Energy Assessment in Shift2Rail European Rail Research Program

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Shift2Rail Programme

S2R OBJECTIVES

+50% **INCREASE** RELIABILITY & PUNCTUALITY **BY 50%**

x2 **DOUBLE** RAILWAY CAPACITY

HALVE LIFE-CYCLE COSTS OF RAILWAY TRANSPORTS

CONTRIBUTE TO **REDUCTION OF NEGATIVE EXTERNALITIES**, SUCH AS NOISE, VIBRATIONS, EMISSIONS & OTHER ENVIRONMENTAL IMPACTS

CONTRIBUTE TO THE **ACHIEVEMENT OF THE SINGLE EUROPEAN RAILWAY AREA**

28 MEMBERS

375 PARTICIPANTS INVOLVED FROM **28** COUNTRIES

101 SMEs

103 RESEARCH CENTRES AND UNIVERSITIES

[1] Data extracted from CORDA database in February, 2019

2015 - € 52 M
SHIFT2RAIL INITIATIVE LIGHTHOUSE PROJECTS

2016 – € 168 M
27 PROJECTS

2017 – € 112 M
17 PROJECTS

2018 - € 153 M
19 PROJECTS & 3 TENDERS

2019 - € 152 M
18 TOPICS & 4 TENDERS

ABOUT € 1BLN and A NEW APPROACH TO R&I IN RAILWAY
working together & driving innovation

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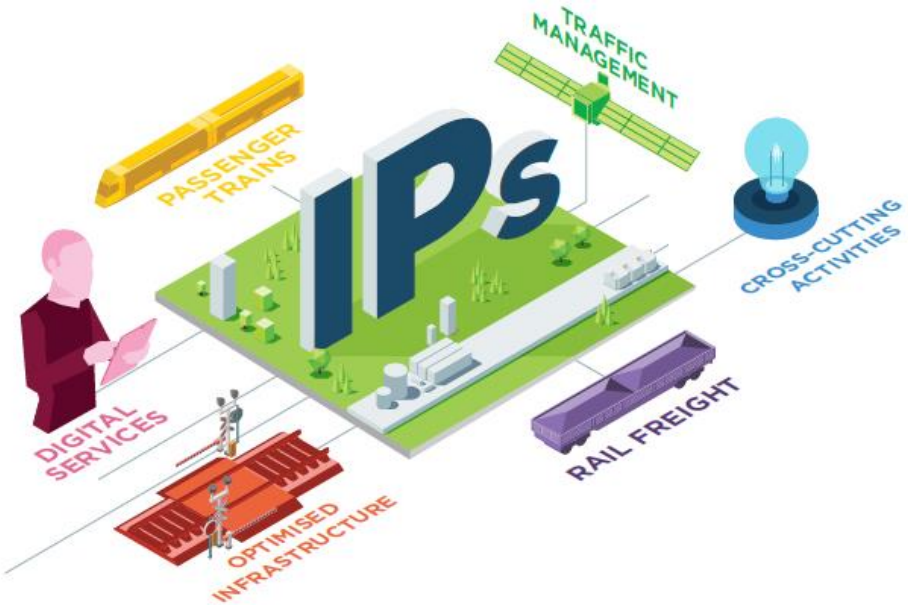
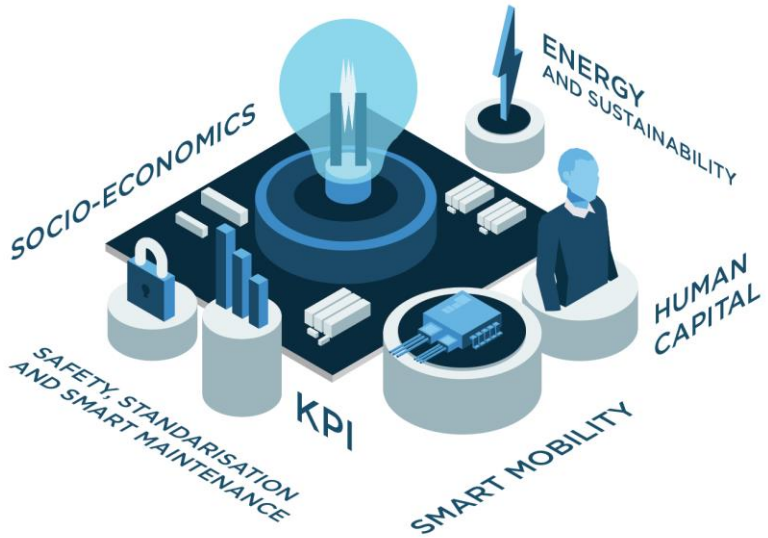
Shift2Rail Innovation Programmes and Cross Cutting Activities





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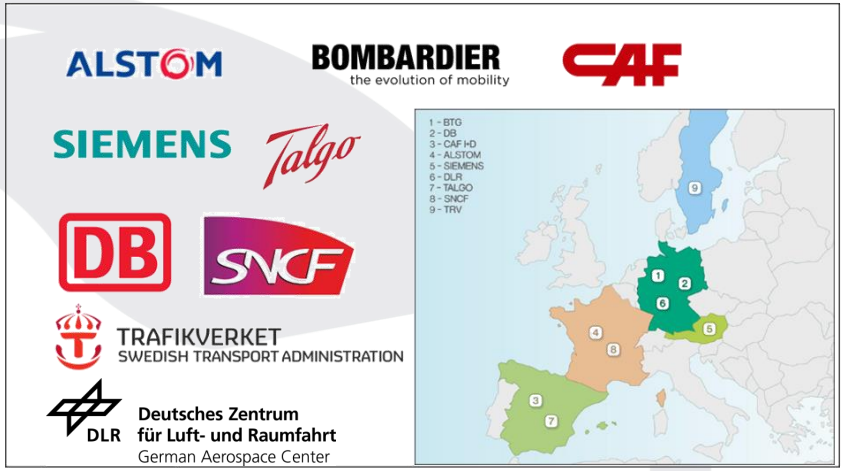
FINE1 - *Future Improvements on Noise and Energy*

FINE1 Main facts:

- 9 partners from 5 countries
- 38 months runtime (09/2016 – 10/2019)
- 3,017 M€ budget
- Coordinator: Bombardier Transportation Germany



FINE1 was supported by the complementary projects:

- OPEUS for Energy (Coordinator: University of Newcastle)
- DESTINATE for Noise (Coordinator: TU Berlin)

FINE1 Objectives

- Develop and implement **energy calculation methodology** to quantify S2R energy savings
- **Develop energy baseline as a reference** for the analysis of energy savings of new S2R technologies.
- **Define operational scenarios** for the traffic segments high speed, regional, urban and freight traffic
- Evaluate and document S2R energy savings (➔ **Energy KPI**)

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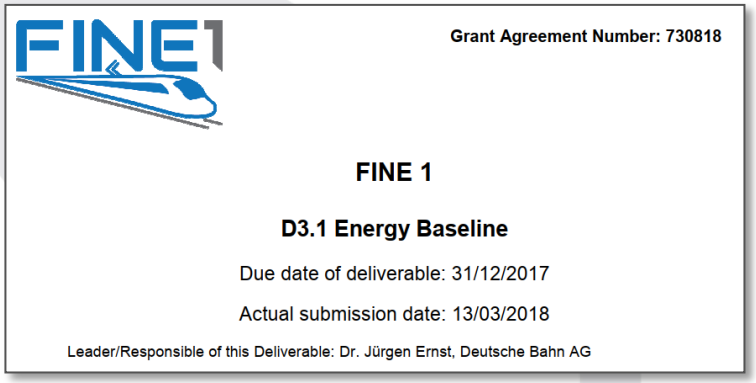
FINE1 Energy Baseline

The energy baseline is used as state-of-the-art reference to quantify energy savings achieved in S2R.

It consists of the following main parts:

- **Service profiles for high speed, regional, urban and freight** traffic segments including line parameters such as timetables, gradients, speed limits, etc. (see EN50591)
- Definition of **reference simulation data** for the traffic segments, consisting of **vehicle, line and traction component parameters**



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FINE 1

D3.1 Energy Baseline

Due date of deliverable: 31/12/2017

Actual submission date: 13/03/2018

Leader/Responsible of this Deliverable: Dr. Jürgen Ernst, Deutsche Bahn AG

FINE1 Energy Baseline: Service Profiles

Main Service Category	Sub Service Category	Max. profile speed [km/h]	Average Station Distance [km]	Station standstill time [min]	Route length [km]	Operational travel time [hh:mm:ss]	Source of profile
High Speed	High Speed 300	300	150	3	300	01:47:00	prEN 50591
	High Speed 250	250	100	3	300	02:03:00	High speed from prEN 50591, but limited to 250km/h, 2 additional stops
	Intercity	200	28	2 – 3	250	02:39:00	prEN 50591
Regional	Regional 160	160	15	1 – 2	250	02:57:00	Intercity from prEN 50591, but limited to 160km/h 7 additional stops
	Regional 140	140	5	1 – 2	70	01:09:00	prEN 50591
Urban	Suburban	120	3,6	1	40	00:43:00	prEN 50591
	Metro	80	1,0	0,5	21,5	00:41:00	based on EU-project OSIRIS [7]
	Tram	50	0,5	0,5	10,7	00:29:40	based on EU-project OSIRIS [7] incl. UITP suggestions
Freight	Freight Mainline	100	50	1 – 5	300	04:17:15	prEN 50591
	Freight Shunting	42	-	-	37	04:32:00	CleanER-D [8] Pmax 870 kW

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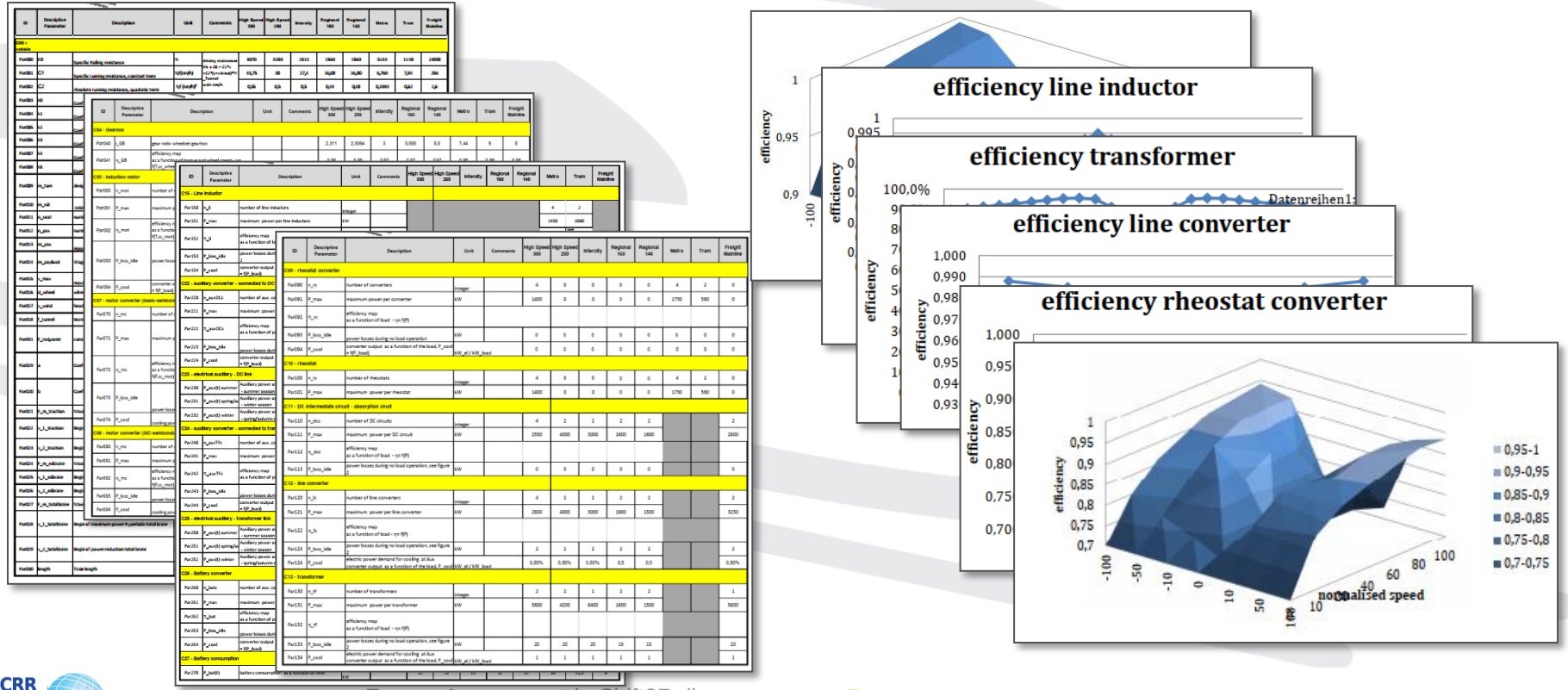
FINE1 Energy Baseline: >200 technical Parameters



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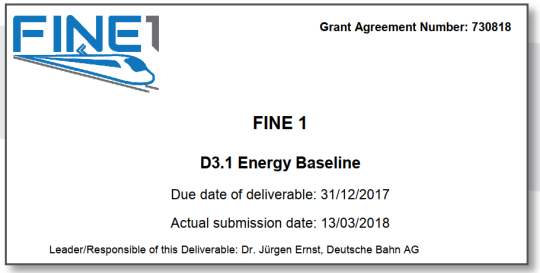
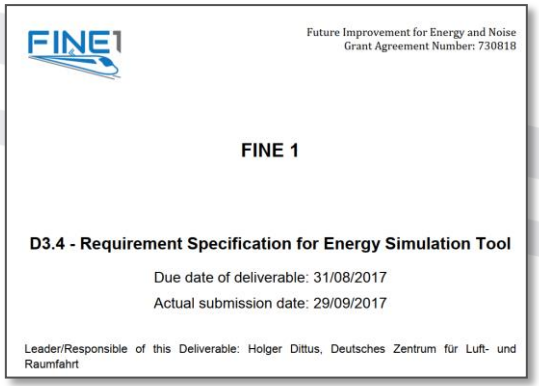
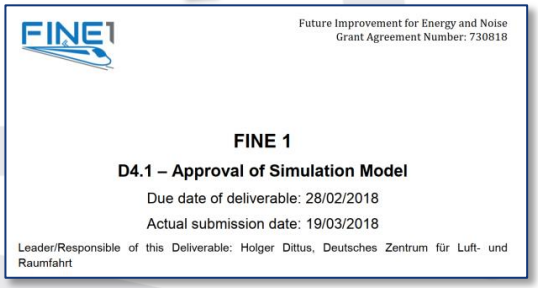
OPEUS Tool: Development Process







OPEUS Tool: General Set Up

Simulation structure is implemented in **Matlab and Simulink:**
- Common software for engineering tasks;
- Based on CleanER-D tool (also implemented in Matlab).

Component models are organized in a Simulink library:
- Avoid ambiguity;
- Easy to implement changes at the component models.

Input data and **Output data** of the tool are implemented as Microsoft Excel files:
- Easy and familiar interface;
- Even users with less background in Matlab/Simulink are able simulate;
- Easy processing of the output data.

Track data and **train data** is organized in Excel libraries:
- Clear handling of data;
- Easy possibility to extend the library with own data.

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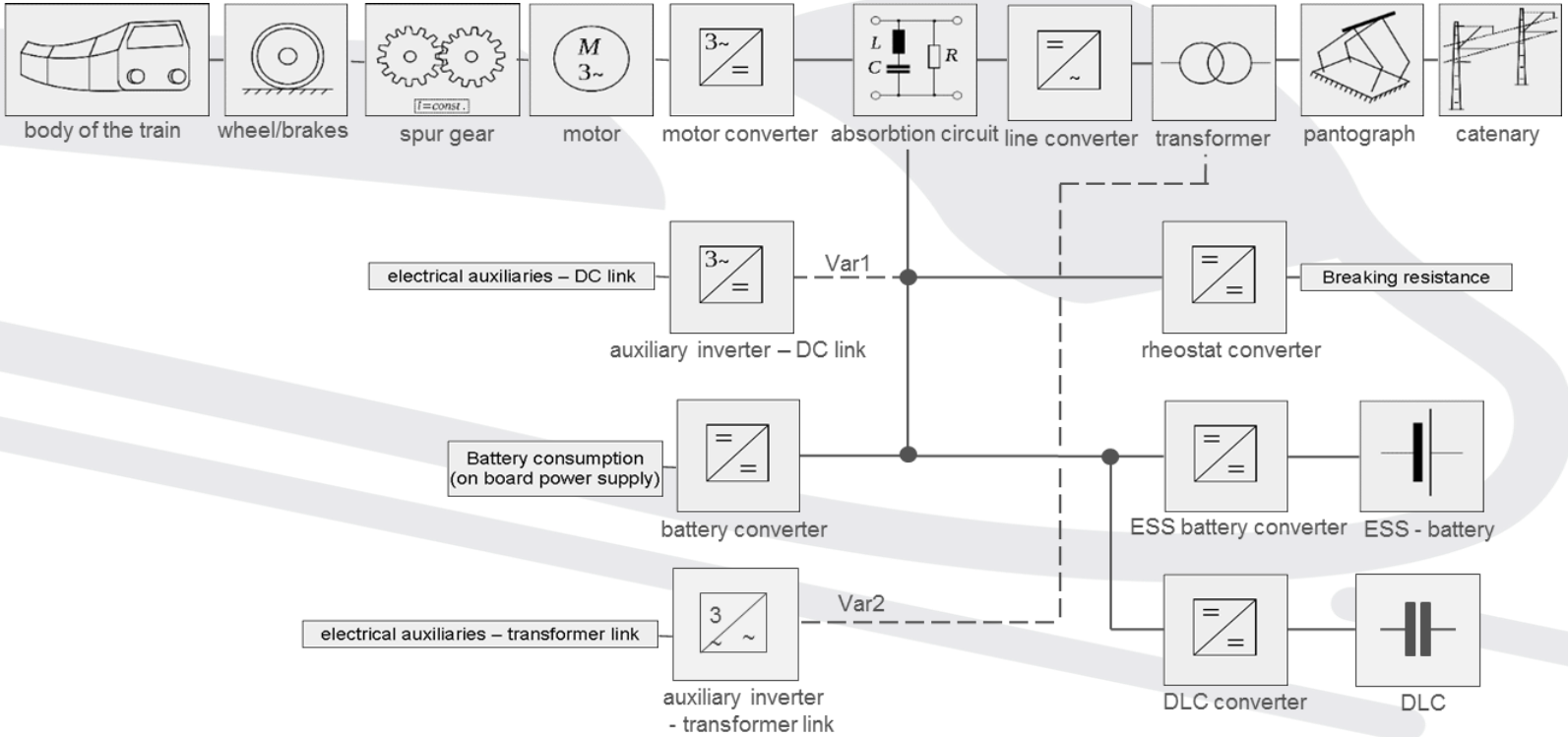
OPEUS Tool: Traction Topologies



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OPEUS Tool: Validation and Approval

Simulation result comparison:

SIEMENS

CAF

STADLER

SNCF

Functionality check:

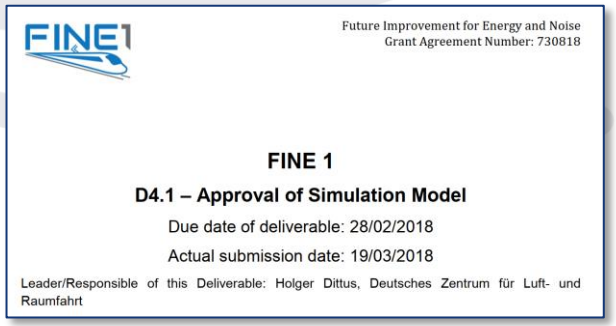
DLR Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center

Implementation of feedback:

Universität Rostock

Comparison to measured data:

DB


Future Improvement for Energy and Noise
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FINE 1

D4.1 – Approval of Simulation Model

Due date of deliverable: 28/02/2018

Actual submission date: 19/03/2018

Leader/Responsible of this Deliverable: Holger Dittus, Deutsches Zentrum für Luft- und Raumfahrt

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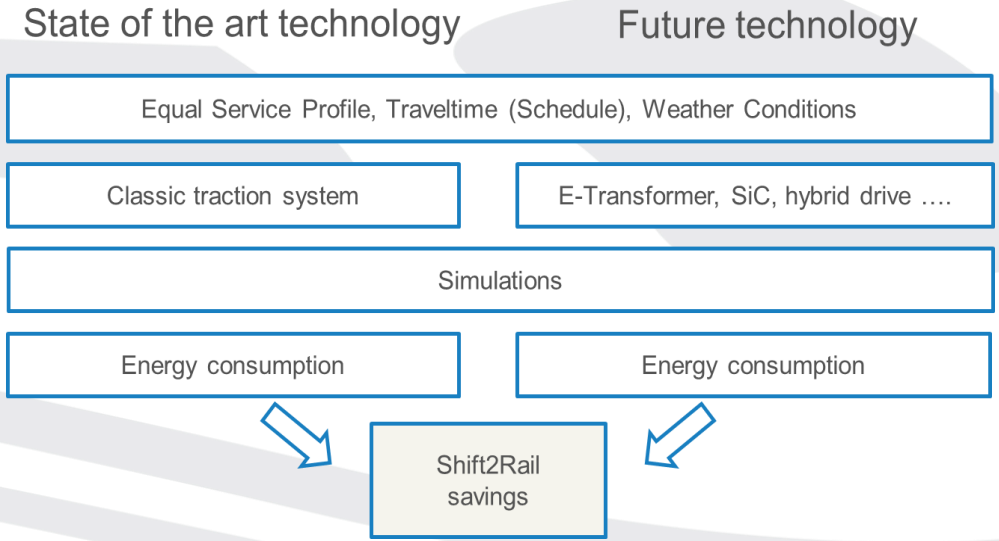
What is an Energy KPI?



- **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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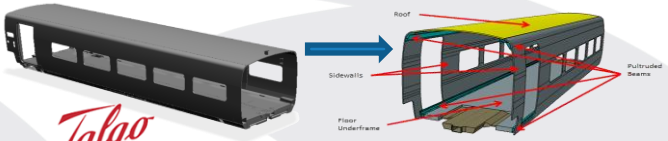
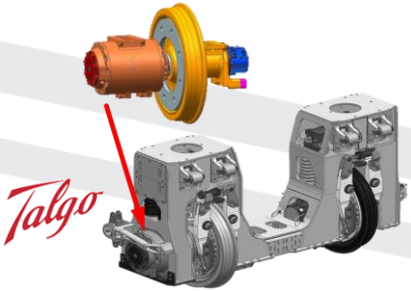
Energy KPI: Improvements from S2R-TDs

TD1.5: Mass reduction by new braking systems

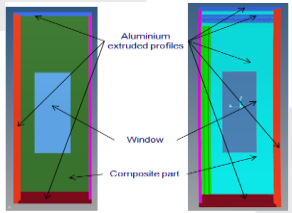


TD1.3: Carbody mass reduction



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

TD3.9: Smart power supply avoids separation sections



TD1.6: Mass reduction doors

TD1.1: SiC converters

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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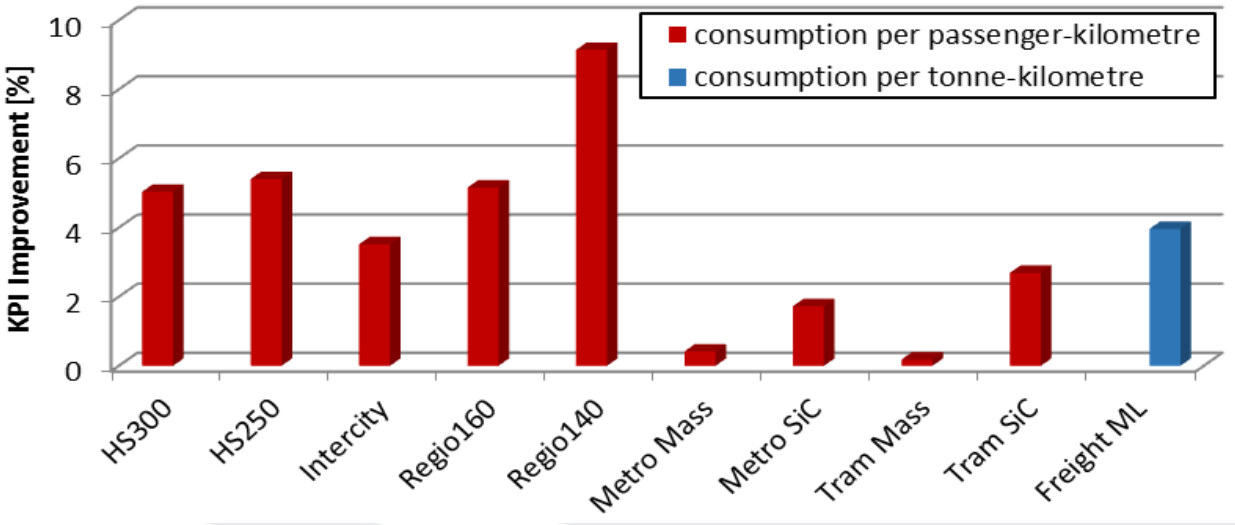
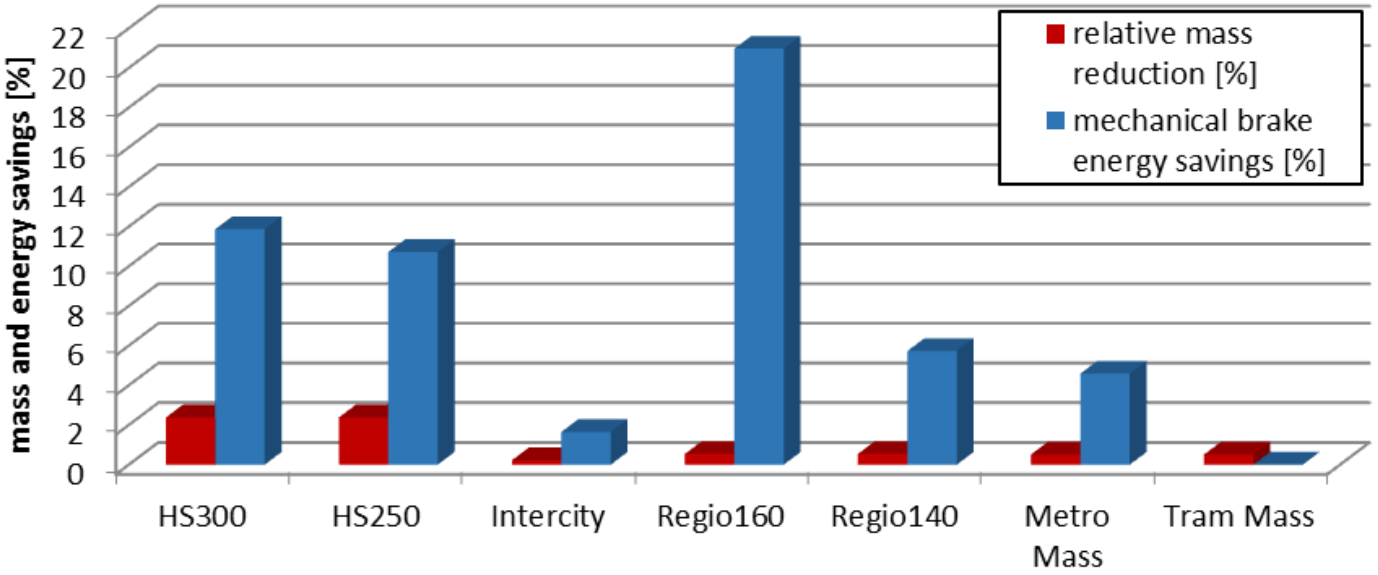
Summary: KPI results



➔ Improvements of energy KPI between 3.5% (Intercity) and 9.1% (Regional140)
➔ Metro and Tram: SiC improves energy KPI by 1.7% (Metro) and 2.7% (Tram)

Summary: Additional LCC savings



➔ Mass reductions lead to significant reduction of brake wear

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Conclusions

What FINE1 & OPEUS 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;

Thanks to FINE1 & OPEUS Team for 3 years of excellent team-work!

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- „Evaluation of Energy KPI - interim “, S2R FINE1 Deliverable 4.5, GA No.: 730818, 2018-04-23
- „Evaluation of Energy KPI - final“, S2R FINE1 Deliverable 4.7, GA No.: 730818, 2019-10-30

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