Introduction to PrimoveCity

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Business Development - PRIMOVE
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## Content

<table>
<thead>
<tr>
<th>Introduction to Bombardier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primove</td>
</tr>
</tbody>
</table>
# Bombardier Overview

| Corporate office based in Montréal, Canada | Workforce of 65,400 people worldwide¹ | Revenues of $17.7 bn US¹ | 94% of revenues generated outside Canada | Listed on Toronto Stock Exchange (BBD) |

¹ for fiscal year ended January 31, 2011
Bombardier
A Diversified Company

Breakdown by revenues¹

- Transportation: 51%
- Aerospace: 49%
- $17.7 bn US

Breakdown by workforce¹

- Transportation: 54%
- Aerospace: 46%
- 65,400

¹ for fiscal year ended January 31, 2011
# Bombardier Aerospace Portfolio

## Business Aircraft
- Learjet family
- Challenger family
- Global family

## Commercial Aircraft
- Turboprops (Q-Series)
- Regional jets (CRJ family)
- Single-aisle mainline jets (CSeries)

## Amphibious Aircraft
- Canadair CL-415

## Services and solutions
- Jet travel solutions
- Specialized aircraft solutions
- Customer support and services
### Bombardier Transportation
The Broadest Portfolio in the Rail Industry

<table>
<thead>
<tr>
<th>Rail Vehicles</th>
<th>Transportation Systems</th>
<th>Services</th>
<th>Rail Control Solutions</th>
<th>Propulsion &amp; Controls</th>
<th>Bogies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light rail vehicles</td>
<td>Monorail systems</td>
<td>Fleet management</td>
<td>Integrated control systems</td>
<td>Traction converters</td>
<td>Portfolio to match entire range of rail vehicles</td>
</tr>
<tr>
<td>Metros</td>
<td>APM systems</td>
<td>Operations &amp; maintenance</td>
<td>Automatic train protection and operation</td>
<td>Auxiliary converters</td>
<td>Full scope of service over the lifetime of a bogie</td>
</tr>
<tr>
<td>Commuter trains</td>
<td>Light rail systems</td>
<td>Material solutions</td>
<td>Interlocking systems</td>
<td>Traction drives</td>
<td></td>
</tr>
<tr>
<td>Regional trains</td>
<td>ART systems</td>
<td>Vehicle refurbishment</td>
<td>Wayside equipment</td>
<td>Control and communication</td>
<td></td>
</tr>
<tr>
<td>Intercity trains</td>
<td>Metro systems</td>
<td>Component reengineering</td>
<td>Services</td>
<td></td>
<td></td>
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<tr>
<td>High speed trains</td>
<td>Intercity systems</td>
<td></td>
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<td></td>
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<tr>
<td>Locomotives</td>
<td>Transit Security</td>
<td></td>
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</table>

- Bogies: Portfolio to match entire range of rail vehicles. Full scope of service over the lifetime of a bogie.
Bombardier Transportation
Global Expertise – Local Presence

- Global Headquarters
- Present in > 60 countries
- 59 production/engineering sites and 20 service centres
- in 25 countries
Content

Introduction to Bombardier

PRIMOVE
Agenda

1. Introduction to PRIMOVE™
2. Proof of concept: Tram - Bus - Car-Applications
3. Roll Out Plan for Primove Bus Application
4. Next Steps
The World goes inductive

Balluff’s Latest Generation of Inductive Ring Sensors

Apple iPad 2 gets inductive charging with iPort LaunchPort

Duracell bullish on wireless charging

New Wireless Power Transmission System for EVs

Apple is Interested in Wireless Charging

CE devices, EVs to gain from wireless charging

How electrified roads could power cars of the future

Over the next decade: the most vibrant Wireless Power Transmission

Wireless recharging co Powermat teams with Duracell

MIT Demonstrates Wireless Power Transfer

Inductive safety switches with cylindrical construction from SICK

Ti introduces QI-compliant, single-chip wireless power transmitter IC to lower implementation cost

Wireless electricity: The wave of the future?

APPLE’S NEXT INNOVATION: WIRELESS CHARGING

Ti offers ‘QI’ inductive power transfer IC

Touchstone mod blesses Samsung Epic 4G Touch with inductive charging powers
BOMBARDIER primoveCity is a game-changing e-mobility solution that supplies power to all types of electric vehicles.
Bombardier PRIMOVE
The inductive principle

A proven concept....

High power transfer up to 500 kW

Transformer

... with an air-gap in the iron core...

... and a primary winding extended as a loop

Vehicle with Pick-Up

Underground power cable

Energy storage on vehicle
Bombardier PRIMOVE

Key characteristics

Static & dynamic charging

High power transfer up to 500 kW

Magnetic field shielded below the vehicle
## Agenda

1. Introduction to PRIMOVE™
2. Proof of concept: Tram - Bus - Car-Applications
3. Roll Out Plan for Primove Bus Application
4. Next Steps
Bombardier PrimoveCity
Portfolio
Flanders Drive, Belgium

Bus proof of concept
Flanders Drive – Lommel, Belgium

- Bus in test since the 8th of February
  - E-road delivers the power needed
  - Static & Dynamic working
  - EMC test conducted
  - Validation testing and characterization of the energy transfer are completed
  - Industrialization is underway
PrimoveCity goes automotive
Go wireless and leave the cables behind

In principle currently there are two chargers for electric vehicles:

- Slow charge c3kW
- Fast charge c44kW

Both require different plugs and cables

There are no solutions for quick and convenient charging – quicker charging time will not be achieved with cables.
PrimoveCity goes automotive
Application for cars and commercial vehicles

Currently in test at the BOMBARDIER Center of Excellence in Mannheim

Convenient cable and plug free charging providing efficient and flexible operations

- Charging power: 40 kW
- Time to charge (80 %): 60 min
- Range between charges: up to 250km (150 miles)
Mannheim, Germany
Automotive proof of concept
## Agenda

<table>
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<tr>
<th></th>
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</tr>
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<tr>
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<td>Roll Out Plan for Primove Bus Application</td>
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<td>4</td>
<td>Next Steps</td>
</tr>
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</table>
Primove Bus Application

Full electric public transport

- Opportunity charging for buses at stops during normal dwell times & terminus stops
- Two separate & independent systems activating & controlling wayside and onboard – system only activated with vehicle over it
**Primove Bus Application**

*Static charging at high power*

<table>
<thead>
<tr>
<th>Application</th>
<th>Distance</th>
<th>...</th>
</tr>
</thead>
<tbody>
<tr>
<td>8m - 10m</td>
<td>100 - 200 kW @5mins</td>
<td></td>
</tr>
<tr>
<td>12m</td>
<td>200 kW @5mins</td>
<td></td>
</tr>
<tr>
<td>&lt; 10 km</td>
<td>&lt;300 kW @5mins</td>
<td></td>
</tr>
<tr>
<td>18m</td>
<td>up to 200 kW @15s up to 300 kW @5mins</td>
<td></td>
</tr>
<tr>
<td>&gt; 20 km</td>
<td>up to 200 kW @15s up to 300 kW @5mins</td>
<td></td>
</tr>
</tbody>
</table>
Higher energy density of the battery dramatically extends the range of electric buses.
Wayside inverter

Simple and reliable technology

- One inverter for up to 4 winding segments
- Connected to 750 Vdc (rail) or standard AC grid (e.g. 480 Vac)
- Everything needed for Primove contained in one box
- Designed for low maintenance
- SCADA interface for diagnostics
- Key performance data of the wayside inverter is:
  - Input voltage: 400 - 600 Vac / 750 Vdc
  - Max output power: 100 – 250 kW
  - Switching frequency: >20 kHz
Onboard components
Integration into the vehicle

- Pick-up and rectifier are designed to be easily integrated into the under-frame of vehicles
- Power and temperature supervision included for safe operation

<table>
<thead>
<tr>
<th></th>
<th>Length: 2310 mm</th>
<th>Width: 750 mm</th>
<th>Height: 100 mm</th>
<th>Weight: 440 kg</th>
<th>Min output voltage: 400 VDC</th>
<th>Max output voltage: 900 VDC</th>
<th>Output Power: 100 kW</th>
<th>Efficiency: ETA = 0.95</th>
<th>Operating range: 76 – 186 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2270 mm</td>
<td>1060 mm</td>
<td>143 mm</td>
<td>539 kg</td>
<td>400 VDC</td>
<td>1000 VDC</td>
<td>160 kW</td>
<td>ETA = 0.95</td>
<td>76 – 186 mm</td>
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</table>
High efficiency
Key for a sustainable e-mobility

- The system is designed for high power and high efficiency at the same time
- High lateral tolerance for bus positioning with high efficiency gives flexibility in operation
- Excellent performance for public transport applications
- Max. efficiency of > 90% has been measured in operation
Agenda

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Full System Energy Simulation

- The simulation optimizes according to capital costs, operating costs, component lifecycle and system performance
- The simulation includes the route topography, energy requirements, operational requirements, fleet size and battery lifetime
- The result is the best TCO with optimum operational performance, infrastructure definition together with the best propulsion & battery system.
The power of primoveCity

One for All.
Stable power, same infrastructure – for cars, buses and light rail vehicles

Easy.
No charging, no danger – no cables or stations, no waste of time

Inductive.
No visual pollution, no emission, Immune to bad weather

Dynamic.
Static and dynamic charging makes range issues irrelevant

Ready Now.
Major public pilots in Europe

E-Mobility for all:
5 Answers
Thank You

http://www.primovecity.bombardier.com