

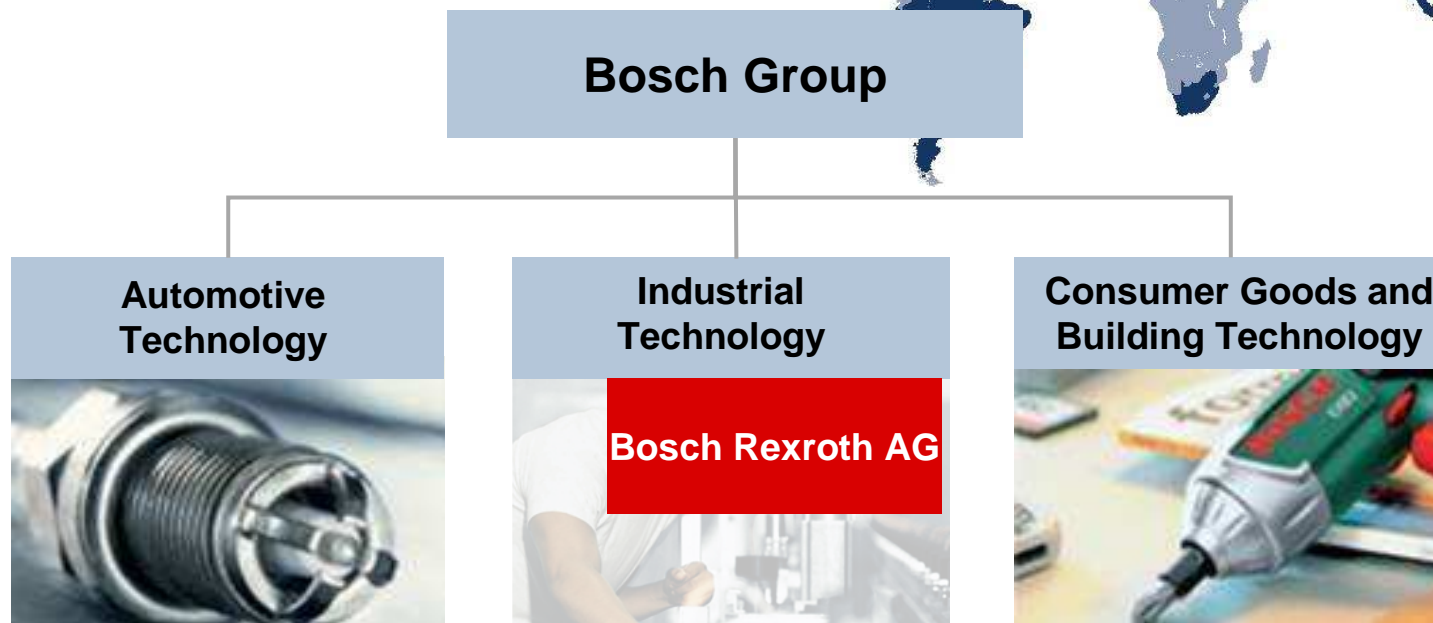
Bosch Rexroth Corporation Intelligent Hydraulic Drive™ (IHD™)

November, 2007

The Bosch Group is a leading global supplier of technology and services


Rexroth
Bosch Group

- Bosch achieved worldwide sales in 2006 of \$54.9 billion
- Bosch employs approximately 260,000 people worldwide
- Bosch is present in more than 50 countries
- Bosch has approximately 300 subsidiary and regional companies



The Bosch Group has extensive portfolio of market leading products and technologies



Automotive Technology	Industrial Technology	Consumer Goods & Building Technology
Gasoline Systems	Automation Technology	Power Tools
Diesel Systems	Mobile Hydraulics	Thermotechnology
Chassis Systems Brakes	Packaging Technology	Security Systems
Chassis Systems Control	 <div style="background-color: red; color: white; padding: 10px; display: inline-block;">Bosch Rexroth AG</div>	Household Appliances*
Car Multimedia		
Automotive Electronics		
Automotive Aftermarket		
Steering Systems*		
Electric Drives		
Starter Motors & Generators		

* 50 percent Bosch

Bosch subsidiary Bosch Rexroth (BR) is global leader in drive & control solutions for on & off-road applications

Rexroth
Bosch Group

Drives



Controls



Systems



Applications



Commercial Vehicles



Construction Machinery



Agricultural & Forestry Machines



Materials Handling Technology

Figures 2006

Total revenue

4,922 million €

Total employees

29,831

R&D Spending

220 million €

Investments

235 million €

- **A big challenge for commercial vehicles is the relatively low power density of electrical storage media.**

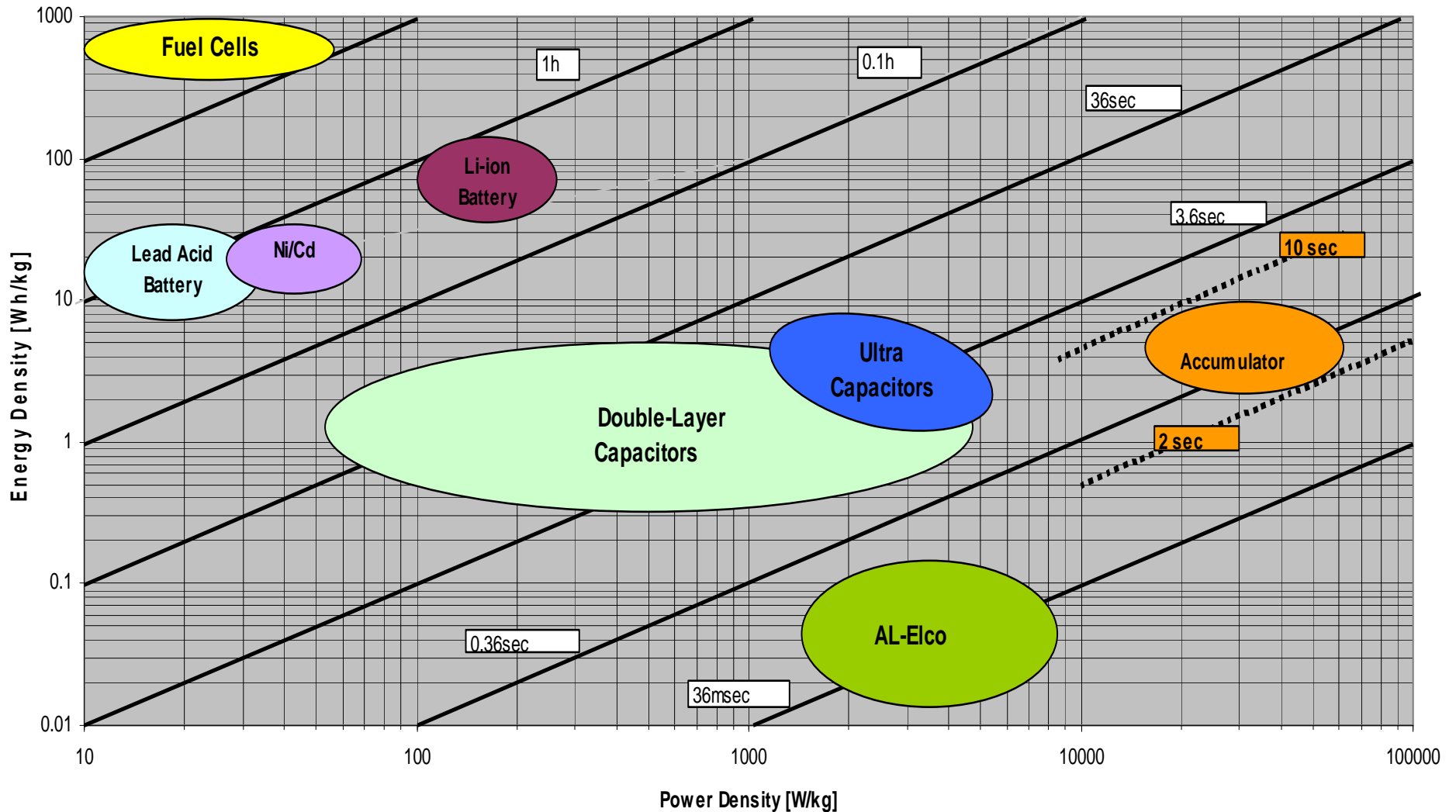
- **Hydraulic bladder accumulators offer considerable advantages over batteries with regards to recovering brake energy in commercial vehicles.**
 - **Fast storage and release of brake energy**
 - **High storage efficiency**

- **Bladder accumulators are nearly maintenance-free and are, therefore, commonly used in hydraulic applications.**

- **Standard versions operate with nominal pressures between 300 and 400 bar.**

Energy Storage Technologies

Storage Technologies



BR is developing platform of hydraulic hybrid solutions for military, commercial and light vehicle applications

Parallel Hybrid Applications

- Medium to heavy vehicles
- Periodic (i.e., start/stop) drive cycles
- Regenerative braking
- Up to 30% reduction in fuel use
- 3-5x increase in brake life

**Medium/Heavy
Military**



Refuse



Transit Bus



Series Hybrid Applications

- Light to medium vehicles
- Transmission replacement
- High efficiency pumps & motors
- Multiple configurations possible
- 10% on highway reduction in fuel consumption
- 50%+ start stop reduction in fuel consumption
- Potential use in off-highway

Light Military



Parcel Delivery



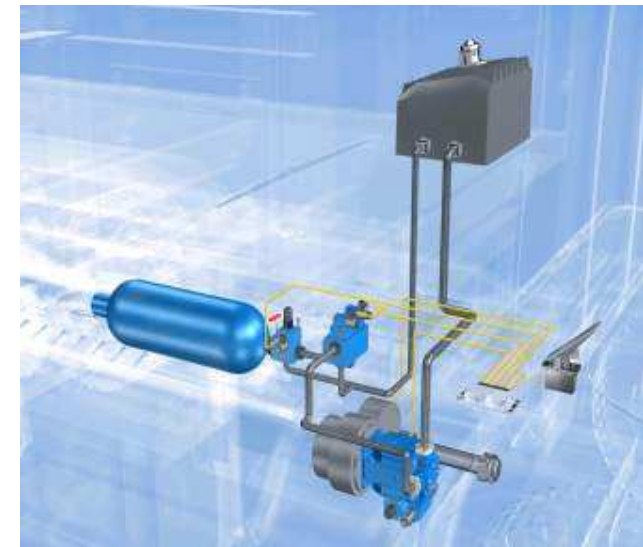
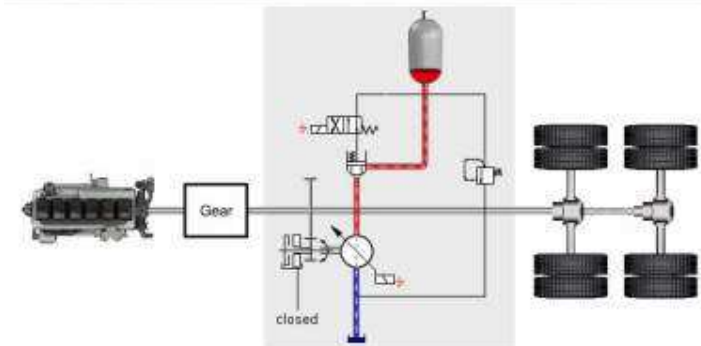
Light Vehicles



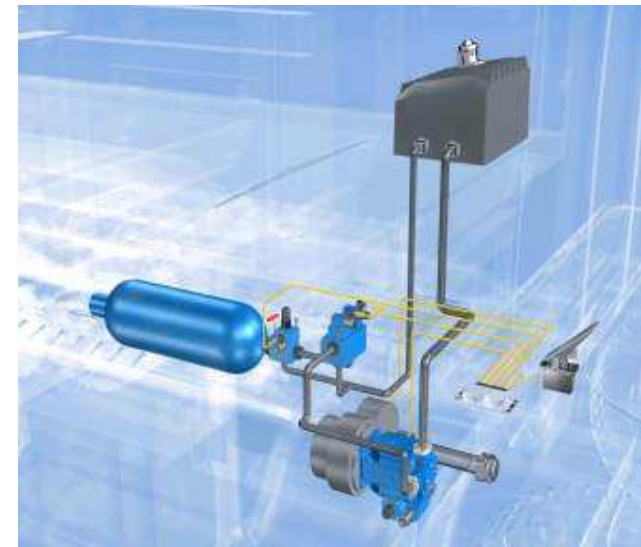
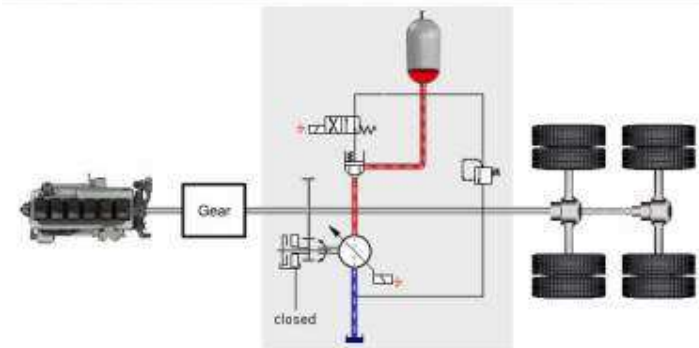
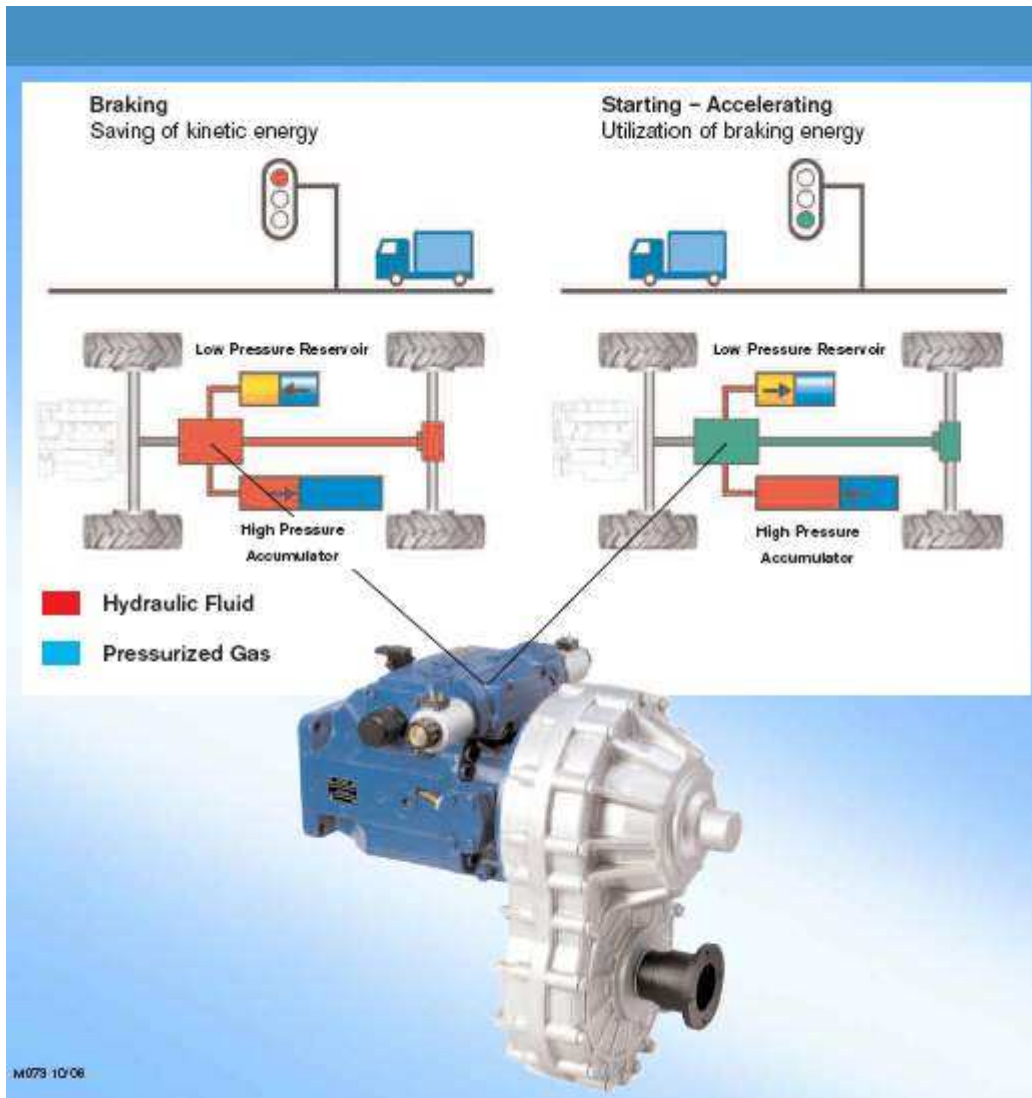
Hydrostatic Regenerative Braking (HRB)

Parallel hybrid system

- Advanced energy recovery vehicle system designed to capture and store the kinetic energy expended during vehicle braking events and re-apply energy during acceleration
- HRB developed by Bosch Rexroth, Germany in close cooperation with the Bosch Rexroth Intelligent Hydraulic Drive™ (IHD™) business unit in the US
- HRB utilizes system components which are in current Rexroth product line

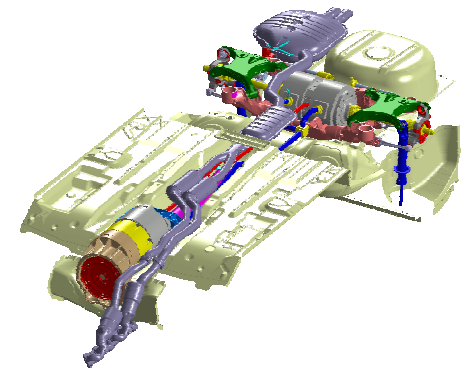
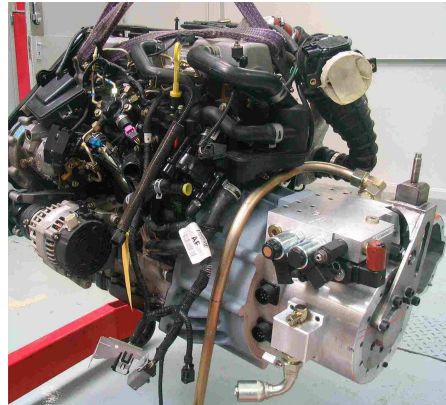


How does HRB work?



Series Hydraulic Hybrid Systems

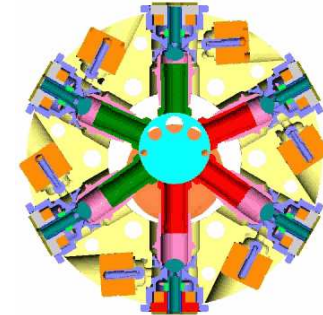
- Eliminate Transmission
- Engine speed independent of vehicle speed
- Infinitely Variable Trans.
- Regenerative Braking
- Over-the-road fuel economy improvement
- Engine Stop-Start



BR is developing platform of advanced pump/motor solutions for on-road commercial applications

Digital Displacement (DD™) Pump/Motor

- Radial piston pumps and motors
- Exclusive arrangement with Artemis Intelligent Power, Ltd. for on-highway use.
- Low friction losses
- Individual pistons are de-activated electronically to progressively reduce capacity (very fast response)
- Excellent part load efficiency (>90%)
- Ability to 'Idle' (Zero Flow)
- Conventional tolerance casting/machining
- Solenoid valve design based on known technology (e.g. transmission control valves or fuel injectors)

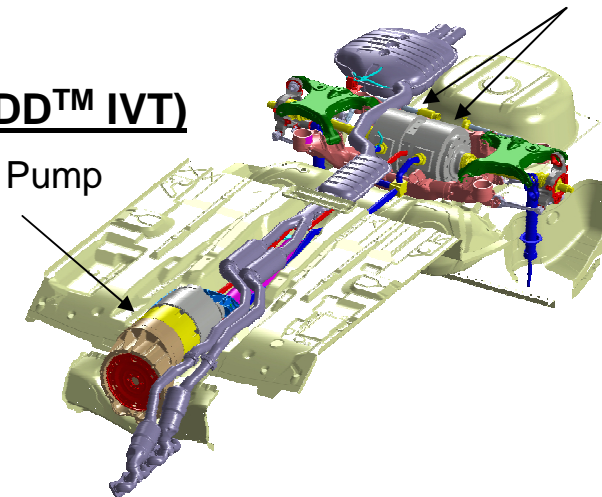


DD™ Wheel Motors

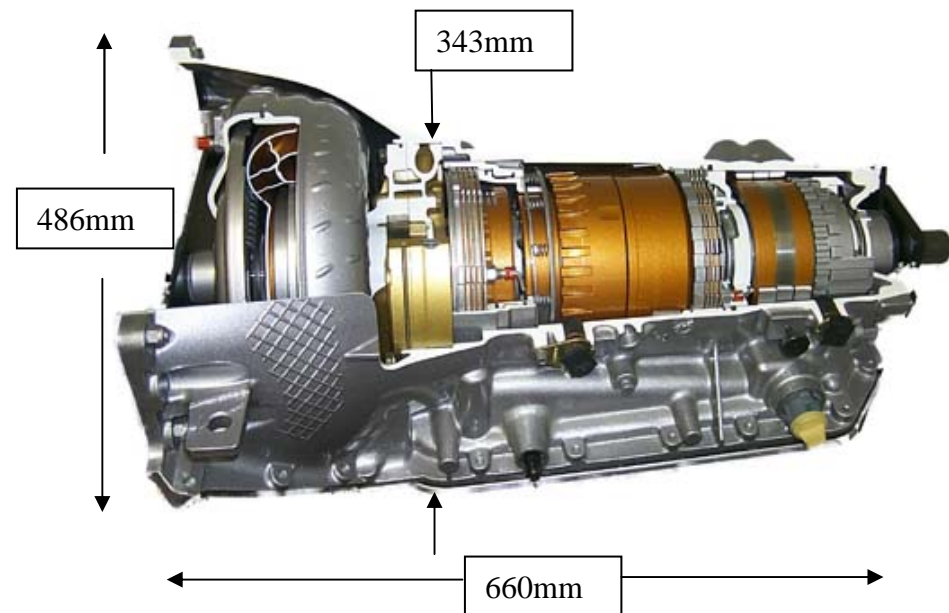
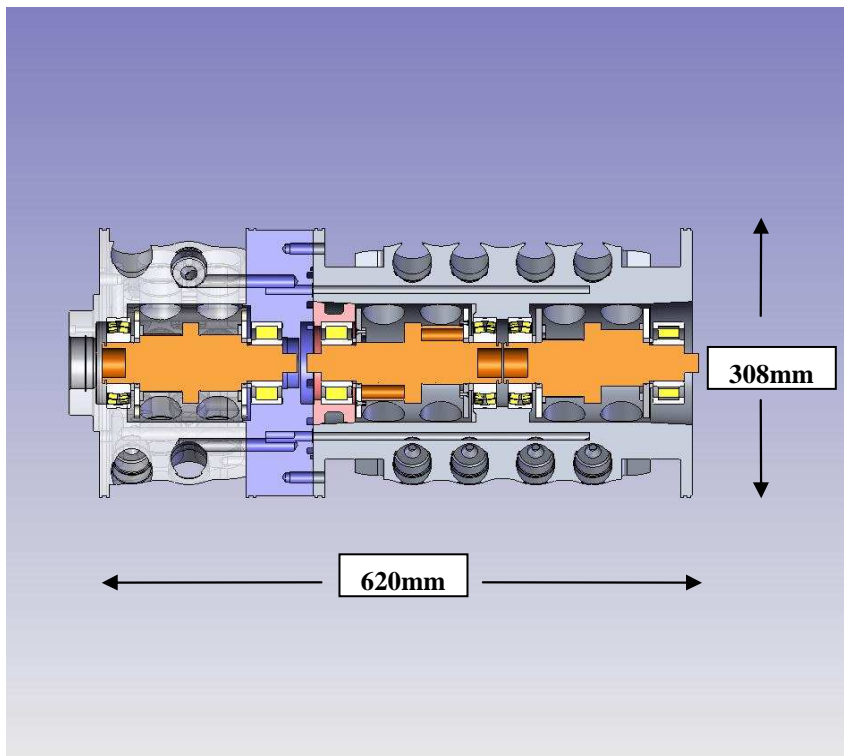
Digital Displacement Infinitely Variable Transmission (DD™ IVT)

- Key features/benefits
- Fully variable transmission replacement
- Facilitates energy storage in an accumulator

DD™ Pump



IVT Comparison to 4L80E Automatic Transmission



BR is engaged in several customer projects to validate parallel and series technology & accelerate commercialization

Rexroth
Bosch Group

- Installation of a Hydrostatic Regenerative Brake (HRB) system on a refuse validator for New York City Department of Sanitation and City of Baltimore Bureau of Solid Waste
 - Partially funded by New York State Energy Research & Development Authority (NYSERDA) and National Association of State Energy Officials (NASEO)
- Potential installation of HRB system on a refuse validator for the City of Los Angeles Bureau of Sanitation
- Installation of full series hybrid system on International Truck and Engine MXT military vehicle
 - Partially funded by US Army
- Potential installation full series hybrid system for New York Taxi application
 - Partially funded by New York State Energy Research & Development Authority (NYSERDA)



1. Hydraulic Hybrid Vehicle Technologies are here
2. Hydraulic Hybrid Vehicle Technologies can offer a significant value proposition
 - Reduced fuel consumption
 - Reduced emissions
 - Improved acceleration
 - Reduced brake wear
3. Hydraulics are known technology with history of performance, durability, quality
4. Bosch Rexroth is global leader in hydraulics drive and control solutions
5. Hydraulic Hybrid systems are “fuel neutral”
 - Integrated with diesel, CNG, LNG, LPG, etc...
6. Bosch Rexroth is building network of strong partners to accelerate development & commercialization
 - Customers
 - Chassis partners
 - Development partners
 - Suppliers

