



**eco<sup>4</sup>** – Bombardier's new Formula  
for Total Train Performance

**Benoit Gachet**  
**Tours**  
**September 2009**

**BOMBARDIER**

**You must hand back this leasing object  
without any damage !**

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## Tremendous Challenges for our Planet and People – Bombardier provides answers

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■ <b>Global Warming</b>	Most likely effect of the man-made greenhouse gas concentration <sup>1)</sup>	Bombardier's electric trains produce zero CO <sub>2</sub> and no particle emissions <sup>2)</sup>
■ <b>Energy Cost Increase</b>	Usage of energy goes up, availability of fossil energy is decreasing	Bombardier technologies allow to reduce the energy demand of a train by 50%
■ <b>Urbanization</b>	Continuous growth of our cities - congestion in urban areas	Bombardier products ensure that megacities do not collapse under road traffic
■ <b>Demographic Change</b>	Low birth and death rates lead to aging of the population	Bombardier offers attractive designs and comfortable interiors suitable for all ages



1) Intergovernmental Panel on Climate Change (2007)

2) If electricity is produced by zero-emission power plants

## The challenges of our world demand a new formula for economic sustainability

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- Saving **E**nergy
- Improving **E**fficiency
- Achieving sound **E**conomic value
- Protecting the **E**cology

## The challenges of our world demand a new formula for economic sustainability

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**eco<sup>4</sup>**: Bombardier's new Formula for Total Train Performance

- Energy
- Efficiency
- Economy
- Ecology



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## **eco<sup>4</sup> - the new Formula for Total Train Performance from Bombardier Transportation**

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**eco<sup>4</sup>** is a **suite of solutions**, services, products and technologies, offering the best in class environmental performance

**eco<sup>4</sup>** balances **E**nergy, **E**fficiency, **E**conomy, **E**cology with convincing and reliable solutions, services and products

**eco<sup>4</sup>** offers our customers **added value** to their trains and services and delivers on the promise of Total Train Performance

### **Welcome to the World of**

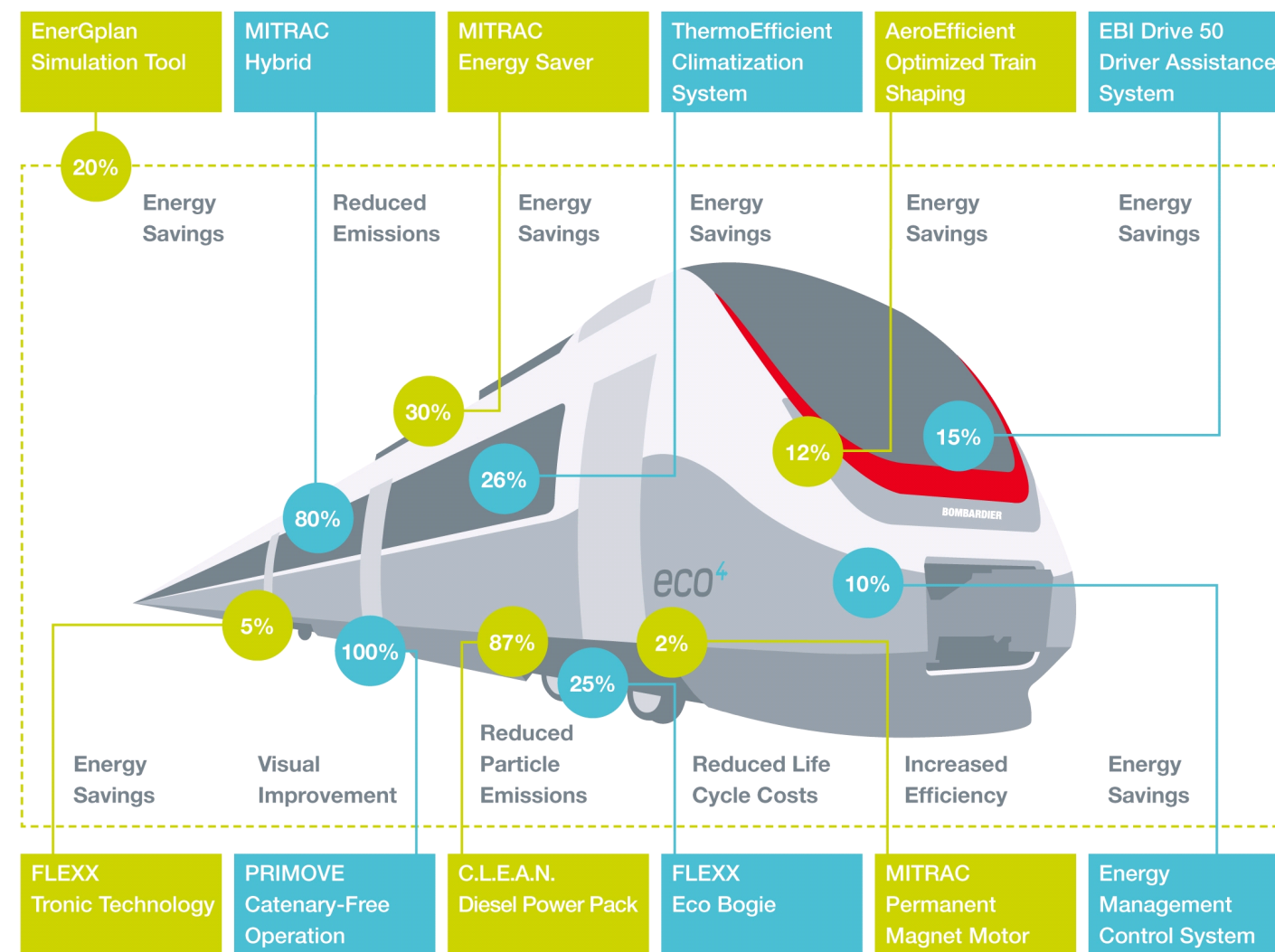
# **eco<sup>4</sup>**



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**eco<sup>4</sup> BOMBARDIER**

# eco<sup>4</sup> - a strong portfolio of technologies and solutions



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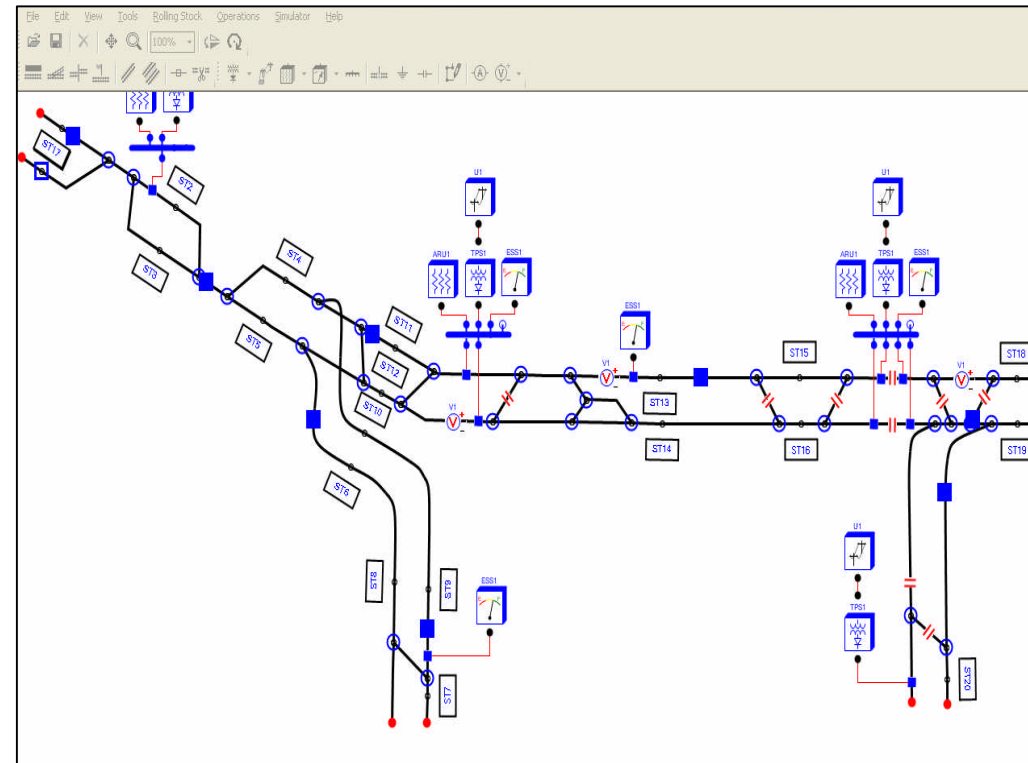
# EnerGplan

## Tool for Predicting and Optimizing the Energy Consumption

Energy Saving  
max 20%

### Features

- Simulating all energy flows of whole systems
- For metros and people movers
- Enabling the optimization of
  - drive performance
  - train schedule
  - power supply
  - distribution system
- For complete fleets
- On multiple routes
- Includes energy storage onboard and/or at wayside



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### Unique Benefits

- Approach for predicting and optimizing the energy consumption
- Max 20% energy saving



# Energy Management Control System

## Managing Energy Consumption of Locomotives and Trains

Energy Saving  
Up to 10%

### Features

- Managing energy consumption of all consumers on-board a vehicle
- Energy Management - Energy Display shows the driver actual & average energy consumption compared to fleet average
- Energy Management - Energy Metering allows billing and tracking the energy consumption for operators (new norm!)
- Energy Management - Smart Stabling reduces unnecessary auxiliary loads at turnaround, inter-peak and overnight



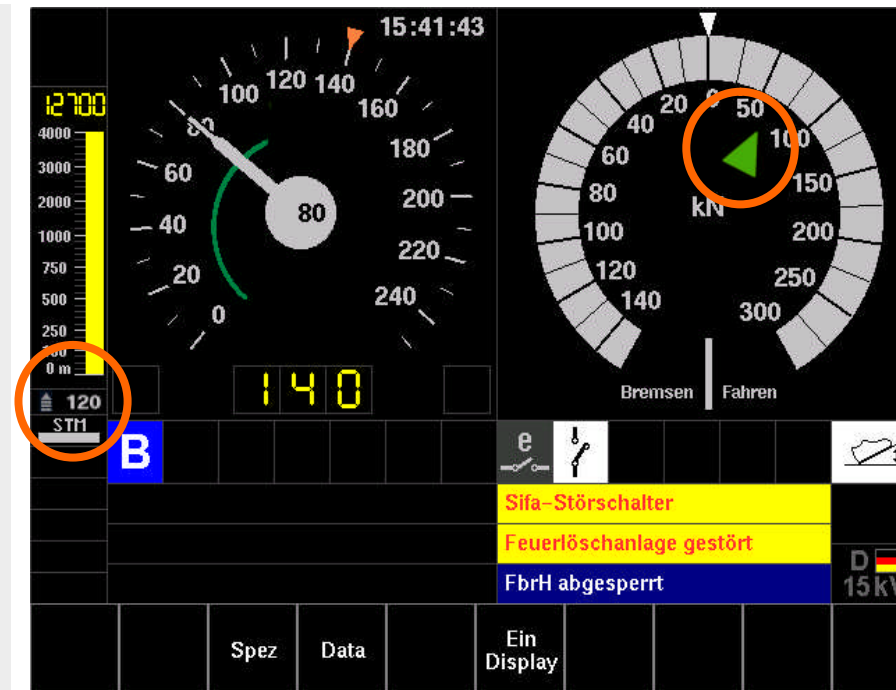
### Benefits

- Increases cost awareness of the driver
- Prepared for future European norm in energy metering
- Reduces energy consumption at standstill

## EBI Drive 50 Driver Assistance System: Features

### Features

- Most complete solution
- Intelligently combining the goals
  - Punctuality
  - Energy savings
  - Reduced wear
- Generating recommendations to the driver for
  - optimized speed
  - optimized traction force
- Information constantly updated, based on actual position, track information, speed and time compared to time table
- Online Data Transfer to trains allows dynamic, energy minimizing management of the fleet

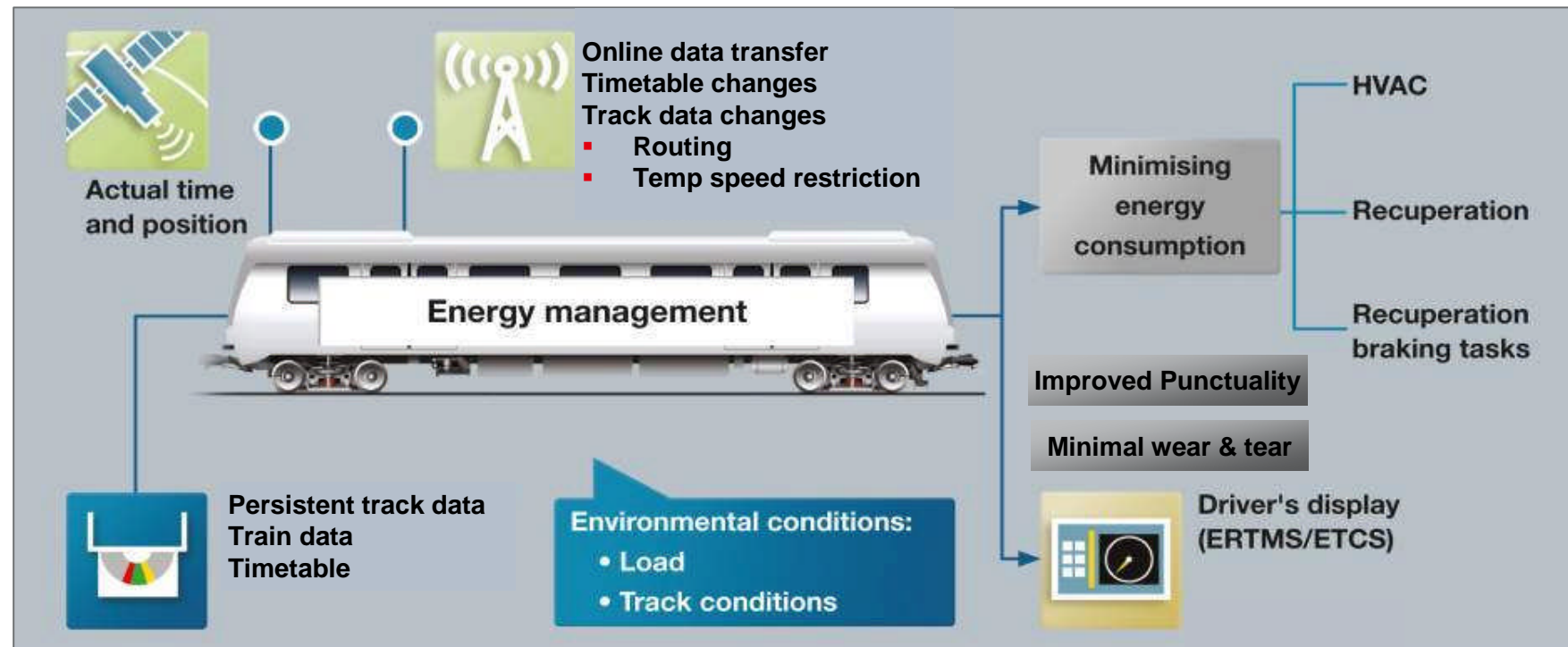


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# EBI Drive 50

## Driver Assistance System: Layout and Benefits

Energy Saving  
Up to 15%



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### Unique Benefits

- Minimize energy consumption for given time-table and various system constraints
- Energy savings of up to 15%

# MITRAC Dual Power

## Extend coverage on tracks without electrification

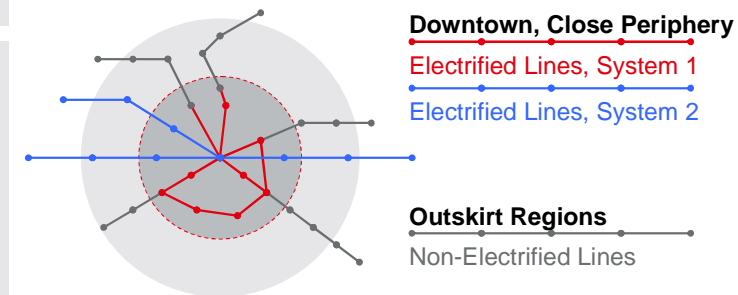
Emission Reduction  
max 80 %

### Functionality

- Pantograph and Diesel engines inside
- Switchover between Diesel and electric and among different electric systems any time, any place
- Innovative propulsion chain able to convert both Diesel-generated and electric power efficiently
- Braking power is fed to auxiliaries or catenary
- No separate starter (ignition)

### Customer Benefits

- 40% lower energy costs \*
- ca 80% less air pollution (CO<sub>2</sub>, NO<sub>x</sub> and particles)
- Average 20% shorter travel time thanks to seamless change between diesel and electric tracks (no transferring, no locos changed)
- Extended seamless coverage of outskirts regions
- Lower operating costs (Efficient fleet, no exchange of locomotive / power cars, high flexibility)
- Less noise during train stops (Diesel engine off)



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\* Figures relate to network with 80% electrification with a locomotive, any motor type  
Assumptions: Diesel: 1.1 € / l; electricity: 0.11 € / kWh

# AeroEfficient

## Tool for Optimized Train Shaping

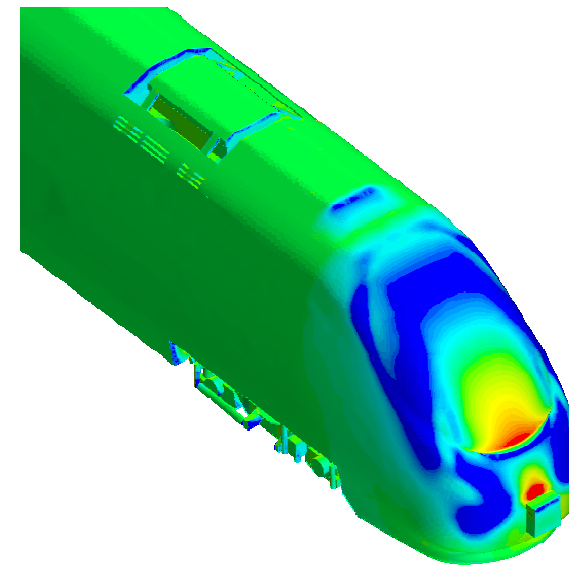
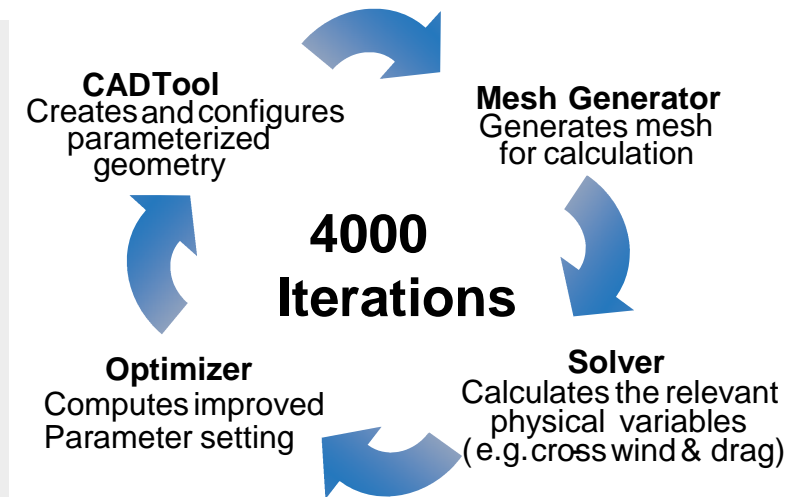
Energy Saving  
max 12%

### Features

- Energy used through aerodynamic resistance: 35% at 200kph, 50% at 300kph
- Developed in cooperation with Bombardier Aerospace
- Components interact with each other in very complex manner
- Optimization of complete train configuration results in an aerodynamic improvement.
- Bombardier has the most advanced system knowledge to achieve the best results / time

### Most advanced Benefits

- Minimizing aerodynamic resistance for a complete train
- Energy savings of max. 12% to current standard design



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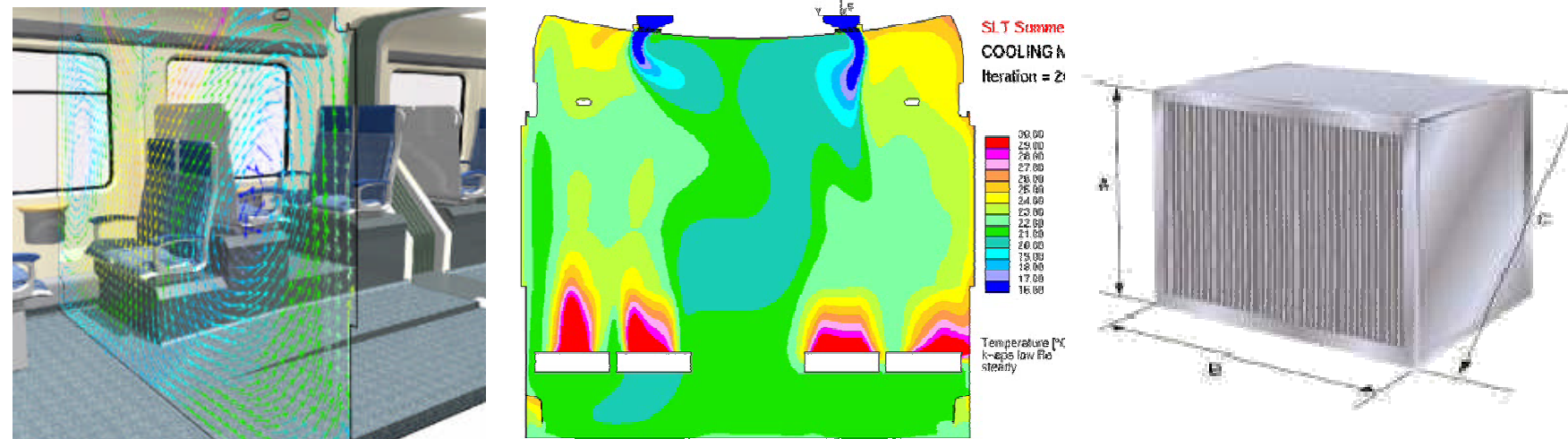
# ThermoEfficient

## Managing the Energy Consumption of HVAC Systems

Energy Saving  
Up to 26%

### Features

- Transferring the energy of the exhaust air into the air which is blown into the cabin
- One heat exchanger per HVAC
- Measuring the number of passengers and supplying the right amount of fresh air



### Unique Benefits

- Improved quality of fresh air in train
- Up to 26% energy savings

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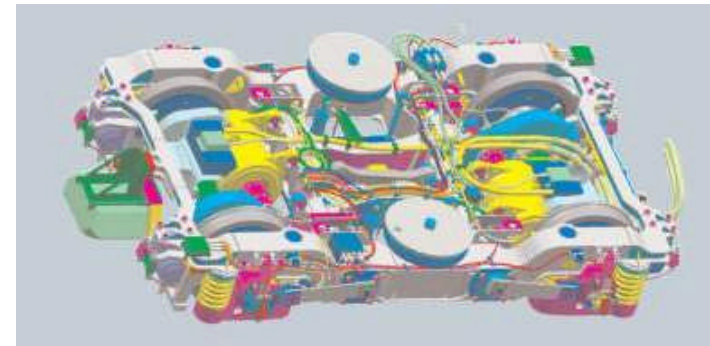
# **FLEXX Tronic**

## **The Intelligent and Active Bogie**

**Energy Saving**  
**max 5%**

### **Features**

- **FLEXX Tronic reduces mechanical complexity by active, multi-functional elements to automatically adapt to changing operation conditions**
  - High speed
  - Tight curves
  - Different track parameters
- **FLEXX Tronic is driven by integrated, model-based controllers which**
  - stabilize the bogie at high speed and
  - steer the wheelsets in curves



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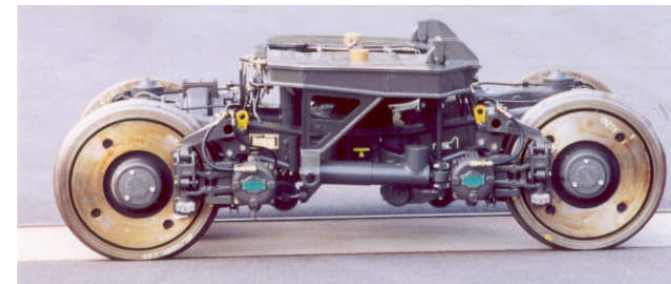
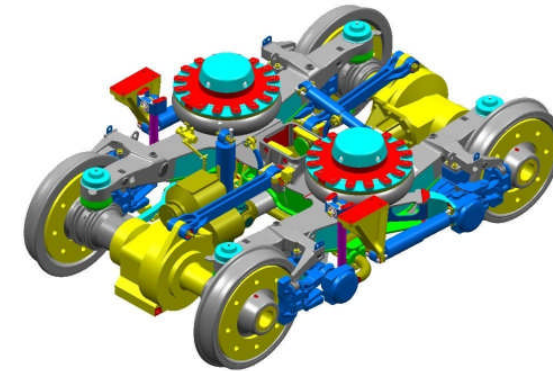
## **FLEXX Eco**

### **The light weight Bogie**

**Energy Saving**  
**max 5%**

#### **Features**

- **FLEXX Eco reduces direct and indirect energy consumption by**
  - Significant reduction in bogie weight and unsprung mass
  - Minimizing aerodynamic drag
- **FLEXX Eco reduces**
  - Cost of bogie maintenance
  - Track wear and risk of rail damage
- **FLEXX Eco is characterized by in-board bearing design and light weight wheelsets**



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# MITRAC Permanent Magnet Motor

## Very High Power Density

Efficiency improvement  
max 2%

### Features

- Design interfaces based on standard Regina motor
- Compatibility with existing systems, approximate same outer dimensions
- Experience from reliable and proven MITRAC induction motor
- Motor reliability / control / protection functionality confirmed



### Benefits

- Max tractive force at 300 km/h 2.65 times than same size induction motor
- Increased vehicle performance and comfort at high speed
- Optimized energy efficiency, reduced volume and weight

## C.L.E.A.N. Diesel Power Pack

### Reducing the Particle Emission and NO<sub>x</sub> Footprint

Particle Reduction  
max 87%

#### Features

- First in the market – already 34 units ordered
- Motor system certified Stage III-B, for minimum particle emissions
- Technology based on state-of-the-art automotive technology, adapted to railway conditions
- The most environmentally-friendly Railway Diesel Motor of the World.



#### Unique Benefits

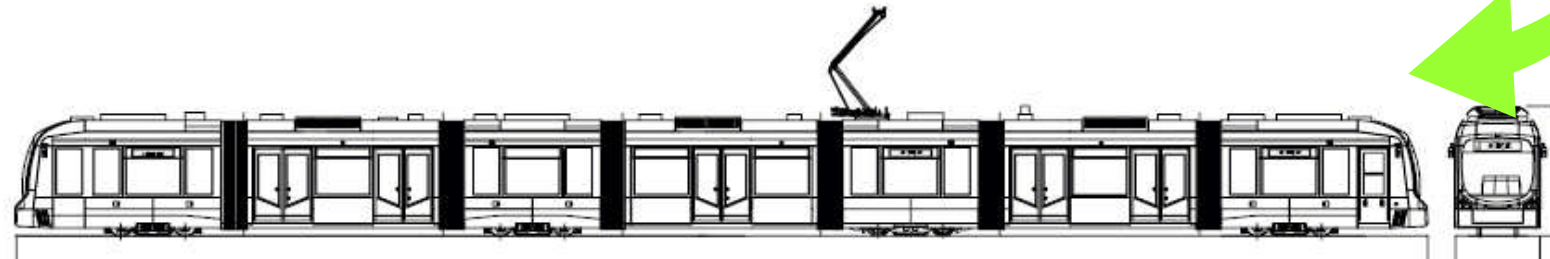
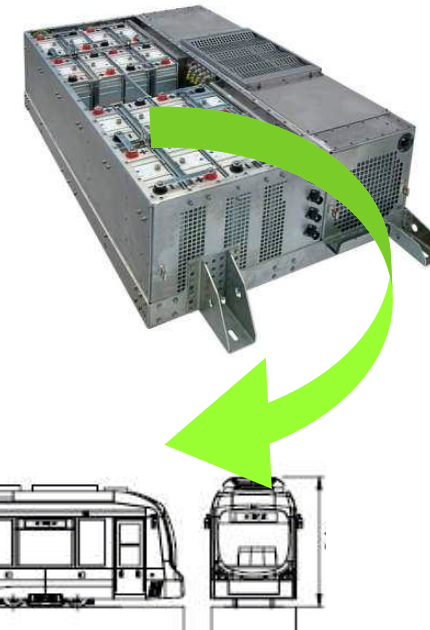
- Max. 87% particle reduction
- Comply with legal requirements and ensure operation of diesel trains > 2012

## MITRAC Energy Saver Recuperating Energy

Energy Saving  
max 30%

### Features:

- Storing electrical energy on-board of LRV, Metro and DEMU
- Re-Use for - acceleration or  
- autonomous operation
- First in the market – 4 years of customer experience



### Benefits:

- Up to 30% energy savings for a train
- Reduce substations along newly built tracks
- Headway reduction through higher acceleration
- Environmentally friendly and reduced CO2 emissions – profit from payback

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# MITRAC Energy Saver

## Benefits from using *MITRAC* Energy Storage

Energy Saving  
max 30%



**DMU**  
Diesel Multiple Unit

- **15 - 35% Energy saving**
  - similar Emission Savings – e.g. CO<sub>2</sub>
- **20...70% additional power „Booster effect“**
  - 30% higher acceleration from 0 to 100 km/h
- **Eliminate Diesel emission in stations**



**Metro**

- **15 - 30% Energy saving**
  - less tunnel heating
- **25...40% Reduced Power from substations**
  - potential infrastructure savings – e.g. less substations
- **Rescue in tunnel**



**LRV**  
Light Rail Vehicle

- **15 - 30% Energy saving**
- **30...50% Reduced Power from substations**
  - potential infrastructure savings – e.g. less substations
- **Catenary free operation**
- **Sold to city of Heidelberg**

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# PRIMOVE

## Catenary-Free Operation

Increase Attractiveness  
100%

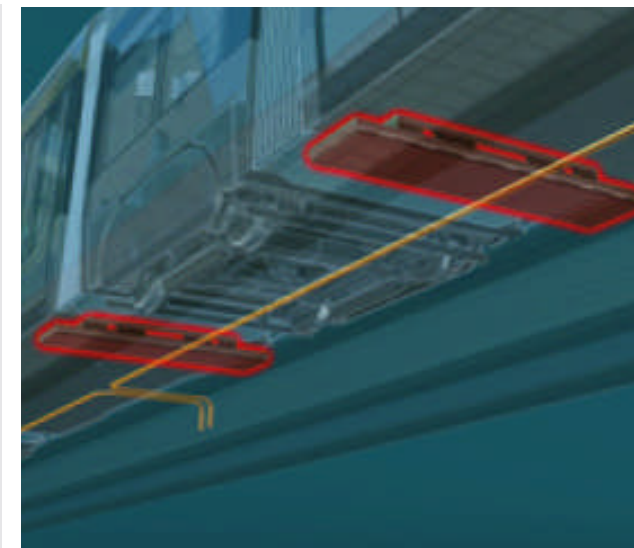
### Features

- Unique concept - driving with contact-less power supply, yet same performance
- Cables in the ground provide the necessary energy – only energized when needed
- Pick-up coils underneath vehicle turns magnetic field below into an electric current
- Providing the same performance characteristic as a normal power supply
- Easily be coupled with the Mitrac Energy Saver for full energy saving potentials
- Tested on a light rail vehicle at the Bombardier site in Bautzen



### Unique Benefits

- Invisible and contactless power supply
- No wear of high voltage pick-up components, lowers service & maintenance costs
- Reliable performance in all weather and ground conditions



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## References

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**eco<sup>4</sup> products are tested successfully with customers or are already sold**

Heidelberg  
Mannheim  
East Midland  
ARRIVA  
SNCF  
National Express  
Veolia  
SJ  
LNVG  
Green Cargo  
National Express  
RMV  
East Anglia Fleet  
NJT  
Transitio

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## THE CLIMATE IS RIGHT FOR TRAINS

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**We have the Solutions**

**eco<sup>4</sup>**

**The new Formula for Total Train Performance  
from Bombardier Transportation**