Rail Sustainability Summit

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Agenda: the view from Bombardier

Introduction: the climate is right for trains

Sustainable train design

Sustainable train manufacture

Case study: *AVENTRA* for Elizabeth Line

Sustainable train maintenance

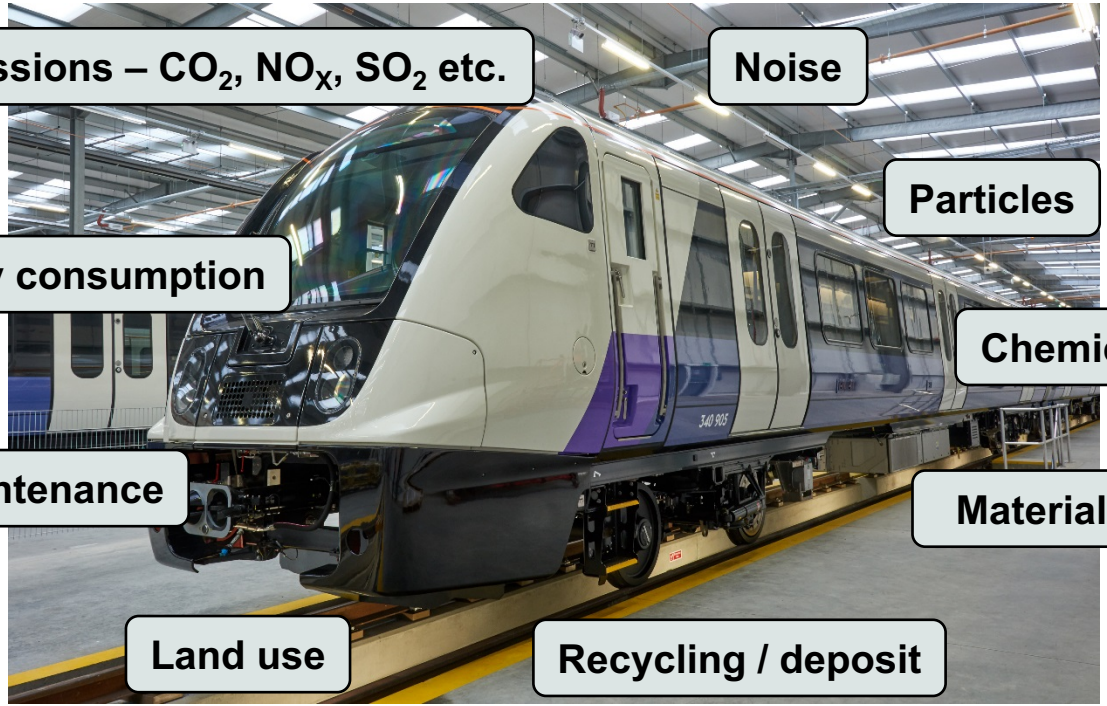
Sustainable train end of life

Case study: Old Oak Common depot for Elizabeth Line

Introduction: The Climate is Right for Trains

- Climate change
- Urbanisation and population growth
- Congestion
- Oil scarcity and price of energy
- Ageing societies

Managing sustainability through the life-cycle



Sustainable train design

Decreased weight means energy savings

FLEXX Eco bogies = 30% fall in bogie mass, 25% fall in unsprung mass

Energy Savings—HVAC control

CO2 management through intelligent air conditioning able to adapt to outside temperature and passenger load

Noise reduction—Low noise systems and components

Low noise bogies and bogie skirts used to reduce noise

Aero-acoustically optimised shape

Optimised wheels with noise absorbers

Sustainable train manufacture

Chemical Control – Paint system

Water-based paint systems since 1990’s

Material Reuse—multiple use package

Storing and re-using packaging materials

Energy Reduction – Green energy source

Renewable source electricity

Case Study: Elizabeth line *AVENTRA*

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AVENTRA for Elizabeth Line: *ECO4*

Introducing *ECO4*

- Modular portfolio of innovative technologies and solutions that add value to trains and services
- Ideal response to wide spectrum of performance requirements
- Easy customization to any fleet

Benefits to our customers

- Save energy
- Improve efficiency
- Achieve sound economic value
- Protect the environment

Elizabeth Line - *ECO4*

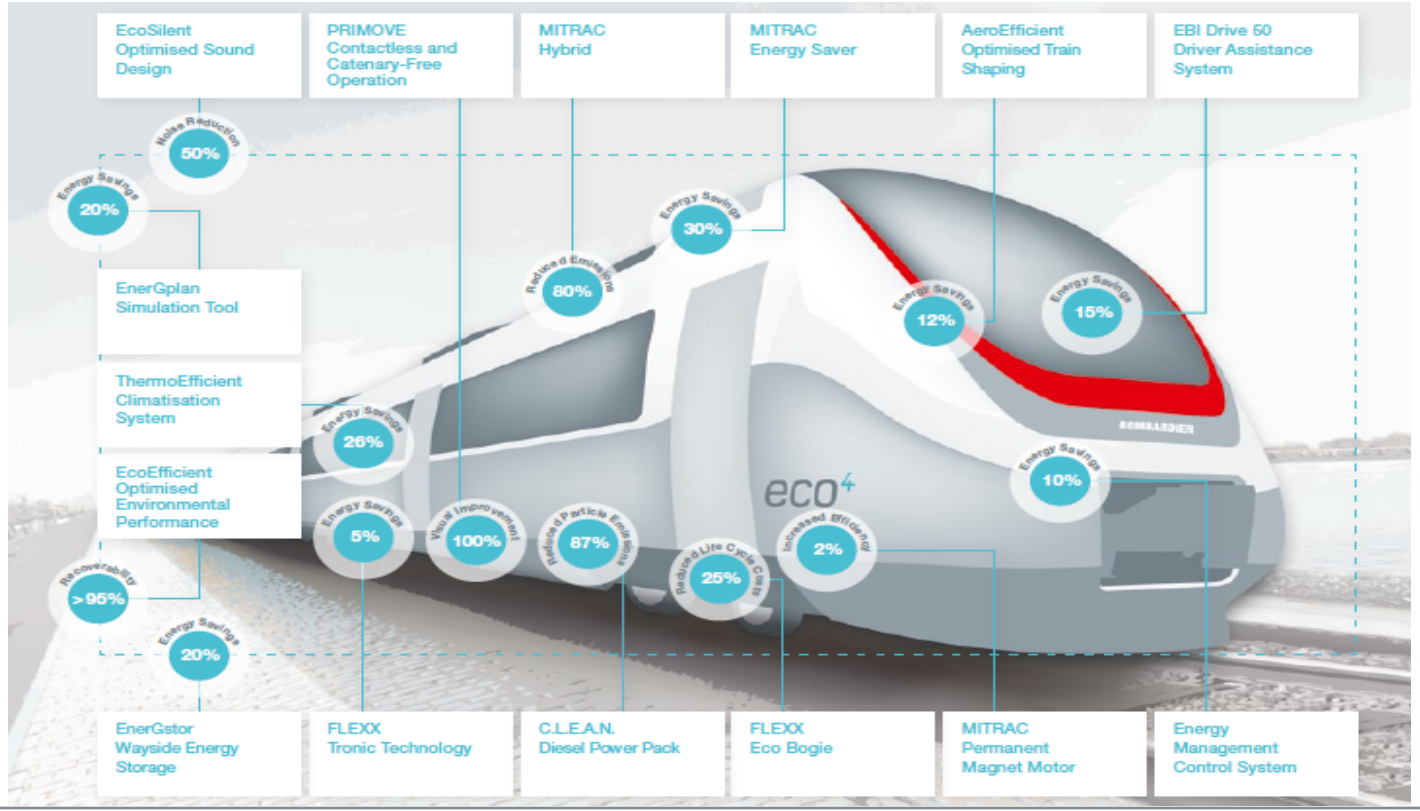
eco4

Energy

Efficiency

Economy

Ecology



eco4

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Sustainable train manufacture

Chemical Control – Paint system

Water-based paint systems

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Renewable source electricity

Hotel loads: energy efficient issues

Intelligent stabling function

Automatically shuts the units down, including the lowering of the pantographs

Saloon LED lighting with an ambient light dimming feature

Approx 64% reduction in energy consumption (vs. existing technology)

CO2 control for HVAC

Optimises the level of fresh air brought into the unit

Takes account of fresh air entering whilst doors are open at stations

Standby State

Optimises the traction chain to deliver auxiliary load only

Half of the LCMs on the train are shut down, also = lower acoustic noise

Sustainable train maintenance

Consumables longevity—Automated visual inspection system

Brake pad life maximised

Eco technology—Oil interceptor tanks

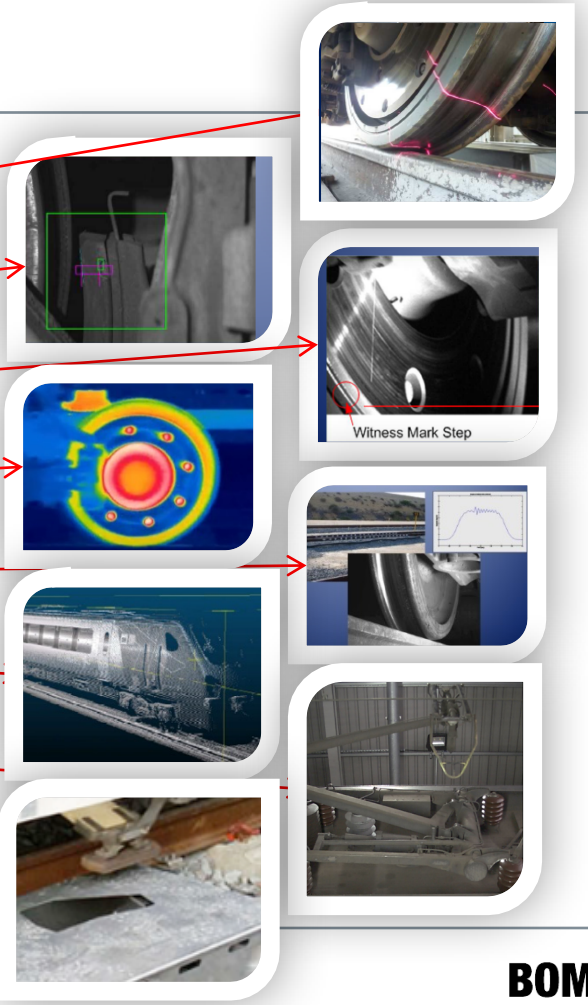
Reduce amount of engine oil discharged into the environment

By-product management— Parts recycling and reuse

Parts are classified as either consumables (recycled) or rotables (reused)

Wayside Measurement Capability

- Wheel Profile & Condition Monitoring
- Brake Pad or Block Monitoring
- Brake Disc Monitoring
- Thermal Monitoring
- Wheel Damage Monitoring
- Optical Recognition & Assessment
- Pantograph Monitoring
- Collector Shoe



On-board Measurement Capability

- HVAC – Pressure & Temperature Monitoring
- Exterior Door – Door Motor Current Monitoring
- TCMS – Remotely configurable data loggers & advanced diagnostics
- Brake & Air System – Pressure output, loadweigh, brake curve monitoring
- Propulsion – Cooling system, traction motor and current monitoring
- Bogie - Onboard wheel bearing monitoring

Train end of life

Waste disposal – Sorting

Waste is segregated in 40 different waste streams

Material recycling – High recoverability

AVENTRA is expected to have a total recoverability rate of ≥95%

90% of the units by weight for material recycling

5% by weight for energy recovery

Hazard containment – Substance Release

The Bombardier 'Prohibited and Restricted Substances List' reduces the use and disposal of toxic substances and emissions.

Batteries are disposed of separately for recycling

Material Composition and Recyclability

Recyclability of typical Electrostar

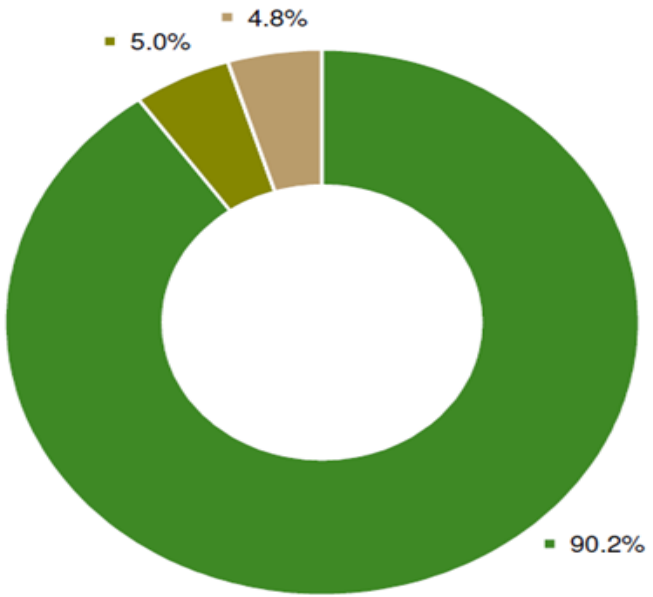
Key:

- Material recycling
- Energy recovery
- Disposal

Recyclability is 90.2%

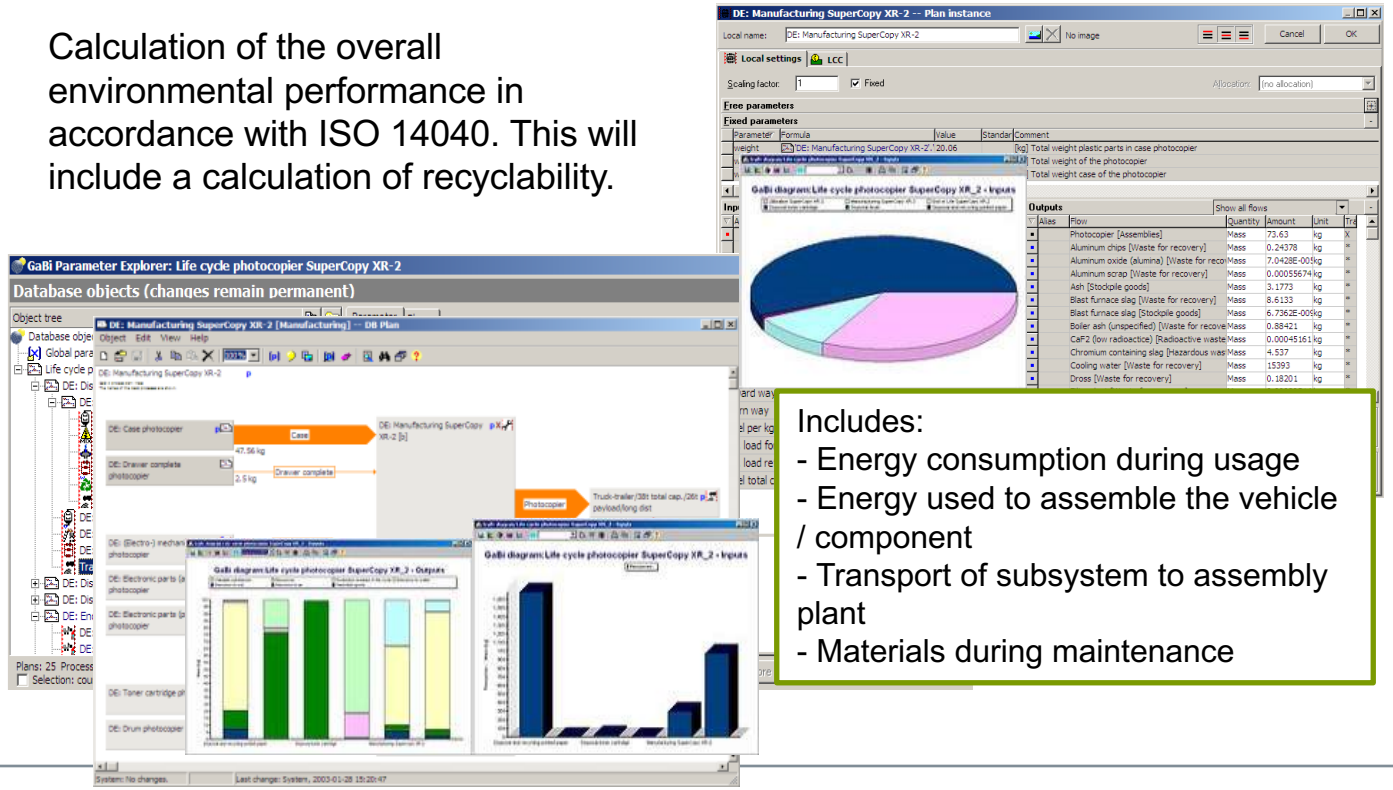
Recoverability* is 95.2%

* Bombardier defines recoverability as the percentage of materials that can be diverted from the end-of-life stream to be material recycled or energy recovered.



Life Cycle Assessment (LCA)

Calculation of the overall environmental performance in accordance with ISO 14040. This will include a calculation of recyclability.



Includes:
- Energy consumption during usage
- Energy used to assemble the vehicle / component
- Transport of subsystem to assembly plant
- Materials during maintenance

Case Study: Old Oak Common Depot

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Old Oak Common Depot: Building sustainably

Crossrail set the initial sustainable parameters. Bombardier has expanded on these and passed on immediate whole life cost savings via the tendered package to Crossrail.

The Energy solution, working with Taylor Woodrow, includes the design and installation of a multi-technology renewable energy solution consisting of:

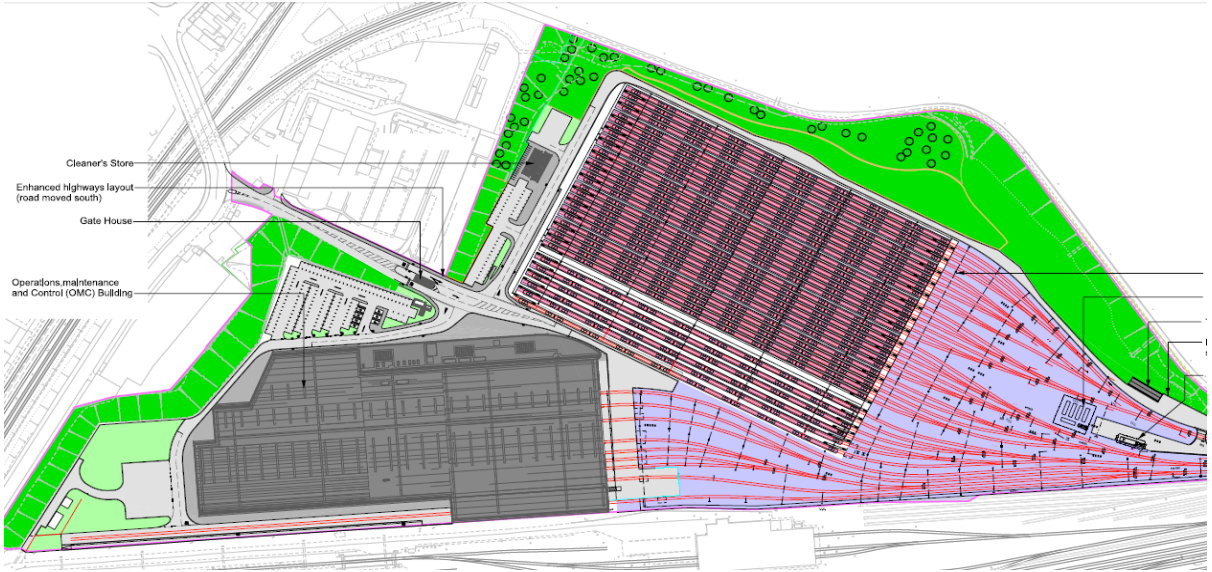
- *Ground Source Heat Pumps using 250 energy piles and 50+ boreholes 150m deep*
- *40,000m2 Under Floor Heating and Cooling*
- *Combined Heat and Power (CHP) Plants + 1500m² Solar PV*
- *CHP heat combines with GS heat + surplus back into ground for reuse*
- *Reduction in mains electricity supply by 30%, overall 33% renewable energy solution = operational savings of c. £100,000 per annum*

Old Oak Common Project targeted BREEAM areas

OMC building and Concrete Perimeter, including renewable energies and piling.

OMC Cark Park and Cleaners Store Parking, Cleaners Store, Gatehouse

Area of enhancement and woodland restoration adjacent to Grand Union Canal



OOC: Europe's Largest Sustainable Train Depot?

It is a relatively new innovation to utilise BREEAM to build sustainable depots. More traditionally these sustainability programmes have leant towards housing stock and office builds.

The benefit that the BREAAM assessment, support and knowledge brings to the Depot should deliver:

- long term staff satisfaction
- successful employment of staff engaged in operating and maintaining trains
- leading to better performance outcomes.

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