Shift2Rail Energy KPI results

Mr. Holger Dittus, DLR

FINE1 WP 4 Leader

17/10/2019, Paris, FINE1 & OPEUS Final Conference

Grant Agreement Number: 730818

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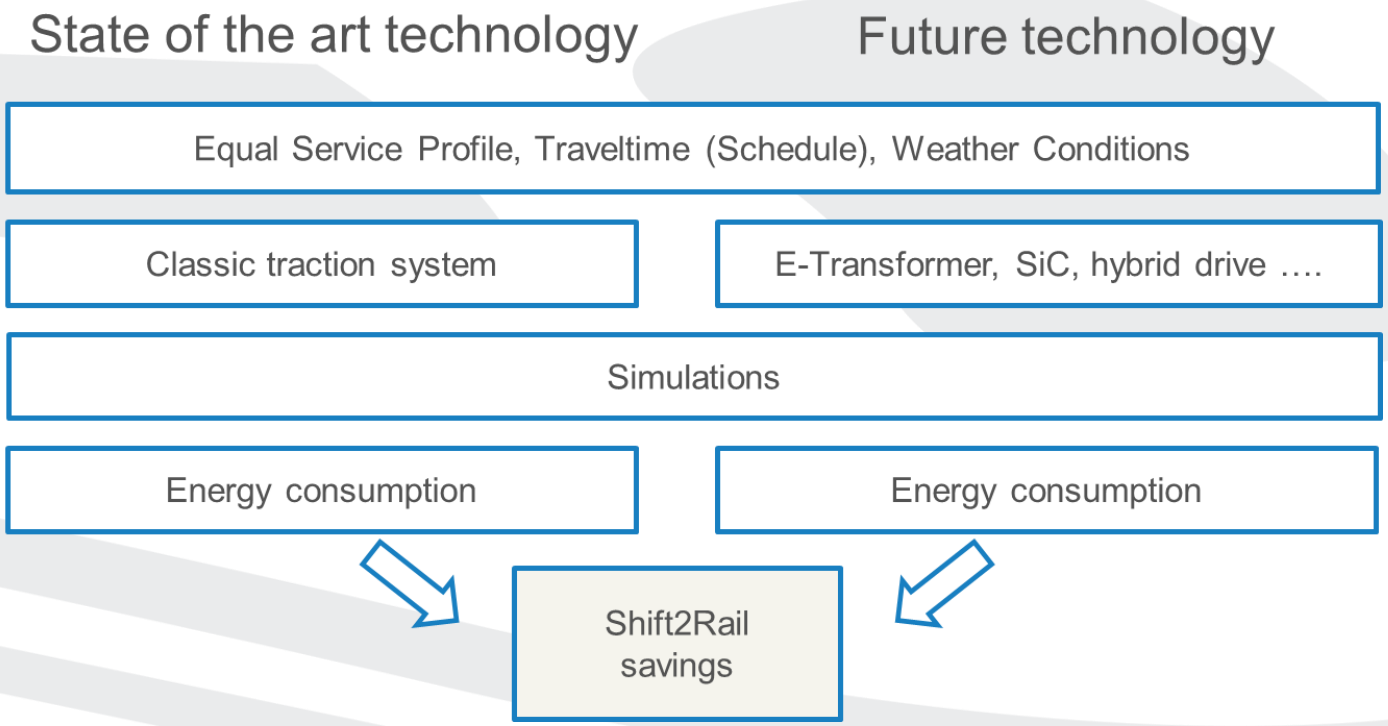
What is an Energy KPI?



- ➔ **Energy KPI quantifies relative savings** of the TD innovations compared to the energy baseline
- ➔ The **Energy KPI summarizes overall savings per SPD**, assuming technical improvements reported by the TDs are applied

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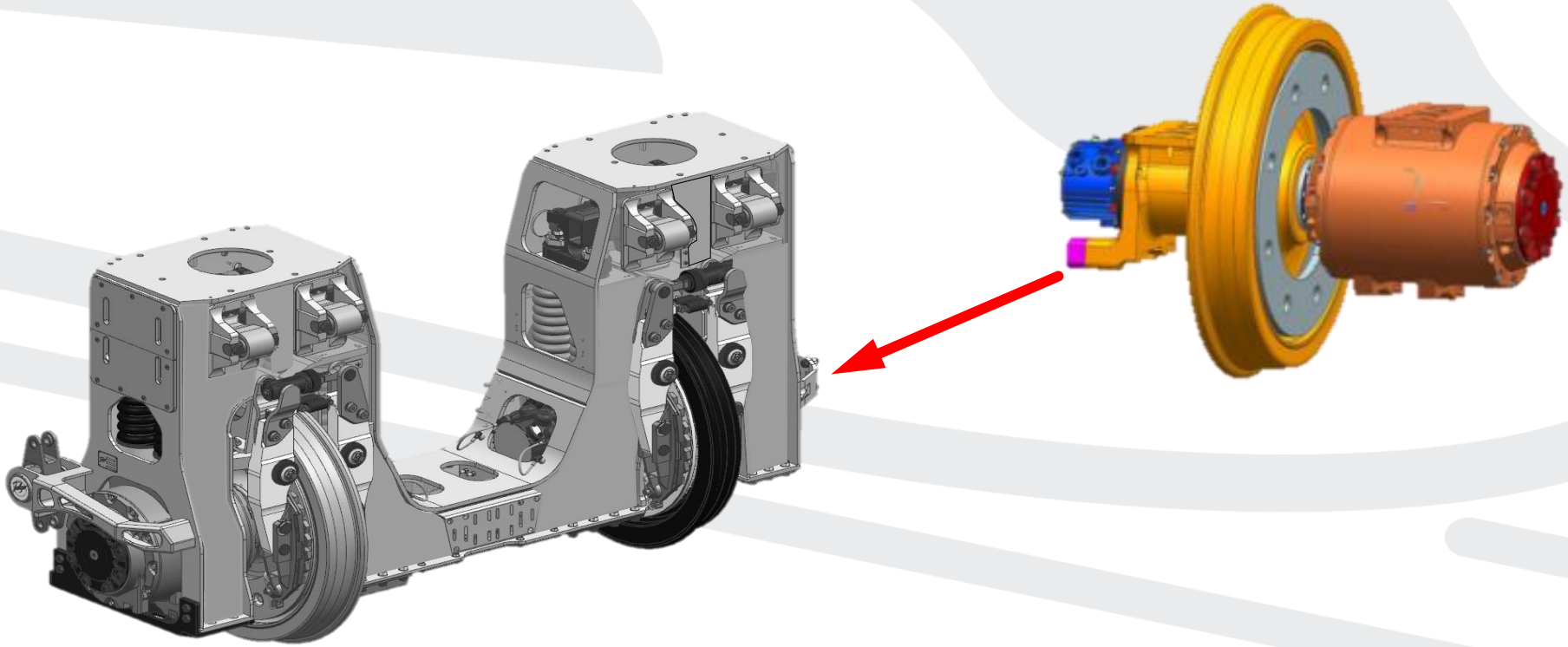
Future Technologies and Improvements reported by TDs

TD1.1: independently rotating PM motor-wheel-system
➔ improved gearbox efficiency



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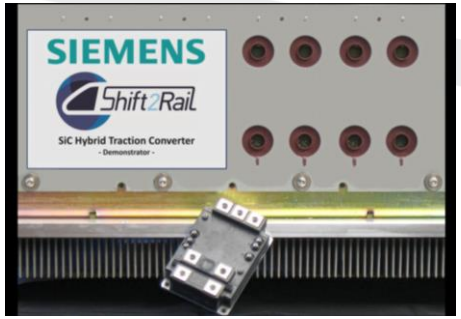
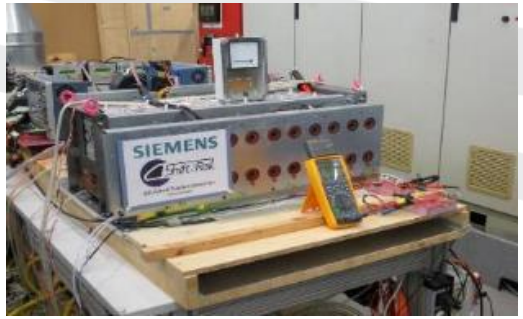
Future Technologies and Improvements reported by TDs

TD1.1: Silicon Carbide (SiC) converter (Metro & Tram)





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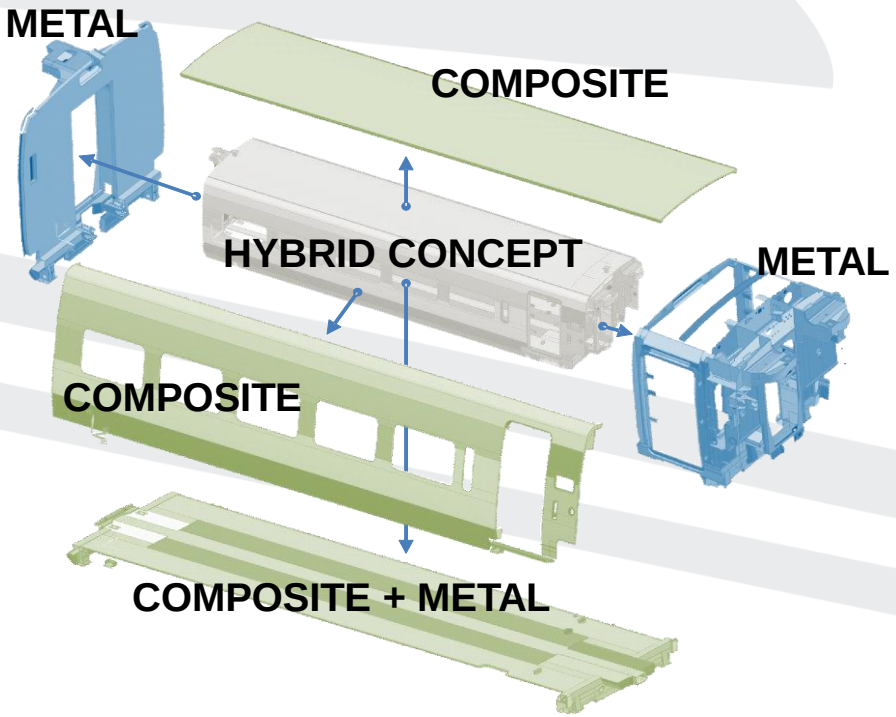
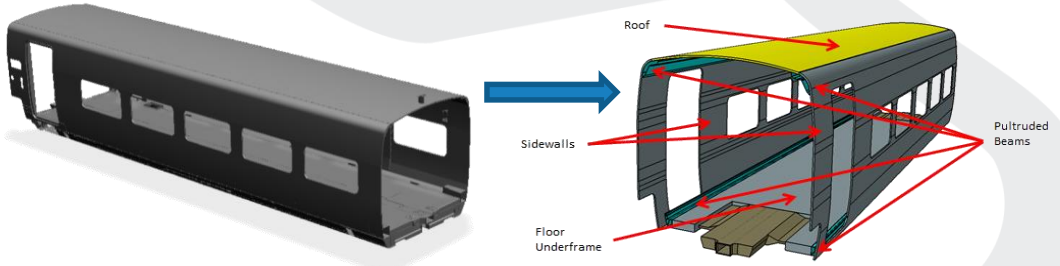
Future Technologies and Improvements reported by TDs

TD 1.3: Carbody mass reduction





30% WEIGHT REDUCTION

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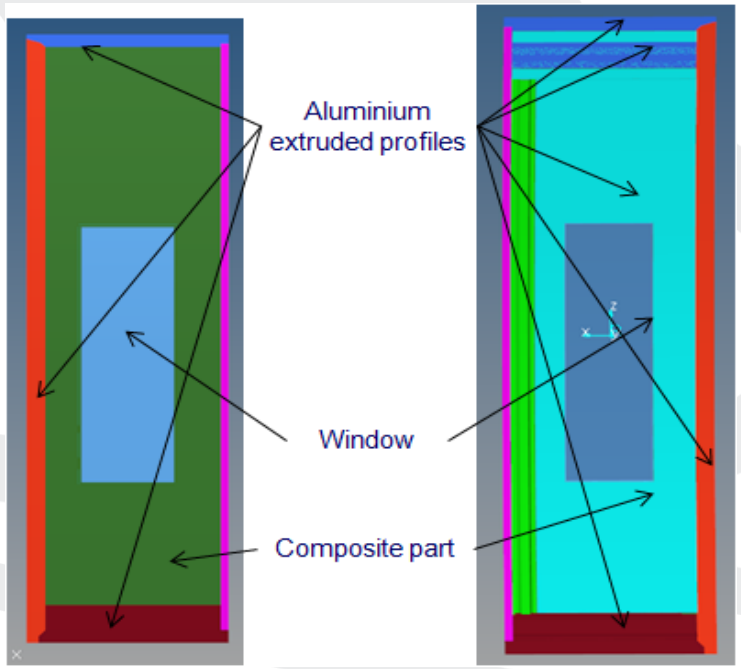
TD 1.5: Mass reduction new braking systems
TD 1.6: Mass reduction doors

Doors: Concept design

Composite sandwich base with aluminium extruded profiles.

- Extruded profiles: aluminium.
- Composite part - materials:
  - Core: PET foam.
  - Semipreg Biaxial E-Glass epoxy resin FST
  - Semipreg Biaxial Carbon epoxy resin FST
- Window

26 kg ➔ 19 kg



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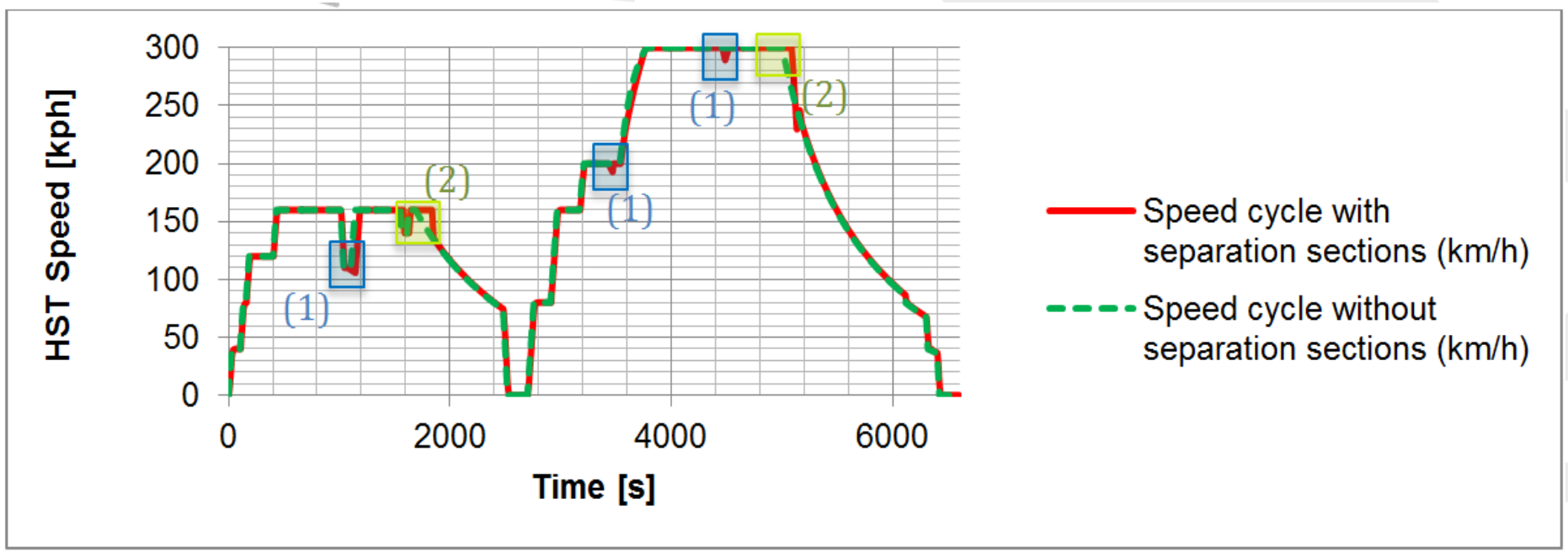
TD3.9: New substation with double side feeding in 25 kV / 50 Hz AC networks avoids separation sections



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Mapping of Technologies and SPDs

SPD	Smart Power Supply	Mass reduction carbody	Mass reduction doors	Mass reduction brakes	Improved line converter (SiC)	Improved motor converter (SiC)	Direct drive with improved gearbox
HST300	X	X	X	X	X	X	X
HST250		X	X	X	X	X	X
Intercity			X	X	X	X	
Regional 160			X	X	X	X	
Regional 140			X	X	X	X	
Metro			X	X	n.a.	X	
Tram			X	X	n.a.	X	
Freight					X	X	

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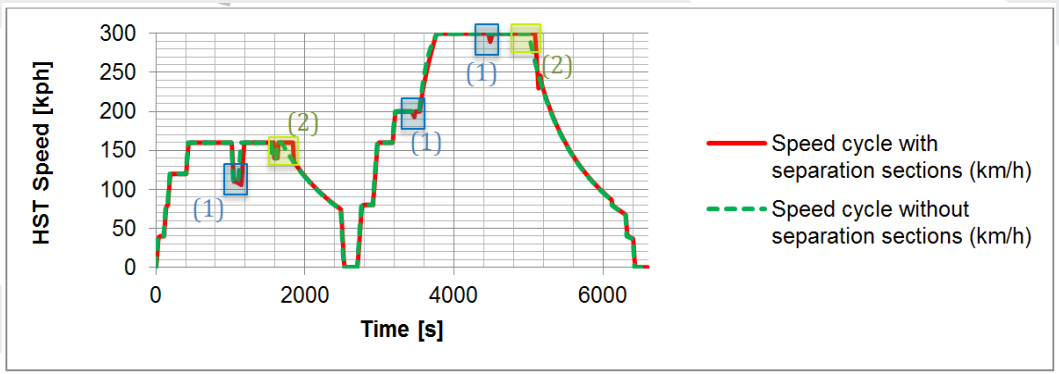
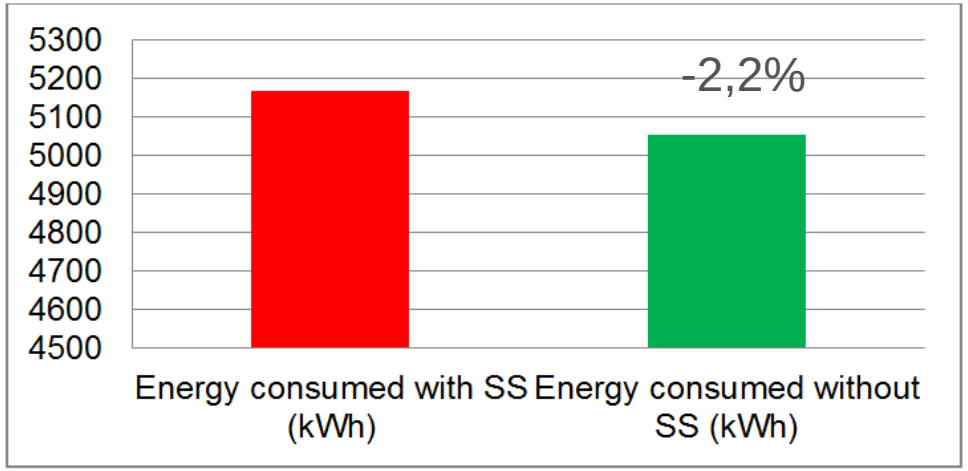
Example: KPI improvement for SPD HST300

TD3.9: New substation with double side feeding in 25 kV / 50 Hz AC networks avoids separation sections





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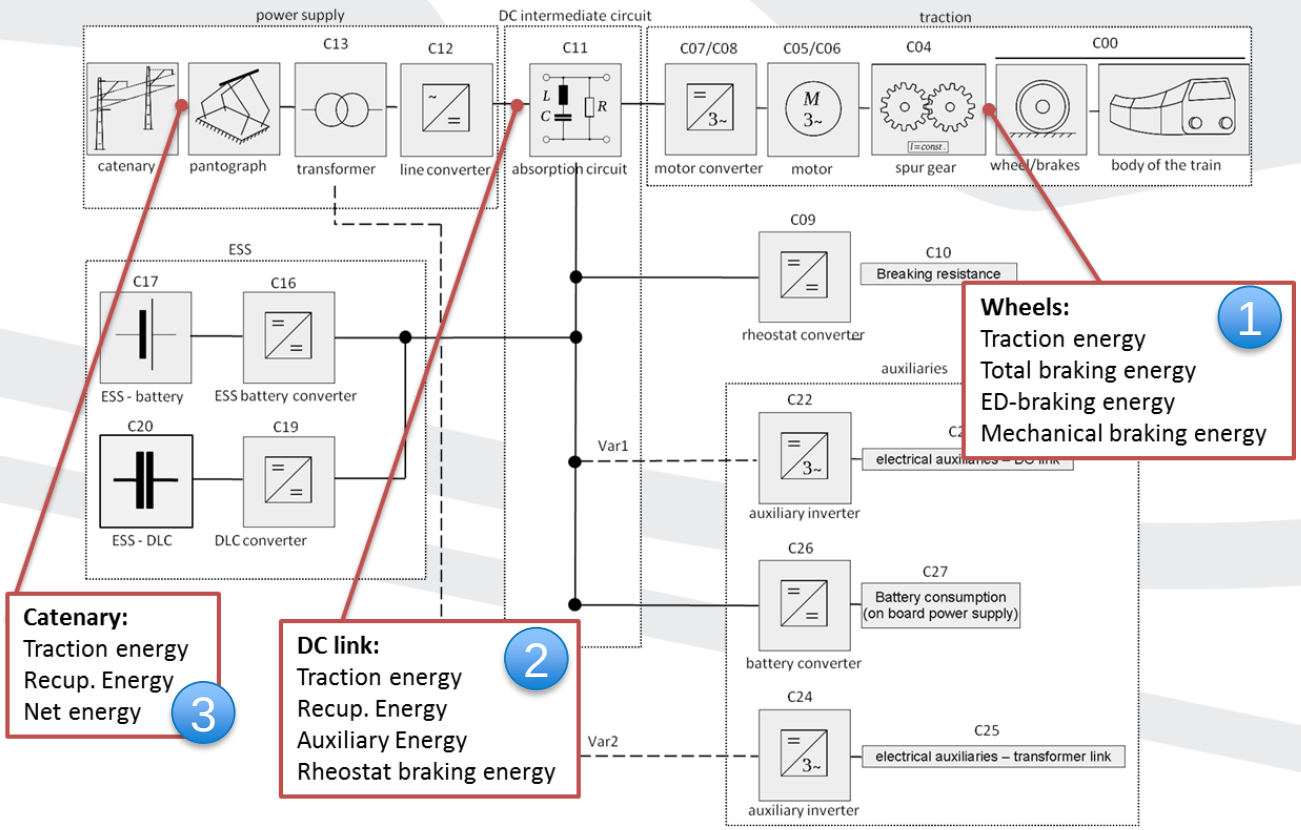
Example: KPI improvement for SPD HST300

Combined assessment of mass reductions and efficiency improvements – comparison of energy demand



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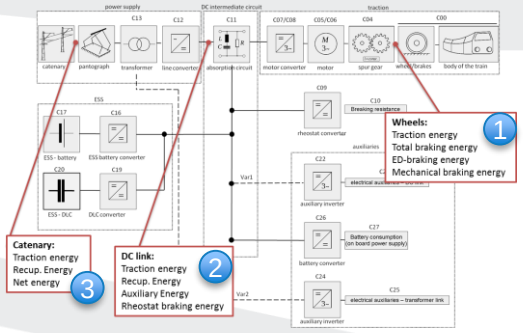
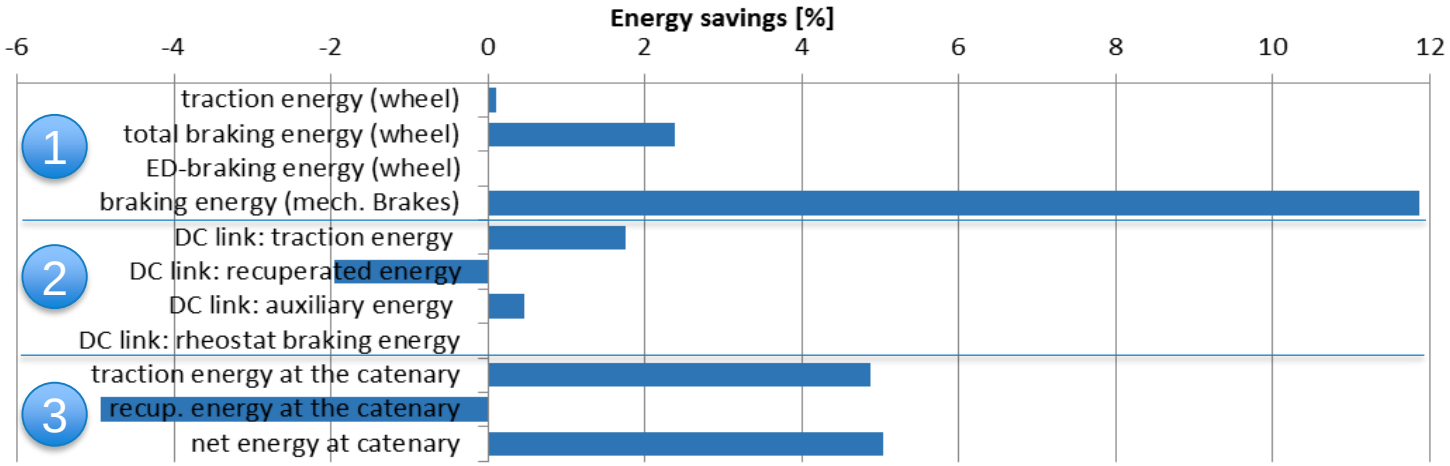
Example: KPI improvement for SPD HST300

Combined assessment of mass reductions and efficiency improvements





	net energy at catenary	recup. energy at the catenary	traction energy at the catenary	DC link: rheostat braking energy	DC link: auxiliary energy	DC link: recuperated energy	DC link: traction energy	braking energy (mech. Brakes)	ED-braking energy (wheel)	total braking energy (wheel)	traction energy (wheel)
HS300 savings [%]	5,04	-4,94	4,88	0,00	0,47	-1,96	1,76	11,87	0,00	2,39	0,10

Energy KPI improvement

3 2 1

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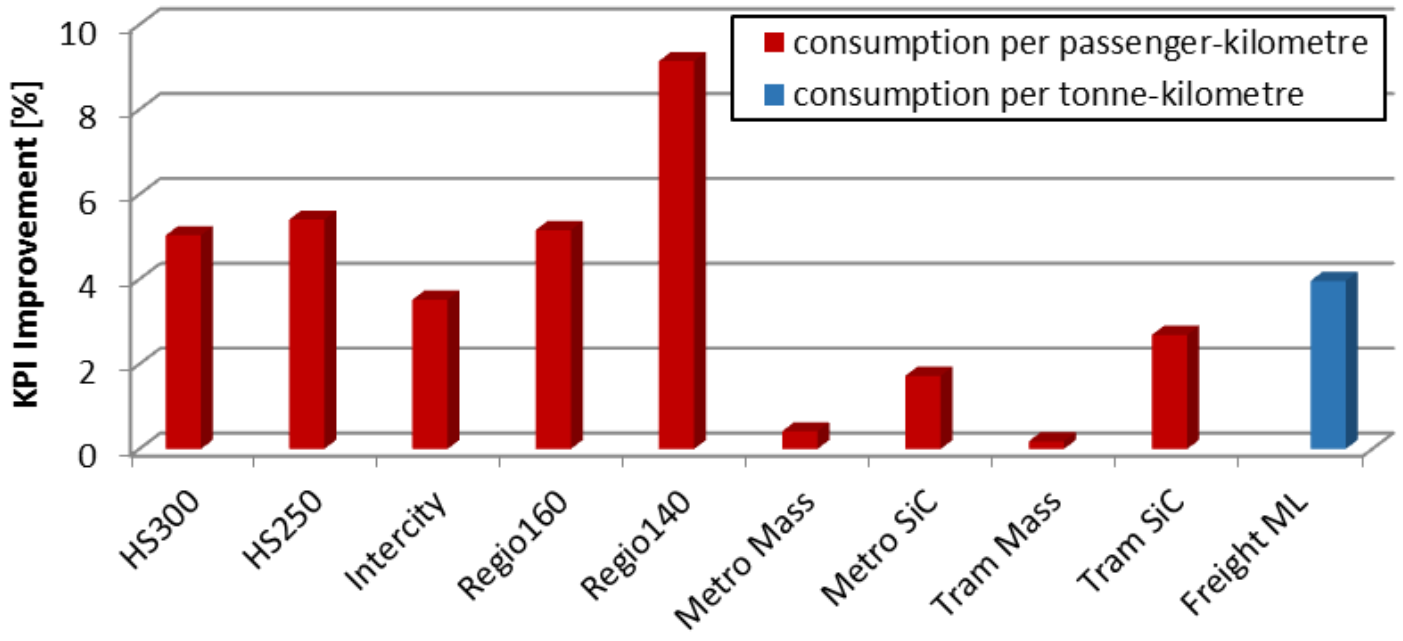
Summary: KPI results



➔ Improvements of energy KPI between 3.5% (SPD Intercity) and 9.1% (SPD Regional140).

➔ Metro and Tram: SiC converter application improves energy KPI by 1.7% (Metro) and 2.7% (Tram)

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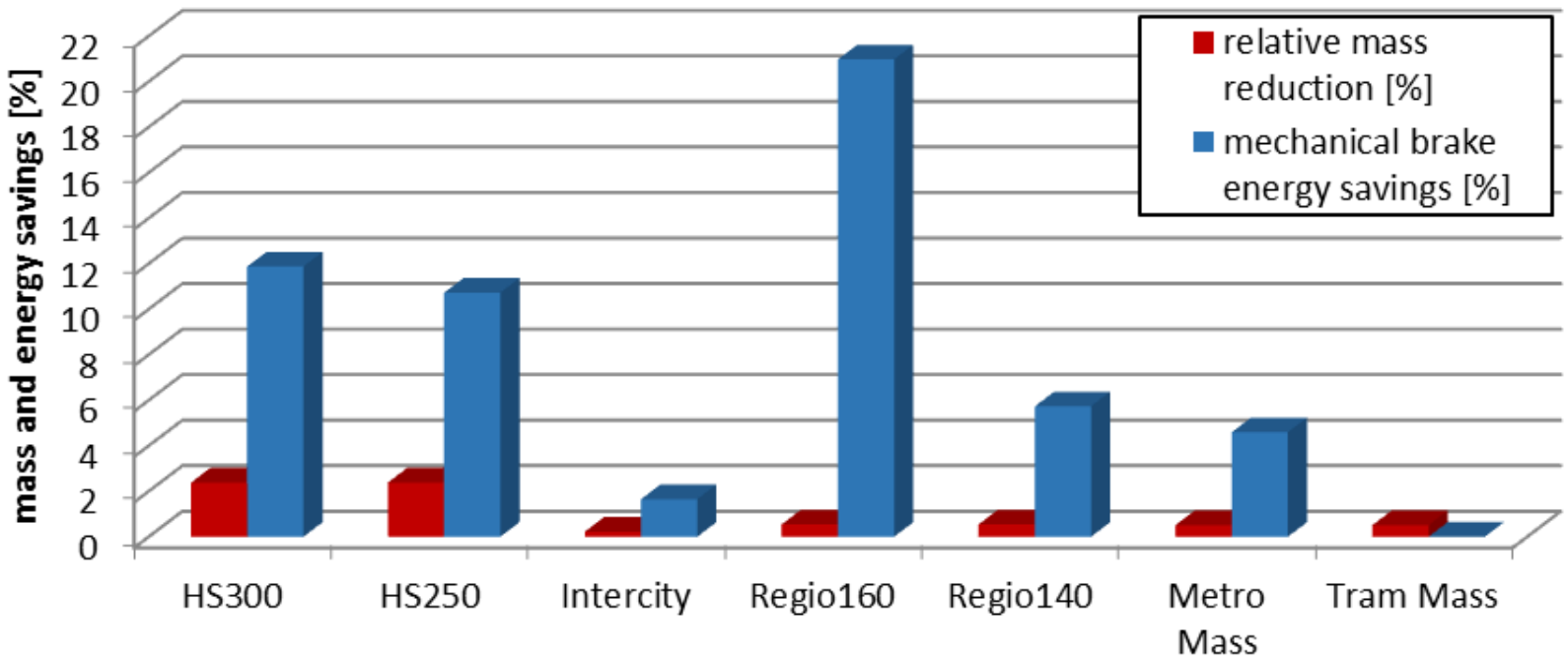
Summary: Additional LCC savings



➔ Mass reductions lead to significant reduction of brake wear

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Conclusions

What FINE1 achieved:

- **S2R energy expert network was established**, connecting people and topics throughout S2R technological and cross-cutting activities;
- Development of **methodology, process and tool to assess S2R technologies** and their impact on energy demand;
- **Reference scenarios and system platform datasets** (energy baseline) have been defined and distributed in S2R;
- Validation and application of the **OPEUS single train energy simulation tool** for KPI analysis;
- Energy KPI evaluations indicated **energy savings of up to 9%** with future S2R technologies;

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Questions and Answers

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Thank you for your attention!

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Henry Völker (BT), Mohamed Abdelgawad (BT)

FINE1 Eco-Labelling Proposal & Introduction to EN 50591

17th October 2019, Paris

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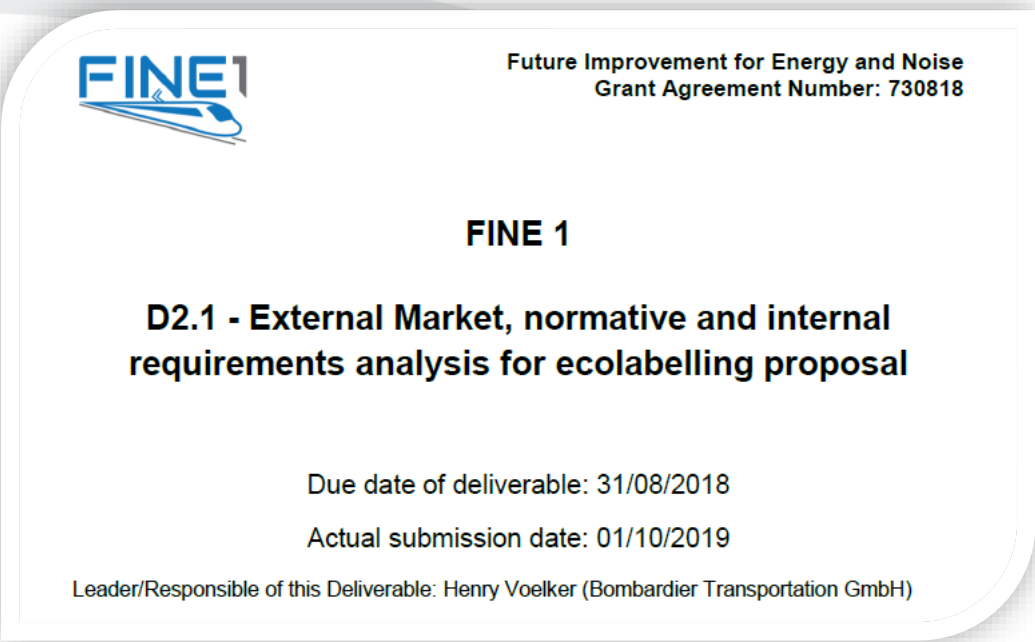
Introduction to FINE1 work on Eco-Labelling

Deliverable (public):



Future Improvement for Energy and Noise
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FINE 1

D2.1 - External Market, normative and internal requirements analysis for ecolabelling proposal

Due date of deliverable: 31/08/2018

Actual submission date: 01/10/2019

Leader/Responsible of this Deliverable: Henry Voelker (Bombardier Transportation GmbH)

1. Analysis of eco labelling in rail; other industries and stakeholders
2. Two separate labels are proposed, complementing each other:
   1. an EU-wise energy efficiency declaration and
   2. an operator-wise CO2 label.

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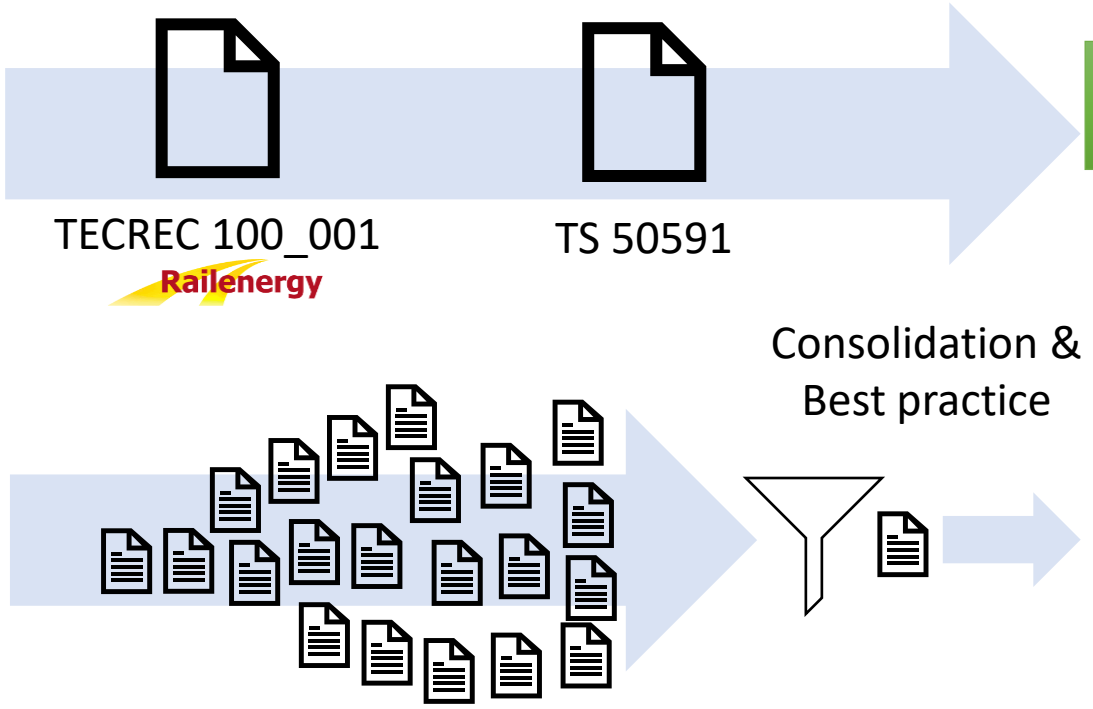
Standardisation – EN 50591



Future

Adoption of EN 50591 method for rolling stock procurement + energy validation

EN 50591

Specification and verification of energy consumption for rolling stock

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Lists of participants

EN 50591 (SC9XB)	FINE1
Alstom	
BT	
CAF	
DLR	
Siemens	
SNCF	
-	Talgo
-	TRV (KTH)
Emkamatik	-
Ricardo/NS	-
SBB	-
Trenitalia	-
-	(DB [not in WP2])

Overlap of participants lists ensured a smooth flow of best practice and knowledge.

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The principle of energy labeling contains three key elements:

Protocol	Measure energy usages of different models with different functions and make the different energy usages comparable.
Standard	Define efficiency and efficiency classes (optional)
Label	indicating the energy efficiency and some other key features.

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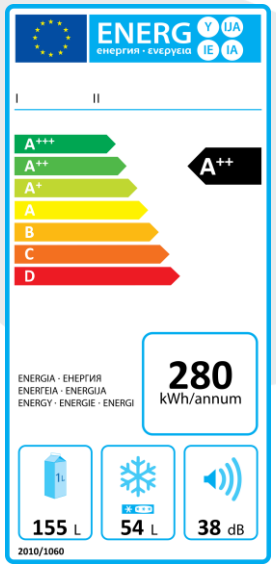
Household products comparative labels

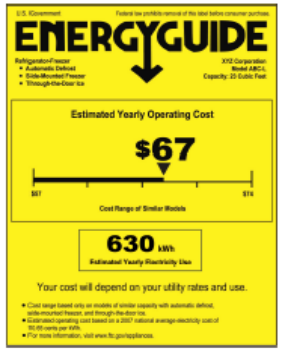
EU energy label



Top-Runner Label

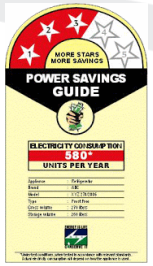
Japan

ENERGYGUIDE



North America

Some variants



India

Australia

China

Endorsement labels

ENERGY STAR

ENERGY LABEL
Reg. No. 登記號碼: LED11-0001
LED Lamp
(LED燈)
機電工程署 EMSD

에너지절약

See extra report FINE 1 Review of Energy labelling Systems (Tohmmy Bustad, Zhendong Liu, Mats Berg)

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Stakeholder analysis

Objective	Stakeholder					Conclusion
	End customer	Train operator	Transport authority	Certifi-cation authority	Train manufacturer	
Improvement of rail sustainability	x	x	x		x	Energy labelling can support this objective.
Comparison of trains regarding energy	x	x	x	(x)	x	It has the risk of technology leakage. Competition can be increased. The old trains seem inefficient.
Comparison between rail and other modes of transport	x	x	x			It is not easy to reflect the energy efficiency of other modes of transport.
Marketing campaign to promote rail	x	x				It has the potential and further action is needed to effectively use it.
Motivation of end users to use rail more	x	x				It has the potential and further action is needed to effectively use it.

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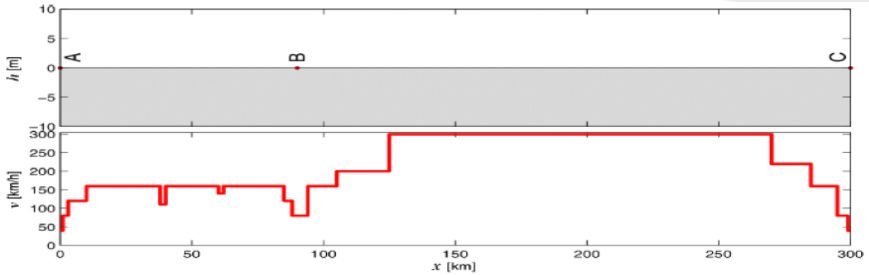
Proposal for rail vehicles

- **Rail services grouped into six service categories:**
  1. Suburban (passenger service)
  2. Regional (passenger service)
  3. Intercity (passenger service)
  4. High speed (passenger service)
  5. Freight mainline
  6. Metro (passenger service)
- **Label format the same as EU household products**
- **Comparison only within the same train service category**

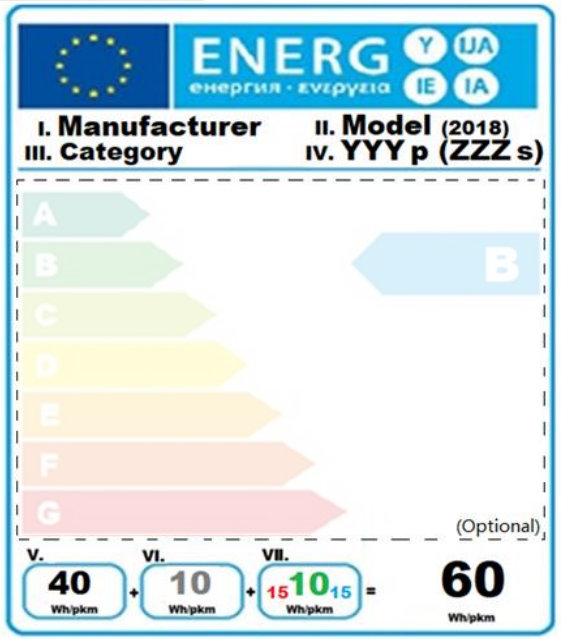
Efficiency indicator: $$\varepsilon = \frac{E}{D \,.\, r \,.\, C}$$

where *E*- energy in *Wh*, *D*- travelling distance, *r*- occupational rate and *C* - maximum capacity. Unit in *W·h/Passenger-km*, for freight train *W·h/ton-km*.

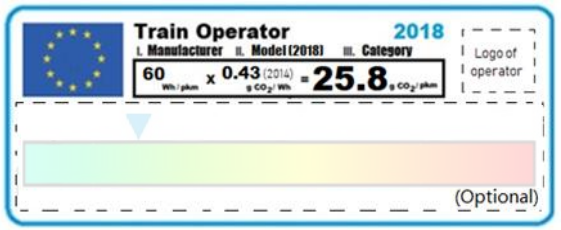
Example: Speed profile of High-speed



EU-wise energy efficiency declaration



Train operator-wise CO_2 label



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No obligation!

Eco-labelling shall be voluntary

- Which rail vehicle
- Which information
- Begin / end of application + disclosure period

Disclosure to public needs approval from manufacturers, train operators and transport authorities

No market entry barrier!

- Labelling / Classification shall not lead to minimum requirements on energy efficiency (antitrust laws, Europe *needs* internal competition)
- Focus on transparency and comparability of energy declarations

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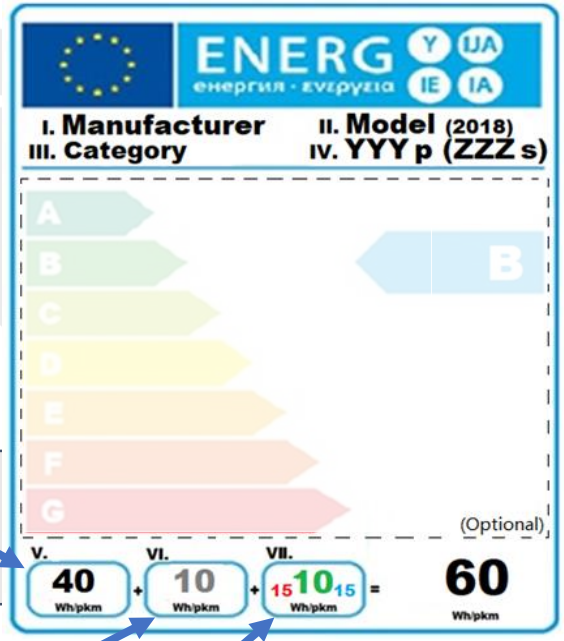
Energy split



Part 1: Traction and auxiliaries with commercial operation, without HVAC.

Part 2: Traction and auxiliaries without commercial operation and in parking mode, without HVAC.

Part 3: HVAC (depending on geographical zone).

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Operating conditions

Payload

In-service mode with commercial operation – Passenger trains:

50 % seated

In-service mode without commercial operation – Passenger trains:

No staff or passengers

Freight trains:

trailing consist according to EN 50591

Environment

Traction:

15 °C, wind 1 m/s

HVAC:

According to e.g. EN 13129 temperatures etc.

Line profile

See EN 50591 (based on TecRec 100.001)

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Energy units and CO_2 efficiency

Energy:

- Electric energy unit *Wh* recommended (*eWh* for diesel train)
- Net energy intake from pantograph, third rail or tank considered
- Efficiency metric, *W·h/Passenger-km* and *W·h/ton-km*
- Simulations for the standardized conditions recommended

CO_2:

- Goal: comparison of transport modes
- Challenge:
  - Variation per country
  - Changes over time
  - Different conditions (e.g. HVAC off in automotive cycle)
- Passenger trains: gCO_2/pkm (= Wh/pkm x gCO_2/Wh)
- Freight trains: gCO_2/tkm (= Wh/tkm x gCO_2/Wh)
- **gCO_2/Wh depends on energy used / bought by operator**
- **Mainly operation and energy sourcing strategy is benchmarked**

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Determination of energy use

1. Simulation:
   - Synthetic track
   - Defined conditions according to EN 50591
2. On-track measurement:
   - Real track
   - Performed in testing conditions according to EN 50591
3. HVAC: verification acc. to EN50591, e.g. climate chamber measurement

Manufacturer and operator have the right to choose method.

For comparability: Simulation is recommended for energy labelling due to difficulties in matching real operations close to standardized conditions.

CO_2 label is subjected to update, e.g due to lowered CO_2 intensity

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Eco-labelling: Conclusion

Eco-labelling proposal based on EN50591 defined

Common format proposal for annual energy acc. to EN50591

Clarity + comparability in procurement and verification

Voluntary and market to be kept open for all products

Following a global trend

Reinforce attractivenesss of railway transport

EN 50591 is released (August 2019) and should be used in vehicle tenders.
Eco-Labelling: 1st proposal exists, refinement planned for upcoming FINE2 project.

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Thank you for your attention

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EU energy-efficiency politics

Grant Agreement
Number: 730818

Introduction

- **The EU has set itself targets for reducing its greenhouse gas emissions progressively up to 2050.**
  - Key climate and energy targets are set in the:
  - 2020 climate and energy package
  - 2030 climate and energy framework
- These targets are defined to put the EU on the way to achieve the transformation towards a low-carbon economy as detailed in the 2050 long-term strategy.
- The EU tracks its progress on cutting emissions through regular monitoring and reporting.
- Before proposing new policies, the Commission carefully assesses their potential impacts.

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2020 Climate & Energy Package

- **The 2020 package is a set of binding legislation to ensure the EU meets its climate and energy targets for the year 2020.**
- The package sets three key targets:
  - 20**%** cut in **greenhouse gas** emissions (from 1990 levels)
  - 20% of EU energy from **renewables**
  - 20% improvement in **energy efficiency**

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2030 Climate and Energy Framework

- The 2030 climate and energy framework includes EU-wide targets and policy objectives for the period from 2021 to 2030.
- Key targets for 2030:
  - At least 40% cuts in **greenhouse gas emissions** (from 1990 levels)
  - At least 32% share for **renewable energy**
  - At least 32.5% improvement in **energy efficiency**
- The framework was adopted by the European Council in October 2014. The targets for renewables and energy efficiency were revised upwards in 2018.

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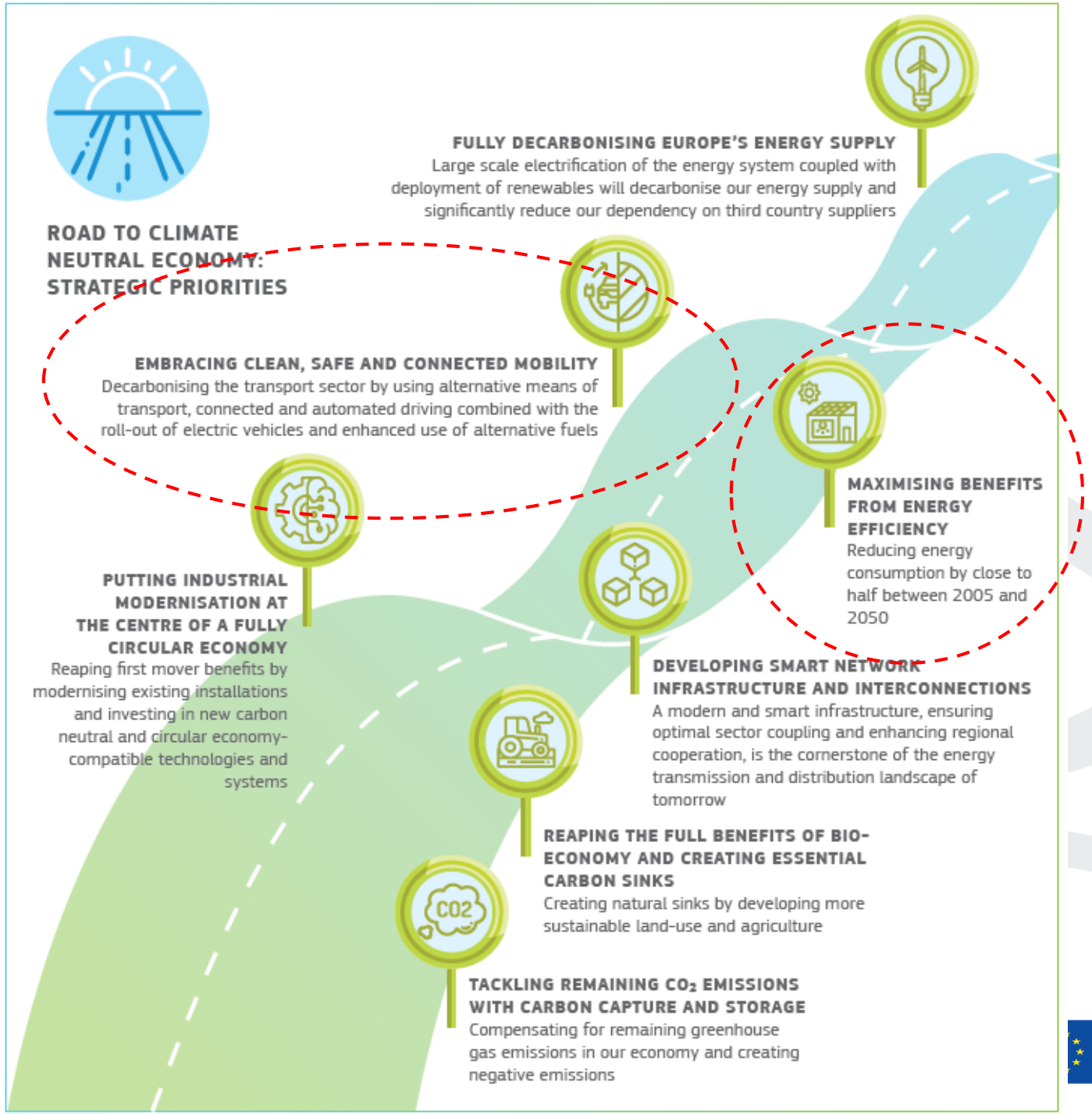
- **Climate-neutral Europe by 2050**



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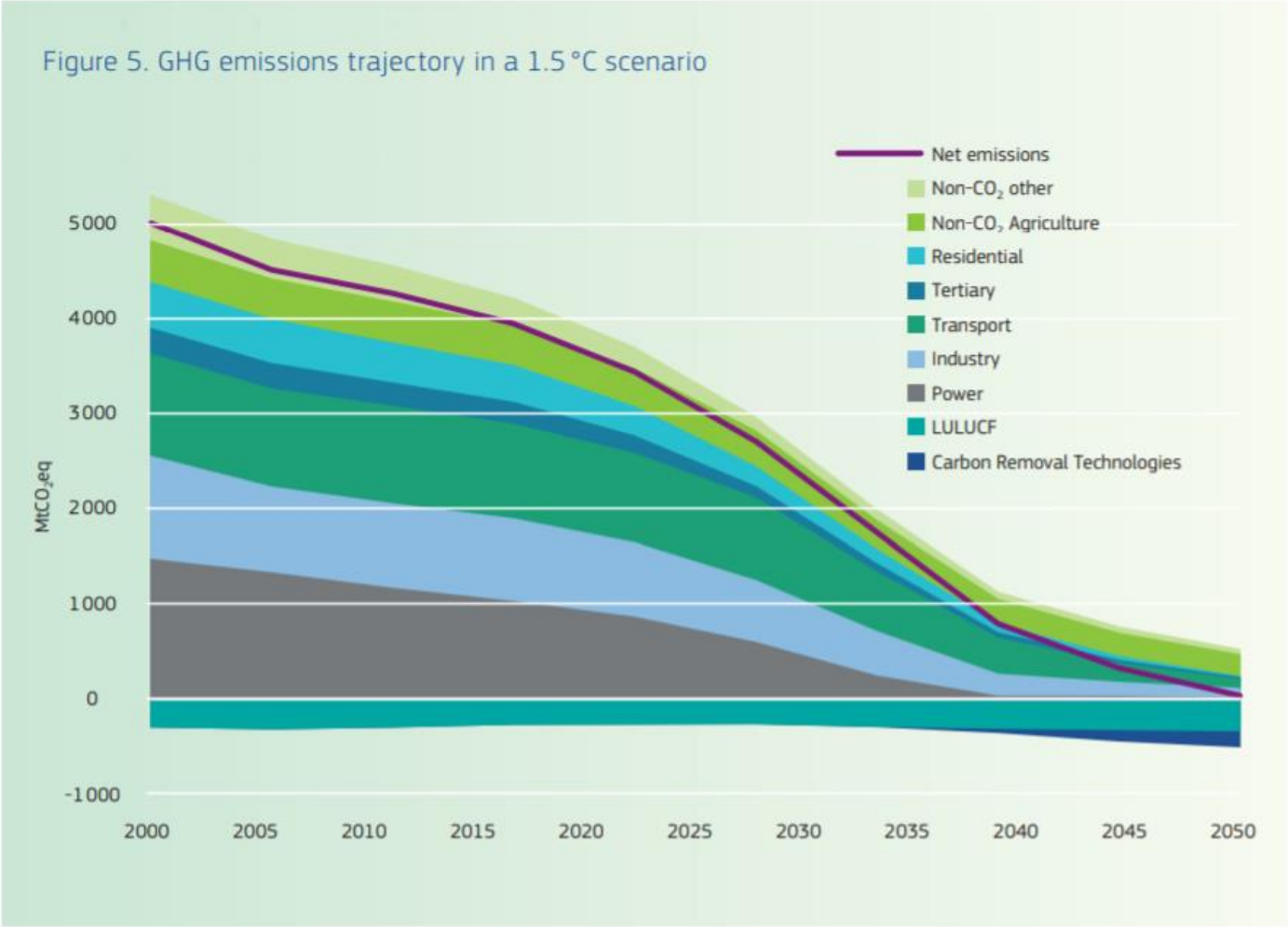
GHG emissions trajectory



Land use, land-use change, and forestry (LULUCF)

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Global Emissions in EU (2017)

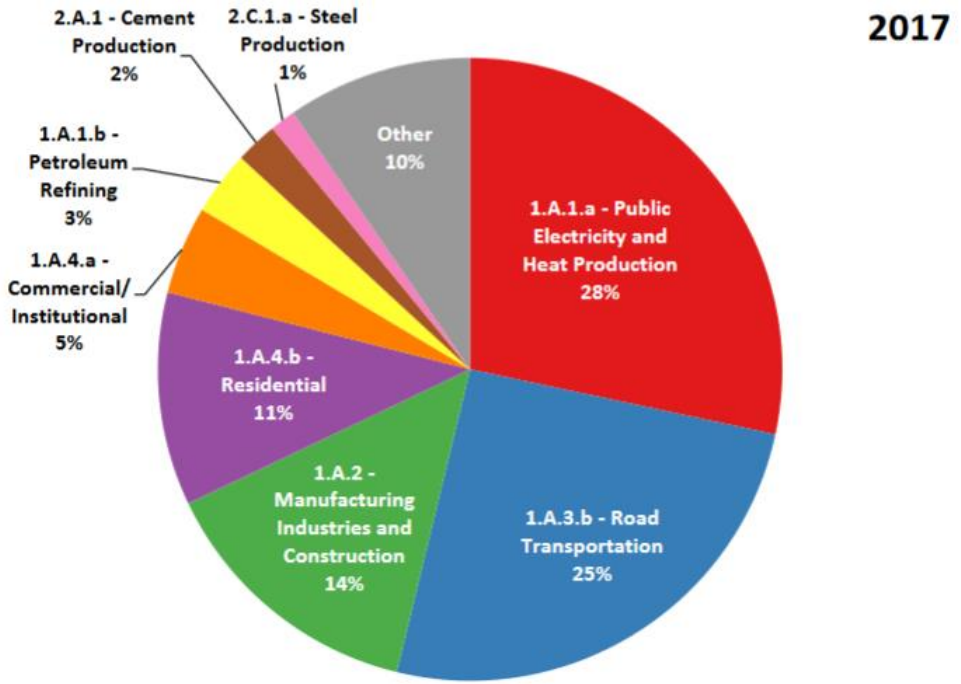
Three main sector producing greenhouse gas:

- Energy supply
- Road Transport
- Industrial system

Total Equivalent CO_2 emissions

4321,4 Millions Tons

Figure 2.4 *CO_2 emissions: Share of key source categories and all remaining categories in 2017 for EU-28 and Iceland*



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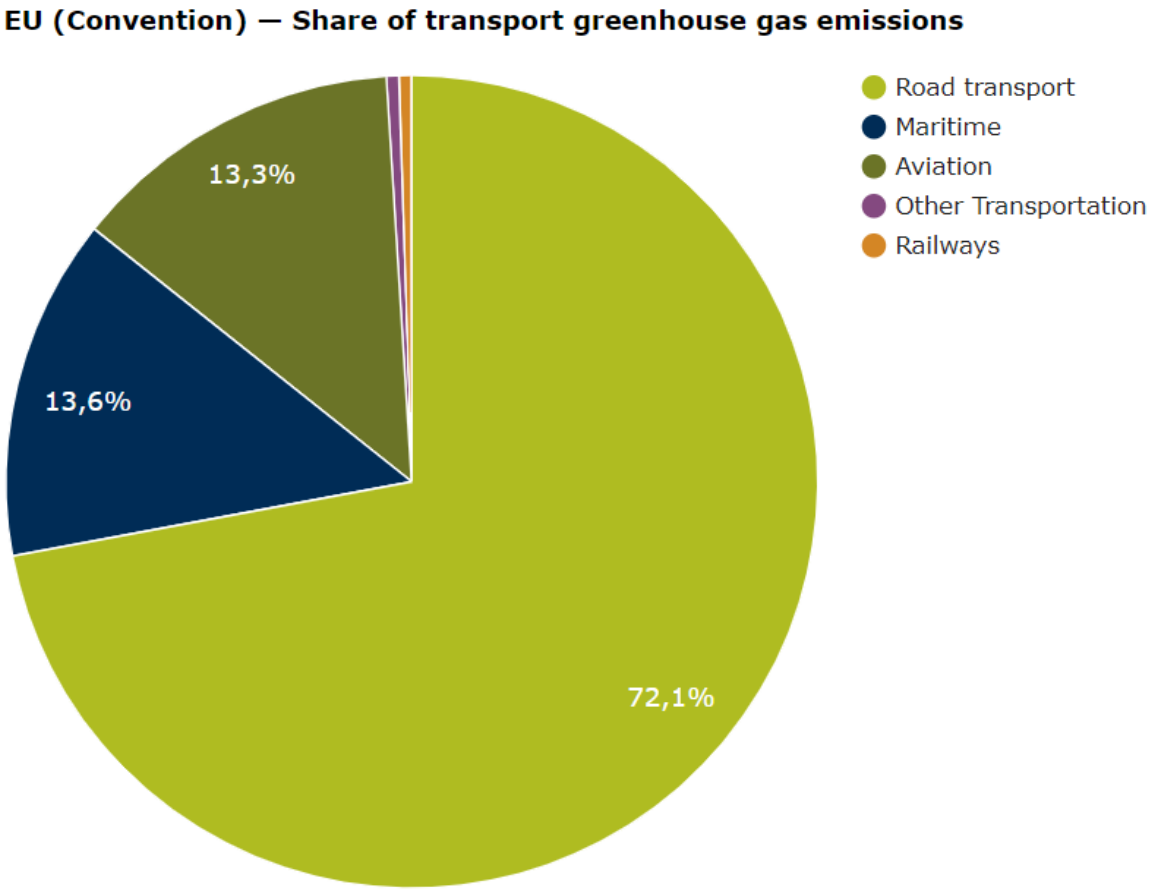
Transport Global Emissions in EU (2017)

Share of emissions in transport

Road Transport	71,1 %
Maritime	13,6 %
Aviation	13,3 %
Other Transportation	0,5 %
Railways	0,5 %

Total Equivalent CO_2 emissions for transport

1097 Millions Tons



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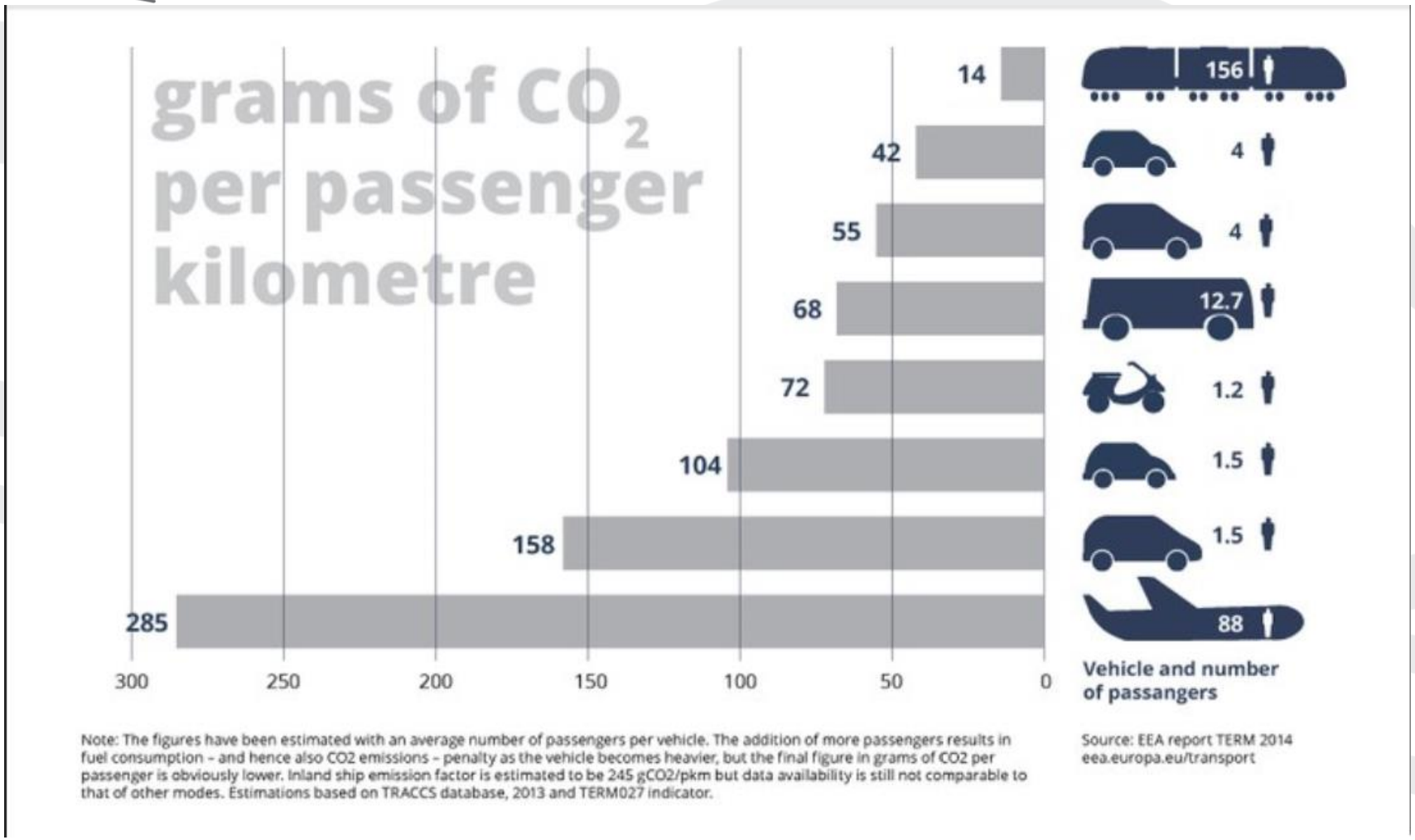
CO_2 emissions from passenger transport



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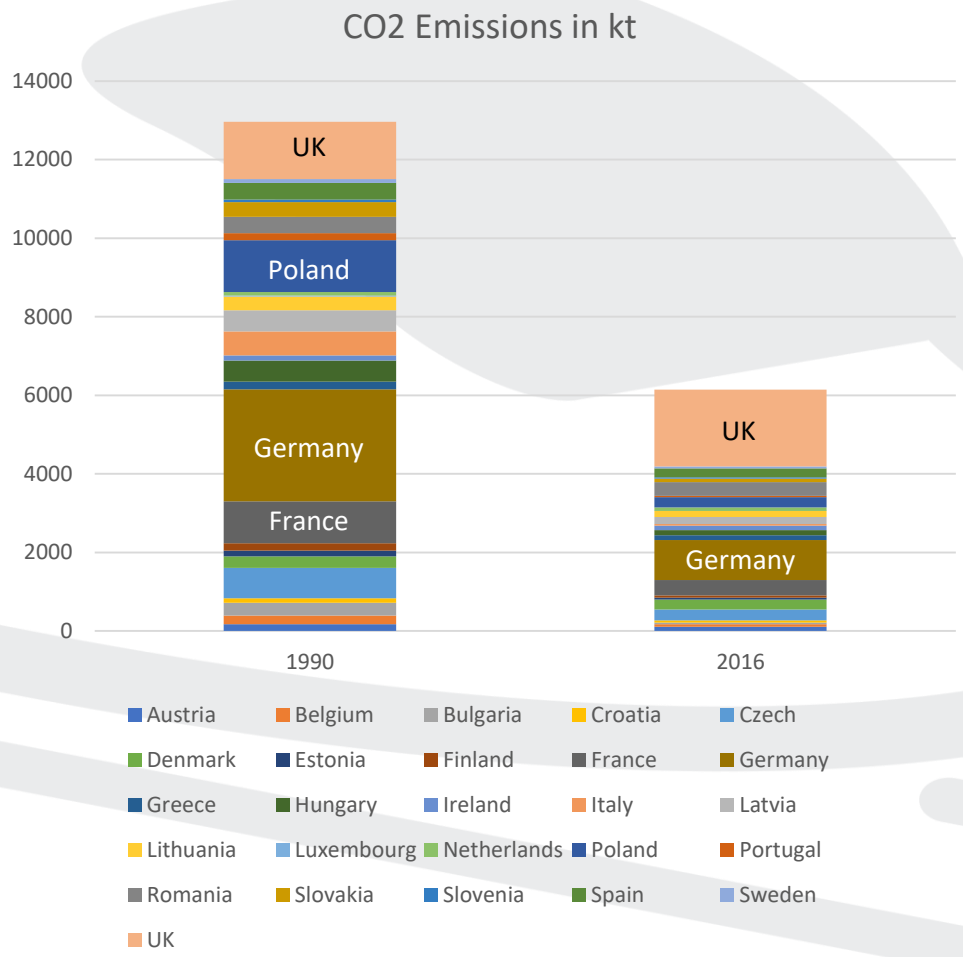
Evolution of CO_2 emissions in Railways

- **Electrification of railways has cut by two the emissions in 25 years**
  - **Evolution of fleet (diesel to electric by electrification)**
  - **Type of electric primary source has a strong impact in CO_2 emissions (nuclear, coal)**



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Railway system : key for emission reduction in transportation

- **Electric railways is far the better for energy efficiency (10g CO_2/passenger/km today)**
- **Electric railways is the most efficient solution for medium and long distance transportation**
- **Electric railways will take full advantage of zero emission electric power generation (renewable, nuclear)**
- **By developing freight and long distance passenger transportation, that will drastically cut the emissions for transport**
- **Autonomous trains with batteries or hydrogen will replace last diesel trains**
- **Electric railways can reach the GHG neutrality before 2050.**

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Reference Documents

- Reference documents for EU policy:
  - Annual European Union greenhouse gas inventory 1990–2017 and inventory report 2019
  - EU Reference Scenario 2016 – Energy, transport and GHG emission – Trends to 2050
  - https://ec.europa.eu/clima/policies/strategies_en

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OPEUS POSITION PAPER

On energy usage, generation and savings

Partners: UNEW (leading); UITP, UIC (contributing)

Presenter : Laurent DAUBY, Rail Director, UITP

D 7.2

INTRODUCTION

- ✓ Alarming climate change situation acknowledged
- ✓ Paris agreement : transport is key
- ✓ Transport decarbonisation possible
- ✓ Immediate and concerted action
- ✓ Investment in low and zero-C rail transport delivers benefits
- ✓ And adds up other benefits for individuals, business and authorities

Strategies and convergence

- ✓ Intergovernmental actions
  - UN UNFCCC
  - UN Development goals
  - EU SETA and ressource efficient transport ; Climate neutral Europe..
- ✓ Sector actions
  - UIC low C rail challenge (2014)
  - UIC railway climate response pledge 2015
  - UITP Climate leadership declaration
  - UITP Action reporting since 2014
  - UITP Climate Change manifesto (2019) and ONEPLANet campaign
  - Railsponsible indutry initiative
  - CER Voluntary targets since 2008
  - Rail Freight Forward

IMPLEMENTATION

Impact

- ✓ CO2 footprint reduction requires "Avoid-Shift-Improve" strategy
- ✓ Avoid : policy, life-style, renewable energy sources…
- ✓ Shift : from C-intensive to C-efficient modes
- ✓ Improve : Technologies and Operation
  - Areas of influence of R&I, S2R etc…

OPEUS CONTRIBUTION

- ✓ Simulation method and associated tools to evaluate and optimize energy consumption in rail systems
- ✓ Supports activities of other initiatives (S2R MAAP) on energy efficiency
- ✓ Robust, stable and readily available assessment methodology

CONCLUSIONS

- ✓ Holistic approach will deliver benefits towards decarbonisation
- ✓ Technical measures are important, however their impact is more limited than other measures

  "A teacher will not improve class performance by working with the best in class"
  - Land-use and urban planning with mobility policy supporting most energy-efficient modes
  - Regulatory framework and financial incentives supporting decarbonisation
  - Technical improvement of assets and operation

- ✓ Coordinated efforts by sector to tackle emission problems to be continued and reinforced
  - Concerted endeavors "avoid-shift-improve"
  - Maximize potential of technological developments into wider implementation strategies

Example: UITP's Climate campaign

CAMPAIGN MESSAGING

One Planet, One Plan

We only have **one planet**, and we only need **one plan**…

so what are you waiting for?

STEP 1:
PRIORITISE breathable and walkable streets through urban planning

STEP 2:
STRENGTHEN public transport's role as the backbone of all mobility services

STEP 3:
GUARANTEE financial incentives and a regulatory framework for an emission transition

STEP 4:
ENSURE clean energy sources are accessible to further reduce carbon footprint