

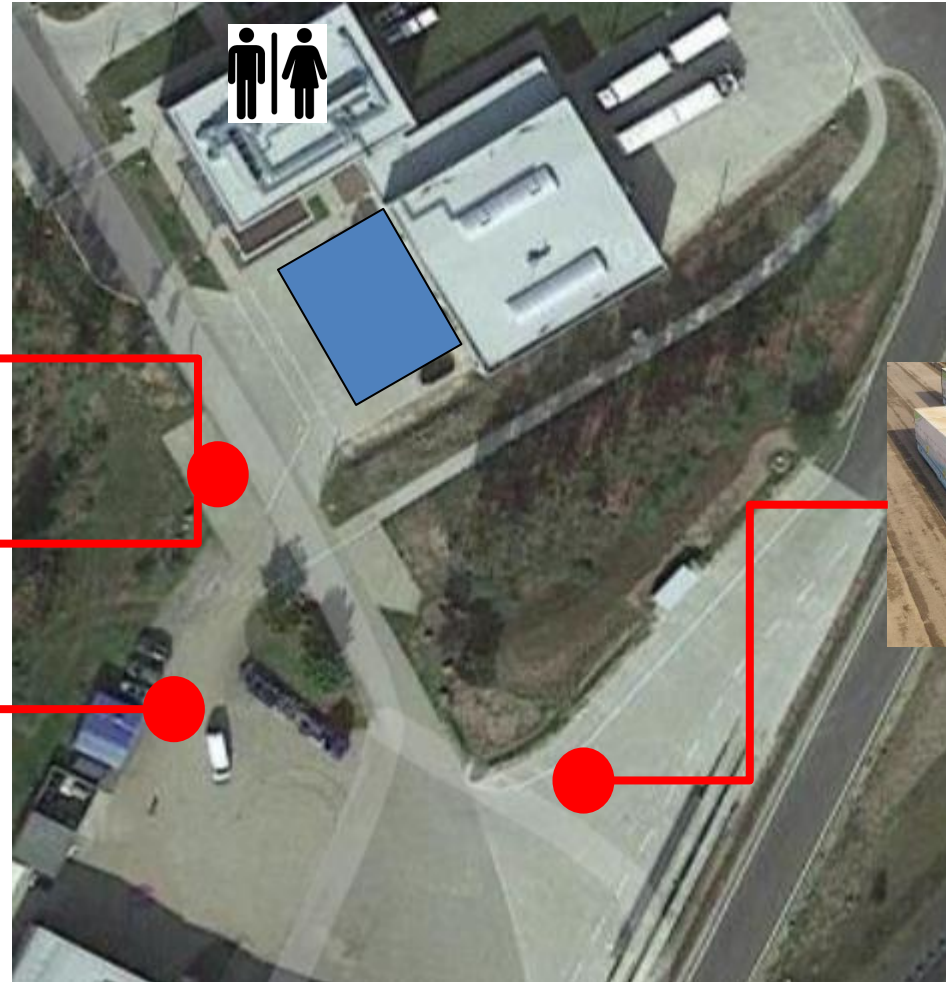


# Welcome to the final event



*The research leading to these results has received funding from the European Union*

# Safety first and mute your mobile phone



TESTBAHN JEVERSEN



## Information for Visitors



Visiting ZF CVCS - Rules for your visit

To safeguard you and us against infection with the corona virus COVID-19



### Submission of a negative test result.

All participants must have a negative test result not older than 24 hours, proof of vaccination or proof of recovery upon entry. For exceptional cases, we will provide tests on site.



### Coming from an international risk area or German hotspot (7-day incidence > 50 cases/100,000 residents)

Inform yourself before your arrival whether the international area or the region you are coming from has been declared a risk area or the 7-day incidence has been exceeded. Inform your ZF CVCS contact person and discuss the further procedure.



### If you show symptoms of illness.

Even if you have mild symptoms such as coughing or a runny nose, you will not be allowed access to ZF CVCS.



### Keep a distance - at least 1.5m.

The distance to other people must be maintained at all times during your visit to ZF CVCS.



### Masks must be worn on the entire site.

Wearing a mouth-nose mask is compulsory as soon as you enter the ZF CVCS premises and during your entire stay. You can take off the mask as long as you are seated at a conference table. Face shields or other types of face covering are not permitted.



### Do not shake hands.



### Wash hands and keep away from face.






### Cough and sneeze hygienically.







# Ride & Drive

-  12:00 – 13:00hr
-  16:45 – 18:00hr
-  Register and show your driver's license



 Enjoy your stay and participate in the dialogue



AEROFLEX

# Welcome to the final event



IVECO



TIRSAN SOLUTIONS



School of Engineering and Automotive



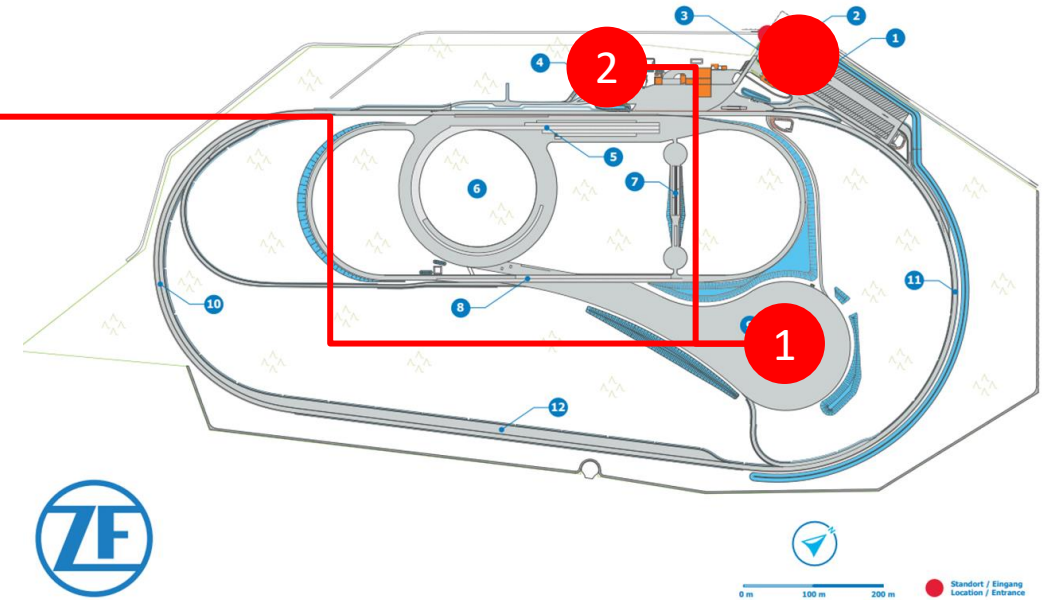
The research leading to these results has received funding from the European Union



AEROFLEX

Welcome & Households Agenda	08:40 – 09:00
Keynote Project overview and main results	09:00 – 09:45
Demonstrations of Innovations	09:45 – 11:45
Lunch and Ride & Drive	12:00 – 13:00
Demonstrations of Innovations	13:00 – 14:00
Benefits for industry and society	14:00 – 15:45
Discussion panel	15:45 – 16:40
Closure & farewell Drinks	16:40 – 17:30

## TESTBAHN JEVERSEN / TEST TRACK JEVERSEN





# A warm welcome to Dr. Christian Brenneke

🚚 A warm welcome to  
Dr. Christian Brenneke  
ZF CVCS, Senior Vice President Engineering

🚚 Our host today

## Dr. Christian Brenneke – My Background



20 years experience in High-Tech Products  
15 years in Automotive Business  
11 years in Global Leadership Roles  
03 years as Corporate Officer  
Strategic, Results focused, Intercultural

ZF CVCS, Senior Vice President Engineering (since 05/2020)  
WBC, Chief Technology Officer (2018)  
WBC, Vice President Engineering (2015)  
WBC, Business Leader Vehicle Dynamic Controls (2013)  
WBC, Leader / Director Project Management (2010)  
WBC, Leader Software Development (2008)  
VW, R&D AD and ADAS (2004)

2011 – MBA in General Management  
2004 – Dr.-Ing. Informatics, Major Data Fusion  
2000 – Dipl.-Ing. in Electrical Engineering, Mechatronics



© ZF Friedrichshafen AG



# AEROFLEX FINAL EVENT

Dr. Christian Brenneke | Senior Vice President Product Engineering | ZF Commercial Vehicle Control Systems



# Performing More but Burden Less:

Transportation is exposed to high expectations and fundamental threats

## Complex Challenges for Transportation

- Emission Regulations
- Reduction of Accidents
- Efficiency & TCO
- Lack of Drivers

## Transportation is the lifeline of our society

Commercial transport is one of the foundations of our economic and social system. Raw materials are delivered to factories, goods are delivered and people are shuttled.

## Growing Demand for Transportation

Transport demand expected to increase significantly mainly due to

- Urbanization and
- E-commerce



Mobilizing  
Commercial Vehicle  
Intelligence.

NOW.





# The ZF System Approach

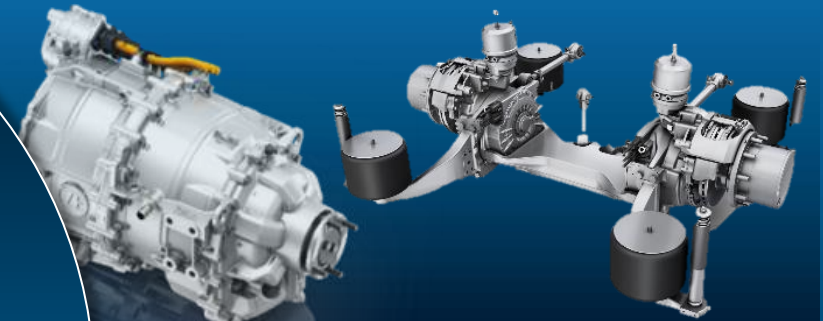
**Up to 10%**

less fuel  
consumption  
and reduced  
CO<sub>2</sub>



High-tech Driveline

**0 Emissions**



Electric Drivelines



**Leading in  
Emission and Fuel  
Reduction  
Innovation**

**Up to 10%**

more Payload



Lightweight Concept Truck

**Up to 16%**

Fuel reduction



eTrailer





**Delivering the Next Generation of Commercial Vehicle Efficiency**



# Results



**Delivering the Next Generation of Commercial Vehicle Efficiency**



**Thank you**



- Project overview
- Main results and impact
- Advanced Energy Management Powertrain
- Live demonstrations on test track



# Project overview & main results

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## Industry

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## Research



Gertjan Koornneef, Msc  
TNO Helmond Netherlands, Project manager

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## Service and validation







Ben Kraaijenhagen  
BeCat, Technical coordinator project AEROFLEX

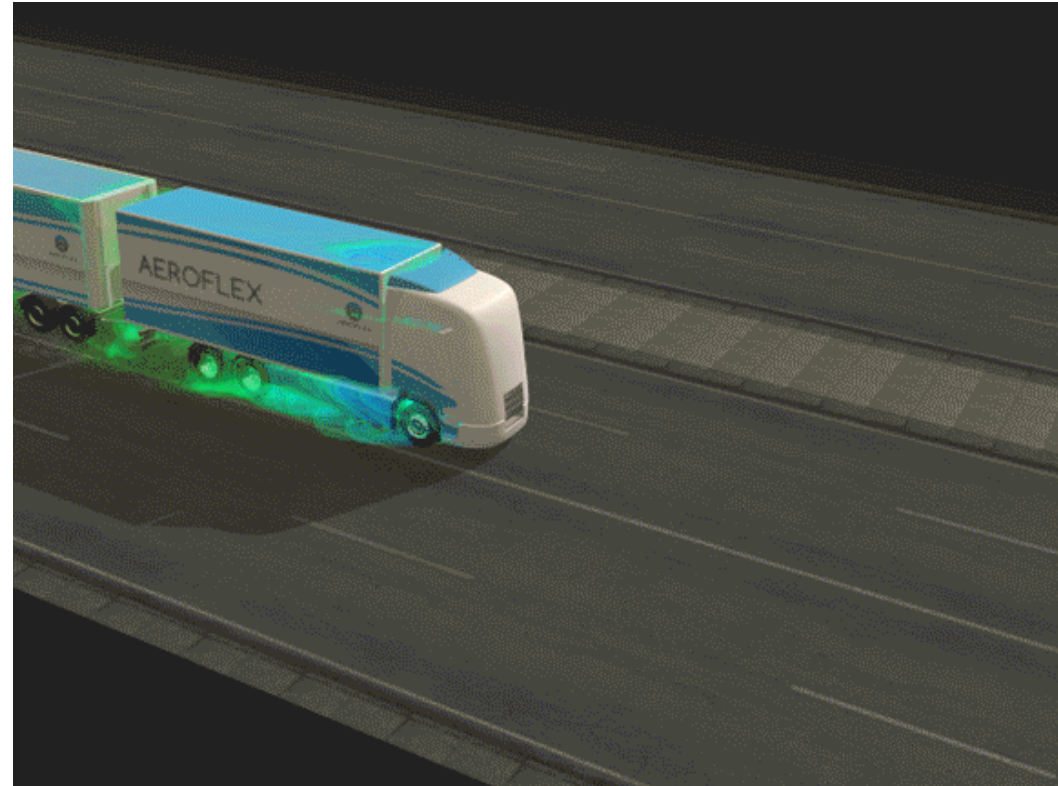
# Long haulage freight road transport

- 🚛 Long haul
- 🚛 High-capacity freight transport
- 🚛 European Modular System
- 🚛 EMS vehicle configurations
- 🚛 Optimal balance of weight & volume
- 🚛 Flexibility in art of transport
- 🚛 Adaptability in size of loading units



# Contribution to energy savings and safety

-  Vehicle concept
-  Powertrain
-  Aerodynamics
-  Front End Design

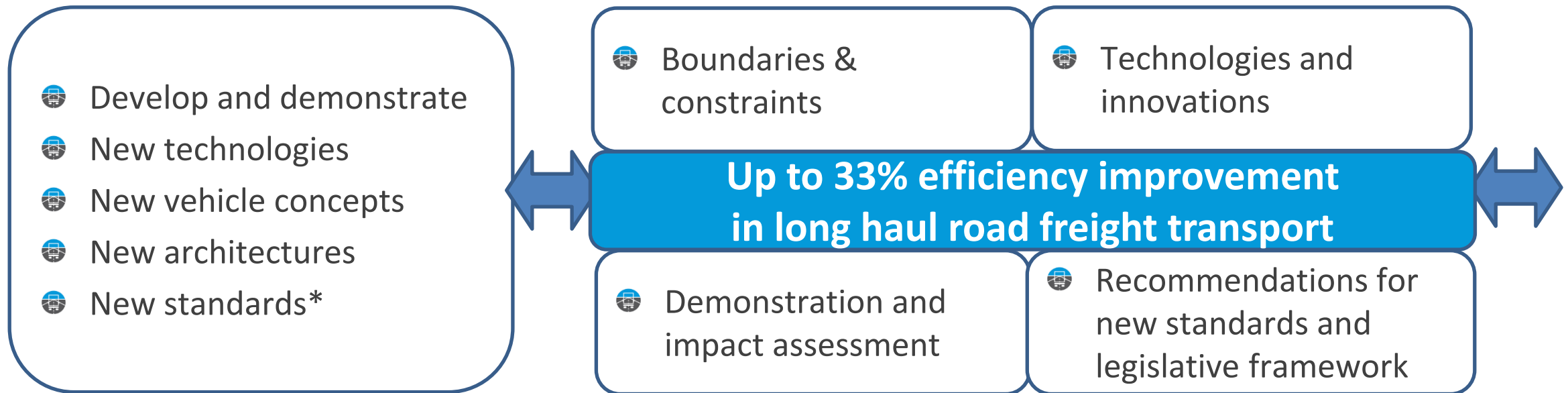


-  **Ability to use AEROFLEX innovations in zero emission vehicle powertrain (BEV and FCEV)**



## Goal and objectives

-  AEROFLEX SUPPORTS VEHICLE MANUFACTURERS  
TO MEET THE COMING CHALLENGES AND INCREASE EFFICIENCY FOR ROAD FREIGHT TRANSPORT



\*new standards for hybrid-distributed powertrain, aerodynamic devices for complete vehicle, utilisation of loading units, performance based standards (PBS), access to infrastructure in a multi-mode context



# Targets to achieve overall efficiency improvement



4-5% energy saving by separate platforms

4-6% energy saving by effective use of loading space

5-12% energy efficiency improvement from flexible advanced powertrains





5-10% reduction in energy consumption through improved vehicle aerodynamics





Standardized interfaces and sharing of components for higher economies of scale

Front end design to ensure survivability in crashes up to 50km/hr for occupants and vulnerable road users

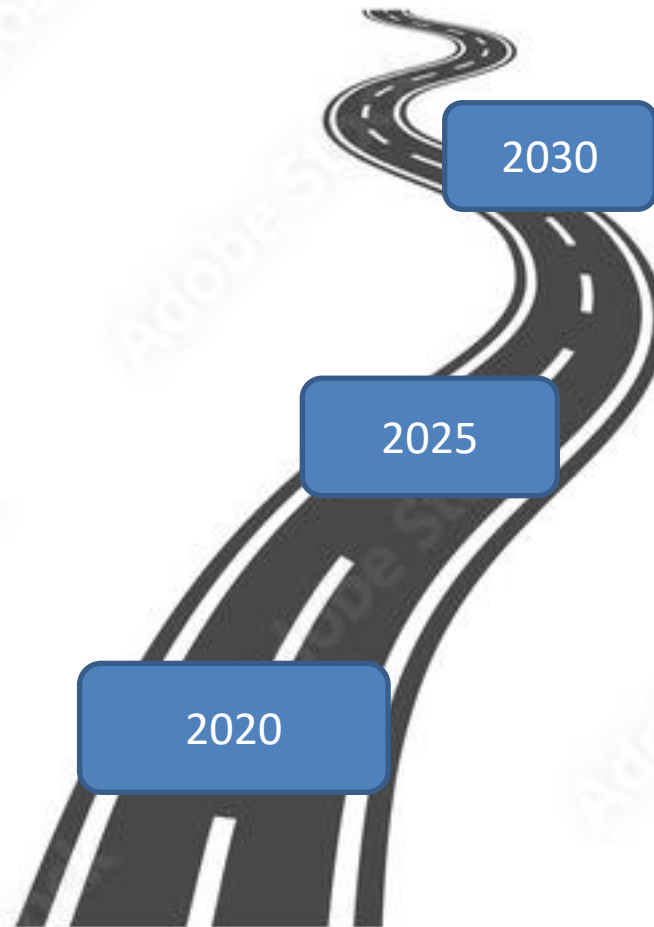
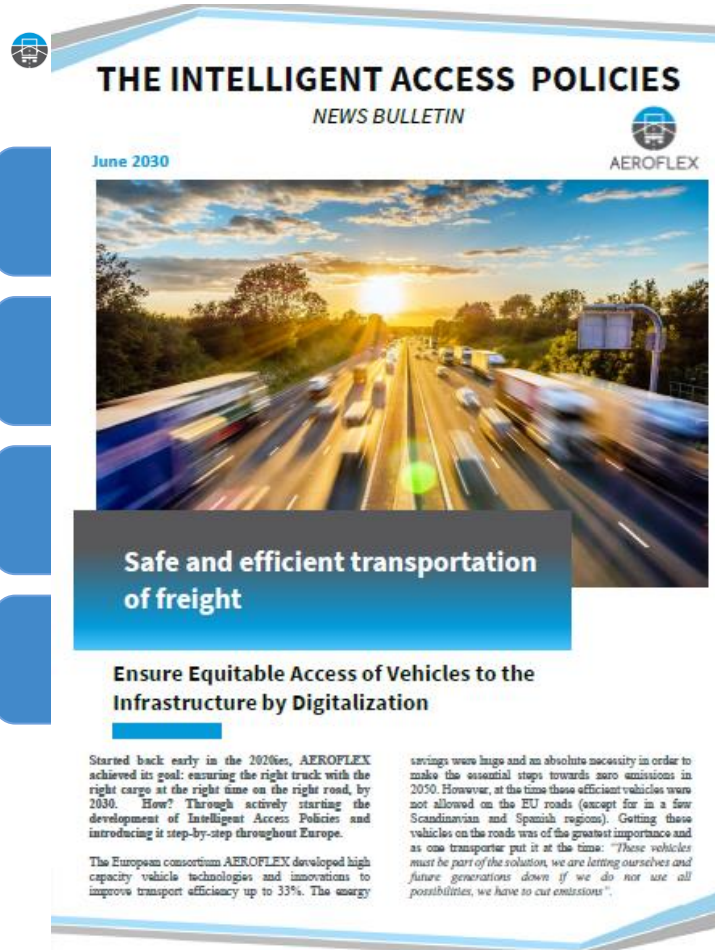
# Our Demonstrators and Innovations



-  Distributed powertrain
-  Smart Powered Dolly
-  Active and passive aerodynamic devices
-  Active and passive safety in new front-end design

-  New Modular Loading Units
-  PUZZLE
-  Cargo Volume Detection
-  Trailer2Train

# Deliverables and roadmap for implementation



## Roadmap for implementation

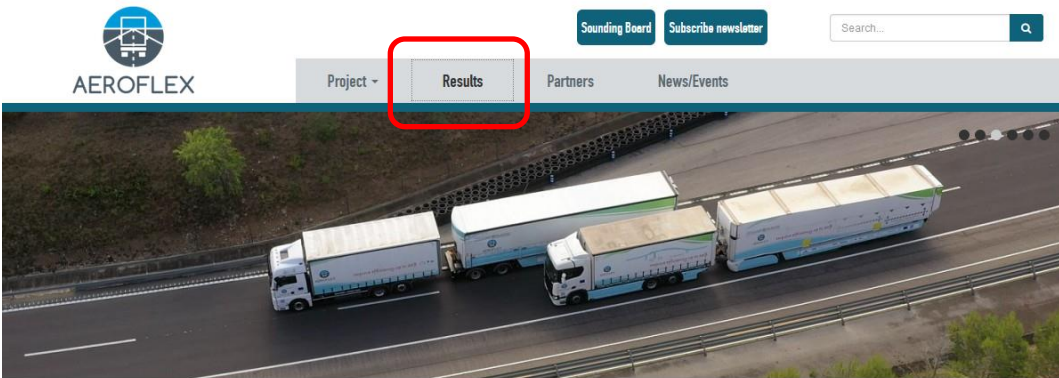
Efficiency by 30%  
achieved and proven

Large scale roll-out concepts  
and standards

Introduction of AEROFLEX  
concepts and standards



<https://aeroflex-project.eu/>



**AEROFLEX – Aerodynamic and Flexible Trucks for Next Generation of Long Distance Road Transport**

The AEROFLEX project is to develop and demonstrate new technologies, concepts and architectures for complete vehicles that are energy efficient, safe, comfortable, configurable and cost-effective, while ensuring that the varying needs of customers are satisfied by being flexible and adaptable with respect to the continuously changing operational conditions. The truck, the dolly and the trailer are ready to undertake the test program

**AEROFLEX FINAL EVENT**  
28 SEPTEMBER 2021  
@ZF Test Track Jeveresen  
[REGISTER HERE](#)

**TESTBAHN JEVERSEN / TEST TRACK JEVERSEN**

**Latest news**

- NEWSLETTER #4
- AEROFLEX FINAL EVENT 28 SEPTEMBER 2021 | Registration & Programme
- AEROFLEX Tests in München

## Results

The results within the AEROFLEX are listed here below.

Most of the reports are confidential (CO), in those cases only a public summary is available, which can be quite short. The Public (PU) documents which are too large to show on the website can be requested via the project manager (see contact details).

### 1. Map and quantify load in EU and potential for configurable truck

- [Transport market and its drivers with respect to new vehicle concepts](#) [2018, full report]
- [Decision maker survey on new vehicle concepts](#) [2018, summary]
- [Market potential and GHG emission changes by new vehicle concepts](#) [2021, summary]

### 2. Advanced Energy Management Powertrain (AEMPT)

- [Book of Requirements AEMPT and KPI](#) [2019, full public report]
- [Architecture and Design of AEMPT](#) [2019, summary]
- [Validation report AEMPT and ECU with AEMPT for truck, dolly, \(semi\)trailer](#) [2020, summary]
- [Architecture and Design of the SPD](#) [2021, summary]
- [Complete vehicle prepared for hand over to WP6](#) [2021, summary]

### 3. Aerodynamic Features for the Complete Vehicle (AFCV)

- [Report on selection of concepts](#) [2018, summary]
- [CFD simulations](#) [2020, summary]
- [Recommendations for demonstrator](#) [2020, summary]
- [Results from wind tunnel test](#) [2020, summary]
- [Build-up of demonstrator](#) [2021, summary]
- [Project report with conclusions and recommendations based on the CFD simulations and wind tunnel tests](#) [2021, summary]

### 4. Smart loading units (SML)

- [Use cases and requirements defined for smart loading units in a multi-modal context and KPIs](#) [2018, summary]
- [Description of concepts and assessment of potential efficiency improvements](#) [2019, summary]
- [Design specifications of smart and flexible loading units for demonstrator specifications](#) [2020, summary]

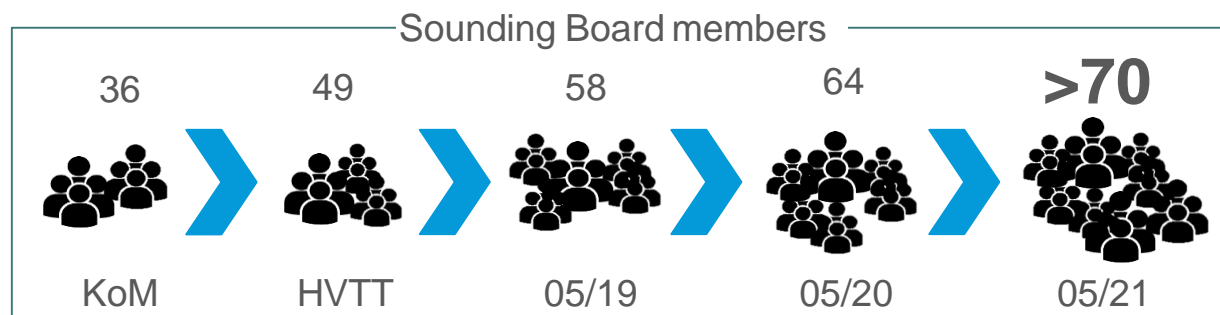
### 5. Innovative Front End Design for more Safety (IFEDS)

- [Safety issues for safety system design](#) [2018, summary]
- [Background and Test Scenarios with inherent targets](#) [2019, summary]
- [Virtual Demonstrator](#) [2019, summary]
- [Predicted benefits and regulatory recommendations](#) [2021, summary]

### 6. Demonstration, validation and analyses of feasibility



- Establishment of a **Sounding Board** to advise and help guide the process of defining the recommendations for implementation of the solutions and measures developed within the AEROFLEX project



- Thank you for your engagement and contribution!

acea

alice | Alliance for Logistics Innovation through Collaboration in Europe

BayWa Baustoffe  
Immer ein gutes Baugeräte

BayWa



Ewals Cargo Care

Gebrüder Weiss  
Transport und Logistik



VOLKSWAGEN  
Konzernlogistik



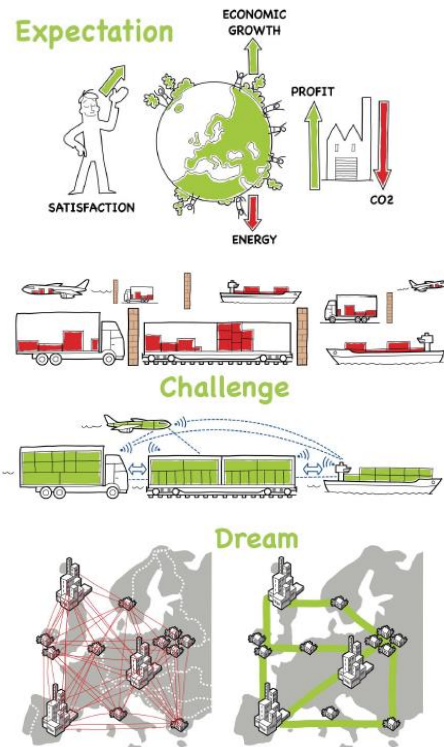
CFL multimodal



# What happened the past years

2010

- Focus on Physical Internet (ALICE Roadmap)



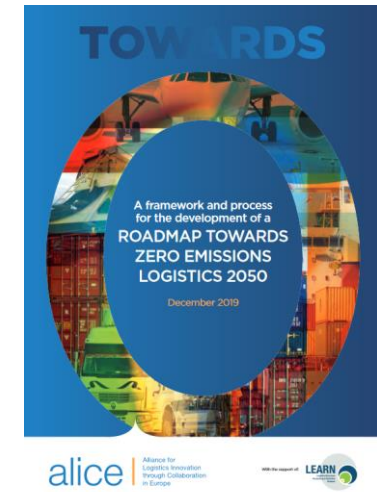
2020

- Green Deal Europe Roadmap 2Zero



- Covid-19, digitalization as “game changer”

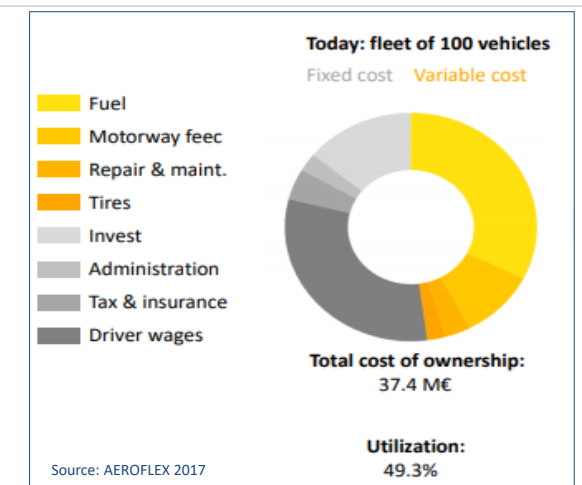
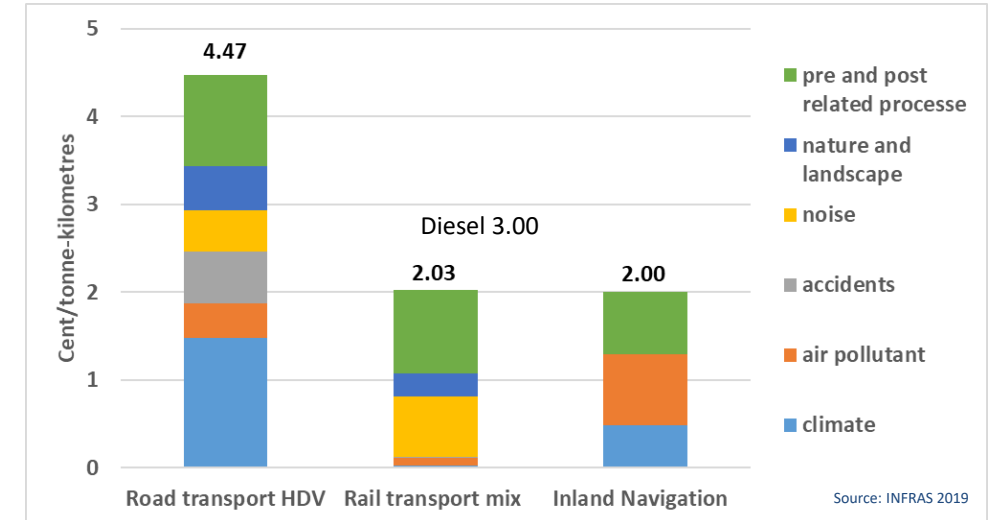
- Focus on Zero emission logistics powered by the physical internet







- Zero emission vehicles
- Automation & digitalization





# Future challenges and focus AEROFLEX

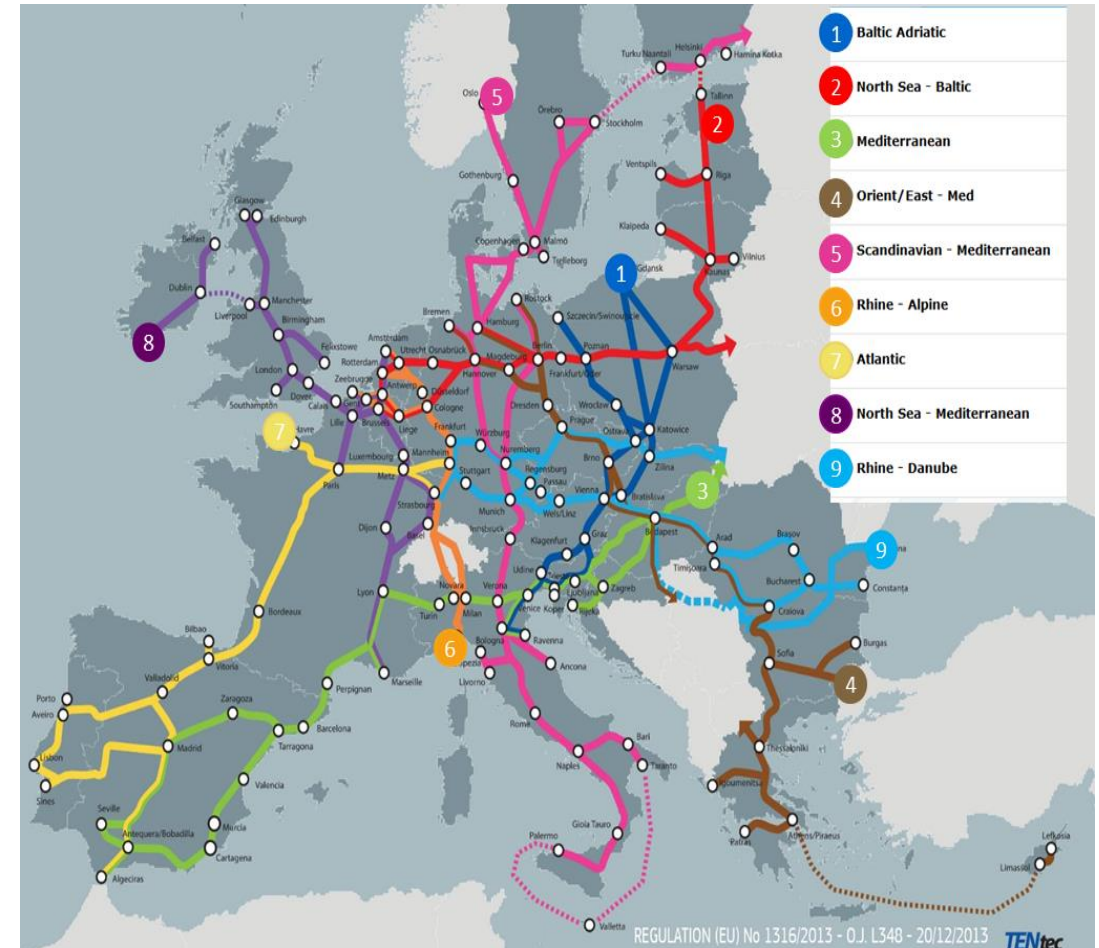
- Transport sector, 25% of the total CO2 emissions in EU
- Transport of freight will increase 45% by 2040.
- The cost for transport.  
Road transport, climate impact and accidents > 50%.  
Pre- and post-related processes up to 1ct/ton-kilometers.
- The TCO of trucks for long haul road transport.  
Driver wages and fuel >66%.  
Utilization <49%
- Focus of AEROFLEX is to reduce  
CO2 emissions, the impact on climate, road accidents,  
TCO and pre & post related processes.



# Focus on multimodal transport

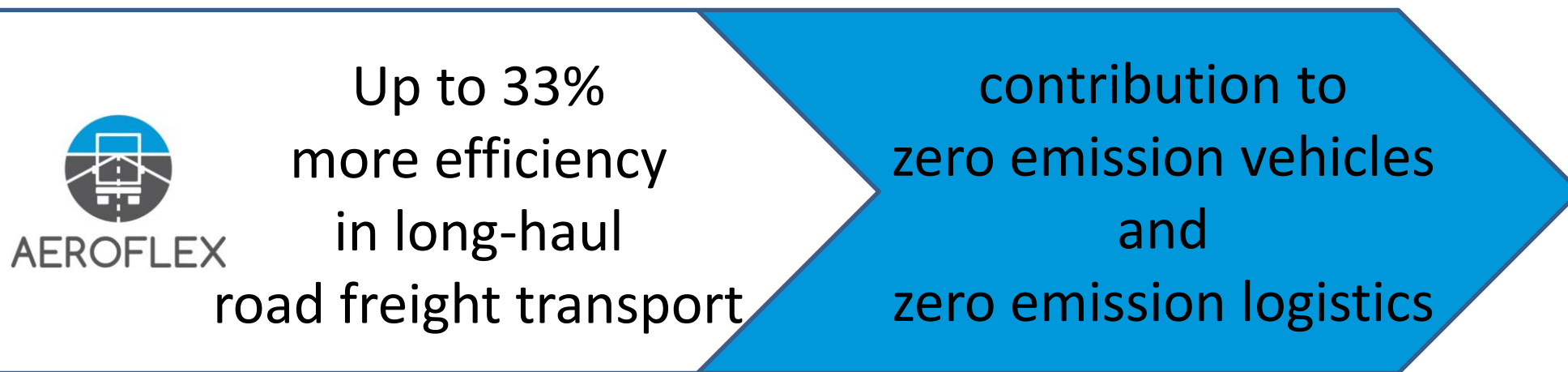
Mode	Time	Probability	Cost (€/tkm)
	-	0	+
	0	0	+
	+	+	0
	++	+	-

-  Time, duration of the journey from A -> B
-  Probability, arrive on time in the right quality
-  Cost, today €/tkm -> in future including external cost
-  More criteria are often needed depending type of commodity





# Our contribution to cope with future challenges



## The impact of AEROFLEX on



### Project goals

All goals reached or came within close reach



### Transport efficiency

New vehicle configurations and innovations significantly increase transport efficiency, up to 50% in specific cases



### 2ZERO

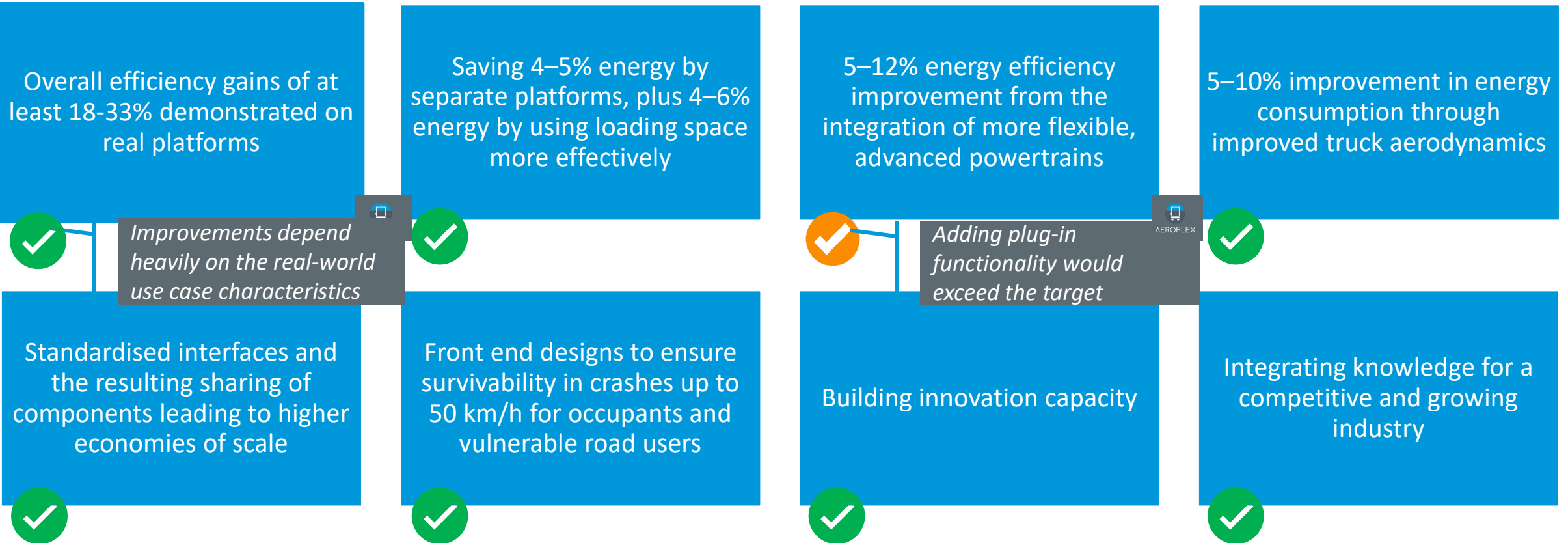
The AEROFLEX innovations pave the way for the transition to ZE logistics and zero casualties



### Societal impact

Improving efficiency and sustainability go hand in hand with the current mega trends: digitalisation and intelligent access

# Did we meet the goals of the project?





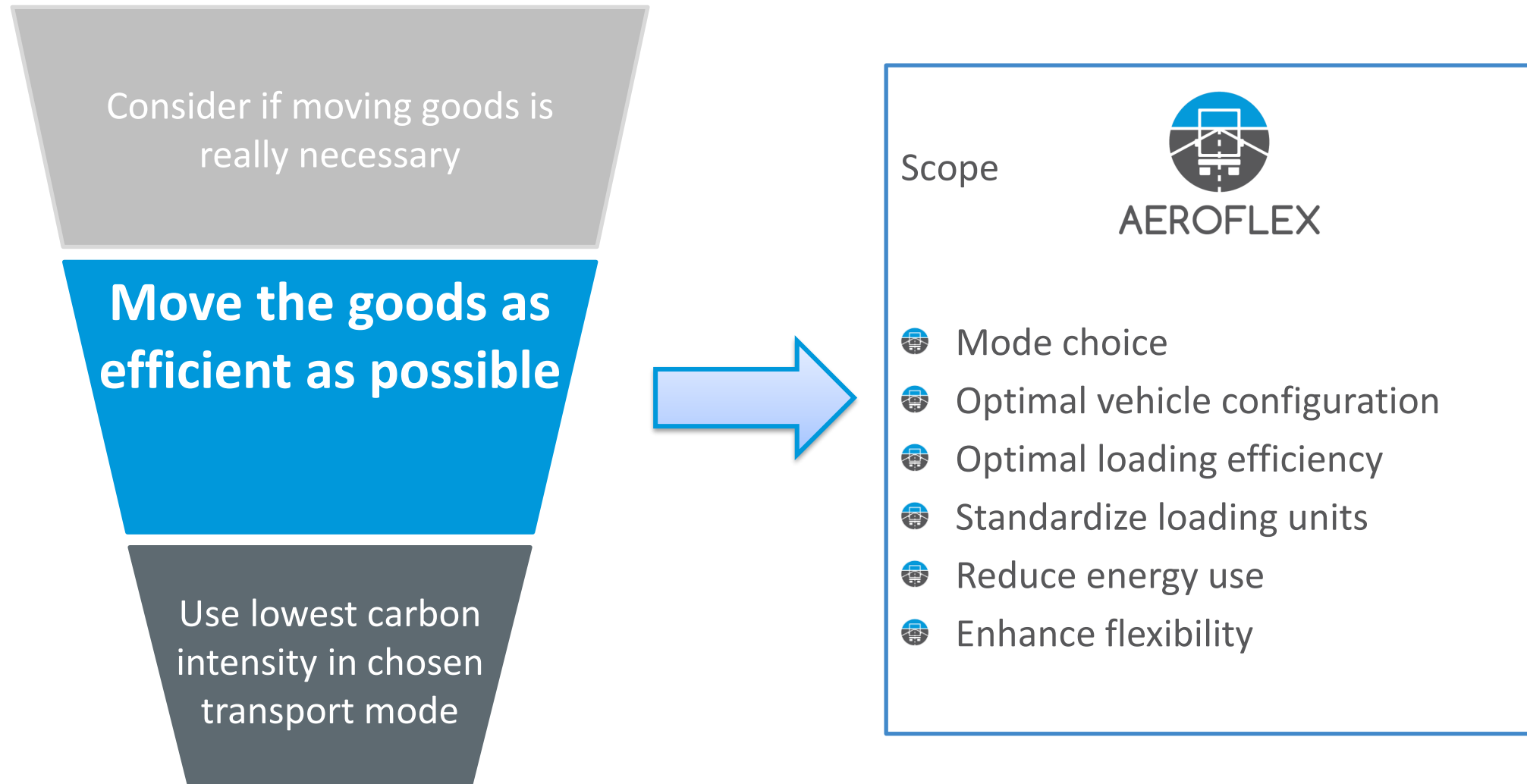


Overview of the results and impact of the project

# THE IMPACT ON TRANSPORT EFFICIENCY

# Ordering efficiency measures

The order of measures in logistics and scope of AEROFLEX



# Contributions to transport efficiency

A layered perspective from engine to economy

$$gCO_2 = \underbrace{\frac{gCO_2}{MJ} \times \frac{MJ}{v.km}}_{\text{CO}_2 \text{ intensity of transport}} \times \underbrace{\frac{v.km}{ton.km} \times \frac{ton.km}{ton} \times \frac{ton}{product} \times \#products}_{\text{transport demand}}$$

Not to worry..., this will be the only formula...

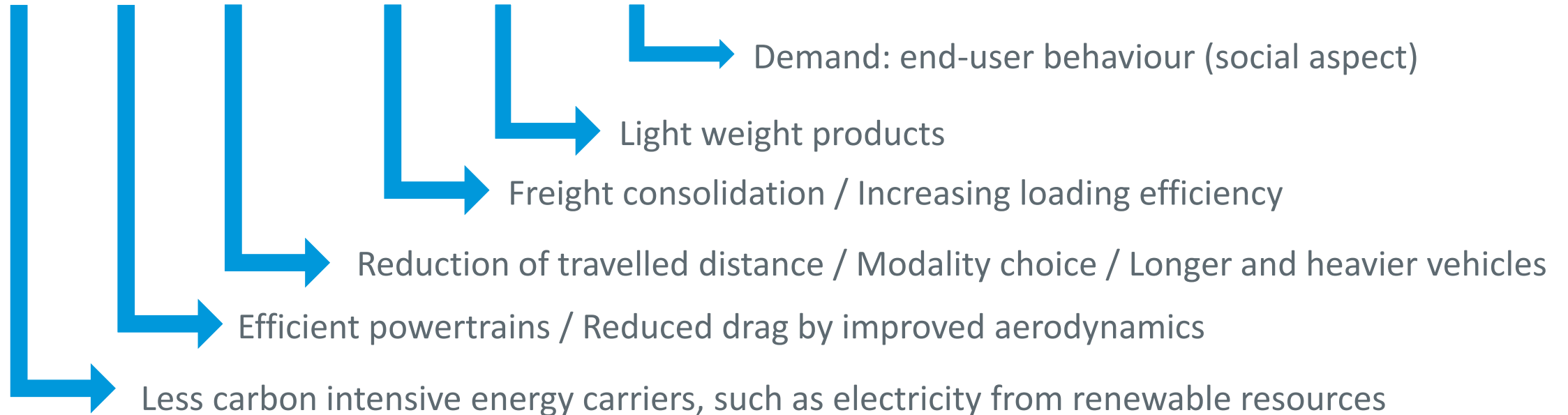


ENERGY  
CARRIER

VEHICLE

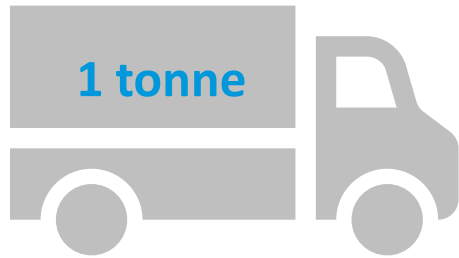
SUPPLY CHAIN

PRODUCTION SYSTEM





## Intermezzo: Why looking at t-km (or tonne-km)?



***“The tonne-kilometre (t-km):  
transporting 1 tonne over a  
distance of 1 kilometre”***



The vehicle is heavier, so the fuel consumption in litre per kilometre (l/km) increases, say from 1 l/km to 1.5 l/km = +50%

However: one vehicle does the work of two vehicles.

So: the fuel used per transported tonne decreases, say from 1 l/t-km to  $1.5 / 2 = 0.75$  l/t-km = -25%

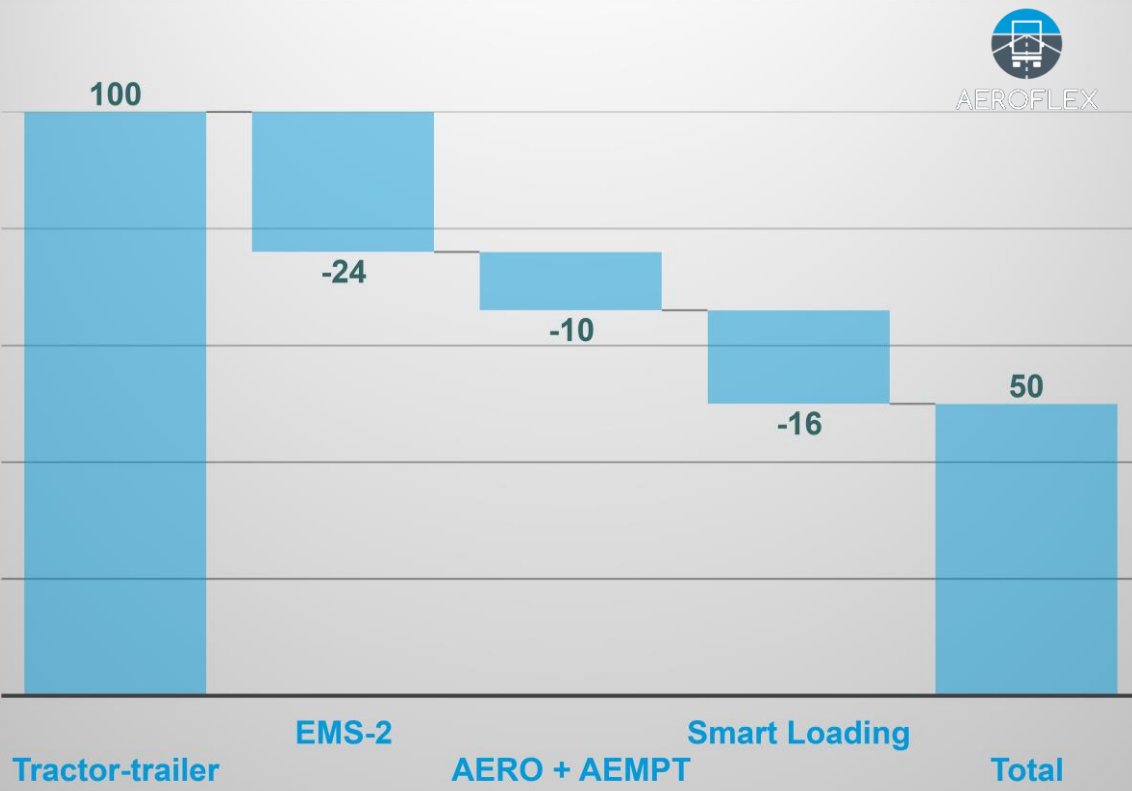
**That is why we look at both fuel consumption in l/km AND l/t-km**

# Two examples of the impact on Transport Efficiency

Up to 50% savings on tonne-kilometre basis compared to baseline tractor-semitrailer

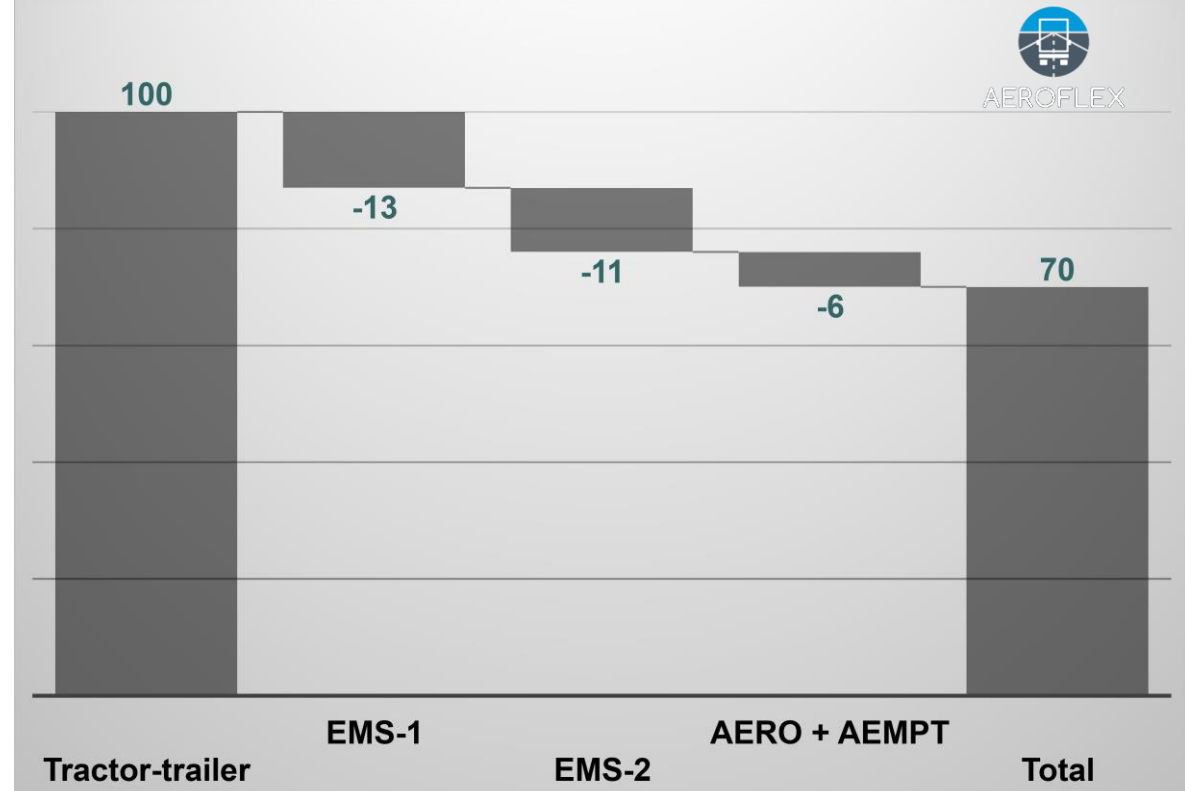
## Transport efficiency on t-km basis

Example customer use-case 1



## Transport efficiency on t-km basis

Example customer use-case 2



# Mass, Volume or Floor Space Limited?

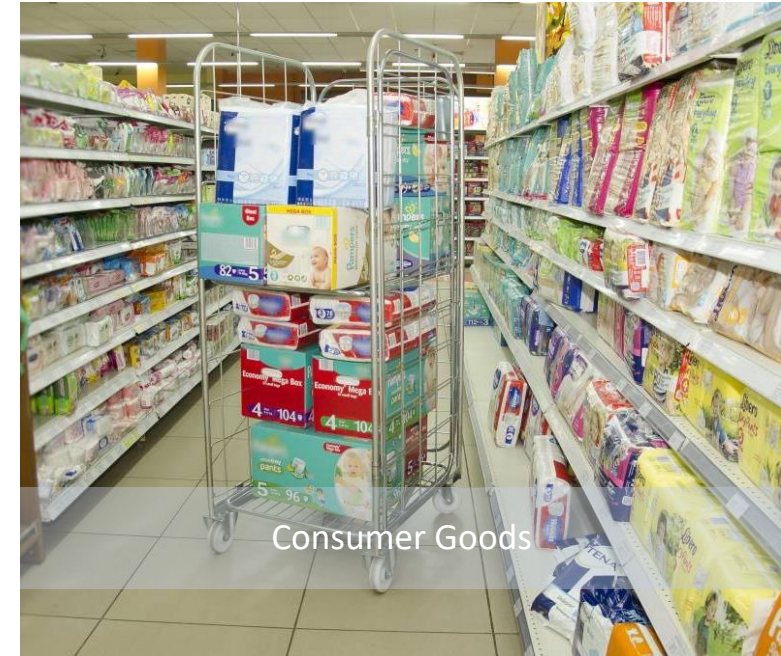
Goods categories and characteristics determine the potential



Containers



Tyres



Consumer Goods

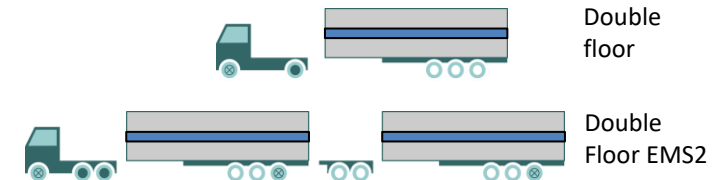
Mass limited



Volume limited



Floor space limited










# An example: Mass and Volume limited transport operations in real-world AEROFLEX usecase 19







## Real-world AEROFLEX usecase 19 (UC19)



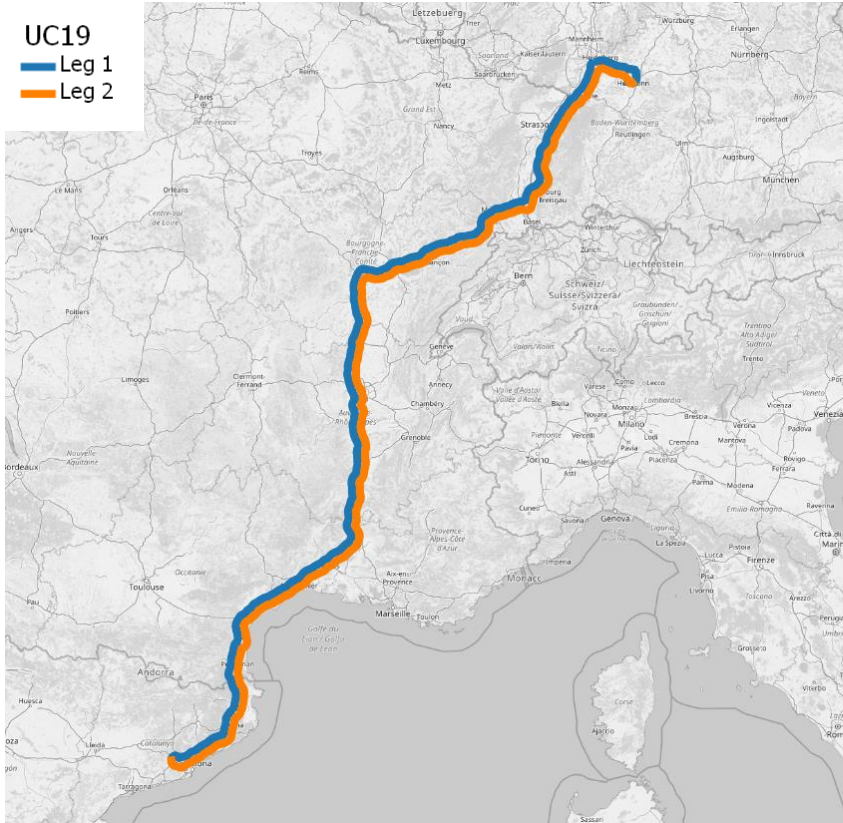
Name	Origin-Destination (modality)	NST Goods categorie	Total distance (# of legs)	Total elevation change	SLU innovations	Current Prime Candidate	Desired future Prime Candidates
UC19	Germany – Spain (road)	12: Transport equipment	1300 km (2)	8000 m	4. Shift to train	480hp  Mega	580hp  Mega  Mega
							650hp  Mega  Mega

# Micro-modelling the complete end-to-end line-hauls

## Real-world AEROFLEX usecase 19 – automotive parts

Name	Origin-Destination (modality)	NST Goods categorie	Total distance (# of legs)	Total elevation change	SLU innovations	Current Prime Candidate	Desired future Prime Candidates
UC19	Germany – Spain (road)	12: Transport equipment	1300 km (2)	8000 m	4. Shift to train	480hp  Mega	580hp  Mega  Mega  Mega 650hp  Mega  Mega

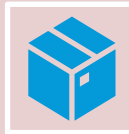
UC19  
— Leg 1  
— Leg 2



### Model inputs



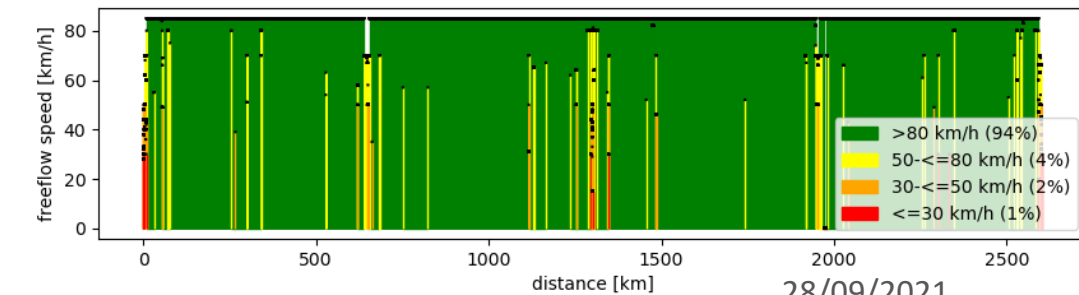
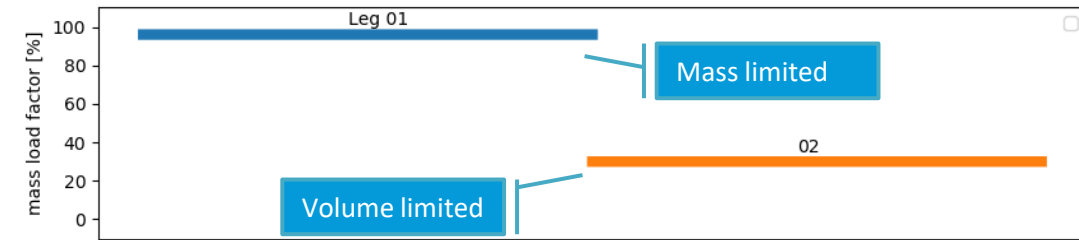
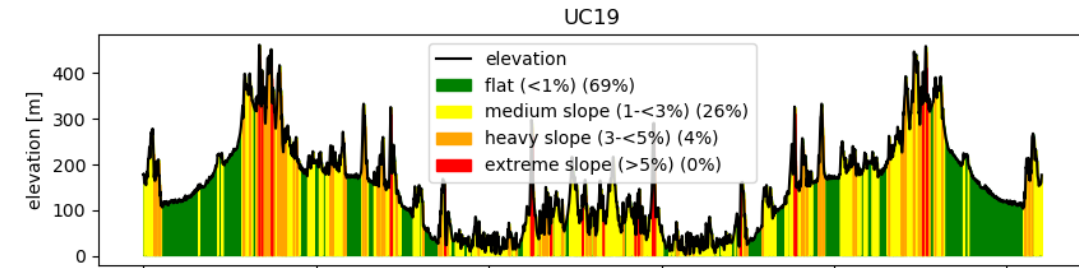
Terrain and geo-information



Payload characteristics



Speed profiles



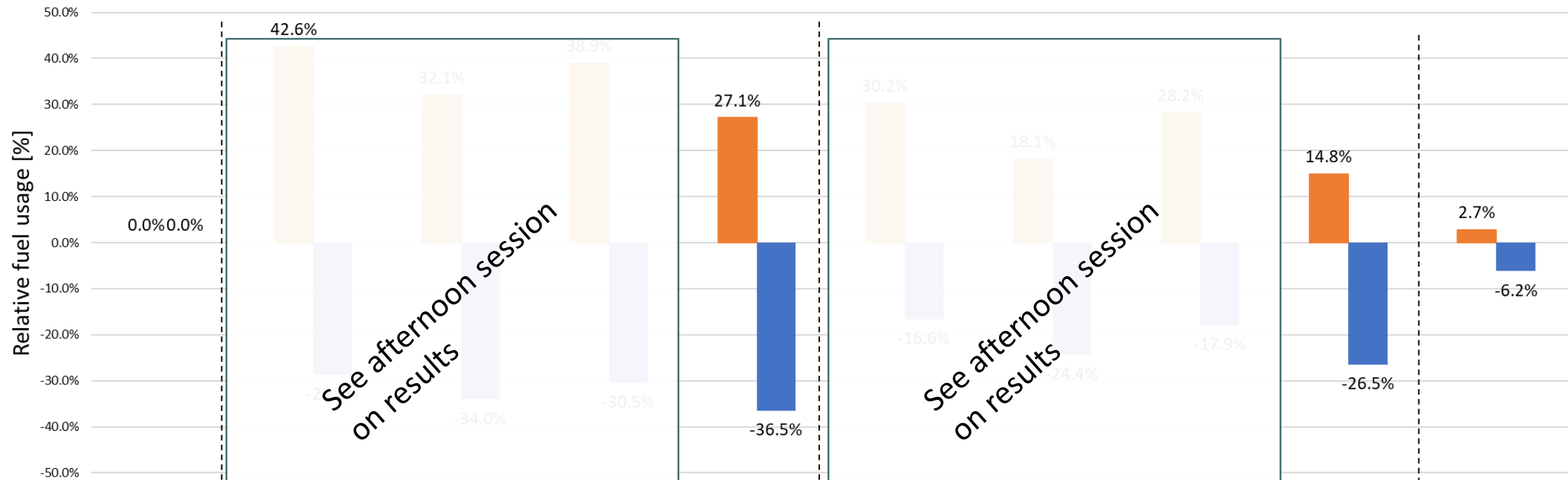


# Quantitative results of AEROFLEX Technical Assessment

## Volume limited usecase 19 leg 02 (backward haul)



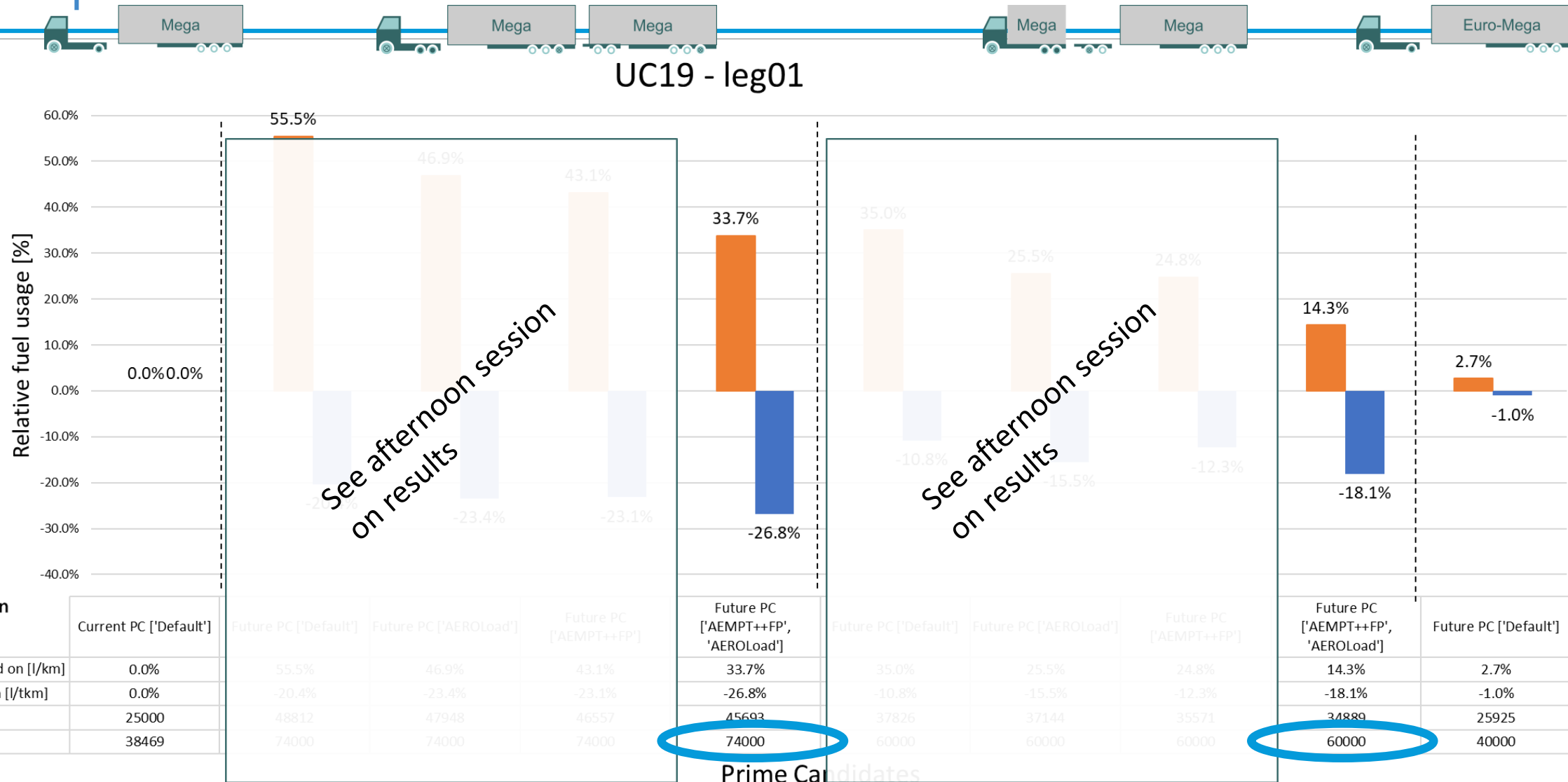
UC19 - leg02



Rel. Fuel consumption based on [l/km]	0.0%
Rel. Fuel efficiency based on [l/tkm]	0.0%
Payload [kg]	7020
GCW [kg]	20489

# Mass limited: potential for significantly better transport efficiency

## Potential limited by max gross combination weights (GCW)









# Another example - AEROFLEX usecase 99





The potential of efficient loading of low-weight goods in real-world AEROFLEX usecase 99

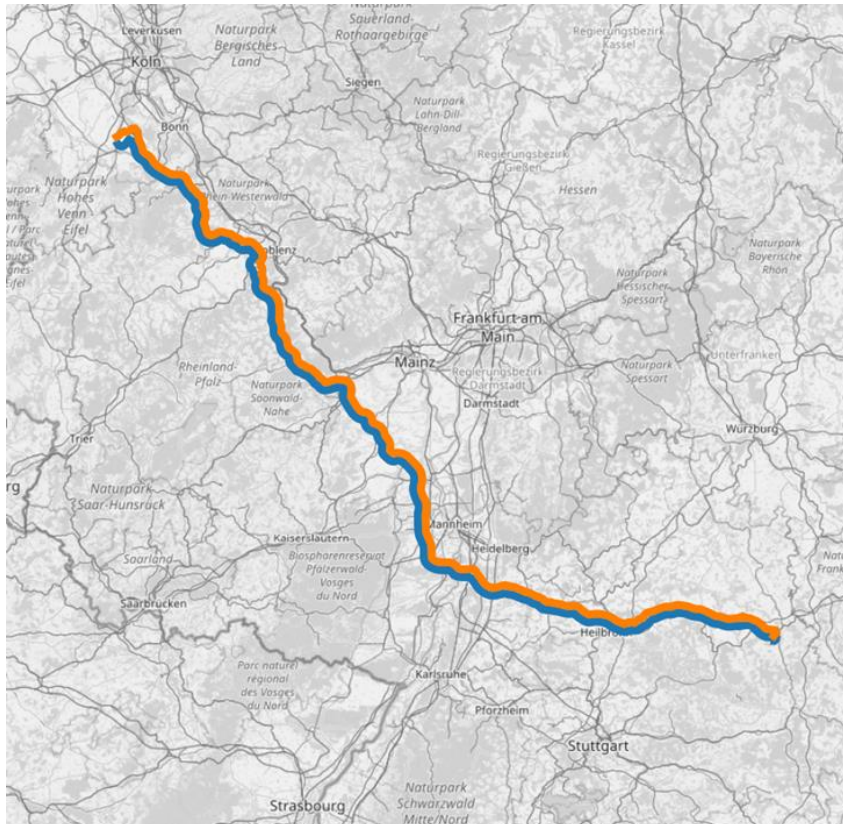
## Real-world AEROFLEX usecase 99 (UC99)



Name	Origin-Destination (modality)	NST Goods categorie	Total distance (# of legs)	Total elevation change	SLU innovations	Current Prime Candidate	Desired future Prime Candidates
UC99	Germany (road)	18: Grouped goods: a mixture of types of goods which are transported together	720 km (2)	5900 m	2. Heavy and light weight palletized goods	480hp 	650hp   

# UC99 properties – a.k.a the best-case AEROFLEX usecase with the highest transport efficiency potential

Name	Origin-Destination (modality)	NST Goods categorie	Total distance (# of legs)	Total elevation change	SLU innovations	Current Prime Candidate	Desired future Prime Candidates
UC99	Germany (road)	18: Grouped goods: a mixture of types of goods which are transported together	720 km (2)	5900 m	2. Heavy and light weight palletized goods	480hp 	650hp   



## Model inputs



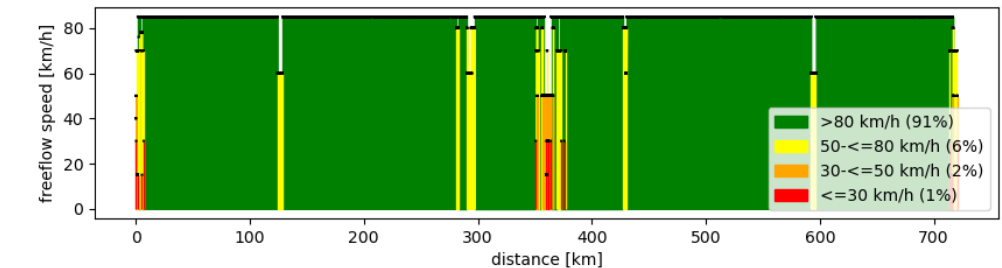
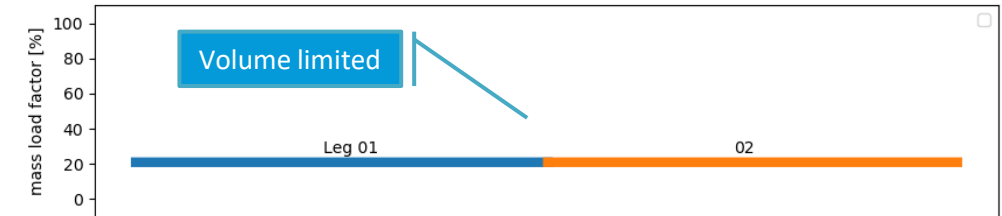
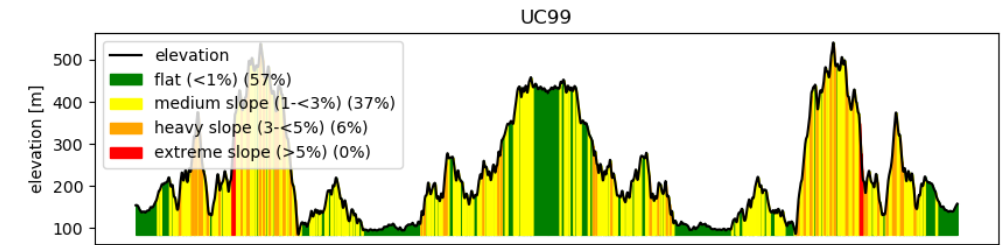
Terrain and geo-information



Payload characteristics



Speed profiles



# Quantative results AEROFLEX Technical Assessment

## Example (UC99 shipment 1) – Floor Space limited





# Unique assessment framework, calculating energy efficiency for nearly all possible European long-haul routes

- One of the results of the project: an assessment framework for the impact on:
  - Energy efficiency
  - Transport efficiency
  - CO2 emissions
  - Cost-benefit
- For every logistic use case using road transport
- Usable as a basis for assessment of the impact of Zero Emission logistics
- See afternoon session for more results





Overview of the results and impact of the project

# THE IMPACT ON ZERO EMISSION LOGISTICS



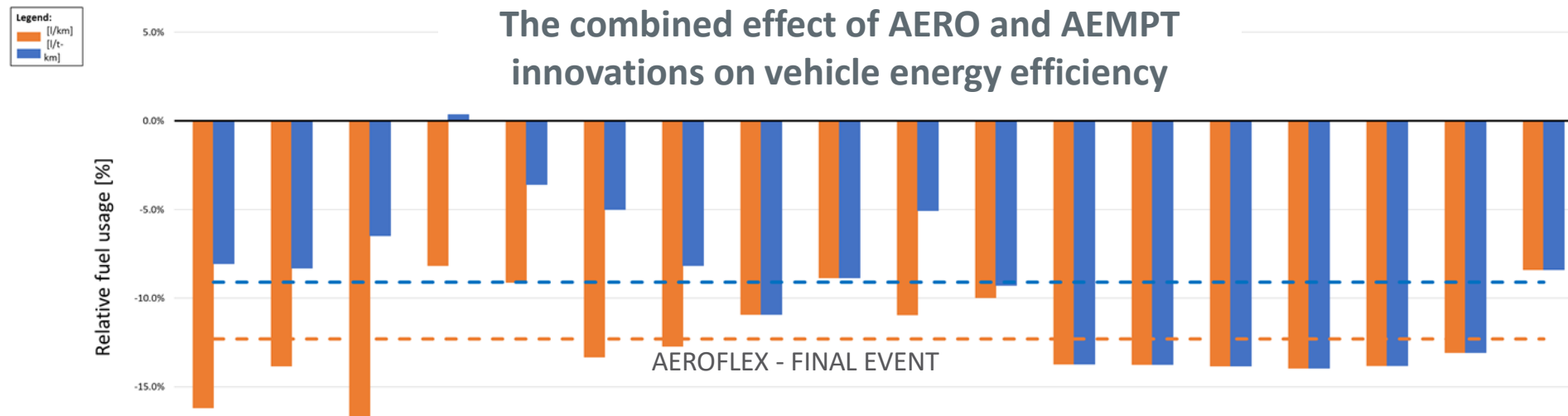
# Zero Emission trucks require the highest vehicle energy efficiency by using the AEROFLEX innovations



A higher energy efficiency increases the feasibility of Zero Emission trucks



The AEROFLEX AERO and AEMPT innovations increase the energy efficiency by 5 – 15%



Overview of the results and impact of the project

# THE IMPACT ON SOCIETY



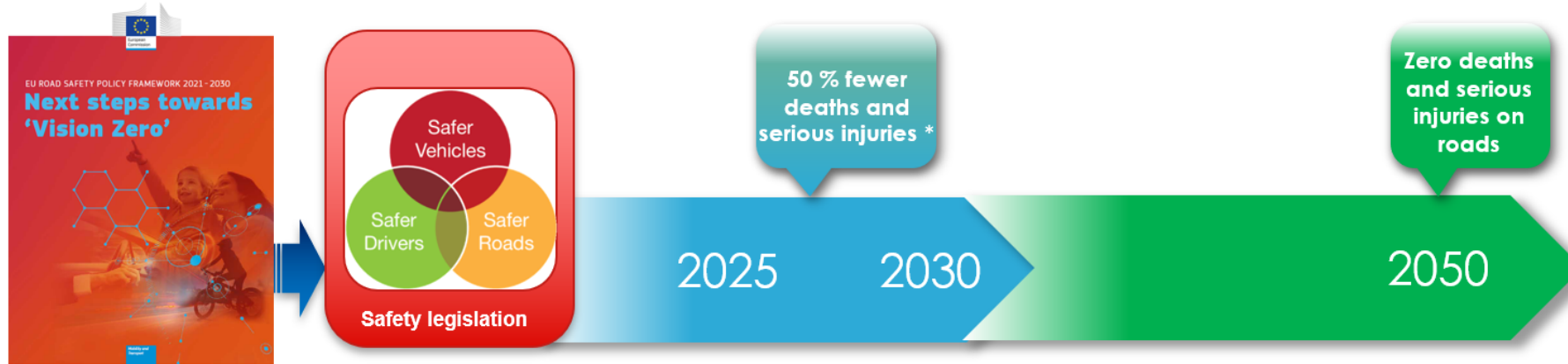
# The role of the truck driver

- Today's shortage on truck drivers in the EU: more than 400.000\*
- More efficient transport reduces the need for truck drivers
- EMS2 vehicles reduce the need for truck drivers almost by a factor of 2
- Technology can help to increase what a truck driver wants to do best: driving
  - E.g. by automation of cargo handling at distribution centres
  - E.g. by automation of vehicle manoeuvring, especially with longer vehicles

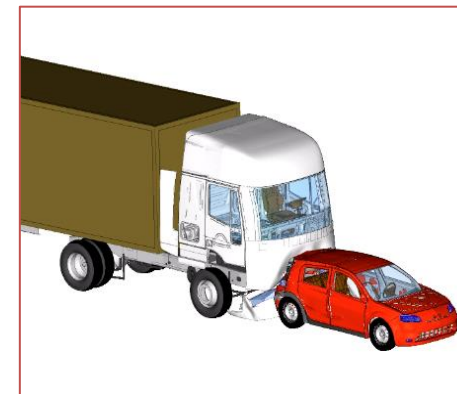




# AEROFLEX contributes to the EU safety roadmap towards the “Vision Zero” by 2050



- Implementing active and passive safety measures
- Supporting the creation of consumer programs to encourage the adoption of the safety measures
- Inspiring the creation/amendment of regulations



# Digitalization & Intelligent Access

## Data sharing

EU member states :  
granted access of longer or heavier  
to the road network only if data is  
shared between transport operator  
and government

## Make technologies digital

AEROFLEX innovations are primarily  
aimed to improve efficiency and  
sustainability, and these will go hand  
in hand with that other megatrend:  
digitalisation

## Digital access to infrastructure

AEROFLEX (re)ignited interest in  
Intelligent Access Policies (IAP)  
across Europe – using data to ensure  
the right truck with the right cargo at  
the right time on the right road

## Harmonization of Access

AEROFLEX moved the discussion  
forward on IAP and brought it into  
context with UVAR (Urban Vehicle  
Access Regulations)



### THE INTELLIGENT ACCESS POLICIES

2030



#### Ensure Equitable Access of Vehicles to the Infrastructure by Digitalization

*"These vehicles must be part of the solution"*

#### Safe and efficient transportation of freight

...d back early in the 2020ies, AEROFLEX  
ed its goal: ensuring the right truck with the  
cargo at the right time on the right road, by  
How? Through actively starting the  
pment of Intelligent Access Policies and  
ucing it step-by-step throughout Europe.

European consortium AEROFLEX developed high  
ty vehicle technologies and innovations to  
ve transport efficiency up to 33%. The energy  
ings were huge and an absolute necessity in order to  
make the essential steps towards zero emissions in

2050. However, at the time these efficient vehicles were  
not allowed on the EU roads (except for in a few  
Scandinavian and Spanish regions). Getting these  
vehicles on the roads was of the greatest importance and  
as one transporter put it at the time:

*"We are letting ourselves and future generations  
down if we do not use all possibilities, we have to  
cut emissions."*



Image credit: AEROFLEX Idiada

Overview of the results and impact of the project

## KEY MESSAGE

*“High capacity transport in combination with the AEROFLEX innovations can significantly reduce vehicle kms and increase transport efficiency and are therefore an essential building block for zero emission logistics”*

# Advanced Energy Management Powertrain

## Industry



Julius Engasser  
MAN Truck and Bus SE, development engineer  
project manager AEMPT AEROFLEX



## Research



Henning Wittig  
Fraunhofer IVI, research associate,  
development Smart Powered Dolly AEROFLEX







## Service and validation



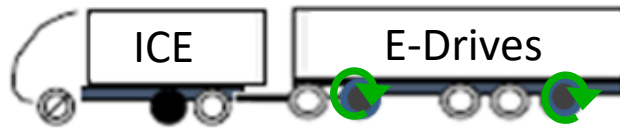
## Develop a distributed powertrain system for EMS vehicles



### Subtasks

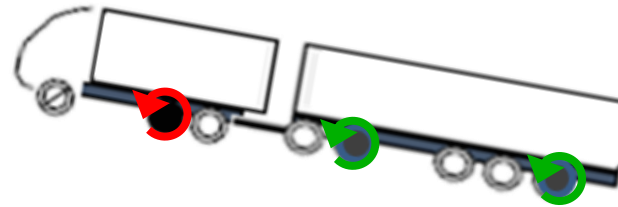
-  Develop a control system for such a drivetrain
-  Find a suitable energy management strategy
-  Develop a suitable communication protocol
-  Build a Demonstrator

## Save fuel in a hybrid configuration



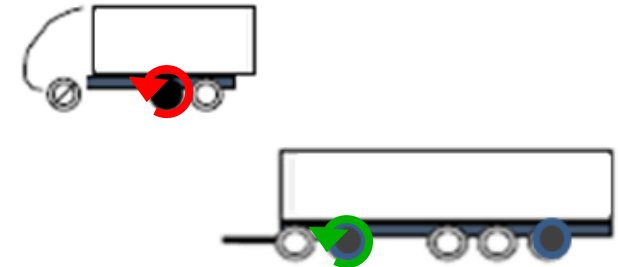
- Recuperation of brake energy
- More efficient operating point of the combustion engine
- Possibility of a plug-in function

## Increase Traction and Performance



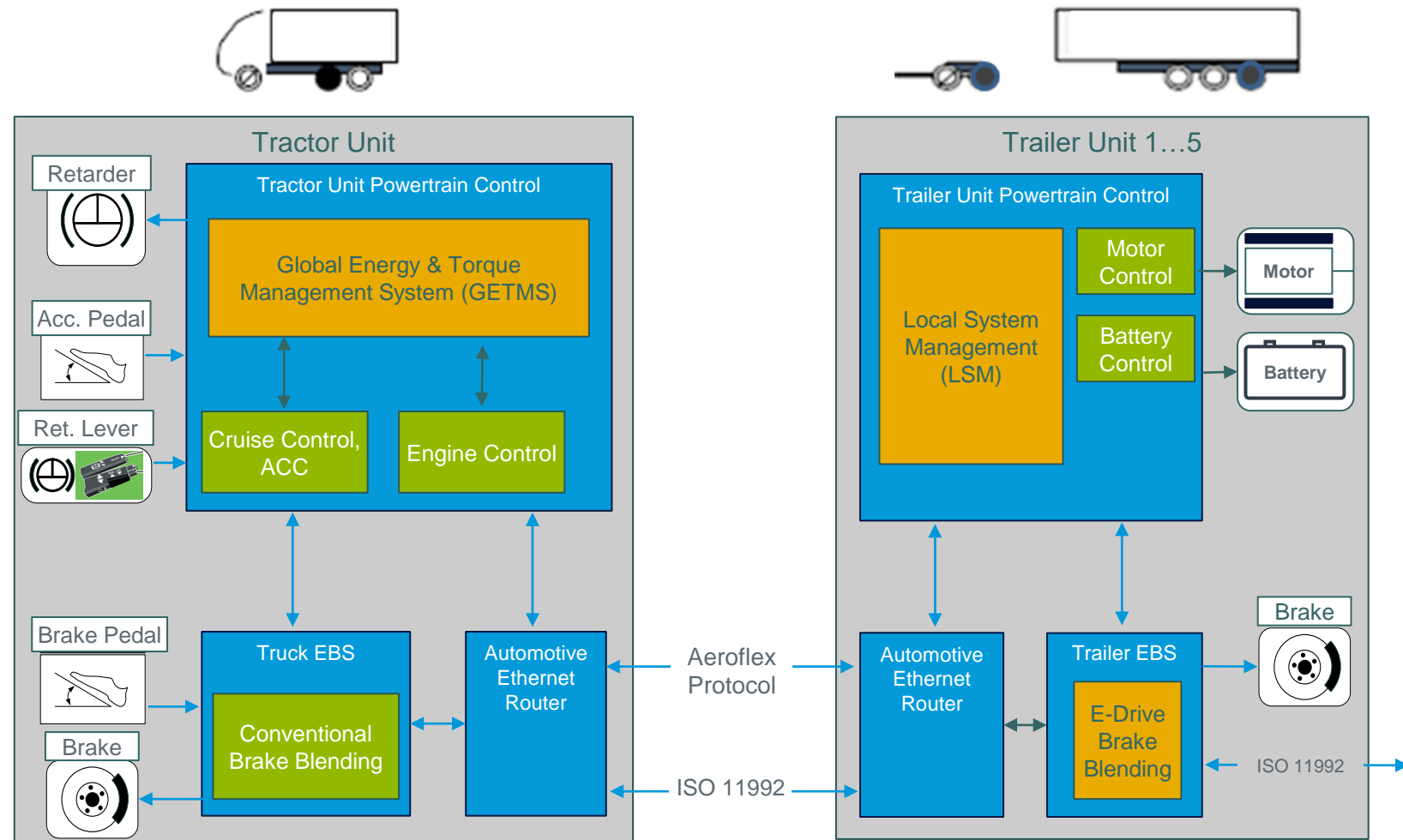
- Overcome traction problems of EMS vehicles. Comply with 25% rule
- Increase acceleration performance

## Allow maneuvering of sub-units


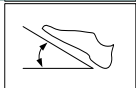
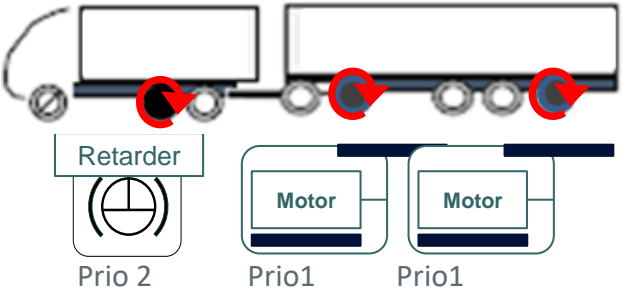
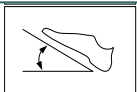
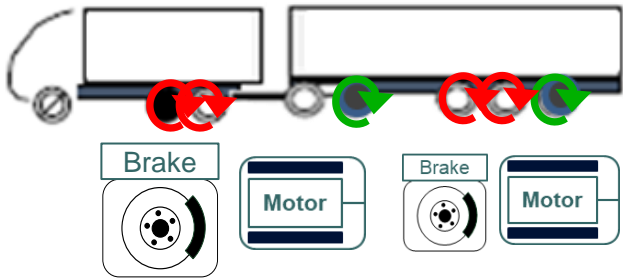
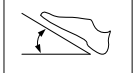
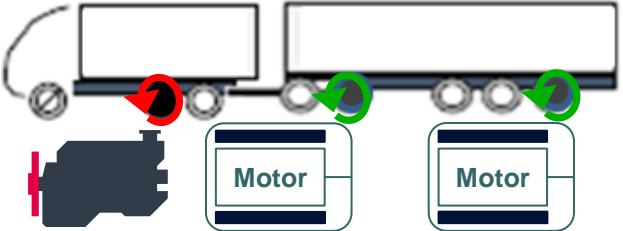


- An e-dolly allows maneuvering of trailers on yards. By remote control or by automation

- Global Energy and Torque Management system**  
 E-drives are fully integrated into the truck's control system. More efficient than decentralized system.
- Extended Communication with Automotive Ethernet**  
 Higher data rate than CAN; No safety concerns as with a additional wireless connection.
- No high voltage connection between vehicle units:** A high voltage connection does not bring efficiency gains but high technical effort



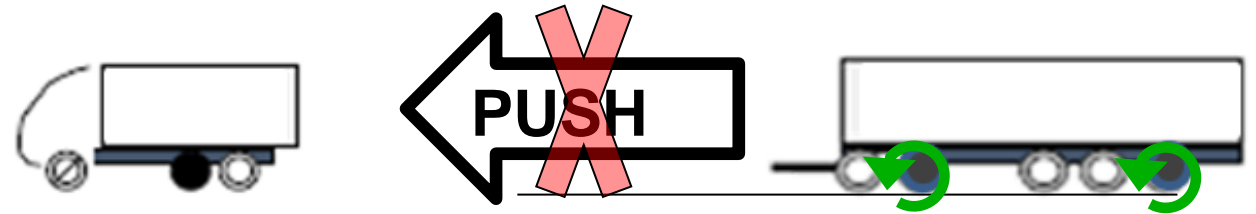
# Core Fuel Saving Functions

Function	Request	Actuation
<b>Endurance Brake Blending</b> Endurance brake requests are directed from the truck to the e-drives.	<div>Ret. Lever</div>  <div>or</div> <div>Cruise Control</div> <div>Brake Pedal</div>  <div>+</div> <div>Conventional Brake Blending (MAN Brakematic)</div>	
<b>Service Brake Blending</b> Service brake requests in dolly/trailer are directed to the e-drive. Dolly: Blending of both axles.	<div>Brake Pedal</div> 	
<b>Load Point Shifting</b> The e-drives shift the operating point of the combustion engine into a more efficient region	<div>Acc. Pedal</div>  <div>or</div> <div>Cruise Control</div>	

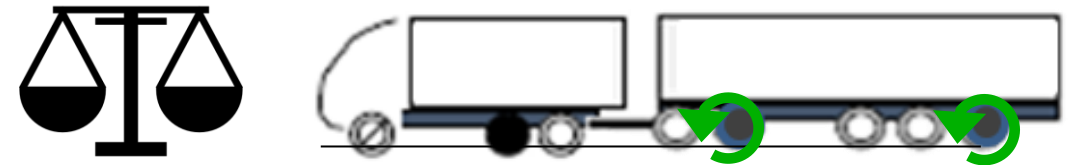


# Torque Management Principles

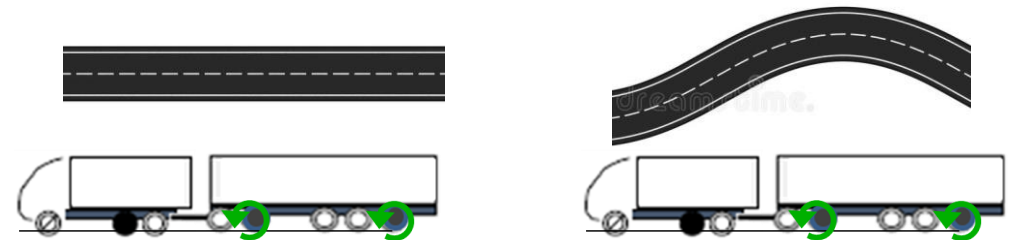
- No pushing of the tractor



- Even distribution of torques as far as possible



- Limitation of e-torques depending on lateral dynamics



# Demonstrator

Communication:  
Automotive Ethernet, new Protocol for  
Energy/Torque Management; no new connectors

eTrailer: Schmitz-Cargobull  
from EU-Project "Transformers"



Hydraulically Steered  
Dolly front axle Axle

MAN 6x2 TGX580;  
Energy and Torque Management; Full integration  
of e-Drives into the truck control system.

eDolly:  
Axle: ZF AVE130, 250kW;  
Battery: AKASOL 75kWh

eTrailer:  
Axle: Bosch 80kW  
Battery: Bosch 22KWh

# Proof of Concept in Real Road Tests

- 🚛 The Demonstrator was run 5000km on a Spanish Highway.
- 🚛 No technical problem interrupted the measurement program
- 🚛 A fuel saving of 3,5% in average could be measured
- 🚛 If prototype restrictions were eliminated savings would be raised to 10,1%
- 🚛 Operating the vehicle as plug-in-hybrid does further increase fuel saving up to 13,5% (measured)



## Adaption of the powertrain concept to zero emission

- As the project was started back in 2017, hybrid drivetrains seemed to be an interesting option
- Now in 2021, a clear path to zero emission transport is set. -> Hybrid technology will not take us to the zero-emission goal.
- However, the distributed powertrain concept is also working with BEV or FCEV -combinations



## Obstacles for market success

- Still low market penetration of EMS vehicles
- Still regulative obstacles (national rules, cross border traffic..)
- Alternative paths to CO2-reduction (BEV, H2)
- Alternative path to overcome driver shortage (Automation)



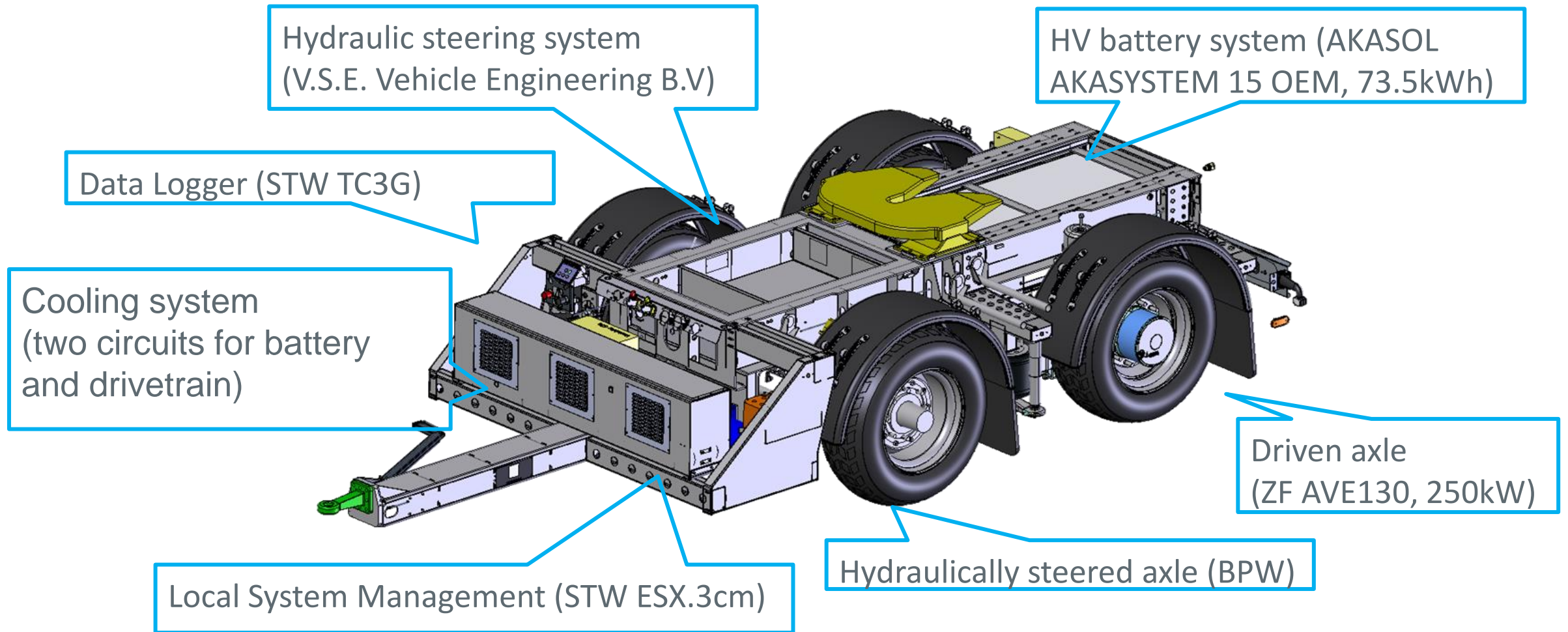
Develop an electrically driven dolly

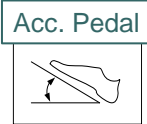




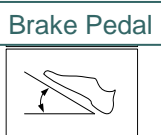







To support the basic ideas of the distributed powertrain

- 🚛 Save fuel in a hybrid EMS vehicle configuration
- 🚛 Increase traction and performance
- 🚛 Enable automated operation of dolly without towing truck for shunting of semitrailers





Function	Request	Actuation
<b>Propulsion support</b> <ul style="list-style-type: none"> <li>Drive requests of the central energy management are realized by the e-drive.</li> </ul>	 or 	
<b>Brake support</b> <ul style="list-style-type: none"> <li>Endurance Brake requests of the central energy management</li> <li>Service Brake requests directed to the e-drive by the EBS (brake blending)</li> </ul>	 or  or  + 	
<b>Manual operation</b> <ul style="list-style-type: none"> <li>E-drive and steering axle can be remote controlled for shunting on yards</li> </ul>		 or 

# Advantages & Opportunities

- Hybrid **distributed** powertrains
  - enables flexible & adaptable EMS1/EMS2 vehicle combinations
  - enables long vehicles driven with standard trucks/tractors with conventional/down-sized engines
  - enables use of battery electric driven trucks in EMS1/EMS2 vehicle combinations
- Automated yard operation with electric powertrain
  - split the vehicle in self driving units
  - safe handling of longer vehicles
  - reduce time for coupling
  - reduce number of tractors & drivers needed for shunting of semitrailers





# Advantages & Opportunities

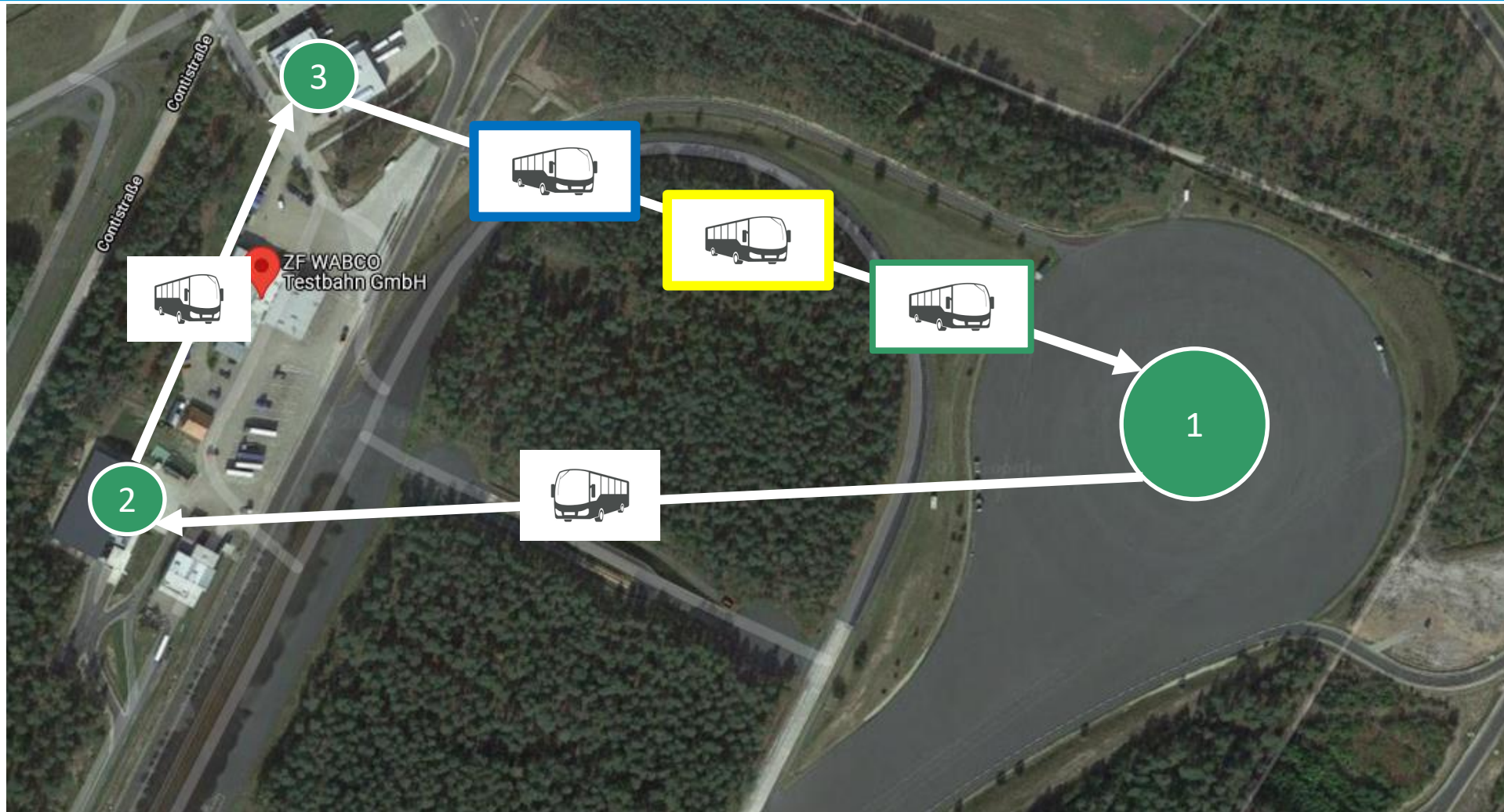
- 🚚 Autonomous driving of the Smart Power Dolly operated by a Control Center Software (e.g., helyOS)
  - 🚚 control and monitor autonomous vehicles worldwide
  - 🚚 know the big picture of the yard → digital real-time twin
  - 🚚 Improve mixed traffic safety
- 🚚 **Focus on yards – instead of public roads**
  - 🚚 Controlled environment
  - 🚚 Lower requirements regarding functional safety
  - 🚚 Quick cost / benefit regarding handling, safety and planning
- 🚚 AEROFLEX Smart Power Dolly equipped with remote control to demonstrate manual operation



# Short introduction live demonstration



**Area 2**  
Dynamic Test  
Field R 110 m





# Thank you



*The research leading to these results has received funding from the European Union*