the interrupted service.

Voith offers a wide-ranging combination of technical features and DIWA Excellence services to avoid unexpected bus breakdowns and to ensure maximum vehicle availability at any time.

Maximum availability by technical solutions

- The DIWA power split principle: Contributes to fewer shifts and lower thermal load
- The robust DIWA cooling concept: Ensures a lower oil temperature and fewer fan engagement
- The DIWA secondary retarder: Ensures a significant increase in brake-lining lifetime

Maximum vehicle availability through

Products and components	Unique DIWA principle Efficient cooling concept Secondary retarder
DIWA Excellence services	Preventive maintenance DIWA SmartNet Service and maintenance contracts Repair (genuine spare parts and exchange transmissions)

The proven DIWA principle with secondary retarder, a preventive maintenance and continuous transmission condition monitoring via DIWA SmartNet significantly increases vehicle availability.

Maximum availability by service solutions

- Exchange transmissions
- Preventive maintenance
- Individual service and maintenance contracts
- Optimization of driveline design
- Worldwide service network with BRT specialists

With DIWA SmartNet always in the picture

Telemetrics for the driveline

Monitoring the driveline online and accessing transmission data: DIWA SmartNet makes it possible. The telemetric system helps operators to combine high vehicle availability with low service and maintenance costs. Because it allows permanent insight into the essential operating parameters of the transmission.

Worldwide, over 1 000 buses are on the road with DIWA SmartNet

A GSM terminal, for example the DIWA SmartBox, periodically transmits the data by GPRS to an Internet server. There they are automatically evaluated and stored across the entire operating time of the bus. Diagnostic tools like ALADIN allow further analysis.

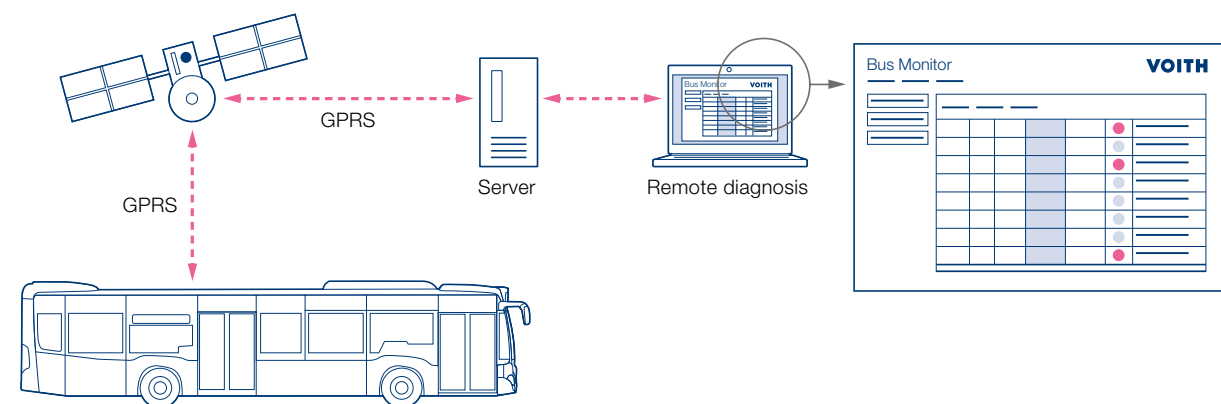
DIWA SmartNet says it with data

and is the ideal basis for preventive transmission maintenance. DIWA SmartNet automatically evaluates transmission data, either integrated into existing on-board computer systems or as a stand-alone solution. Any irregularities can thus be identified at an early stage. Irregularities automatically generate an SMS or an e-mail. This allows preventive maintenance, reduces downtimes and prevents unscheduled vehicle stand-stills. Result: Maximum availability of your buses.

SmartNet at a glance

- + Continuous monitoring of the DIWA transmission
- + Automated data evaluation through Internet portal
- + Analysis and remote diagnosis of all important vehicle data
- + Fast identification of irregularities
- + Higher vehicle availability due to faster diagnosis and preventive maintenance strategies

Monitoring all transmissions – DIWA SmartNet





The target is to cut emissions

Voith BRT components and services are dead on

Clean bus propulsion technology significantly reduces transport-related emissions in megacities. Therefore, BRT Systems use the latest drive systems. Voith solutions ensure environmental-friendly operation with latest technology and services. Solutions that focus on the three main emission dimensions: Carbon dioxide (CO₂), particulate matter and noise emissions.

The well-proven DIWA transmission sets the baseline for an excellent environmental sustainability: Reduced fuel consumption, CO₂ and noise level of the driveline by SensoTop and torsional vibration damper HTSD. Beside this, DIWA driver training supported by Voith operating data cut fuel consumption significantly while increasing comfort and safety. This pays off – for drivers, operators and the environment.

Lower emissions – mean more quality of life

In 2006, the TransMilenio in Bogotá was the first BRT System officially registered as a climate change project under the Kyoto Protocol. By the end of 2012, the TransMilenio BRT System will have saved around 3.8 million tons of CO₂. With 84 % market share in TransMilenio, Voith solutions play a major role in reducing vehicle emissions.

Cleaner air by Voith DIWA

In Bogotá, DIWA transmissions save around 3 tonnes/month of particulate matter because of the integrated secondary retarder. This also leads to a significant increase in brake-lining lifetime. This pays off – for the operators and the environment.

BRT components and services to cut emissions

	Carbon dioxide (CO ₂)	Noise	Particulate matter
Products and components	DIWA transmission SensoTop Torsional vibration damper HTSD Secondary retarder		
DIWA Excellence services	DIWA driver training and operating data analysis		

CO₂, noise, particulate matter: Environmental-friendly Voith solutions reduce the three main emission dimensions in BRT Systems.

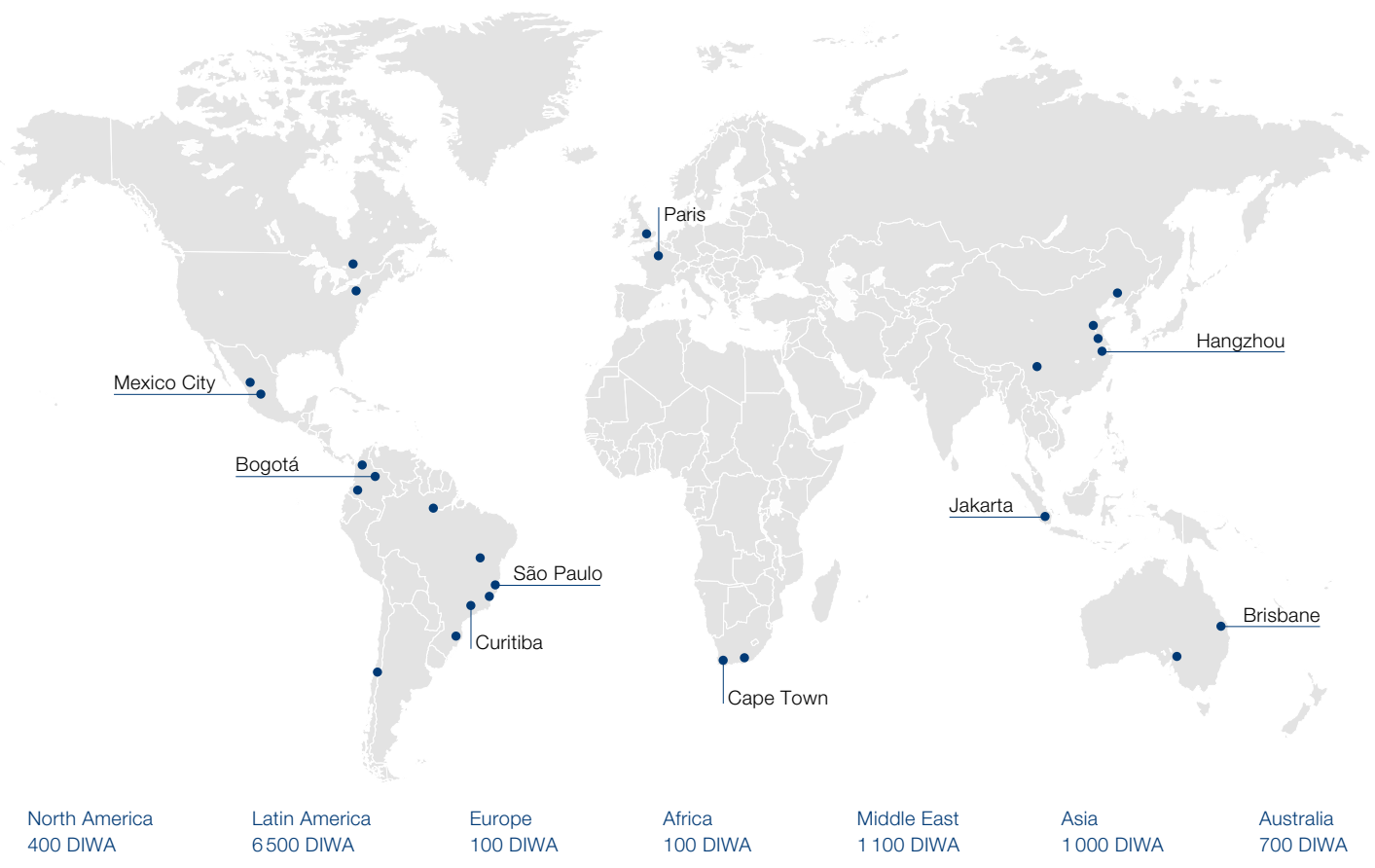
10 000 DIWA transmissions worldwide

Voith is the world market leader in BRT

The Voith DIWA transmission has already proven its applicability in the most demanding BRT Systems of the world (e.g. Bogotá, Jakarta, Santiago de Chile). Today, there are more than 10 000 Voith DIWA transmissions worldwide operating in

the most diverse BRT Systems. Aside from long-established systems like in Bogotá, São Paulo or Curitiba, newly established ones like in China, Indonesia or Africa also count on the DIWA transmission.

Examples of Voith BRT references





BRT references with Voith worldwide

Voith cuts emissions and travel times

Benchmark for BRT Systems worldwide – TransMilenio, Bogotá

Long-term relationship between Voith and the local operators is a key element for the success of TransMilenio. With the introduction of the TransMilenio, travel times have been reduced by 32 % and emissions by 40 %. The TransMilenio BRT System transports close to 2 million passengers per day which makes it one of the world's most efficient BRT Systems. Today, TransMilenio is recognized as the benchmark for many cities worldwide that are planning to introduce a BRT System.

First BRT System worldwide – Rede Integrada de Transporte, Curitiba, Brazil

The first BRT System worldwide is a key element of Curitiba's sustainable urban development since the 1970s. More than 70 % of Curitiba's commuters use the bus system, thus resulting in 27 million fewer automobile trips per year. Within this guided city development of integrated public transport, Voith has acted as a strong and reliable partner from the very beginning.

Cleaner Air by BRT – Brisbane Busway, Australia

The Brisbane Busway BRT System shows: DIWA transmission and DIWA Excellence services improve the ride comfort and safety while reducing transport-related emissions in CNG-powered buses efficiently.

BRT references with Voith

	TransMilenio, Bogotá
System established	2000
System length (trunk lines)	84 km
Passengers per day	1 850 000
Vehicle fleet (trunk line)	1 291
Market share Voith	84 %



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1 TransMilenio, Bogotá

2 Brisbane Busway

3 Hangzhou BRT

4 Zhengzhou BRT

China's second BRT System in operation – Hangzhou BRT

In Hangzhou, a service and maintenance contract with preventive overhaul program ensures maximum availability and cost transparency for operators and stakeholders. The operational speed during peak hours is about 10 km/h faster than the speed of regular buses in the same corridor. This results in a reduction of travel time by 40 % along with a significant decrease in road accidents. Based on these results, Hangzhou extended the BRT System by two more lines.

Integrated DIWA SmartNet concept – Zhengzhou BRT

The integrated DIWA SmartNet concept of the Zhengzhou BRT System enables preventive maintenance and real-time operating data evaluation. Full integration of Voith ECU data with operators Fleet Management System reduces the complexity for the operators.

Rede Integrada Curitiba	Brisbane Busway	Hangzhou BRT	Zhengzhou BRT
1972	2001	2006	2009
81 km	24 km	56 km	30 km
500 000	240 000	153 000	84 000
850	475	176	235
66 %	63 %	89 %	100 %

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