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Technical-economical comparison of Maglev and High Speed Systems

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Content

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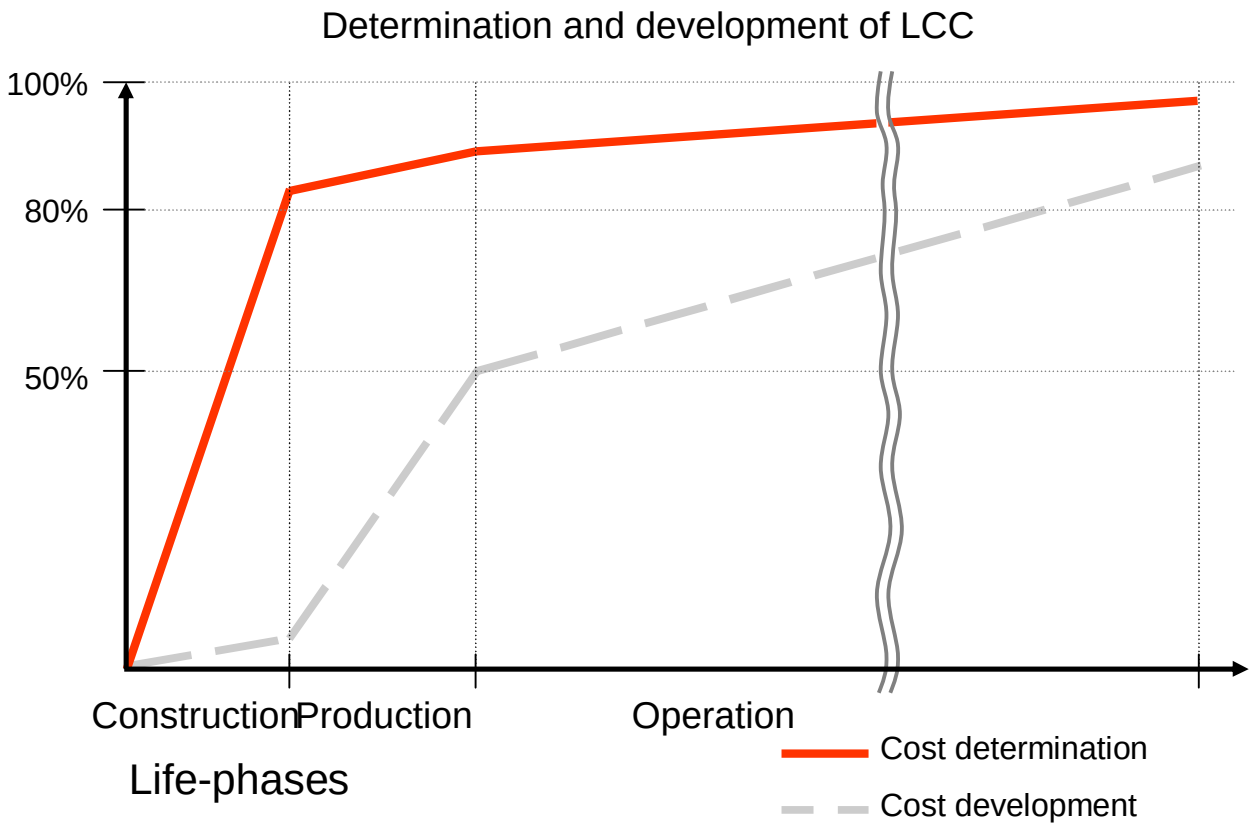
Basis of the LCC Analysis

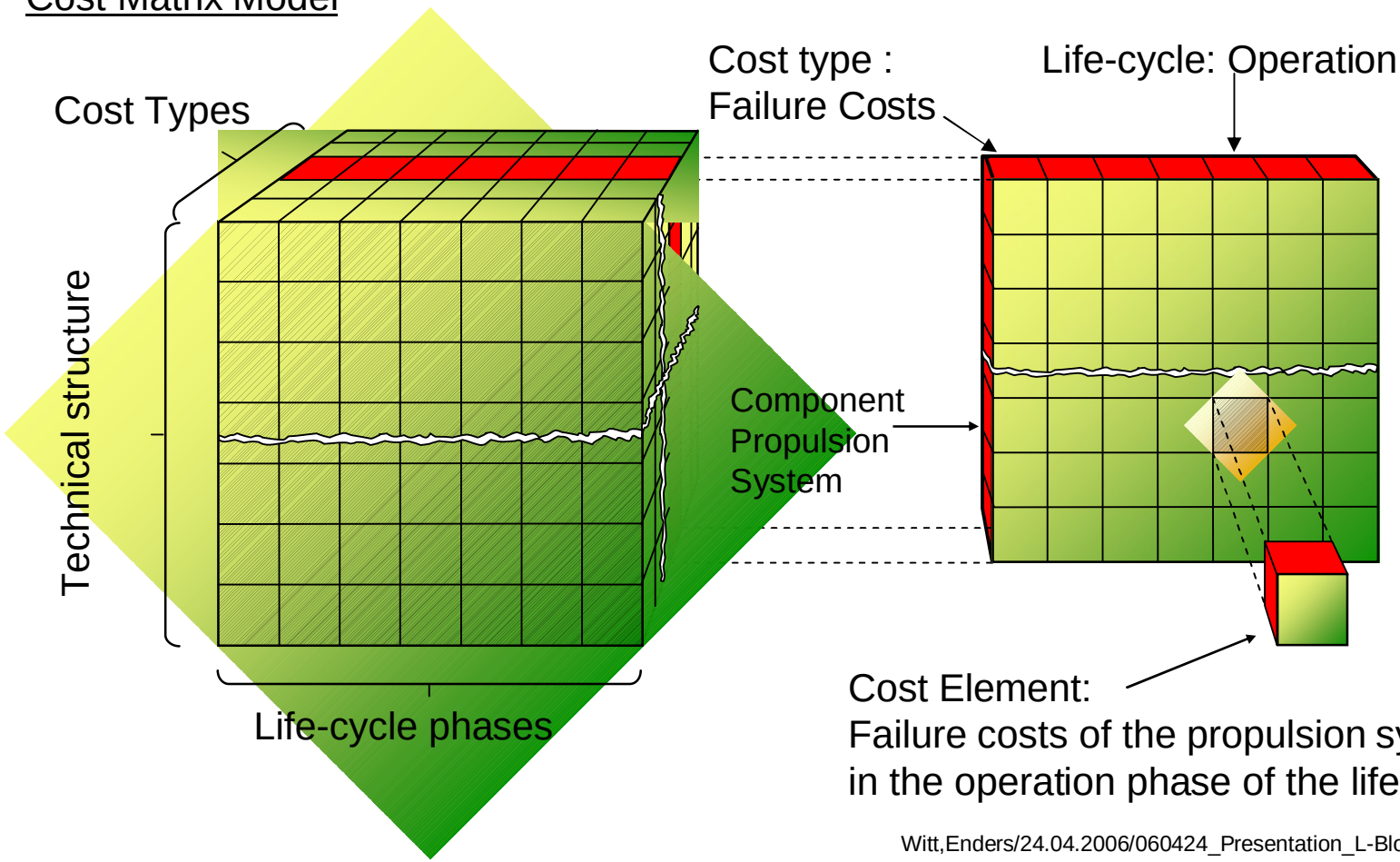
Life-cycle phases

- Development
- Construction
- Prototype
- Test
- Serial-Production
- Initial Operation
- Operation
- Termination of Operation
- Waste disposal



Basis of the LCC Analysis

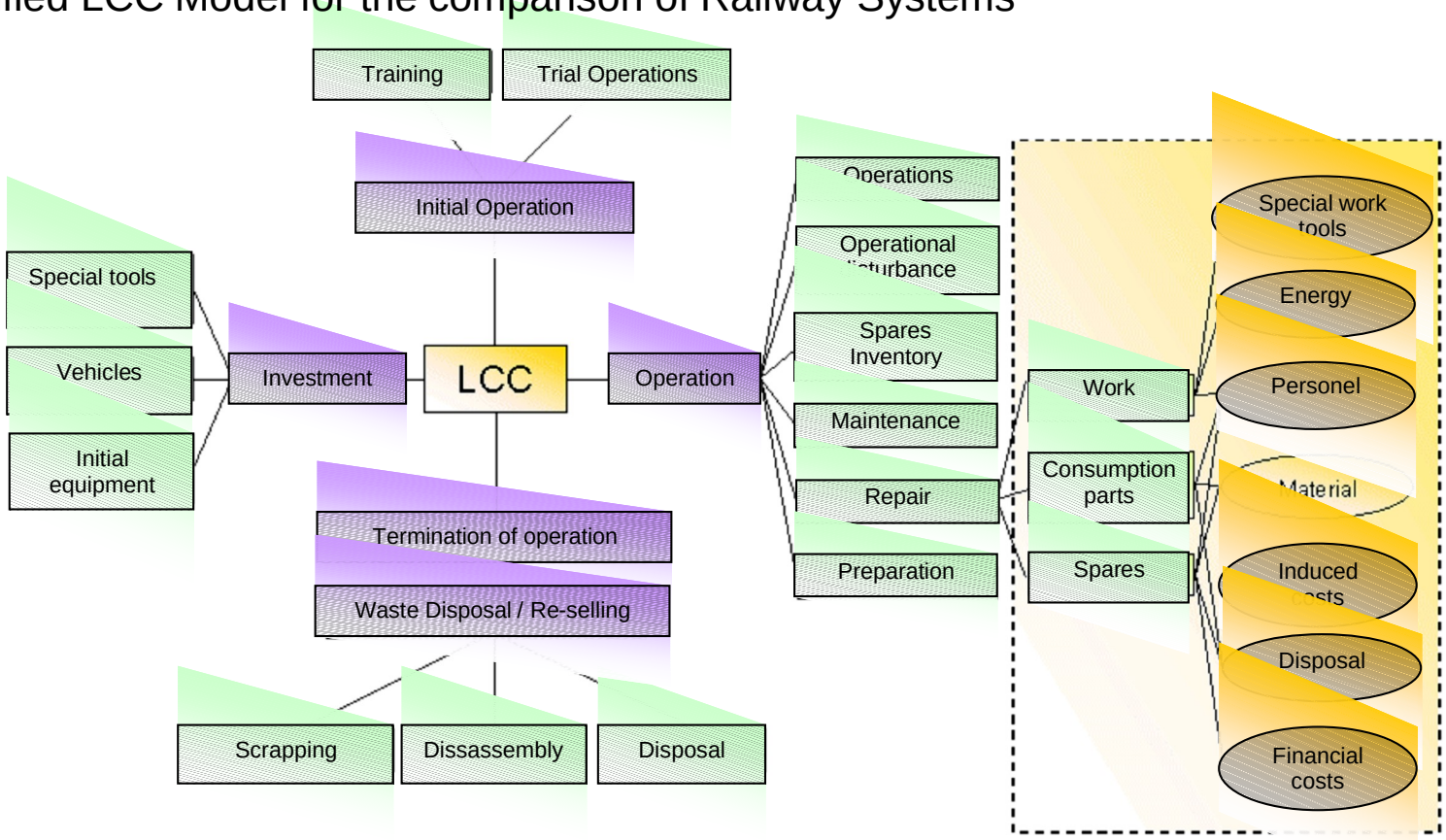
Cost Matrix Model



Cost Element:
Failure costs of the propulsion system
in the operation phase of the life cycle.

Basis of the LCC Analysis

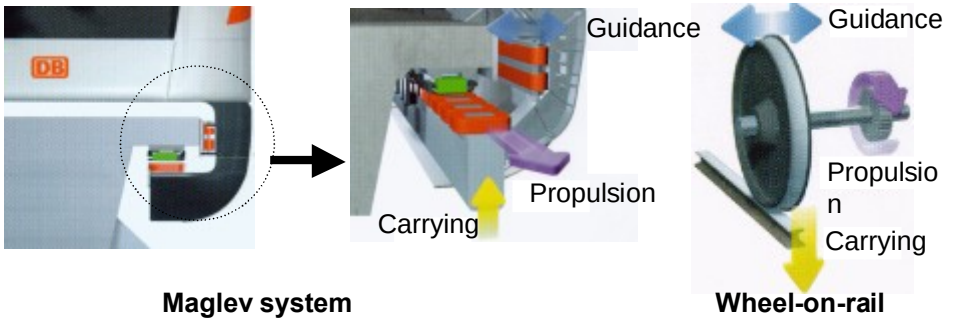
Simplified LCC Model for the comparison of Railway Systems



Comparison of the Technology between Wheel-on-Rail and Maglev Technique

Mechanical stresses and costs of track maintenance				
Type of guided system	**Function of carrying guiding and propulsion**	**Load Effect**	**Mechanically stressed due to carrying (static load)**	**Track main-tenance costs in percentage of initial capital**
Wheel-on-rail	Through contacts	High point load Heavy wear	5000 ï 10000 kg/cm² (approx.)[1) 2)]	2,6 ï 4,5
Maglev (Transrapid)	No contact	Low area load Little wear	1 kg/cm² (approx.) [3)]	0,2 ï 0,5

1) Passenger coach and ICE end power car respectively
2) Mean additional dynamic element for wheel-on-rail approx. 30%
3) Mean additional dynamic element for maglev approx. 10%



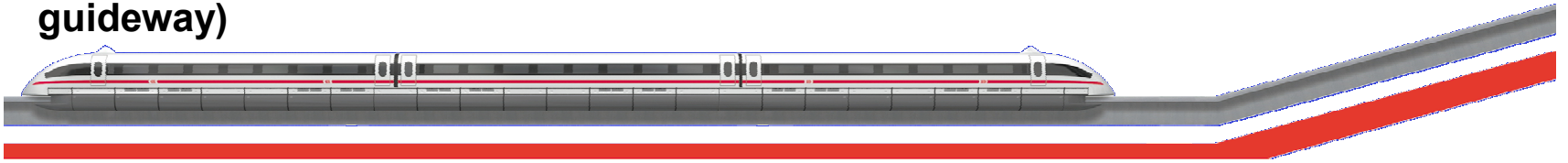
Maglev system **Wheel-on-rail**

Comparison of the Technology between Wheel-on-Rail and Maglev Technique

Alignment Parameters

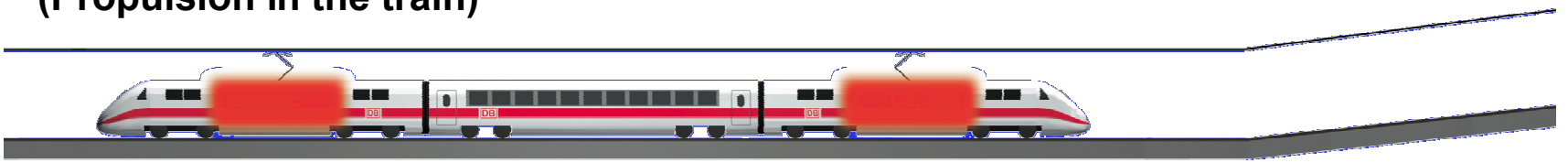
Transrapid
(Propulsion integrated in guideway)

gradient (max 10%)



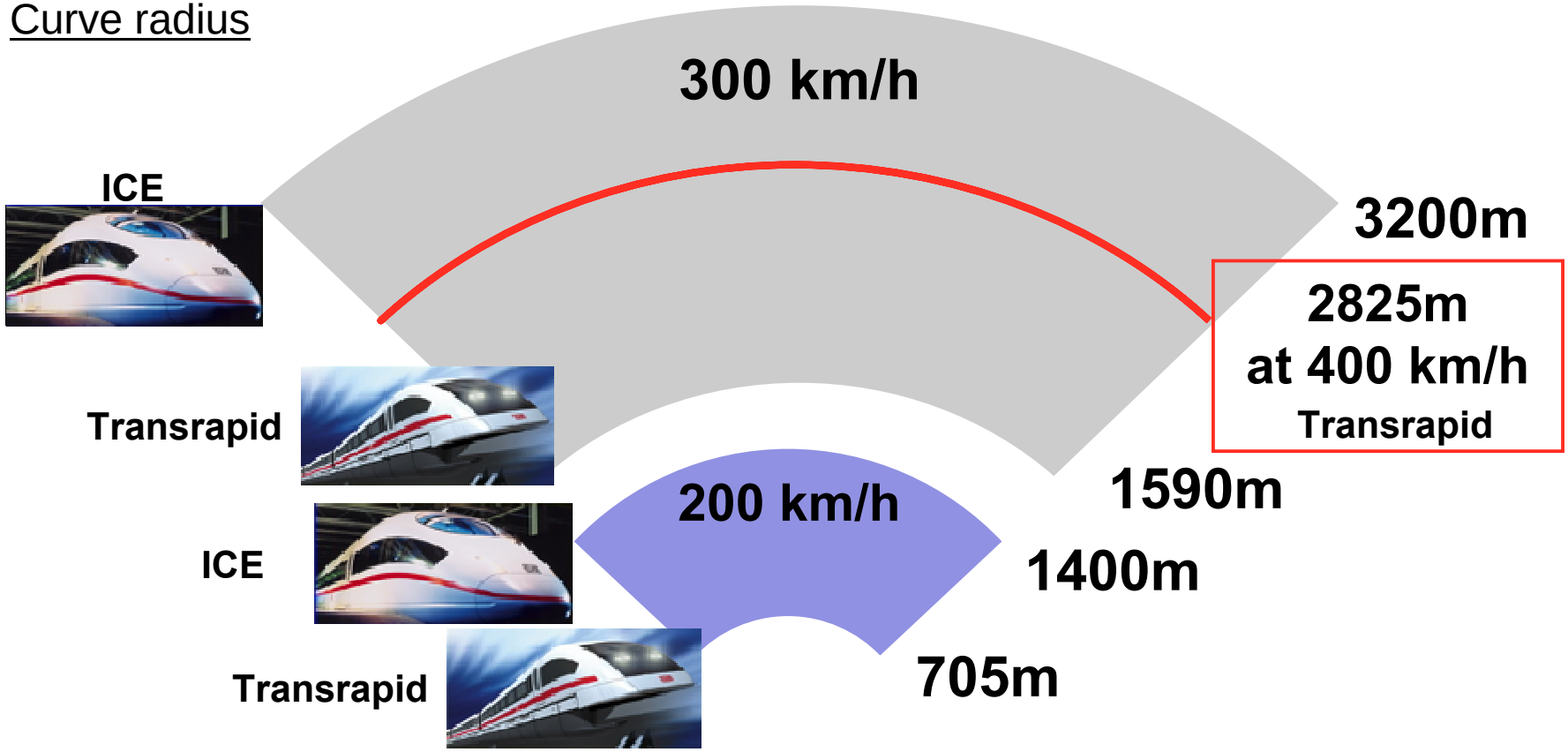
Wheel-on-rail
(Propulsion in the train)

gradient (max 4%)



Comparison of the Technology between Wheel-on-Rail and Maglev Technique

Curve radius



Comparison of the Technology between Wheel-on-Rail and Maglev Technique

Crest and Sag of the High Speed Systems

	Wheel/Rail System ICE3		Maglev Transrapid	
	Crest	*Sag*	*Crest*	*Sag*
Vertical Acceleration	0,5 m/s²	0,6 m/s²	0,6 m/s²	1,2 m/s²
Design Speed 200 km/h	6.400 m	5.200 m	5.150 m	2.600 m
300 km/h	14.400 m	11.700 m	11.600 m	5.790 m
330 km/h	17.400 m	14.200 m	14.000 m	7.000 m
400 km/h	-	-	20.600 m	10.300 m
450 km/h	-	-	26.000 m	13.000 m

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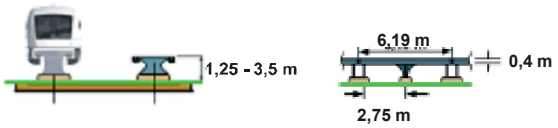
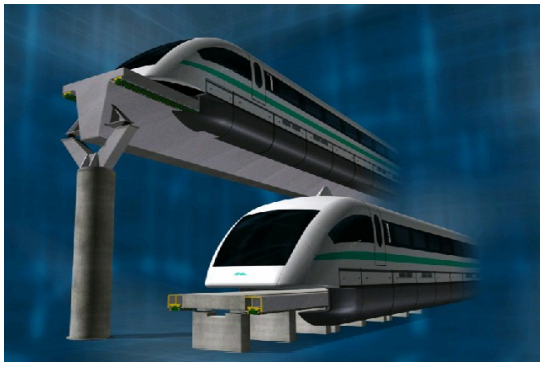
Comparison of the Technology between Wheel-on-Rail and Maglev Technique

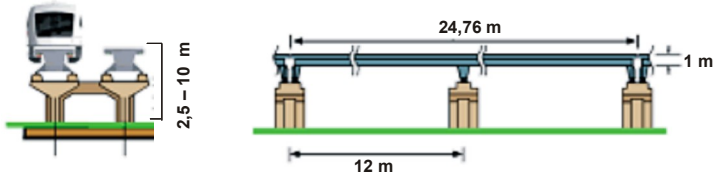
Guideway

At grade guideway
Typ III

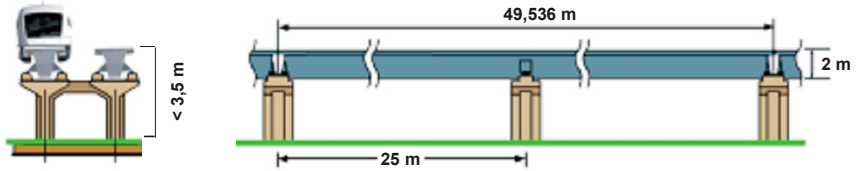


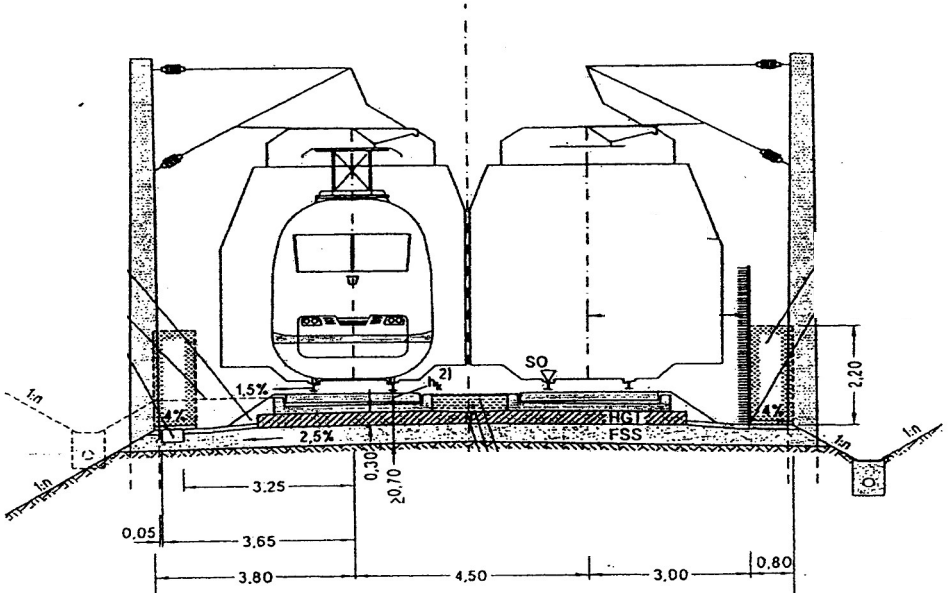


Elevated guideway
Typ II



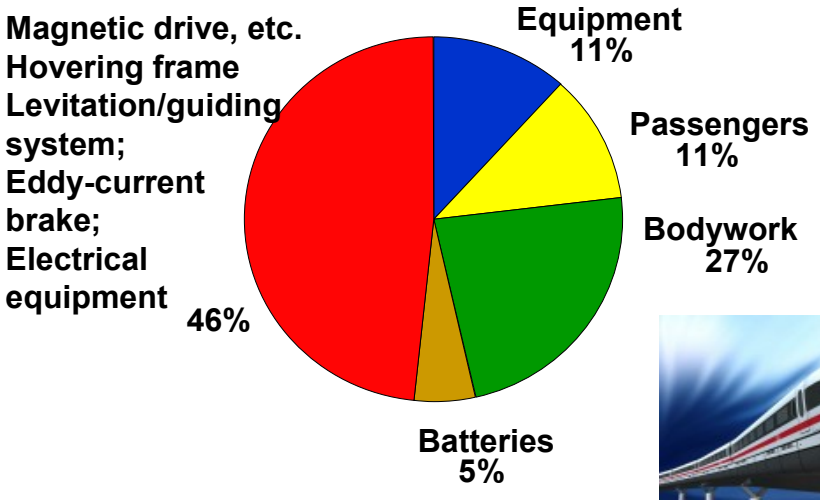
Elevated guideway
Typ I





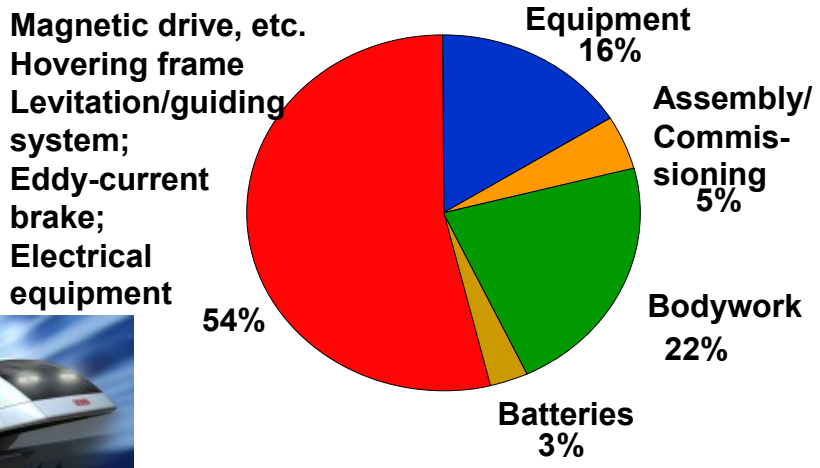
System Comparison

Mass balance



Length of vehicle: 129 m

Cost balance



Total mass:	**318 t (247 t unladen)**[2) 3)]
Number of seats (standard config.):	**446 (approx. 36t)**[1)]
Number of sections:	**5 (approx. 64 t/car)**
Specific mass per seat:	**0,63 t/seat**

1) 80 kg per person with luggage
2) Laden mass (passengers and equipment)
3) Basis configuration of TR 08

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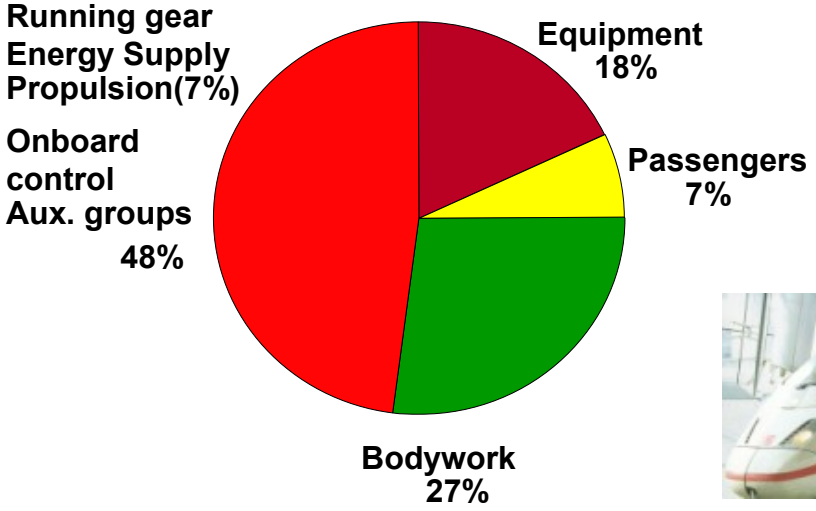
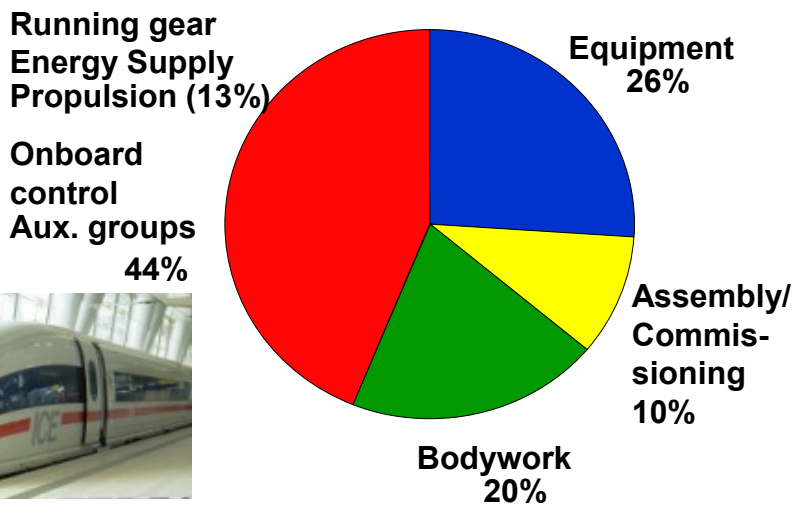
System Comparison

Mass balance



Length of vehicle: 200 m

Cost balance



Total mass:	**442 t (408 t unladen)[2)]**
Number of seats (standard config.):	**415 (approx. 33 t[1)])**
Number of cars:	**8 (approx. 55 t/car)**
Specific mass per seat:	**0.99 t/seat**

1) 80 kg per person with luggage
2) Laden mass (i.e. including passengers)

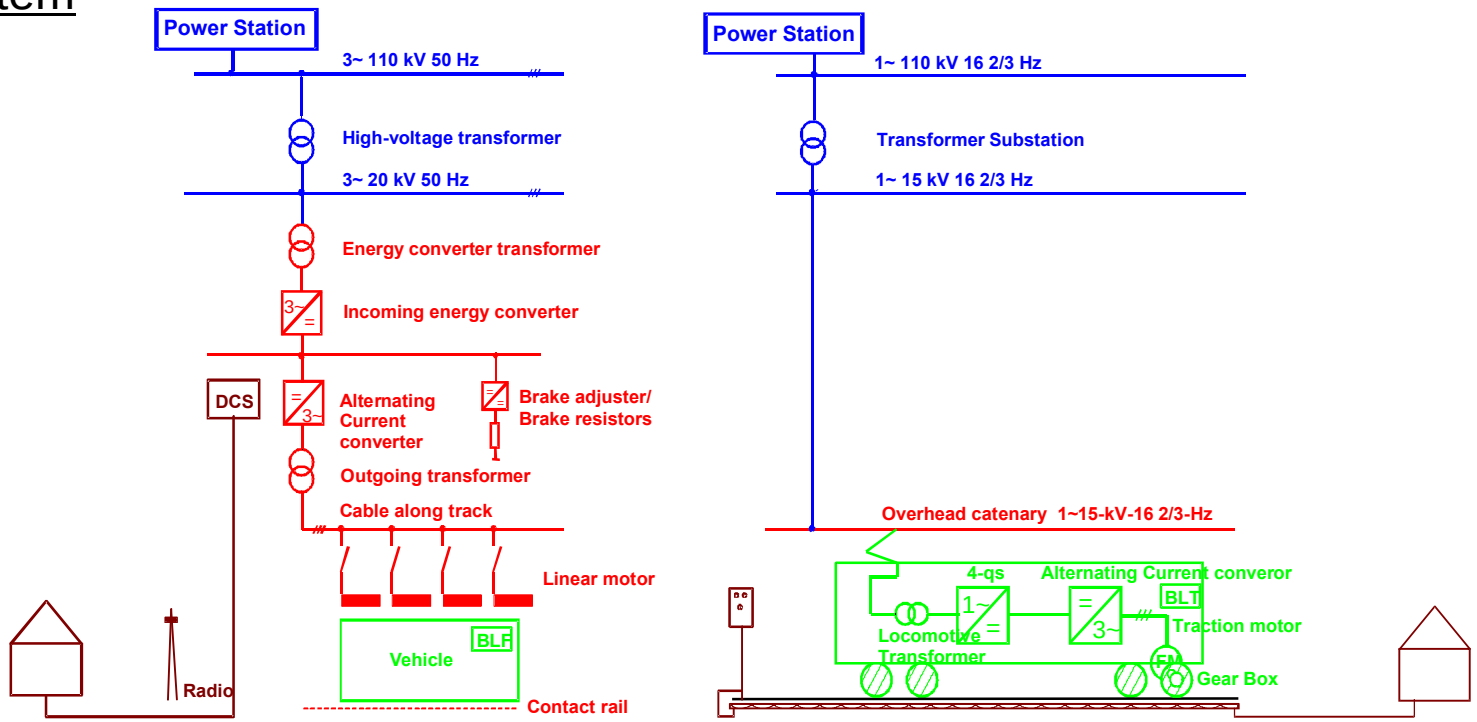
System Comparison

Vehicle

Parameters	Wheel on Rail System	Maglev System
Carriages/Sections per Train	8	5
Seats	415 (+ 24 in the dining car)	446
Operational speed	300 km/h	450 km/h
Max. engine power	8000 KW	25000 KW
Net weight of the train	409 t	247 t
Weight / Seat	Approx. 930 kg	Approx. 550 kg
Total length of train	200m	128 m
Width	2,95 m	3,70 m
Heigth	3,89 m	4,16 m
Axel load	17 t (2,1 t/m)	2,2 t/m

System Comparison

Subsystems for Maglev and Wheel/Rail System



Energy Supply
Vehicle

Propulsion
Signal & Control System

System Comparison

Comparison of general system structure

Subsystem	Maglev	Wheel on rail
Vehicle	Maglev vehicle Vehicle-OCS	Vehicle incl. Propulsion components and OCS
Operations control system	Operation center, control facilities, Radio facilities	Signal box, ETCS
Propulsion/ Conductor rail	Substation (incl. current converter), Incoming current converter, Intermediate circuit, Braking chopper, Inverter, Output converter, Track cable, Stator windings, Feeder rail	Overhead catenary
Energy supply	Power Station, local energy network (3~ 110 kV 50 Hz), High voltage converter, 3~ 20 kV 50 Hz	Power station, railway energy supply network (1~ 110 kV 16,7 Hz), Substation
Guideway	At grade, elevated	At grade

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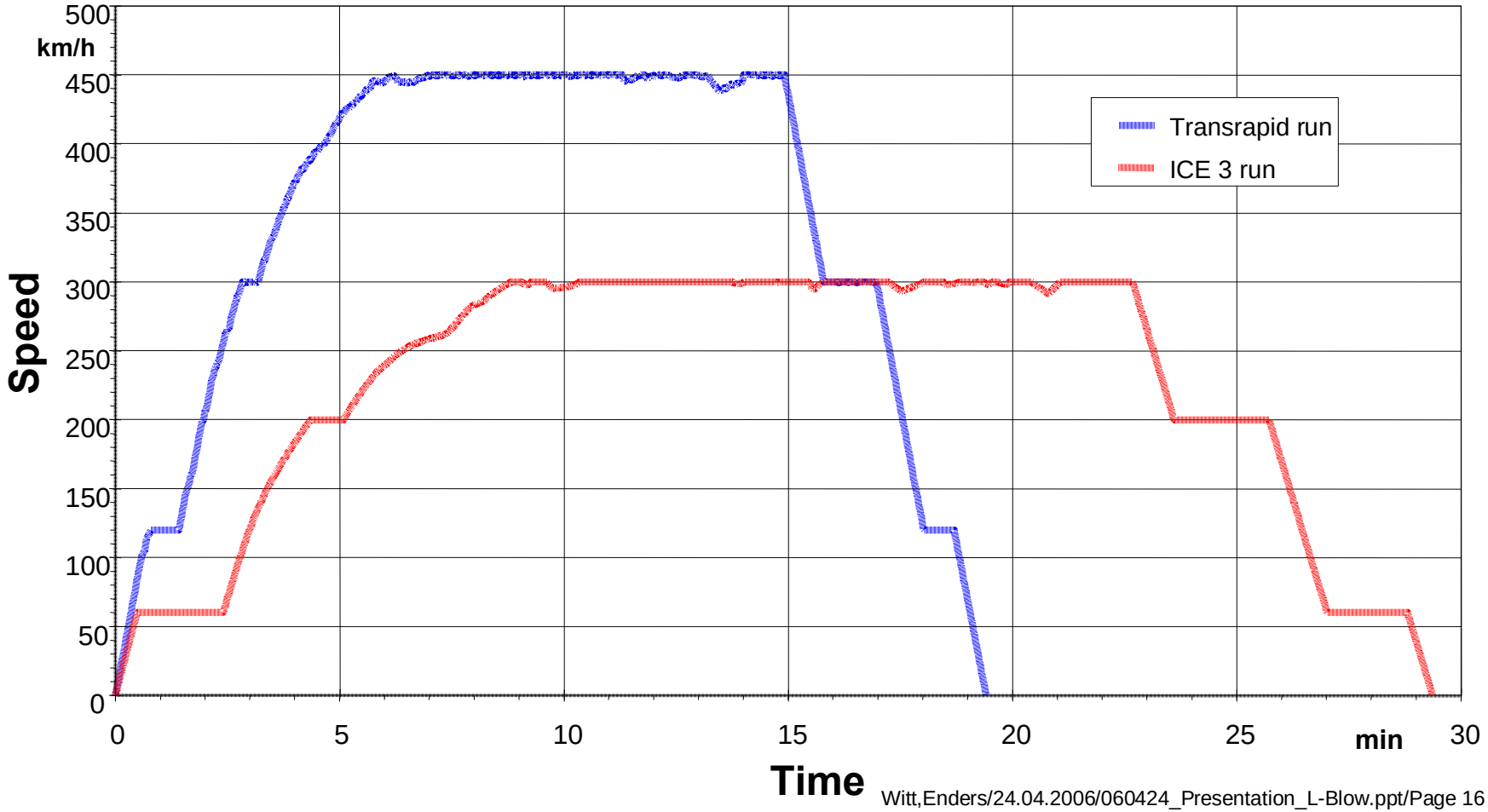
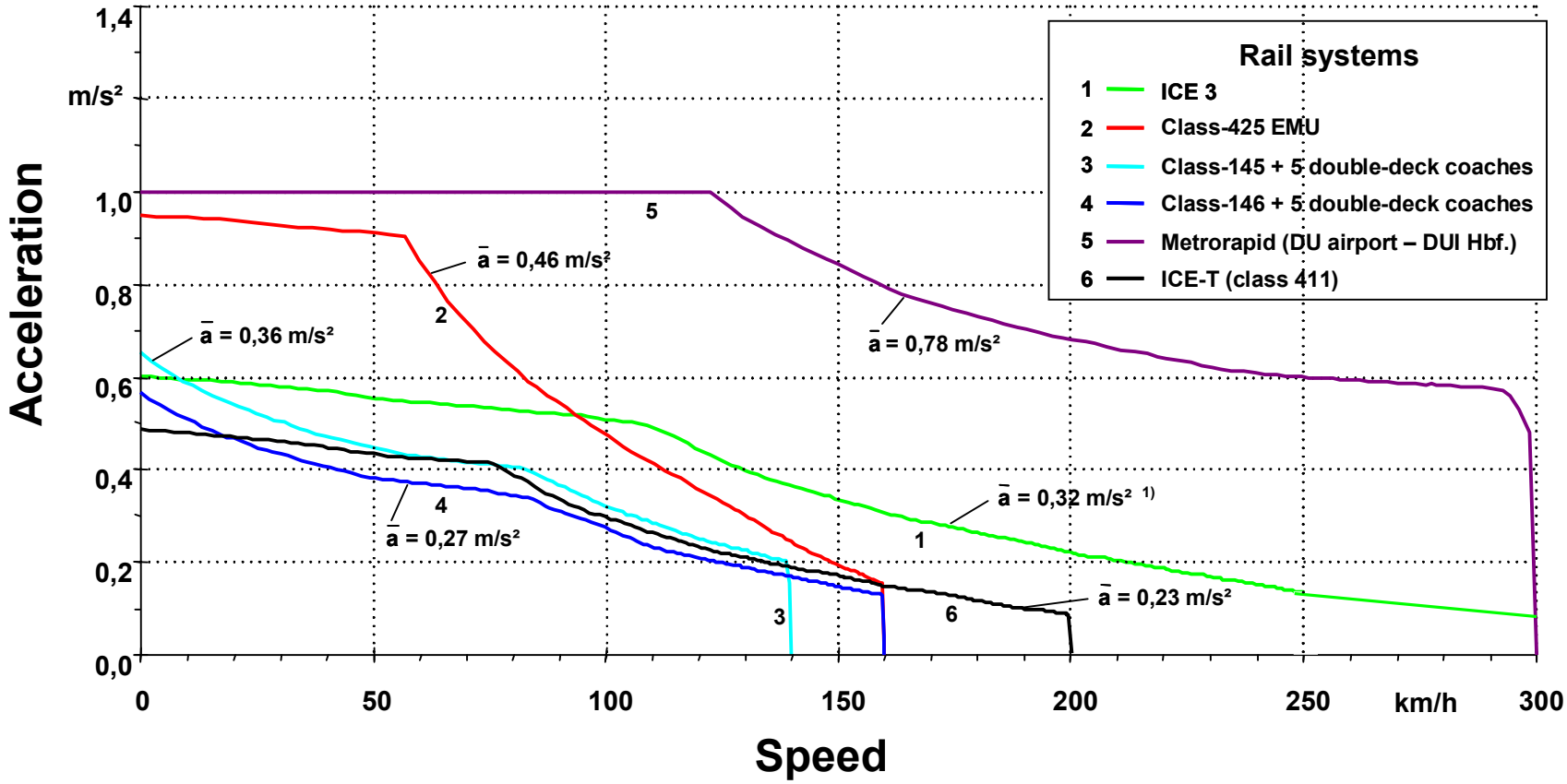
System Comparison



System Comparison



1) V_{max} = 200 km/h; $\bar{a}$ = 0,41 m/s²
(ā : mean acceleration)

System Comparison

Energy consumption

	Wheel/Rail	modified MAGLEV	MAGLEV
running time including timetable reserves	**32 min.**	***32 min.***	**21 min.**
Design Speed	300 km/h	*246 km/h*	450 km/h
Energy supply	Substation 15 kV	*Substation 20 kV*	Substation 20 kV
Traction energy consumption	62,2 GWh/a	*44,1 GWh/a*	89,6 GWh/a
secondary energy consumption	6,2 GWh/a	*13,2 GWh/a*	13, 2 GWh/a

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Identification of the Quantity and Cost Frameworks

Cost Structure of the system comparison

Investment Costs

Infrastructure costs

- Land requirement
- Guideway / track
- Power supply
- Propulsion/feeder
- Operation control system
- Noise protection

Vehicle Costs

Other Costs

- Facilities
- Planning costs

Operational Costs

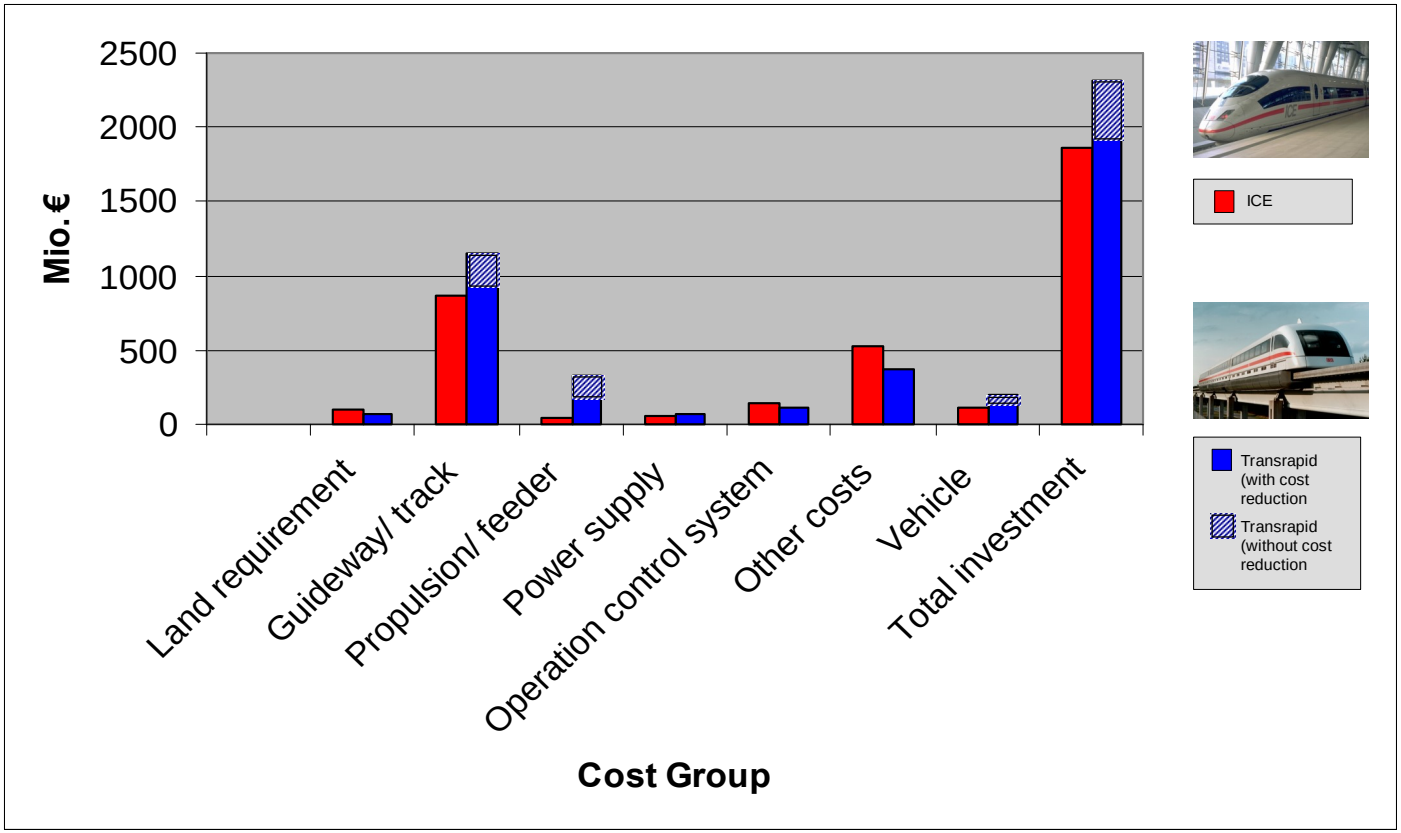
Personnel costs

Energy Costs

Maintenance Costs

Identification of the Quantity and Cost Frameworks

Comparison of the Investments Costs



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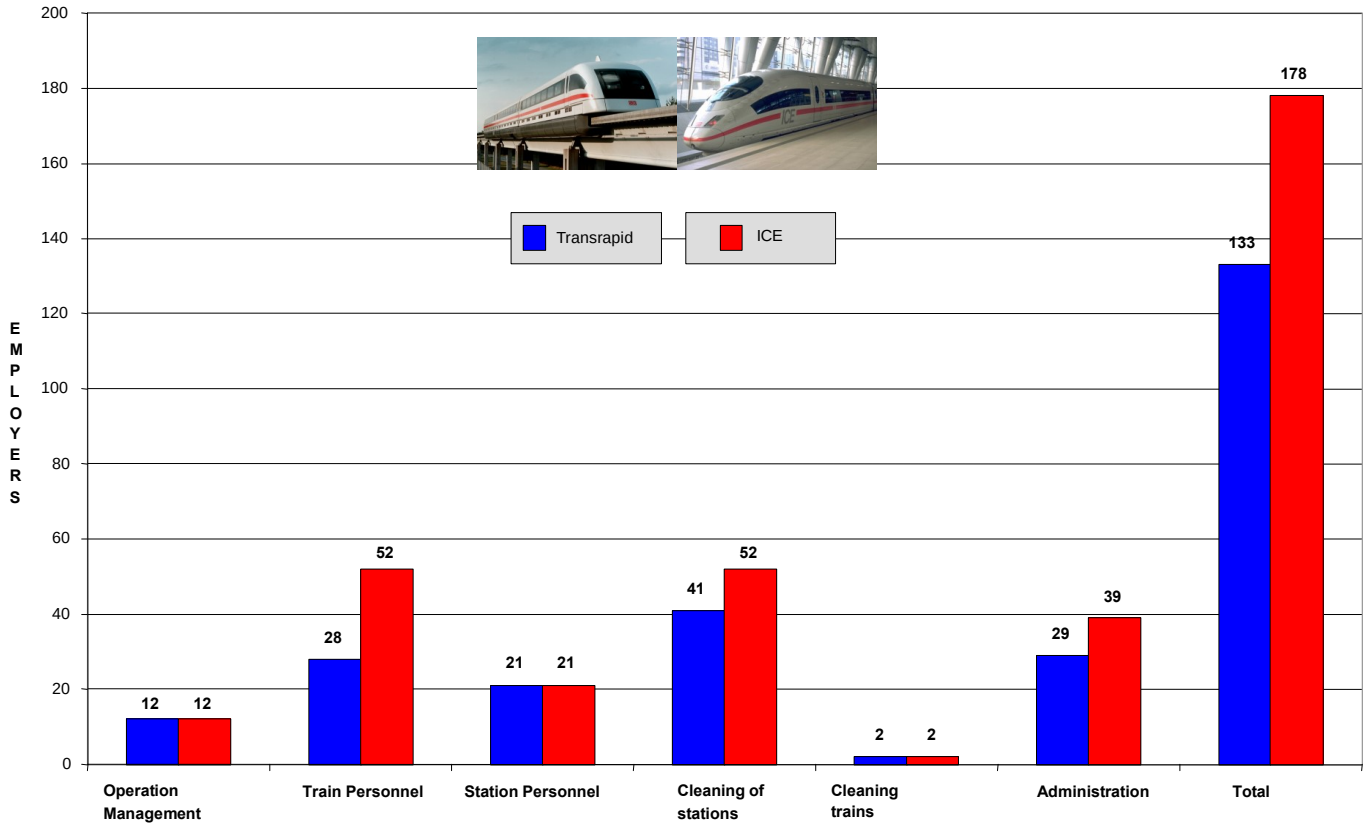
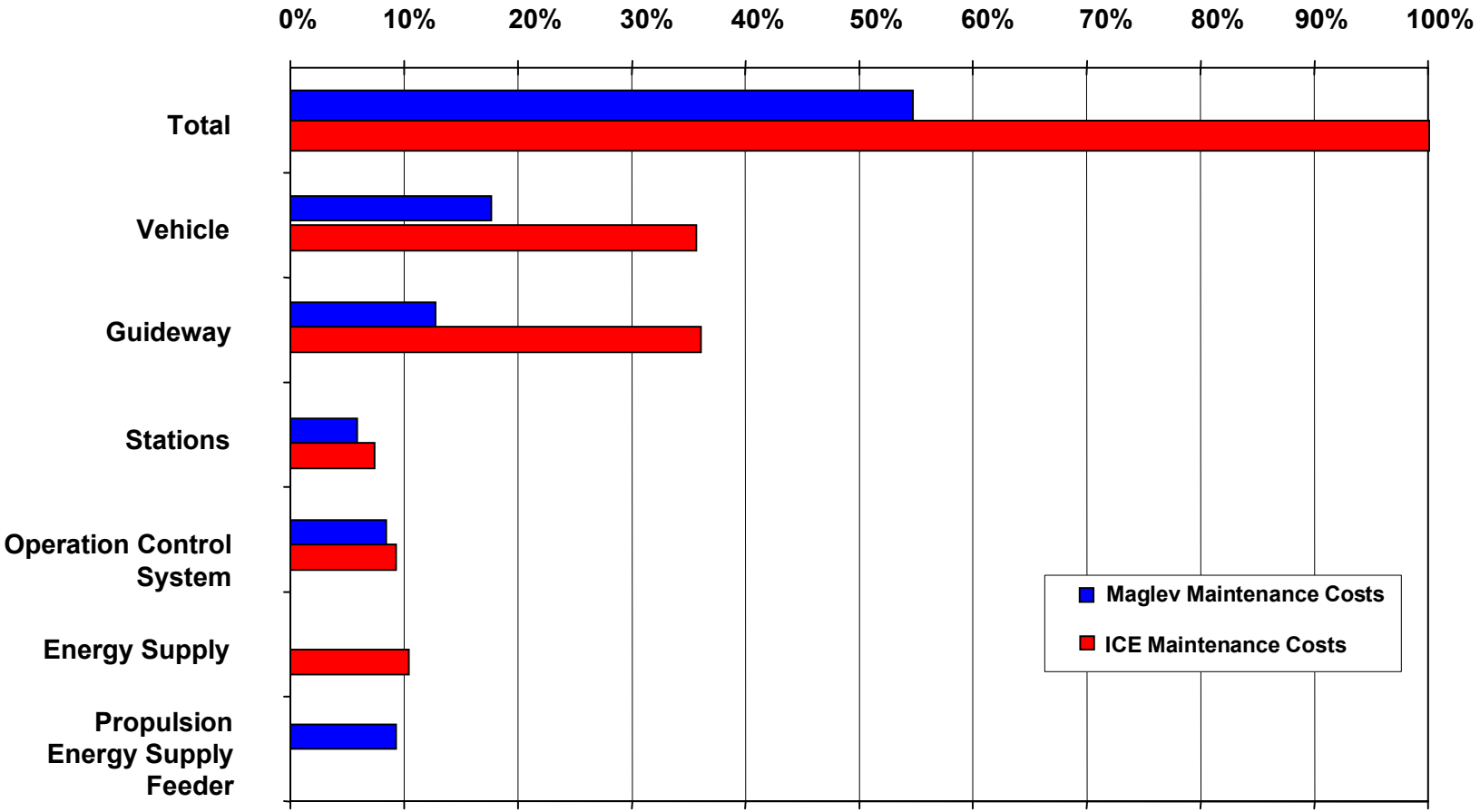
Identification of the Quantity and Cost Frameworks

Comparison of Personnel Costs

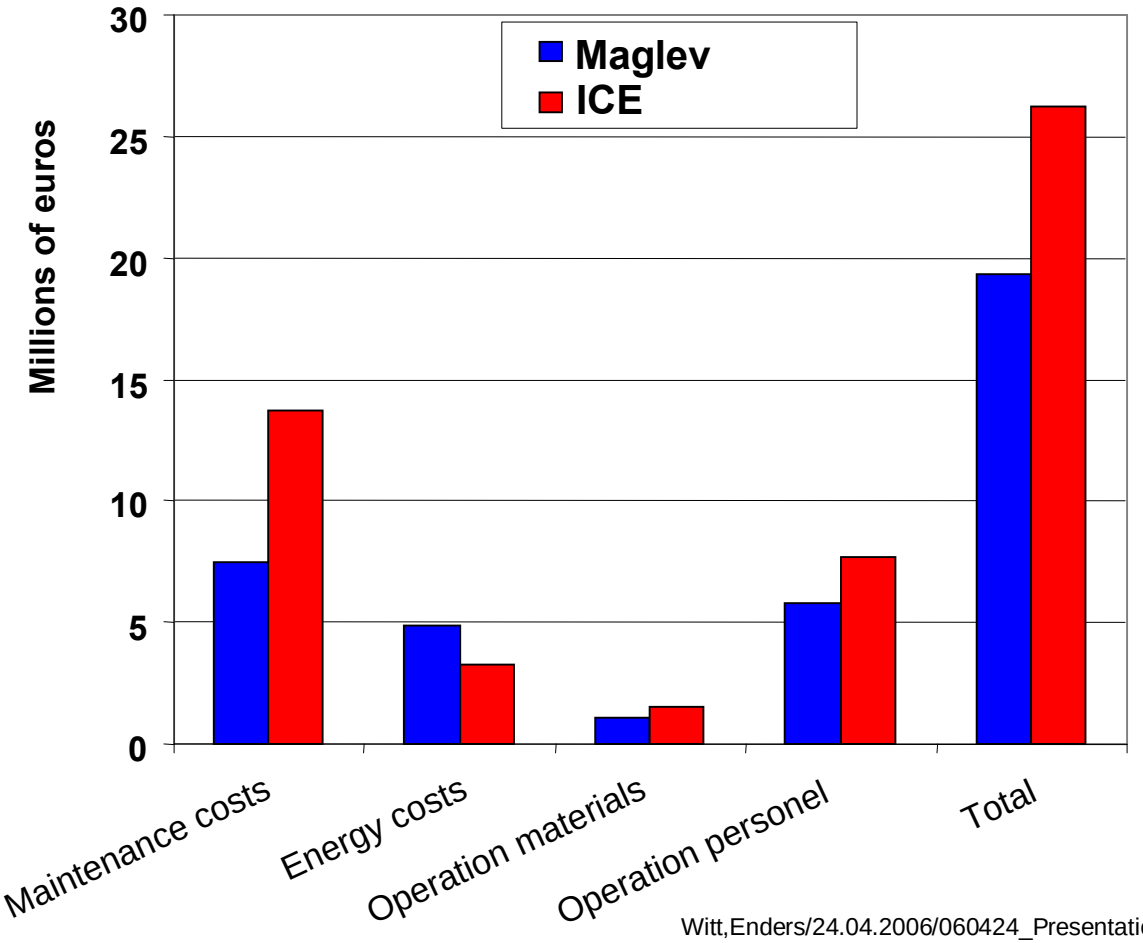


Identification of the Quantity and Cost Frameworks

Comparison of Maintenance Costs

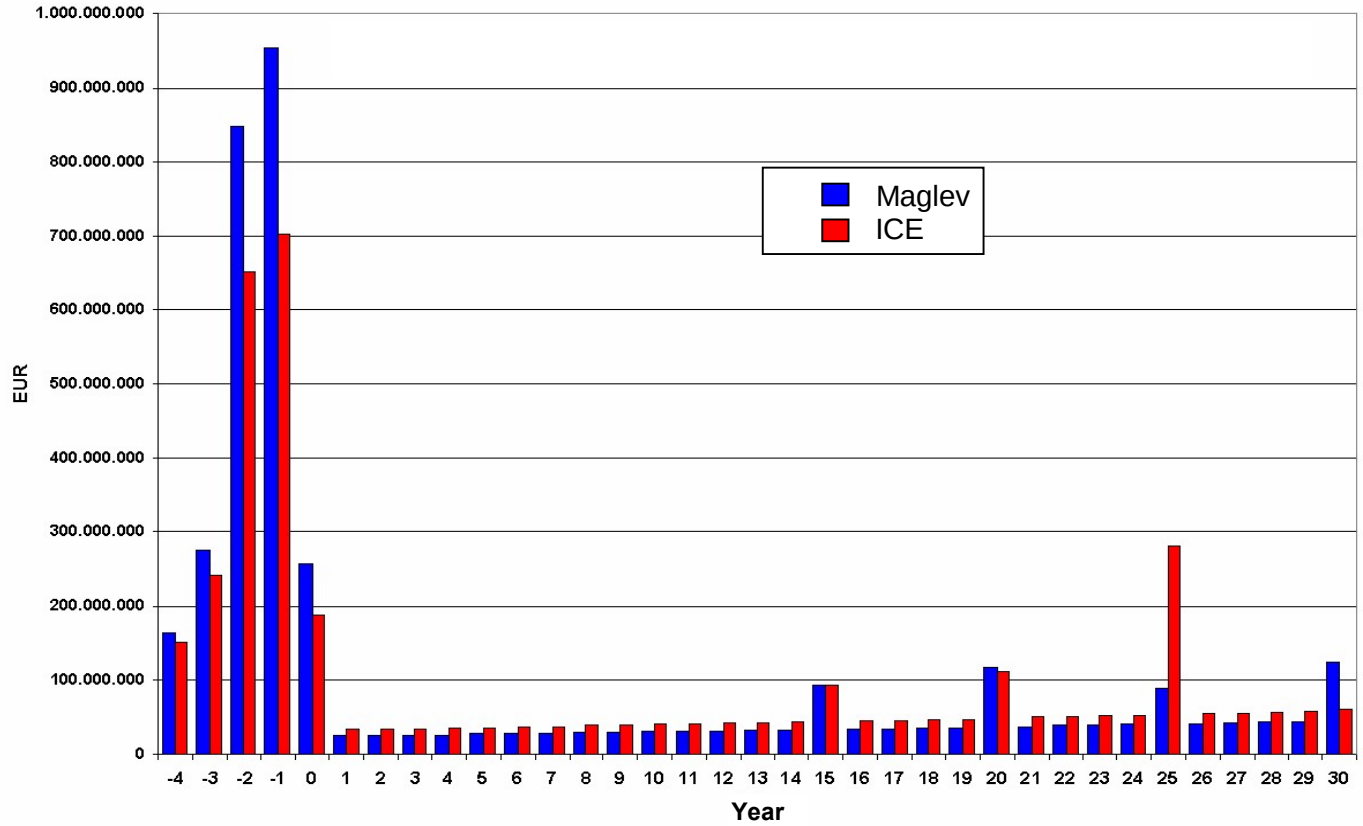


System Comparison



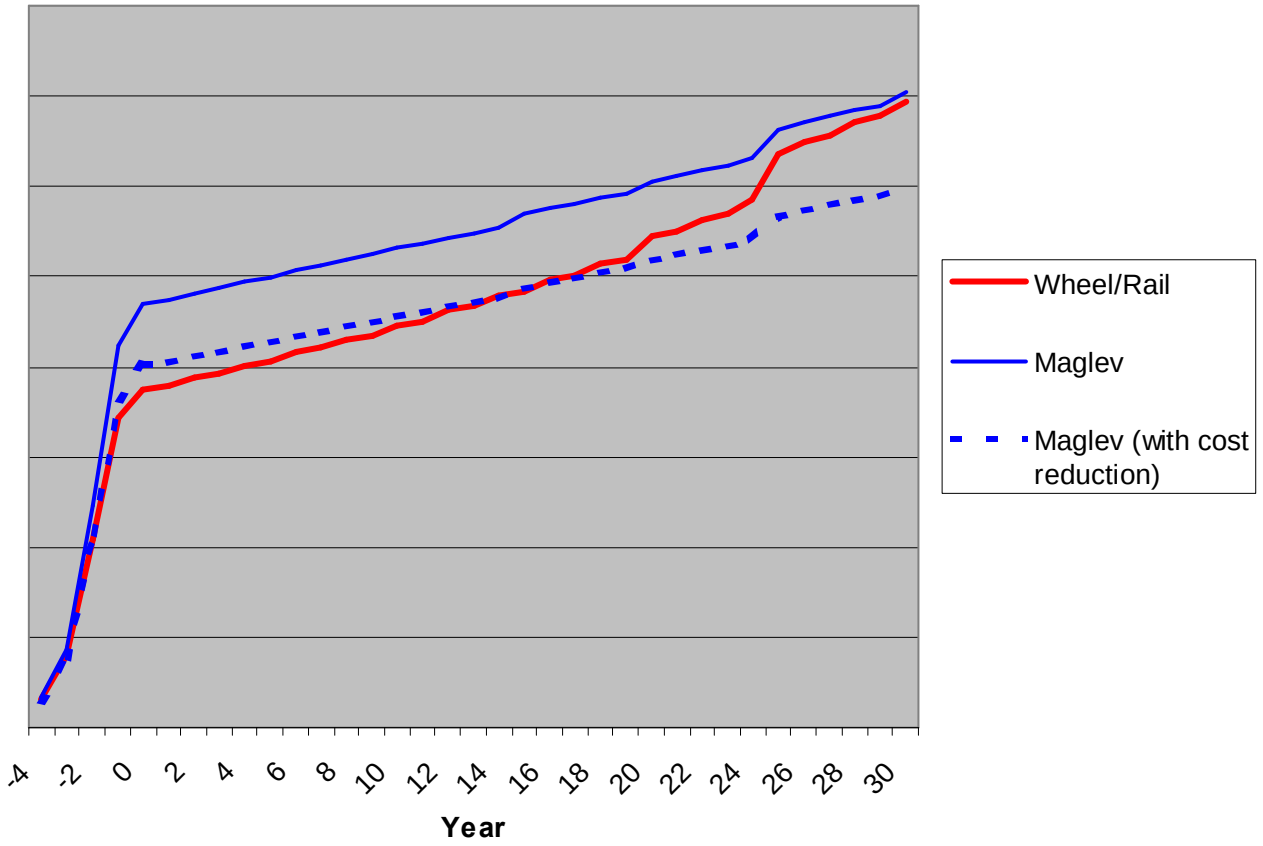
Analysis of the LCC

Periodic Cost Development



Analysis of the LCC

Total Cost Development for Maglev and for Rail



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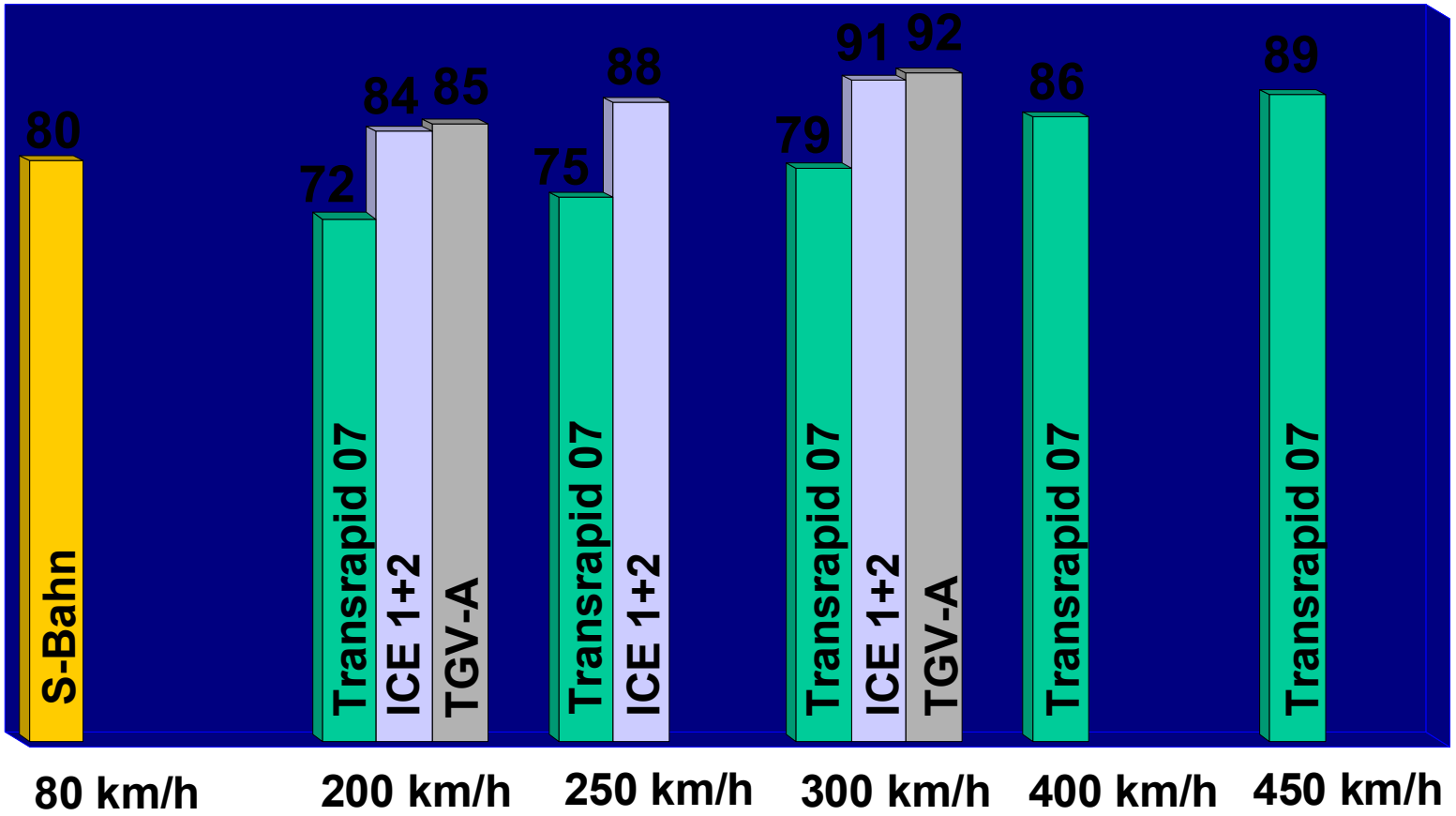
Noise emission



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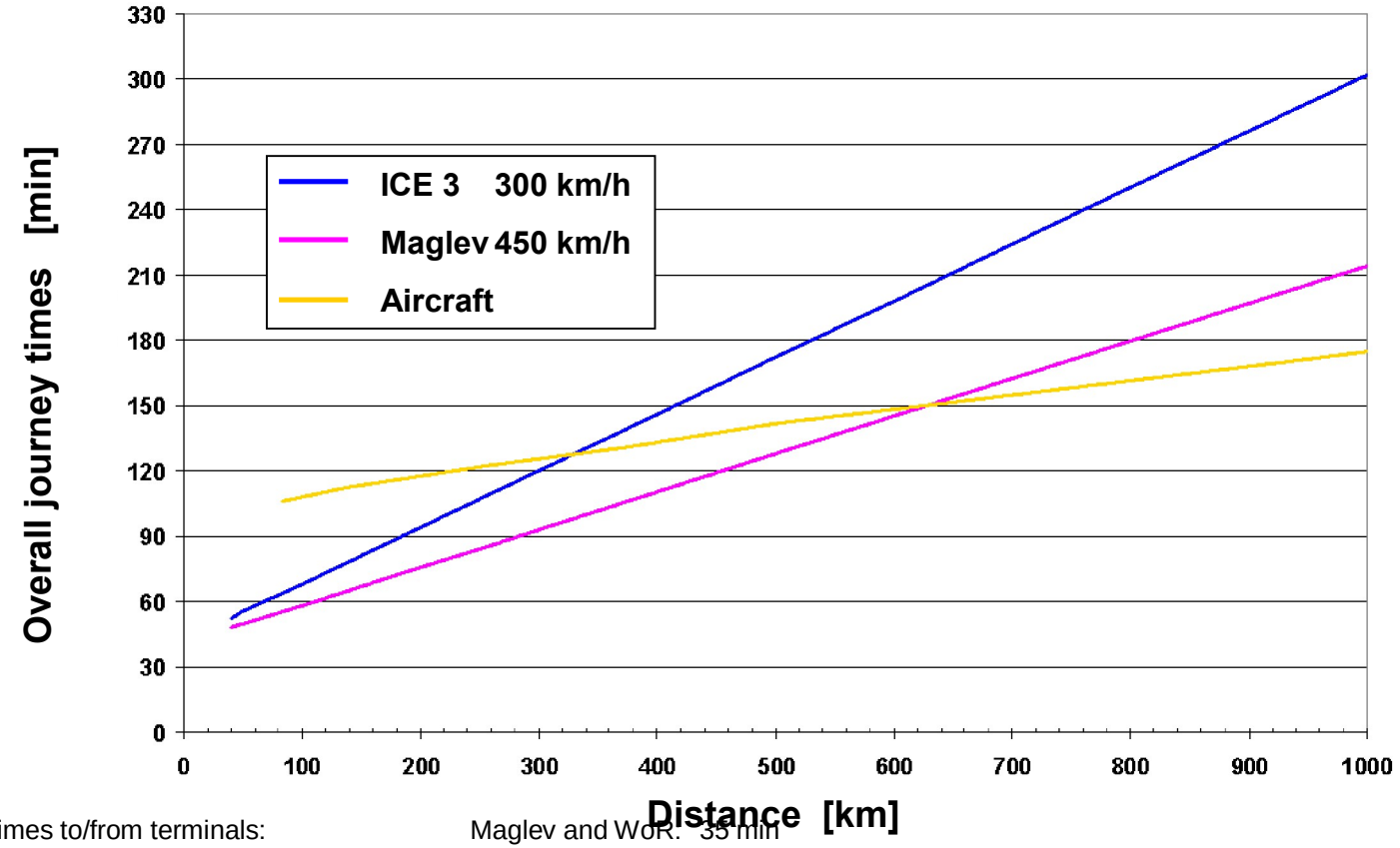
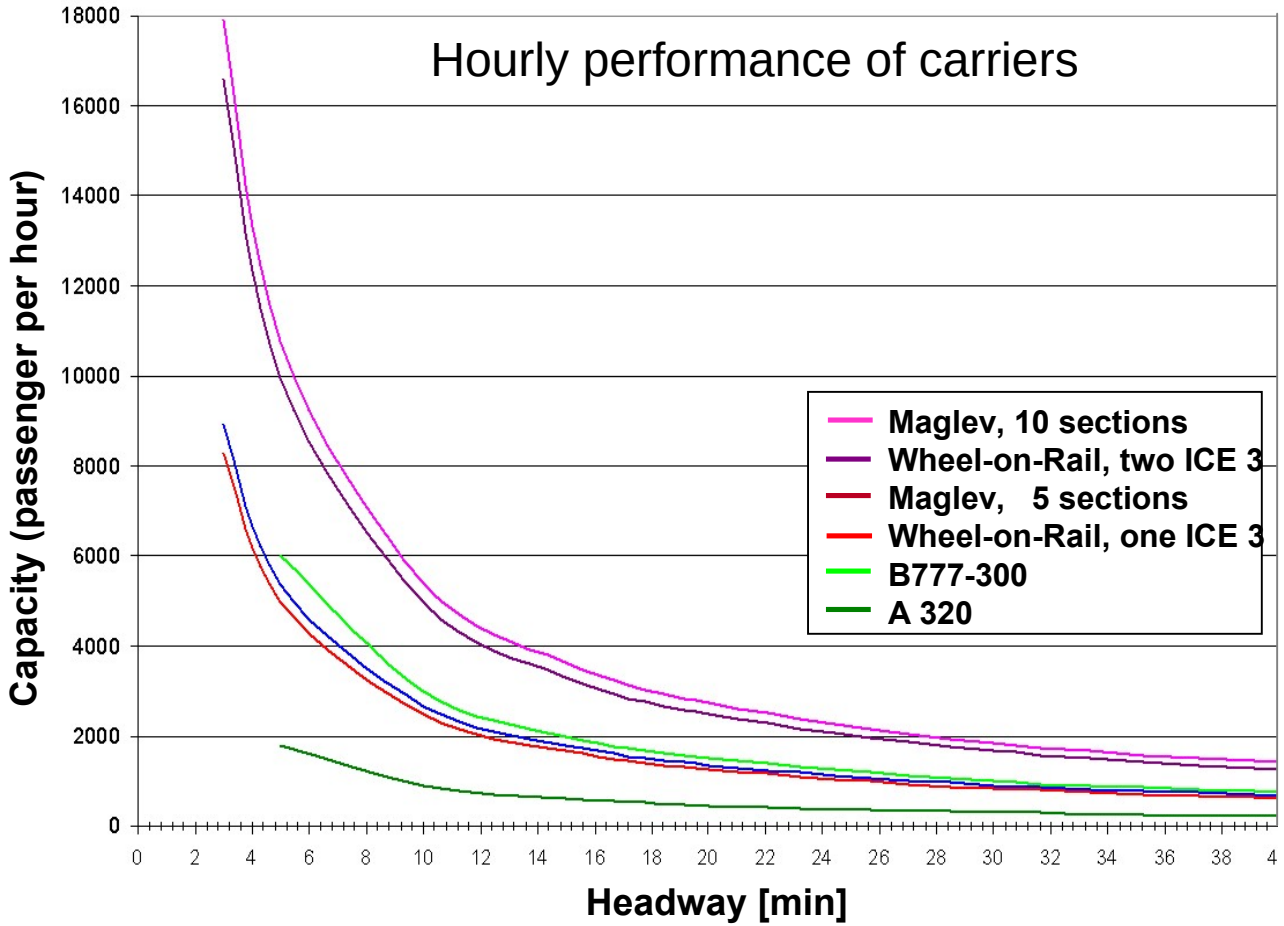
Journey time Comparison

Journey time



Times to/from terminals:
Aircraft
Maglev and WOR: 35 min
80 min

System Comparison



Summary of Evaluation

Potential Cost Savings of the High Speed Maglev System

High Speed Maglev System has Lower Costs than the Wheel-on-Rail System

High Speed Maglev System has Lower Maintenance Expenses than the Wheel-on-Rail System

High Speed Maglev System has Lower Life Cycle Costs than the Wheel-on-Rail System

Environmentally Compatible Operation

Macro-economical Benefits