

# Good practices in Design for Environment: -15 years of experiences at Bombardier Transportation



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**BOMBARDIER**

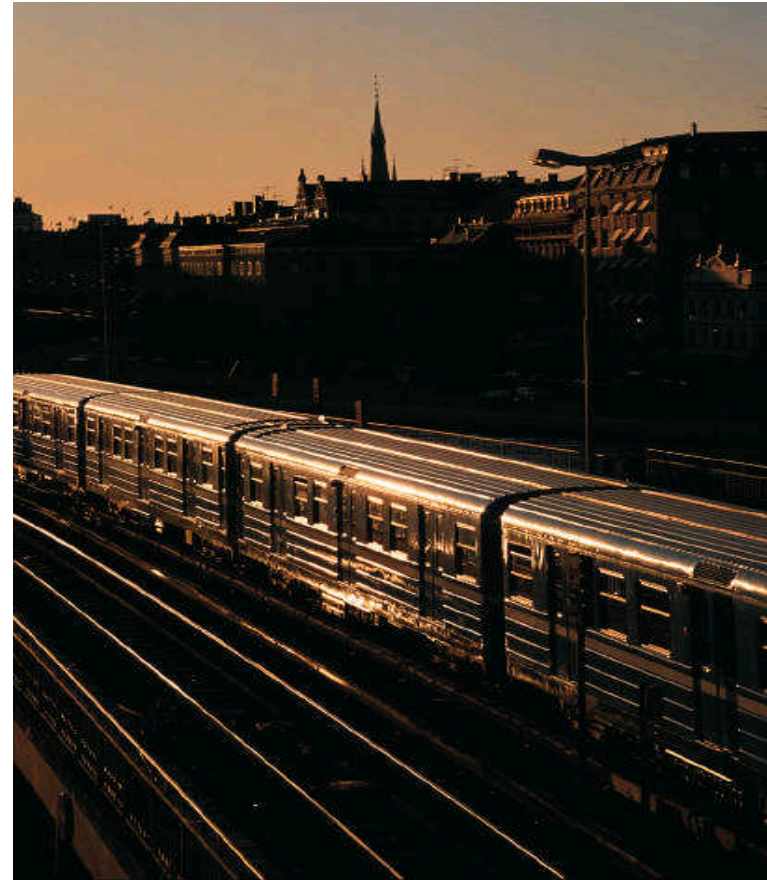
# Topics

- History of DfE
- Examples of improvements
- To work with DfE
- Product Declarations (EPDs)



# History - DfE at Bombardier Transportation

- **Stockholm Underground initiated the DfE work**
  - 1992
  - 1 person at Bombardier dealt with DfE
- **All Nordic customers more or less requested the same level of environmental requirements**
  - SJ, DSB, NSB etc
- **Today spread to most customer in Europe – even harder environmental requirements than in the Nordic countries**
  - E.g. SNCF, SNCB, DB, Trenitalia etc



# Example Stockholm – Västerås distance 107km

## Early 1990's

### Intercity train

- Loco + 4 coaches, 275 seats
- Speed: 110 – 130 km/h
- Travel time: 1:18 min
- Load factor: 35 %
- Energy: 0,12 kWh / pkm\*



## Today

### Regina, EMU

- 3 coaches, 272 seats
- Speed: 110 – 200 km/h
- Travel time: 0:53 min
- Load factor: 35 %
- Energy: 0,087 kWh / pkm\*



\*pkm = passenger kilometre

Energy  
consumption  
25-30% lower!

# Example Stockholm – Västerås distance 107km

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## Today

### Regina, EMU

- 3 coaches, 272 seats
- Speed: 110 – 200 km/h
- Travel time: 0:53 min
- Load factor: **53** %
- Energy: **0,057** kWh / pkm\*

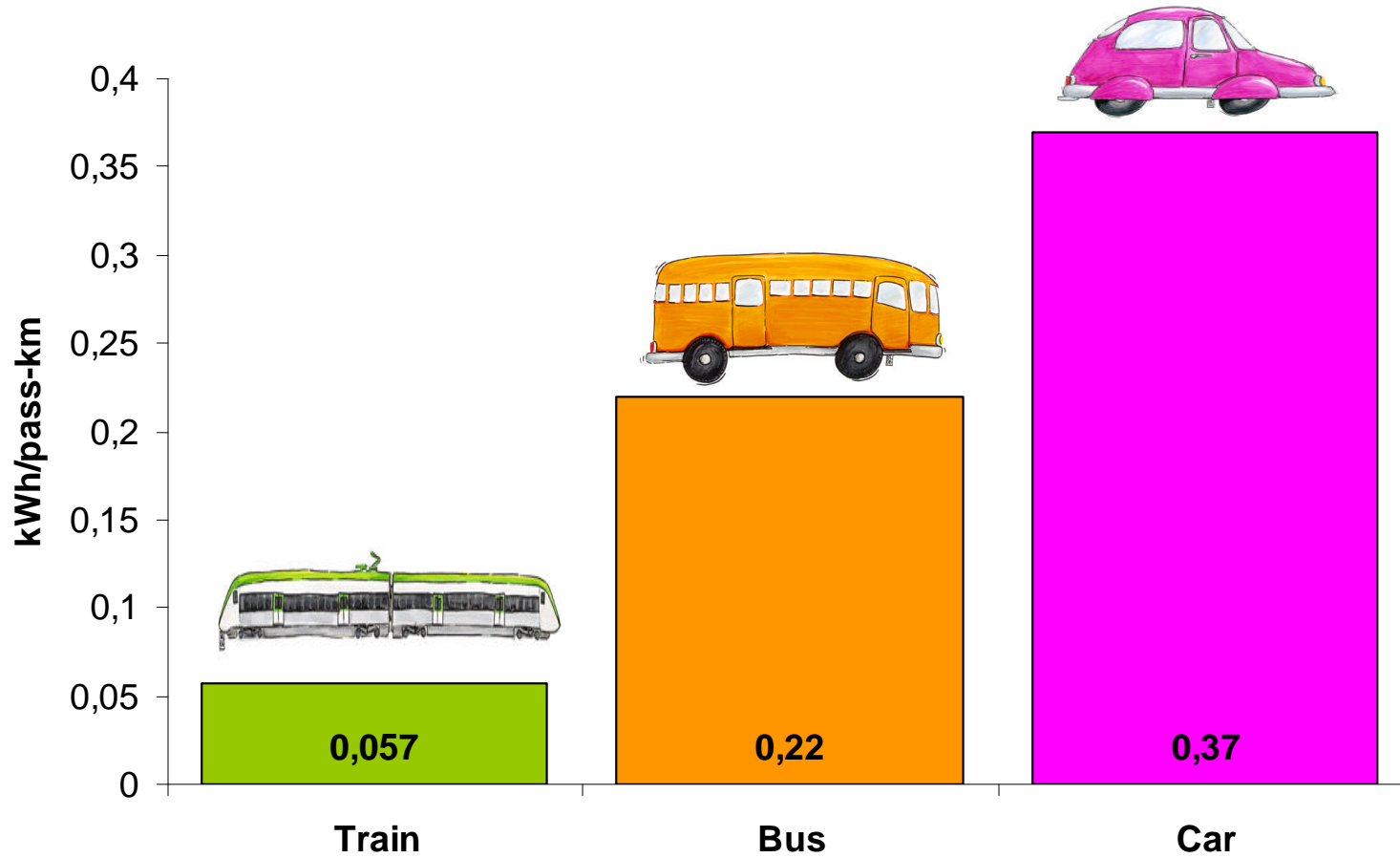


\*pkm = passenger kilometre

Energy consumption over 50% lower!

# Stockholm - Västerås

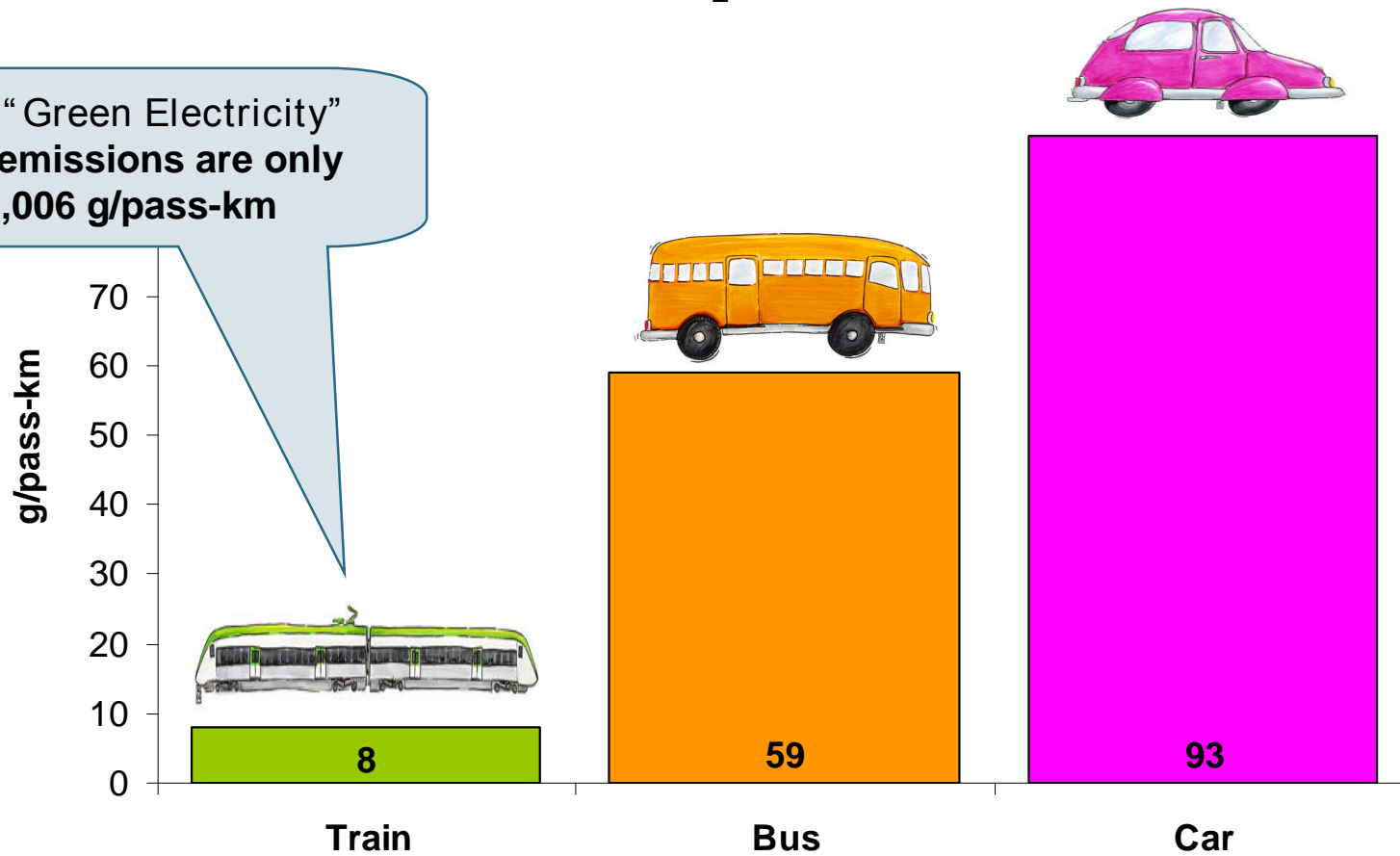
## Stockholm- Västerås Energy Consumption



# Stockholm - Västerås

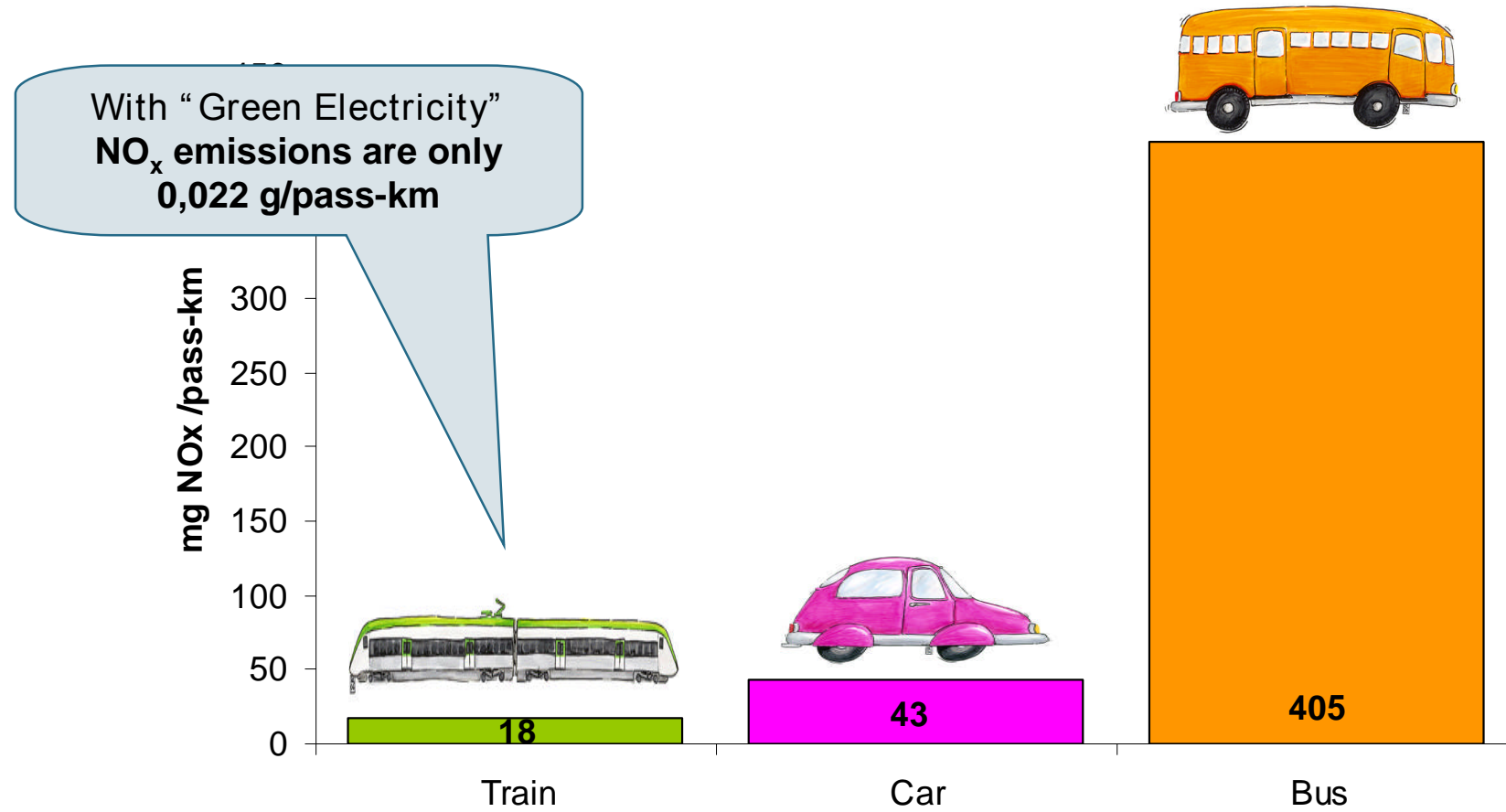
## Stockholm- Västerås CO<sub>2</sub> Emissions

With "Green Electricity"  
CO<sub>2</sub> emissions are only  
0,006 g/pass-km



# Stockholm - Västerås

## Stockholm- Västerås NO<sub>x</sub> emissions





## Calculation assumptions

- **Case Stockholm- Västerås (107 km).**
- **Average emissions - Nordic mix of electricity have been used**
- **Train, Regina, 3 cars, 8,3 kWh electric power/km, load factor 53%.**
- **Car, medium size, environment class 2000, fuel efficiency 0,075 l petrol/km, passengers 1,8.**
- **Bus, Euro 3 emissions, fuel efficiency 0,45 l diesel/km, load factor 34%.**
- **Data from the report..... Evert Andersson KTH**

# Common Customer Environmental Requirements

- **Environmental Management System (EMS)**
- **Restrictions on Materials**
  - Prohibited & Restricted Substances
- **Specify the Materials used**
- **Material Safety Data sheets (MSDS)**
  - To be provided for harmful materials
- **Recycling highly prioritized**
  - Specify recyclability of materials used
  - Use materials that are recyclable, sometimes also specify the amount
  - Marking of polymers to facilitate recycling
- **Environmental Report**
  - Describing the environmental impact
- **Recycling Description / Manual**
  - Including end-of-life treatment
- **Life Cycle Assessment (LCA)**
  - According to ISO 14040
- **Restrictions on Emissions**
  - Particulate e.g. brake pads, leakage of oil, greases etc
- **Disposal cost included in the LCC-calculations**
- **Energy efficiency**
- **Take-back obligation**



## To work with DfE



**BOMBARDIER**

# Bombardier Transportation Centre of Competence - Design for Environment

Global centre of competence  
in Design for Environment,  
with a company wide network  
- to ensure harmonized and  
high level of environmental  
competence

Close link to Health, Safety  
& Environment (HSE)  
- Michael Schemmer



Sara



Saemundur



Christina



Jessica



Ylva



Pia

# DfE Tasks

Lead DfE Engineer in projects



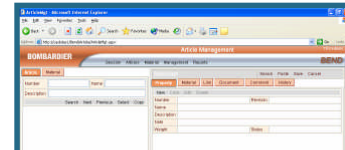
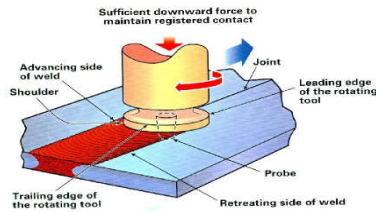
Material Issues



Knowledge Management

<http://casblns2.tg.bombardier.com/de/de500043.nsf>

## Environmental Case Studies

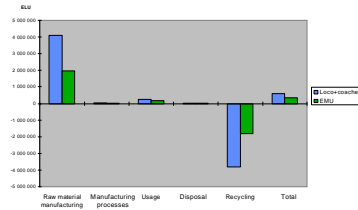


CE-Mat – Certification & Environmental Materials Database

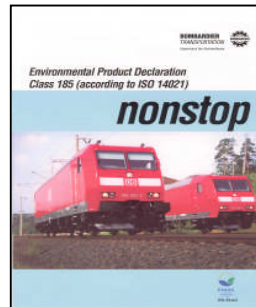


DfE Training

## LCA - Life Cycle Assessment



Environmental Product Declarations



Research & Development

| BT Prohibited Substances  |                |   |  |            |           |  |
|---------------------------|----------------|---|--|------------|-----------|--|
| Substance                 | Classification | Examples of type or area of use   | Conditions of restriction (Limit value in %) | Material   | Phase out | Reference  |
| Arsenic and its compounds | Severe         | Joining agents in plastic, adhesives, repair compounds, primers, penetrants of wood, varnishes and electronic devices | May not be used in the presence of wood      | C, E, H, V | Phase out | EN 50155EC, EN 50077IEEC   |
| Asbestos                  | Severe         | Insulating material and fireproofing  | General ban of application                   | C          | Phase out | EN 50155EC, EN 50077IEEC, EN 50155IEEC, EN 50077IEEC, EN 50077IEEC, EN 50077IEEC |



Standards, Guidelines, Templates & Checklists  
e.g. Environmental Legislation

# Examples - Support for Sustainable Product Design

## Bombardier Design for Environment Guidelines

- Designers and product developers are continuously striving to develop and improve the environmental performance of our products
- To facilitate this work the DfE Guidelines has been developed
- This is a “quick an easy” selection of guidelines how to move towards more sustainable products and services
- Are available in three languages; English, French and German

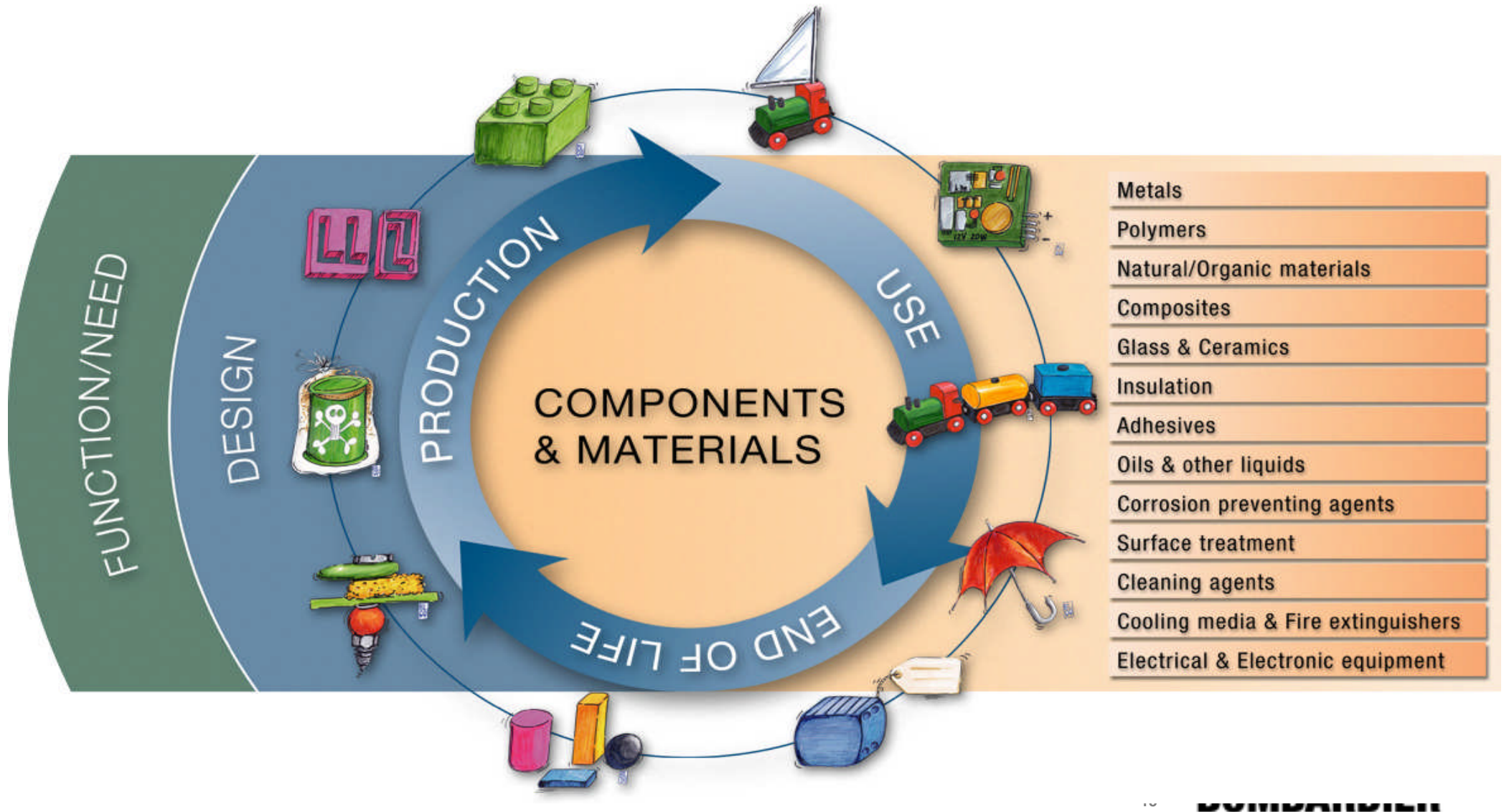


## Bombardier Prohibited & Restricted Substances List

- Bombardier has developed a list of Prohibited & Restricted Substances to make sure that harmful substances are not used in our vehicles
- This list is applied at engineering & design functions and for procurement of materials and parts used in the vehicle
- All suppliers are requested to conform compliance with this list

| Substance                        |     | Restriction | Application | Notes                      | Reference |
|----------------------------------|-----|-------------|-------------|----------------------------|-----------|
| Hexachlorocyclopentadiene        | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Hexachlorobenzene                | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Polychlorinated biphenyls        | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Polycyclic aromatic hydrocarbons | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Phthalates                       | PCB | Restricted  | PCB         | Restricted in all products | RoHS      |
| Lead                             | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Cadmium                          | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Mercury                          | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Chromium VI                      | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Organotin compounds              | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Organophosphorus compounds       | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Organochlorine compounds         | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Organofluorine compounds         | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Organosulfur compounds           | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Organonitrogen compounds         | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Organic peroxides                | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Organic acids                    | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Organic bases                    | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Organic solvents                 | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Organic pigments                 | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Organic dyes                     | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Organic colorants                | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Organic fillers                  | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Organic binders                  | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Organic adhesives                | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Organic coatings                 | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Organic inks                     | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Organic pigments                 | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
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| Organic coatings                 | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |
| Organic inks                     | PCB | Prohibited  | PCB         | Prohibited in all products | RoHS      |

# Design for Environment Guidelines



# Environmental Product Declarations (EPDs)

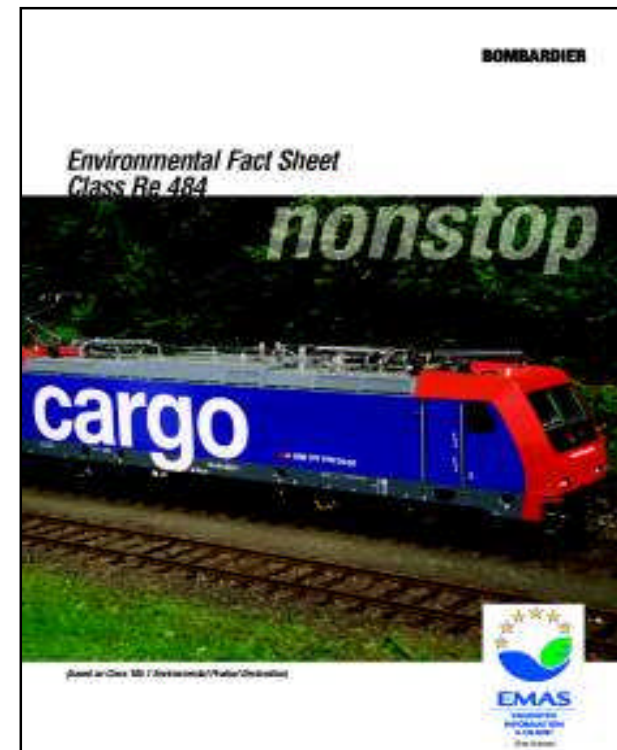
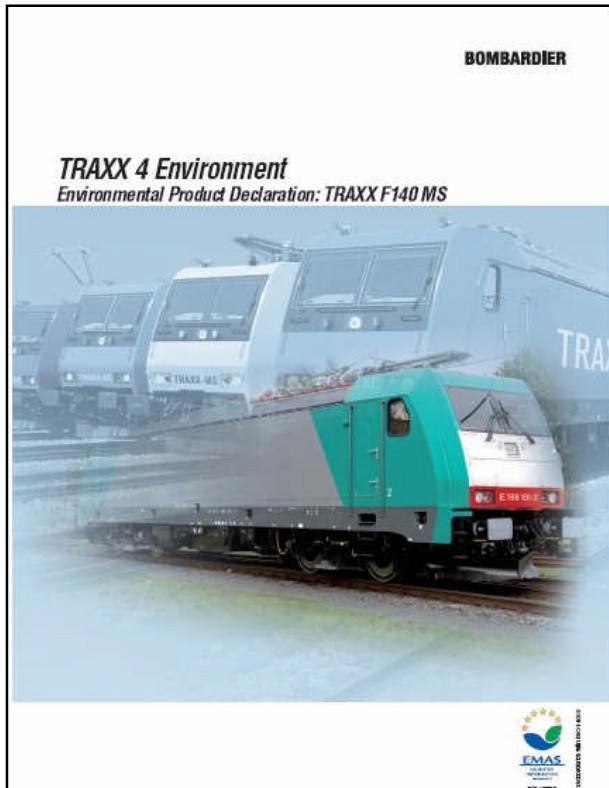


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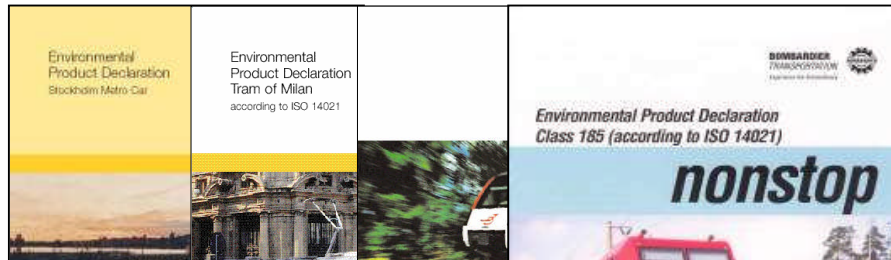


# Two types of presenting Environmental Product Information at Bombardier Transportation

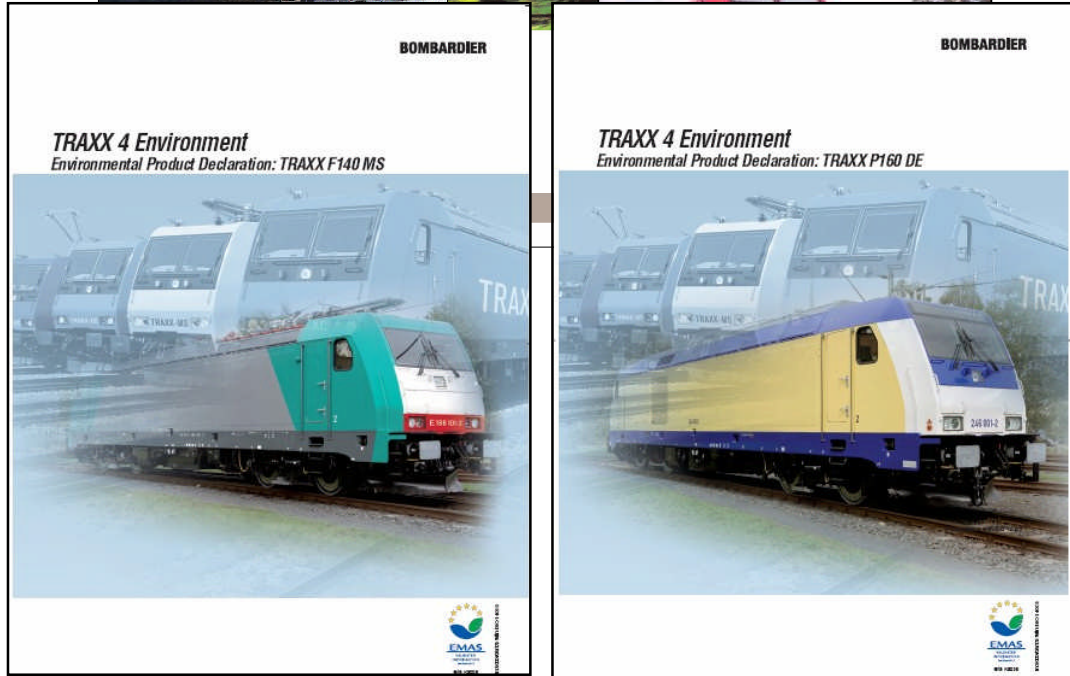
- **Environmental Product Declaration (EPD)**
- **Environmental Fact Sheet (EFS)**
  - Customer specific version, closely related to a core product



# Bombardier Environmental Product Declarations (EPDs) - Communicates excellent environmental performance



**Present environmental performance in a reliable way - ISO standard**



- **Stockholm Metro Car**
  - Bombardier produced the first EPD within the railway industry
- **Tram of Milan**
- **Regina**
- **BR 185**
- **TRAXX F140 MS**
- **TRAXX P160 DE**

# Example: TRAXX 4 Environment

- **Environmental Product Declaration (EPD) for the TRAXX Locomotives**
  - Present the environmental performance in a reliable way according to an ISO standard
  - Includes information over the complete life cycle
- **Environmental features of TRAXX**
  - Environmentally sound materials
    - All materials used are known and listed
  - Reduced cooling volume of the traction converter
    - Due to new IGBT technology
    - Water/glycol mixture for cooling
  - Modular design
    - Easy to change and upgrade individual components
  - Recyclability up to 96 % (by weight)
  - Fulfils the TSI noise requirements
  - Possibility to use regenerative braking



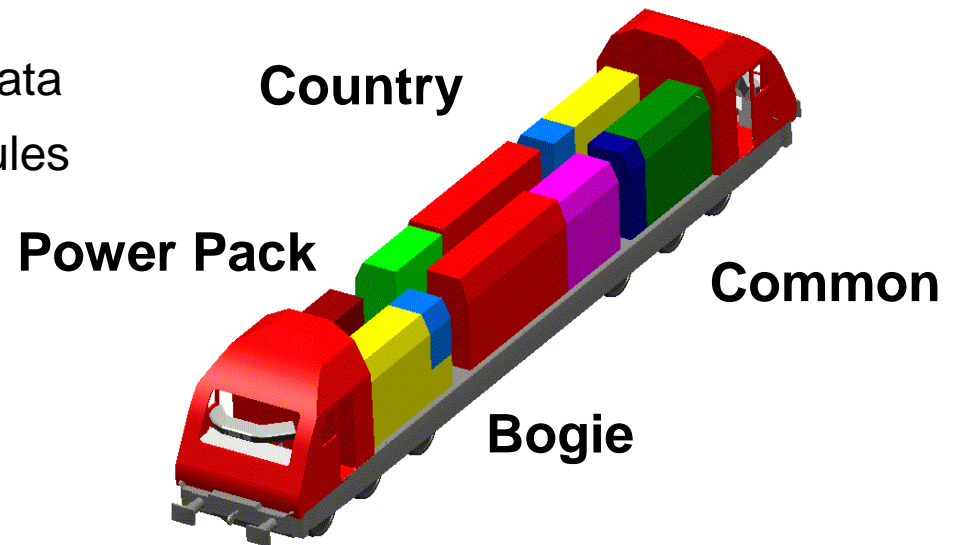
# EPD according to ISO 14025

- **Product Category Rules**

- Product Category: Locomotive
- A set of specific rules for developing the Life Cycle Assessment (LCA) data
- Definition of information to be declared in the EPD

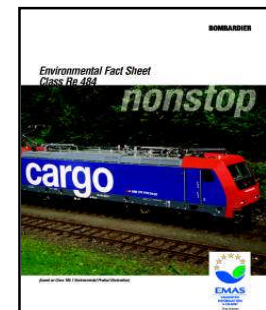
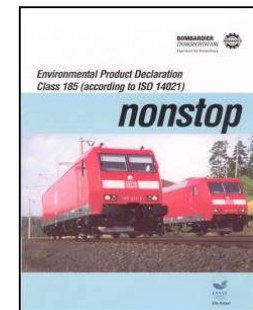
- **Modularization**

- Using specified modules to gather data
- Environmental performance of modules could be compared
- Reuse of data



# Use of the EMAS logo at Bombardier Transportation

- **After the revision of EMAS in 2001 it is possible to make environmental statements that are validated by the EMAS verifier**
- **EMAS logo – a way of validating the content in e.g. an EPD and or EFS**
  - Indicates the reliability and credibility of the information provided, thus being third party validated
  - Indicates the organisations commitment to improvement in environmental performance
- **Have been used at four environmental communication brochures at Bombardier Transportation so far:**
  - EPD Class 185 (according to ISO 14021) in February 2003
  - EFS Class Re484 (based on EPD Class 185) in September 2004
  - EPD TRAXX P160 DE in September 2006
  - EPD TRAXX F140 MS in September 2006



**Thanks for your attention!**

