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To assess the efficiency improvement potential of AEROFLEX innovations in typical European long-haul road operations, building on the reference and demonstrator test results, using realistic simulations and providing input to the impact assessment of the EU freight transport and book of recommendations.

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calculating the energy efficiency for any given vehicle, equipped with any given AEROFLEX innovation or combination of innovations, used in any given transport application.

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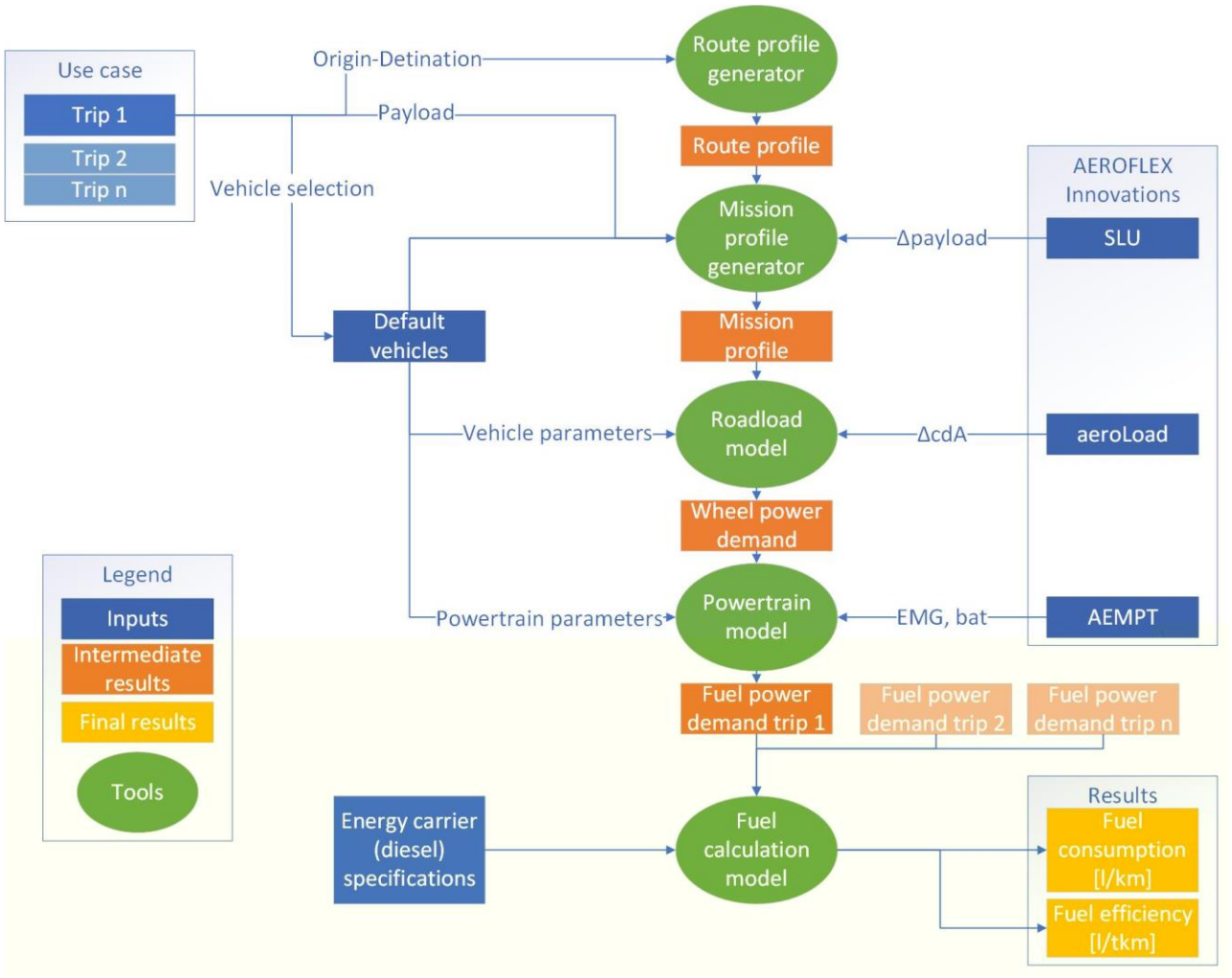

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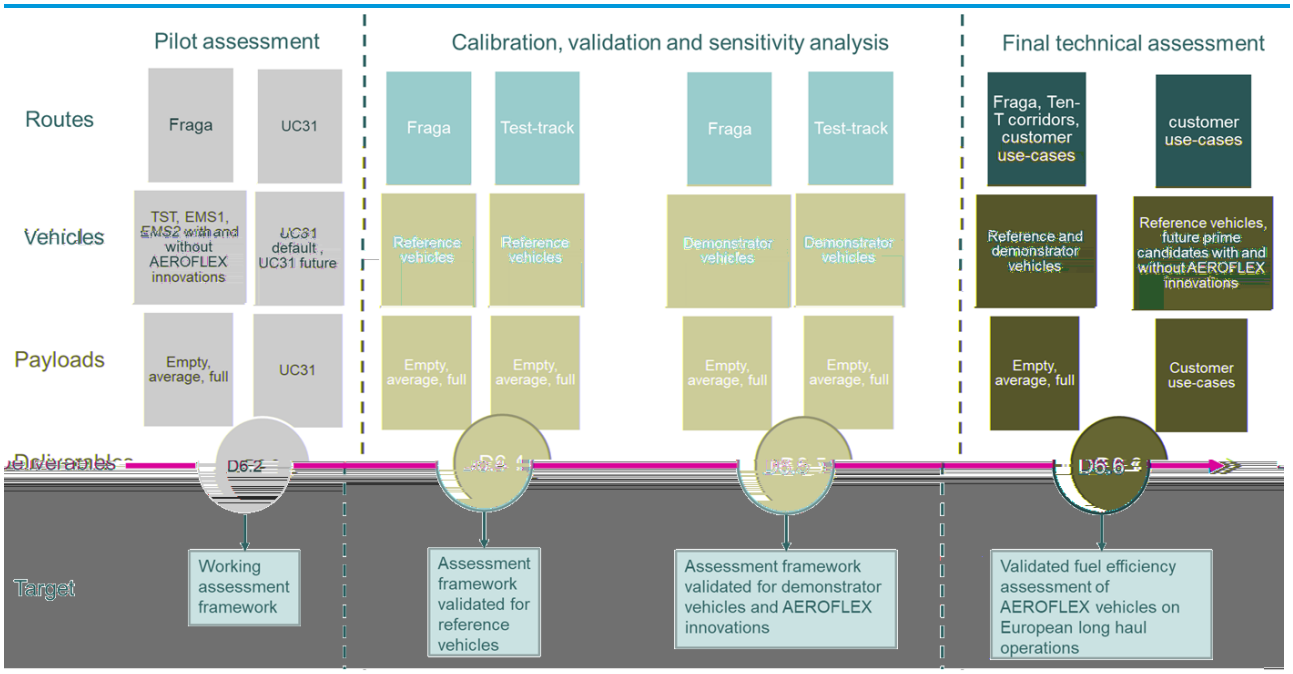
[1] The Fraga-route is a route in the South of Spain that is used by IDIADA for the on-road tests of reference and demonstrator vehicles.

[2] Innovations developed within the project, i.e. Advanced Energy Management Powertrain, Aerodynamic features, Smart Loading Units, Innovative Front-end design (see section 3.2)


Pilot assessment
Calibration, validation and sensitivity analysis
Final technical assessment
Routes
Vehicles
Payloads
Deliverables
Target
Fraga
UC31
Test-track
Fraga, Ten-T corridors, customer use-cases
customer use-cases
TST, EMS1, EMS2 with and without AEROFLEX innovations
UC31 default , UC31 future
Reference vehicles
Demonstrator vehicles
Reference and demonstrator vehicles
Reference vehicles, future prime candidates with and without AEROFLEX innovations
Empty, average, full
Customer use-cases
D6.2
Working assessment framework
Assessment framework validated for reference vehicles
Assessment framework validated for demonstrator vehicles and AEROFLEX innovations
Validated fuel efficiency assessment of AEROFLEX vehicles on European long haul operations

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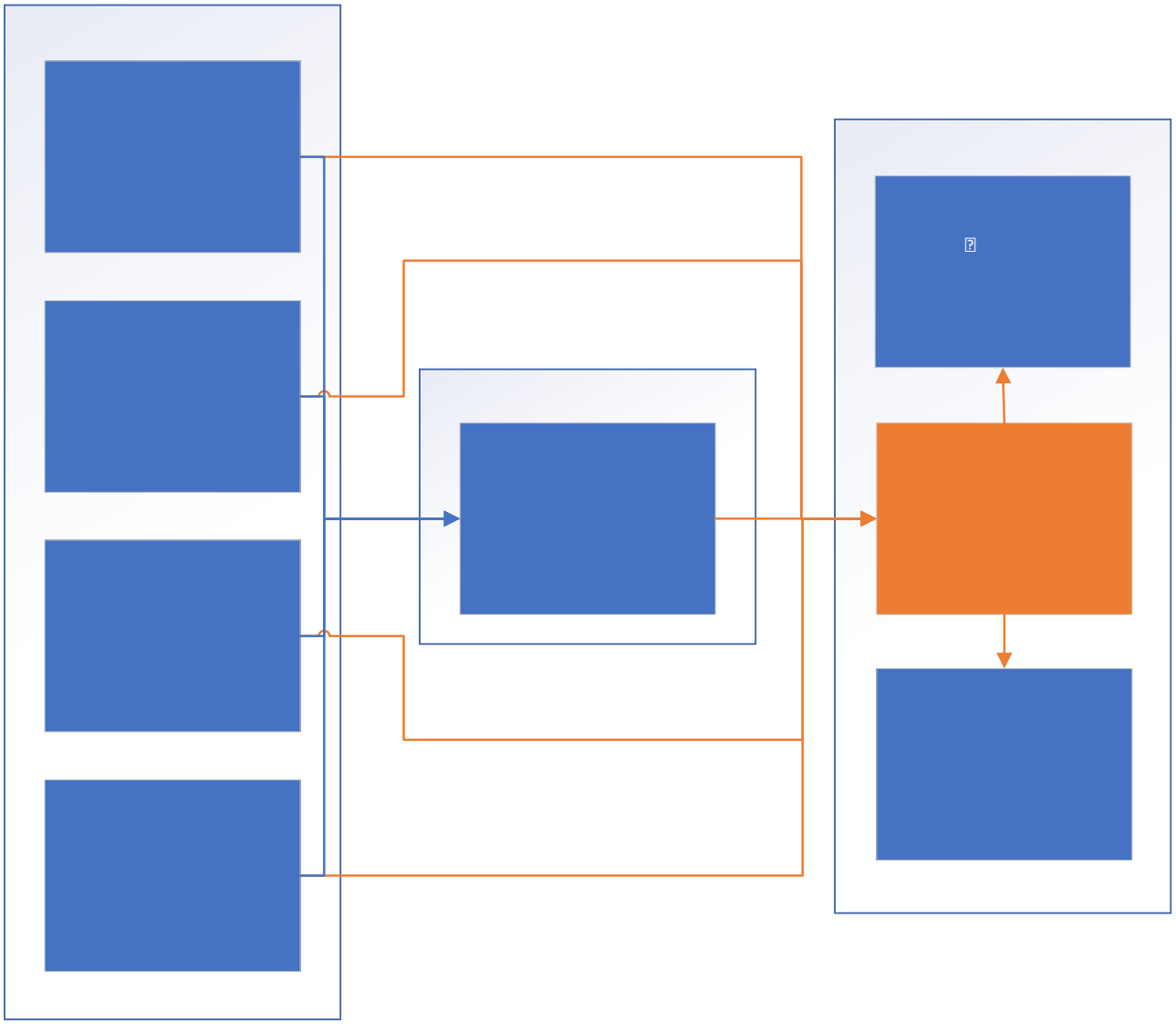

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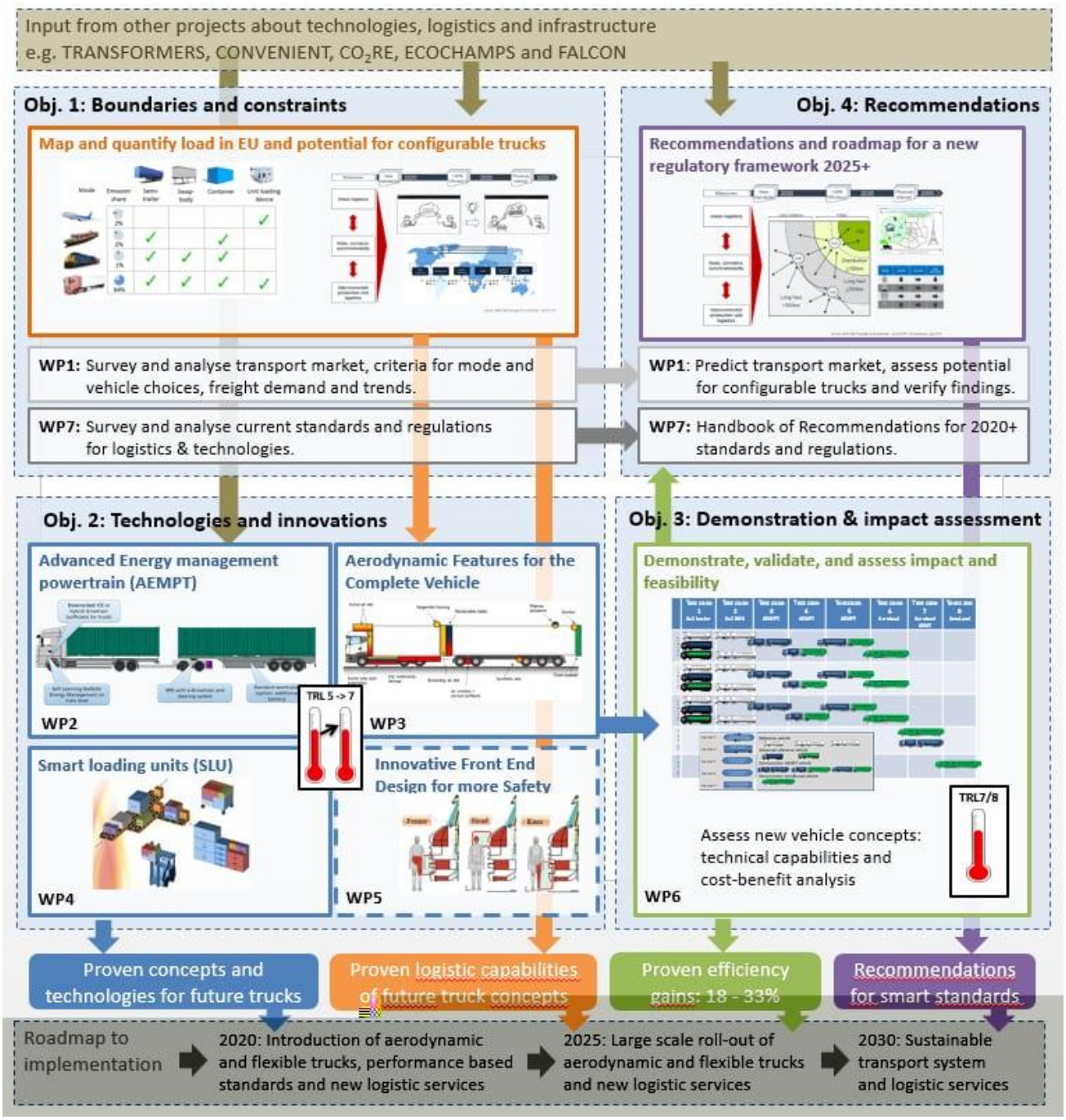
Input from other projects about technologies, logistics and infrastructure
e.g. TRANSFORMERS, CONVENIENT, CO_2RE, ECOCHAMPS and FALCON
Obj. 1: Boundaries and constraints
Map and quantify load in EU and potential for configurable trucks
WP1: Survey and analyse transport market, criteria for mode and vehicle choices, freight demand and trends.
WP7: Survey and analyse current standards and regulations for logistics & technologies.
Obj. 4: Recommendations
Recommendations and roadmap for a new regulatory framework 2025+
WP1: Predict transport market, assess potential for configurable trucks and verify findings.
WP7: Handbook of Recommendations for 2020+ standards and regulations.
Obj. 2: Technologies and innovations
Advanced Energy management powertrain (AEMPT)
WP2
Aerodynamic Features for the Complete Vehicle
TRL 5 -> 7
WP3
Smart loading units (SLU)
WP4
Innovative Front End Design for more Safety
WP5
Obj. 3: Demonstration & impact assessment
Demonstrate, validate, and assess impact and feasibility
TRL7/8
Assess new vehicle concepts: technical capabilities and cost-benefit analysis
WP6
Proven concepts and technologies for future trucks
Proven logistic capabilities of future truck concepts
Proven efficiency gains: 18 - 33%
Recommendations for smart standards
Roadmap to implementation
2020: Introduction of aerodynamic and flexible trucks, performance based standards and new logistic services
2025: Large scale roll-out of aerodynamic and flexible trucks and new logistic services
2030: Sustainable transport system and logistic services

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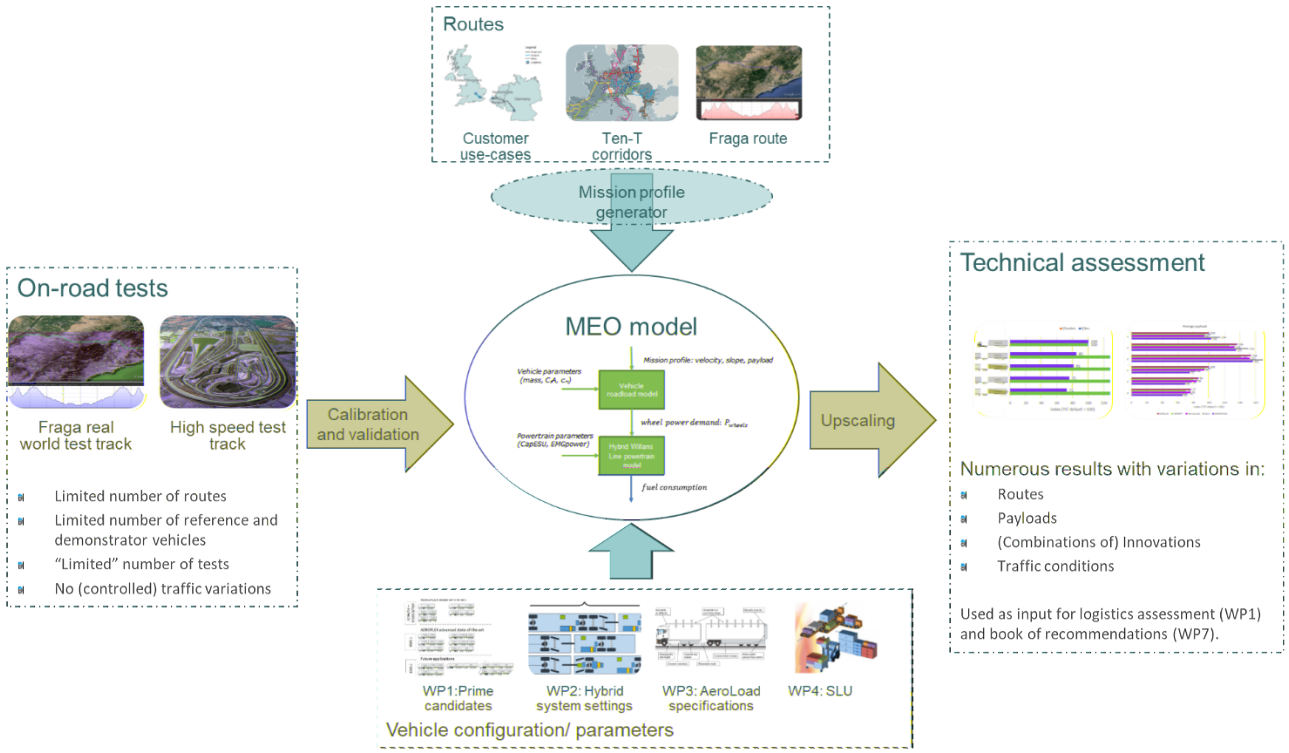

To assess the efficiency improvement potential of AEROFLEX innovations in typical European long-haul road operations, building on the reference and demonstrator test results, using realistic simulations and providing input to the impact assessment of the EU freight transport and book of recommendations.

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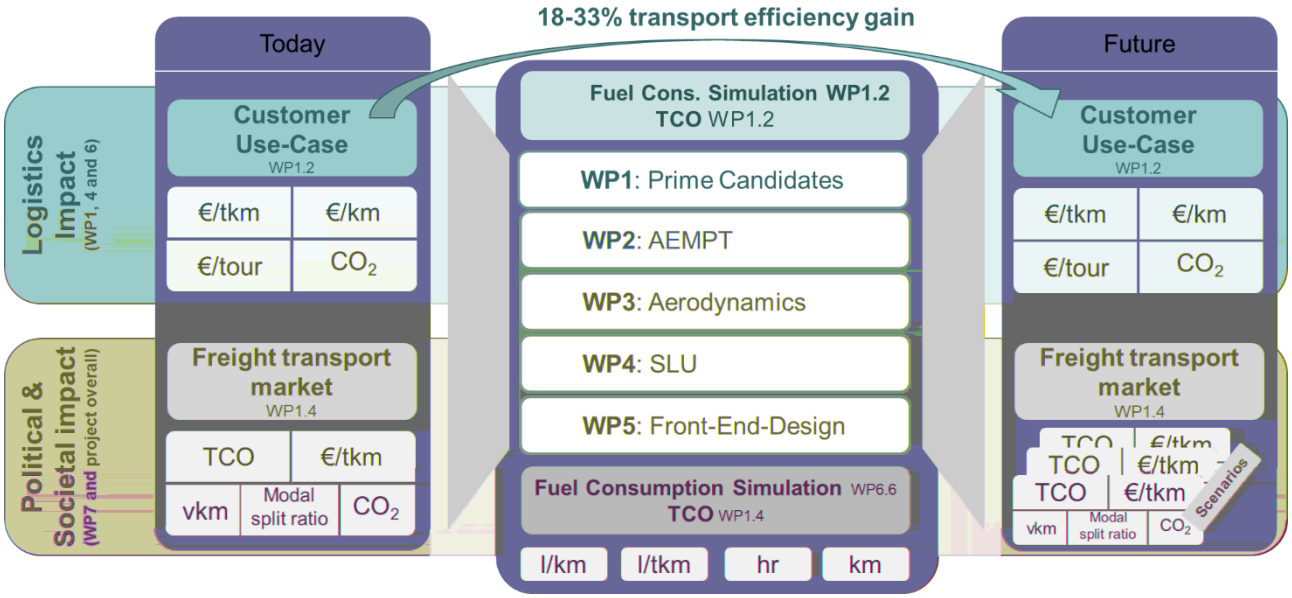

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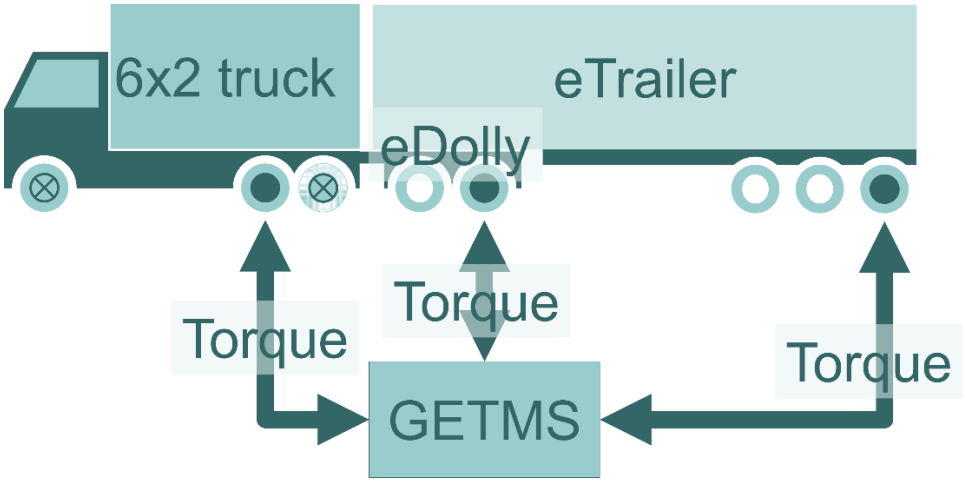

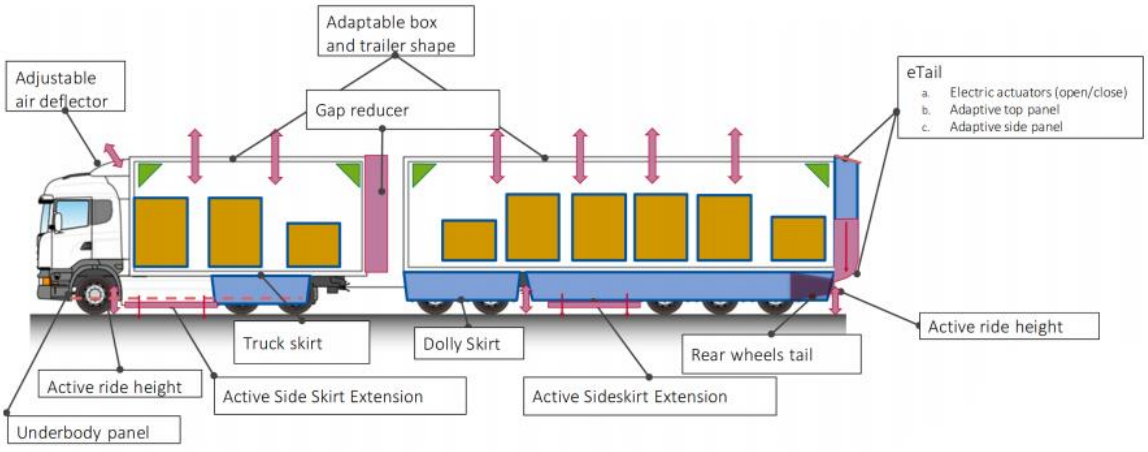

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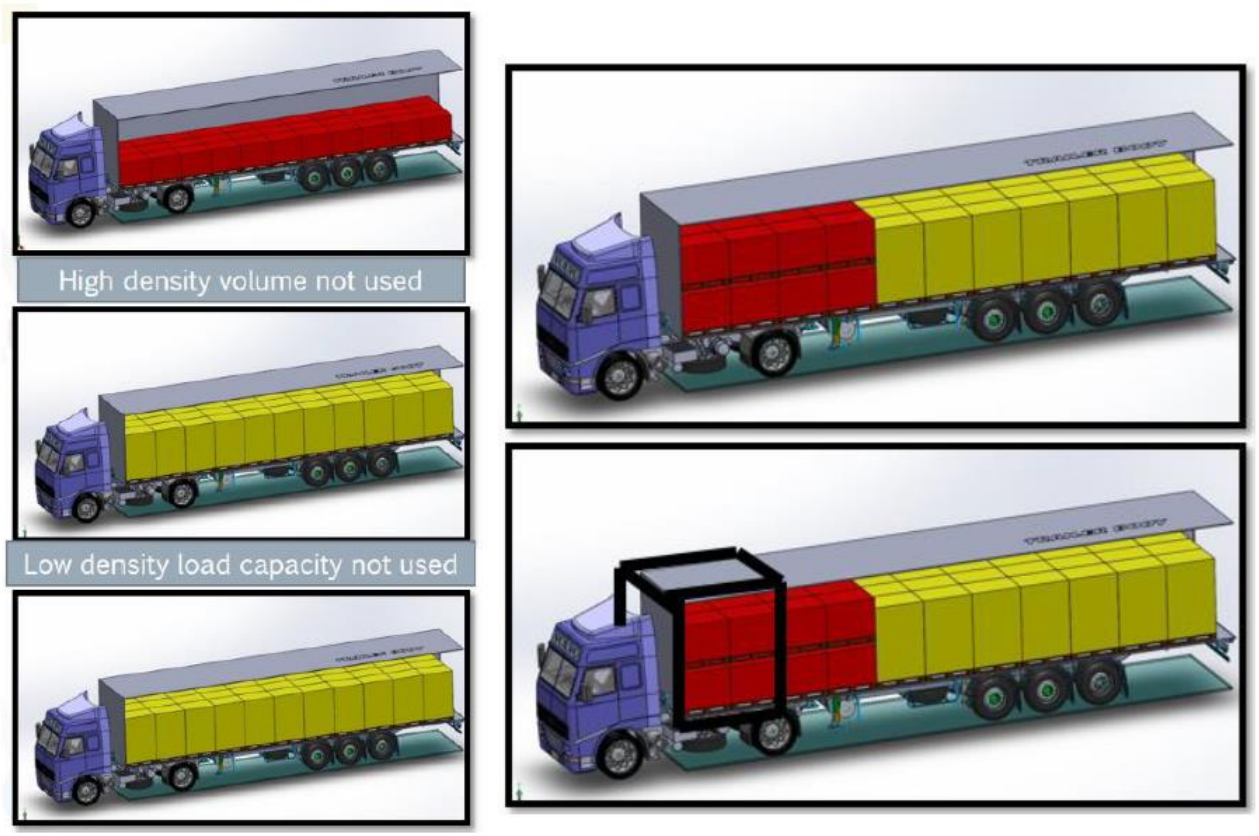

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To assess the efficiency improvement potential of AEROFLEX innovations in typical European long-haul road operations, building on the reference and demonstrator test results, using realistic simulations and providing input to the impact assessment of the EU freight transport and book of recommendations.

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to enable calculating the energy efficiency for any given vehicle, equipped with any given AEROFLEX innovation or combination of innovations, used in any given transport application.

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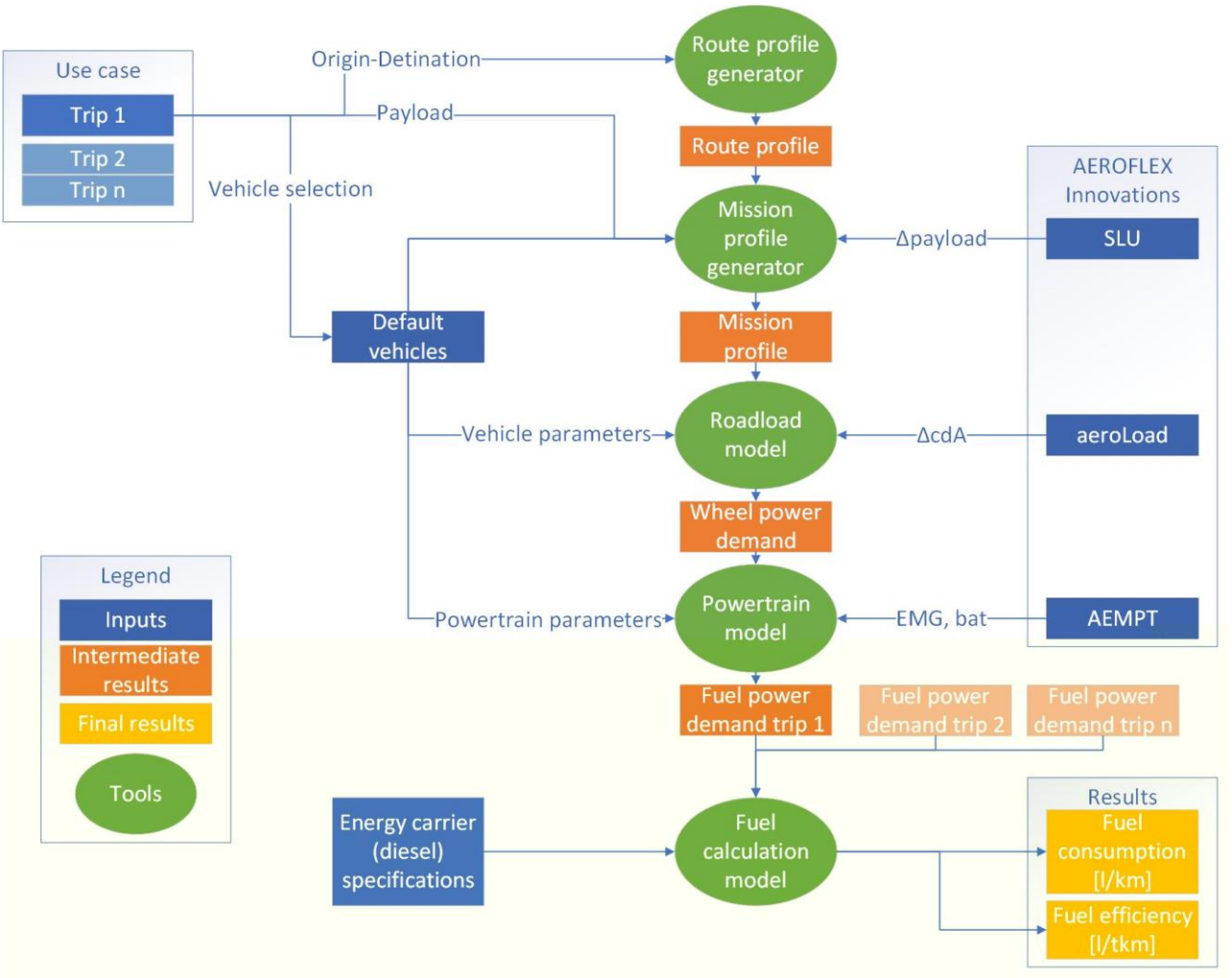
Use case
Trip 1
Trip 2
Trip n
Origin-Detination
Payload
Vehicle selection
Route profile generator
Route profile
Mission profile generator
Δpayload
AEROFLEX Innovations
SLU
Default vehicles
Mission profile
Vehicle parameters
Roadload model
ΔcdA
aeroLoad
Wheel power demand
Powertrain parameters
Powertrain model
EMG, bat
AEMPT
Fuel power demand trip 1
Fuel power demand trip 2
Fuel power demand trip n
Legend
Inputs
Intermediate results
Final results
Tools
Energy carrier (diesel) specifications
Fuel calculation model
Results
Fuel consumption [l/km]
Fuel efficiency [l/tkm]

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[3] 156.3 kg/m[3] loading space, as reported in the FALCON project (de Saxe, et al., 2018)

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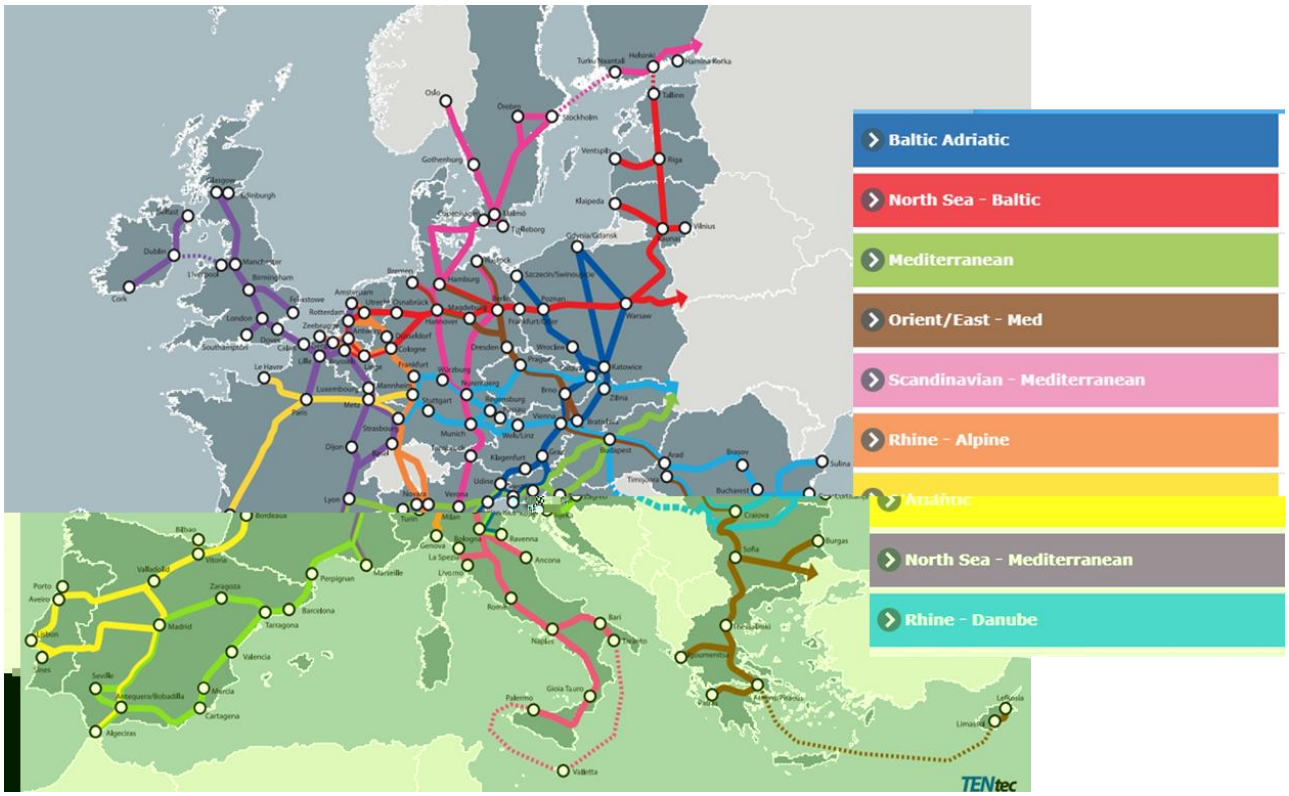
[4] The sum of the total ascent and descent of the route.


Baltic Adriatic
North Sea - Baltic
Mediterranean
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Scandinavian - Mediterranean
Rhine - Alpine
North Sea - Mediterranean
Rhine - Danube
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		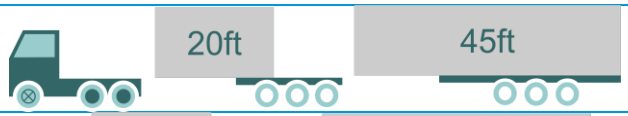	T
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		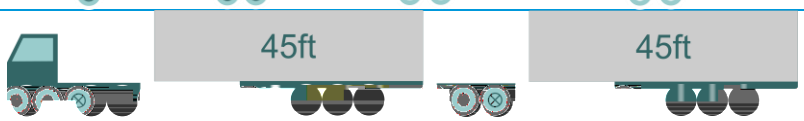	T T T T T T
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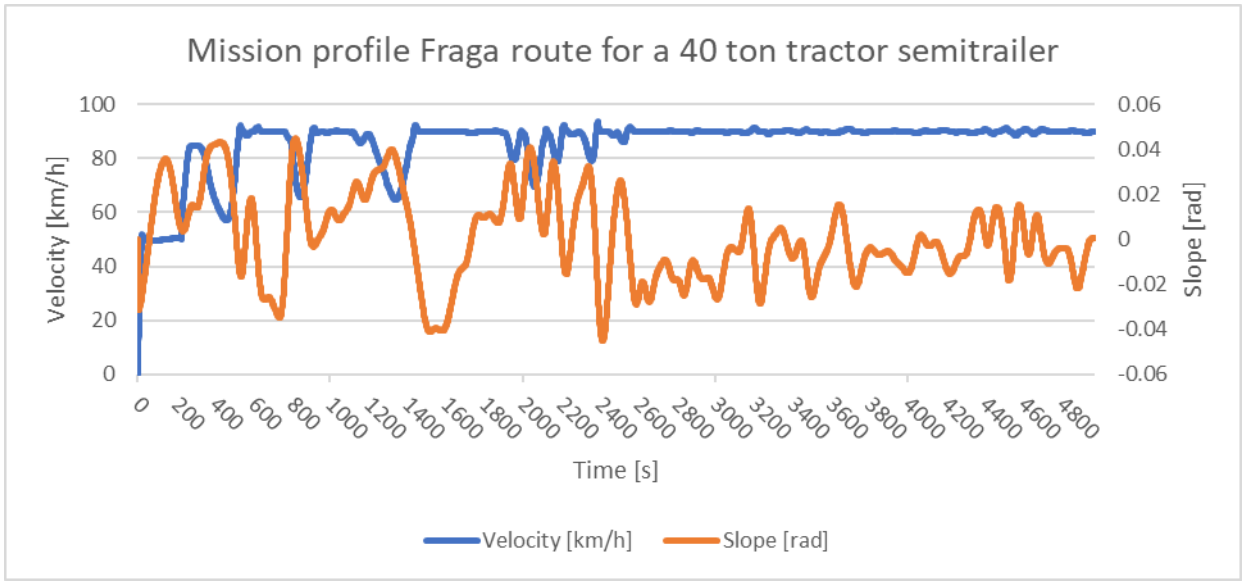

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[5] These properties are aligned with WP1 so that the same values will be used in the impact assessment and originates from JEC2014.

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$$P_{wheels} = P_{rolling} + P_{drag} + P_{inertia} + P_{gradient}$$

$$P_{wheels} = mgC_{rr}\cos(\theta)\,v + \frac{1}{2} * \rho C_d A v^3 + ma^{+}v + mgsin(\theta)v$$

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C_d → R
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a^{+}

$P_{traction} = P_{Wheels}^{+}$
$P_{braking} = P_{Wheels}^{-}$

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$$P_s = P_b - \beta P_b^2$$

$$S\dot{O}E = \frac{P_s}{E_{s\_cap} \times 3600 \times 1000} * 100\%$$

P_b
P_s
β
E_{s_cap}
$S\dot{O}E$ R D R D

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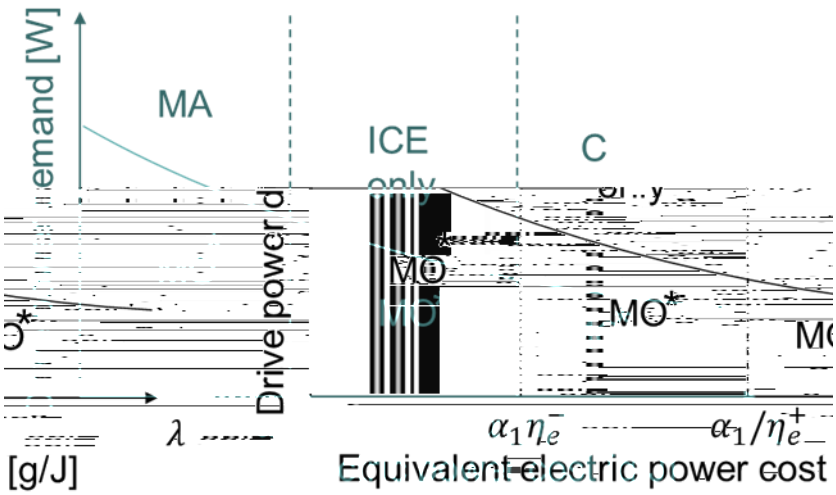

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$\dot{m}_{fuel}\ [kg/s]$

$FC\ [l]$

$$FC\ [l] = \frac{1}{\rho_{fuel}} \int_{t_{start}}^{t_{end}} \dot{m}_{fuel}\, dt$$

$\dot{m}_{fuel}$ ρ_{fuel}

$FC\ [l/tkm]$ $PL\ [t]$
$d\ [km]$

$$EE = \frac{FC}{PL \cdot d}$$

$$FC = \frac{l}{km} * \frac{km}{veh} * \#veh$$

FC
$\frac{l}{km}$
$\frac{km}{veh}$
$\#veh$

$$\#veh = \frac{veh}{ton} * \frac{ton}{m^3} * \frac{m^3}{prod} * \#prod$$

$\frac{veh}{ton}$
$\frac{ton}{m^3}$
$\frac{m^3}{prod}$
$\#prod$

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calculating the energy efficiency for any given vehicle, equipped with any given AEROFLEX innovation or combination of innovations, used in any given transport application.

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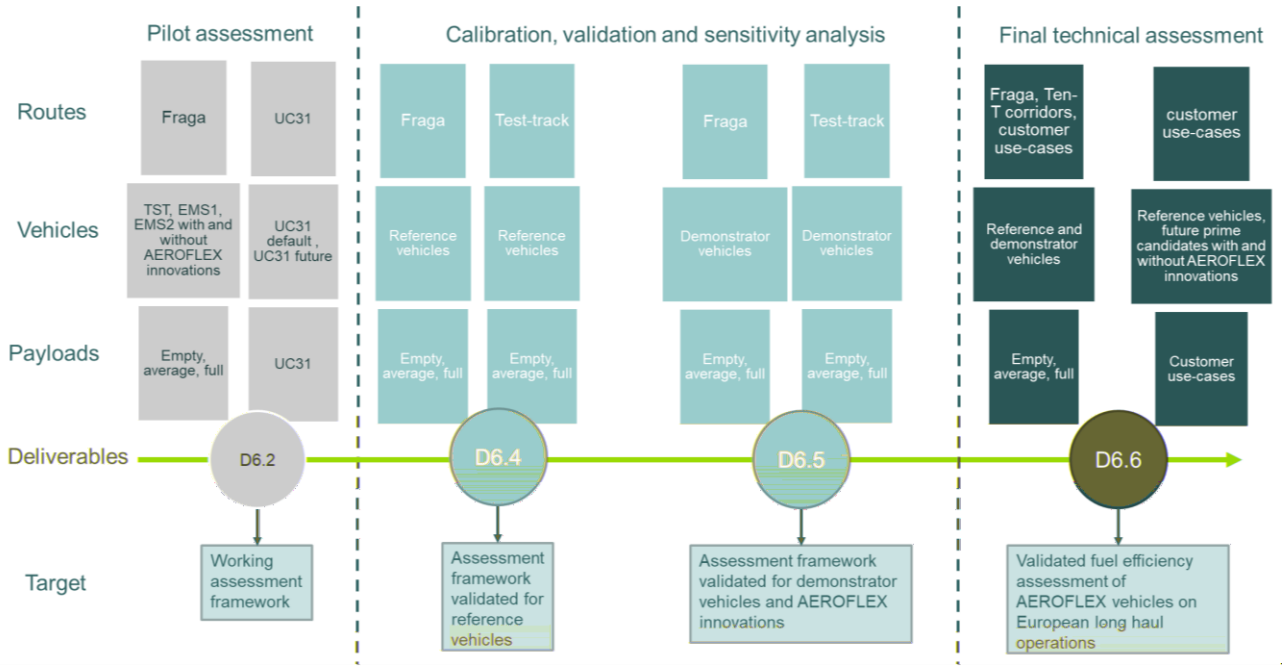

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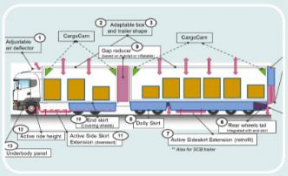

AEMPT:
E-trailer

- Battery: 20 kWh
- E-motor: 80 kW

Additional mass:
1200 kg

AEMPT:
E-dolly

- Battery: 73.5 kWh
- E-motor: 250 kW

Additonal mass:
1750 kg

AeroLoad:

- ΔC_d*A:
TT -25% (+300kg)
EMS1 -15% (+500kg)
EMS2 -10% (+600kg)

SLU:
Double load floor trailer (and PUZZLE® software, CargoCam)
- Average payload increase:
+5000 kg
Additional trailer mass: 2500kg

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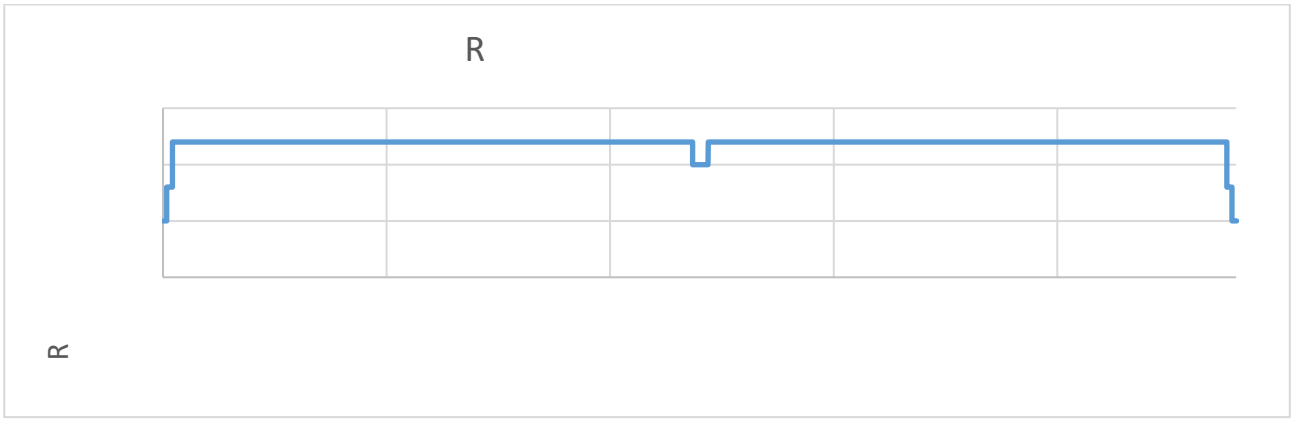
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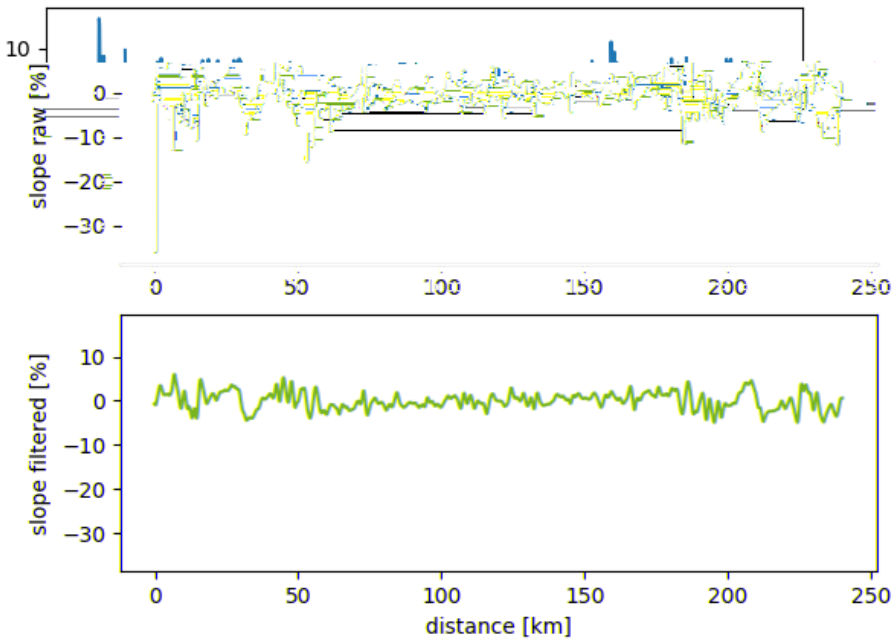
slope raw [%]
10
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−10
−20
−30
0
50
100
150
200
250
slope filtered [%]
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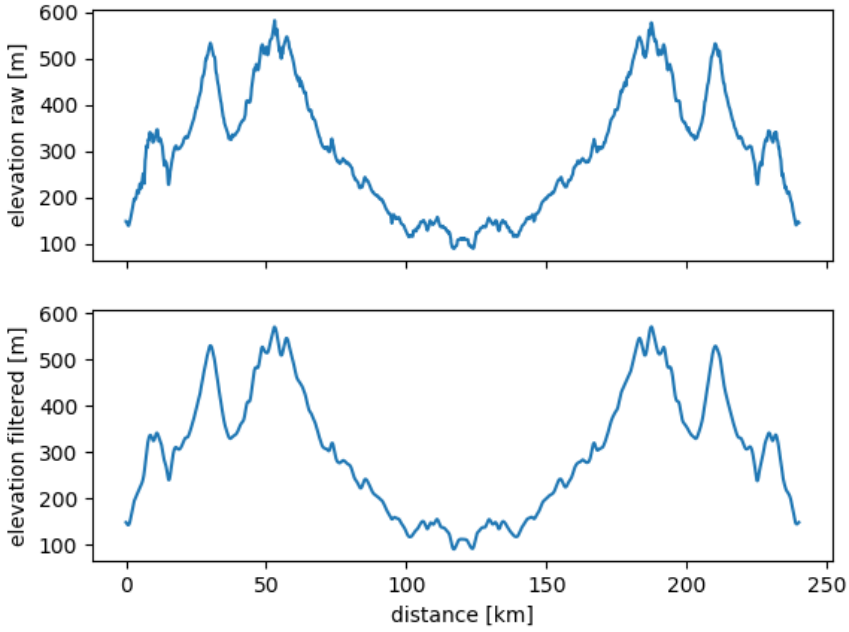
0
50
100
150
200
250
distance [km]


elevation raw [m]
elevation filtered [m]
600
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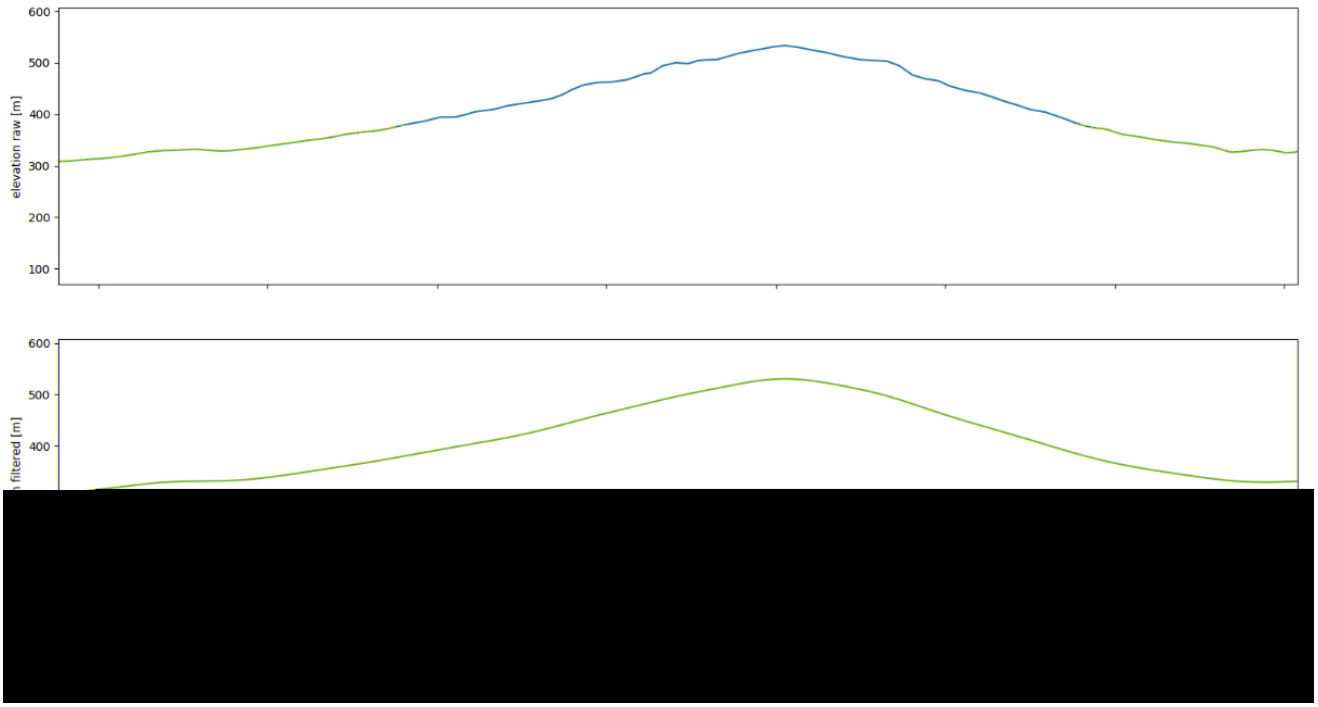
distance [km]


elevation raw [m]
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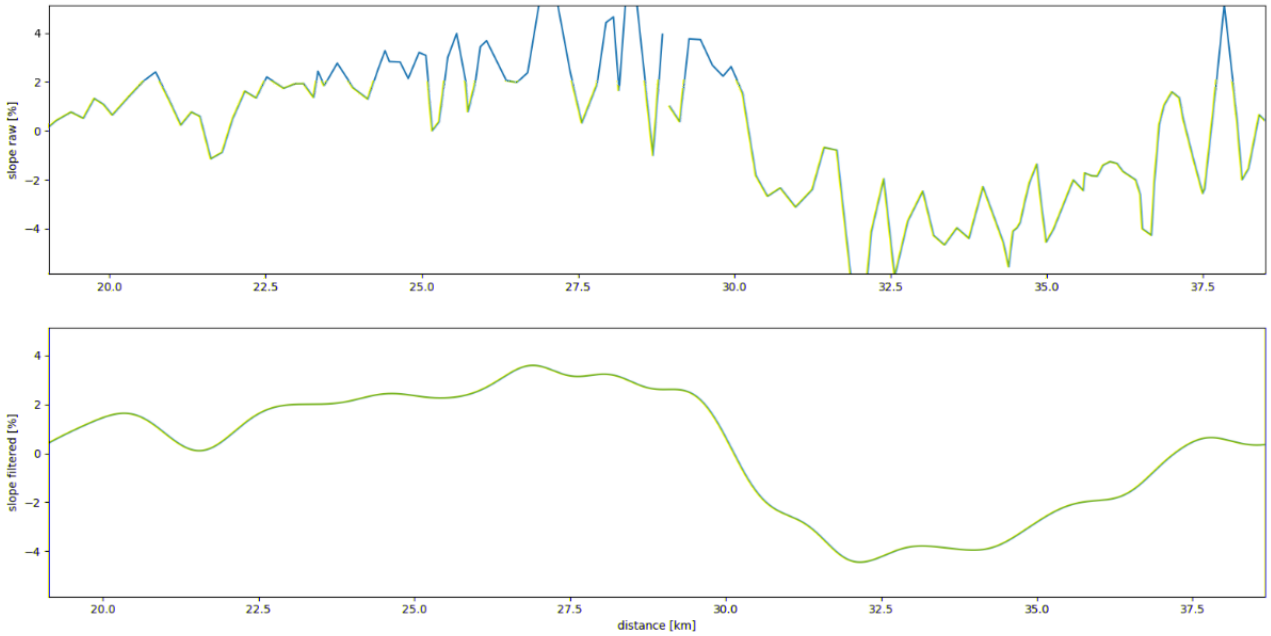
slope raw [%]
4
2
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−4
20.0
22.5
25.0
27.5
30.0
32.5
35.0
37.5
slope filtered [%]
4
2
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distance [km]

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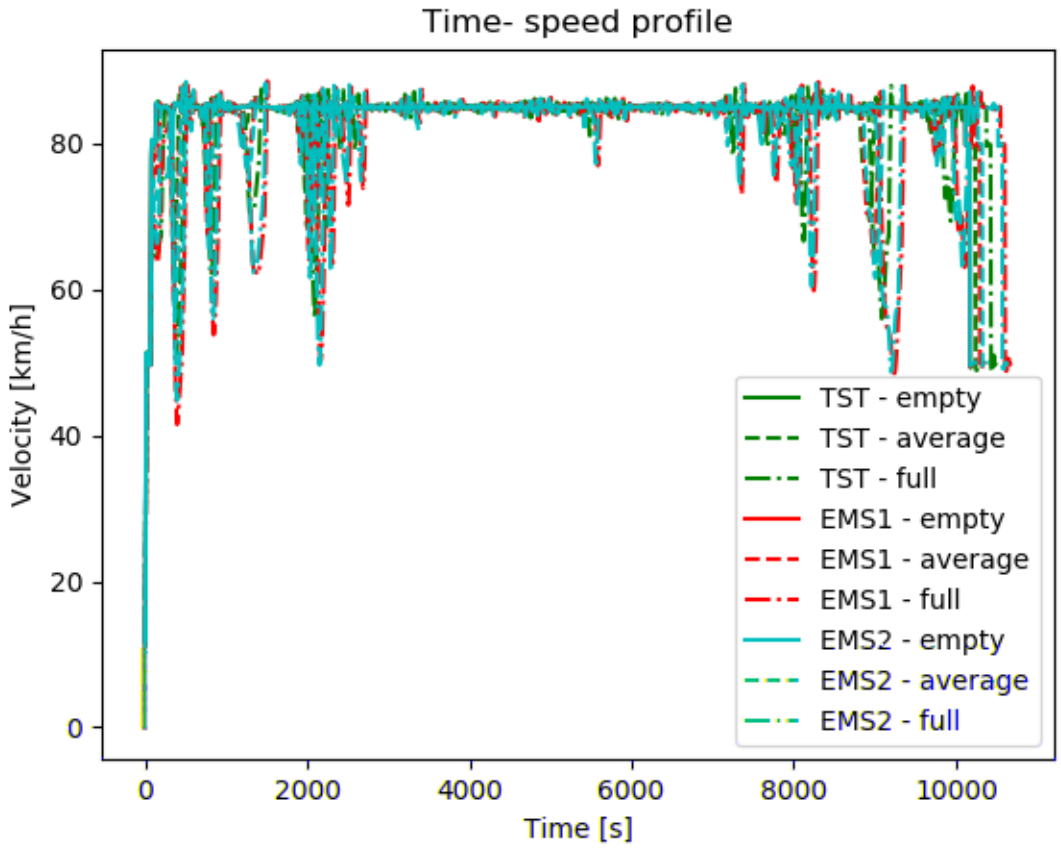
Time- speed profile
Velocity [km/h]
Time [s]
0
20
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0
2000
4000
6000
8000
10000
TST - empty
TST - average
TST - full
EMS1 - empty
EMS1 - average
EMS1 - full
EMS2 - empty
EMS2 - average
EMS2 - full

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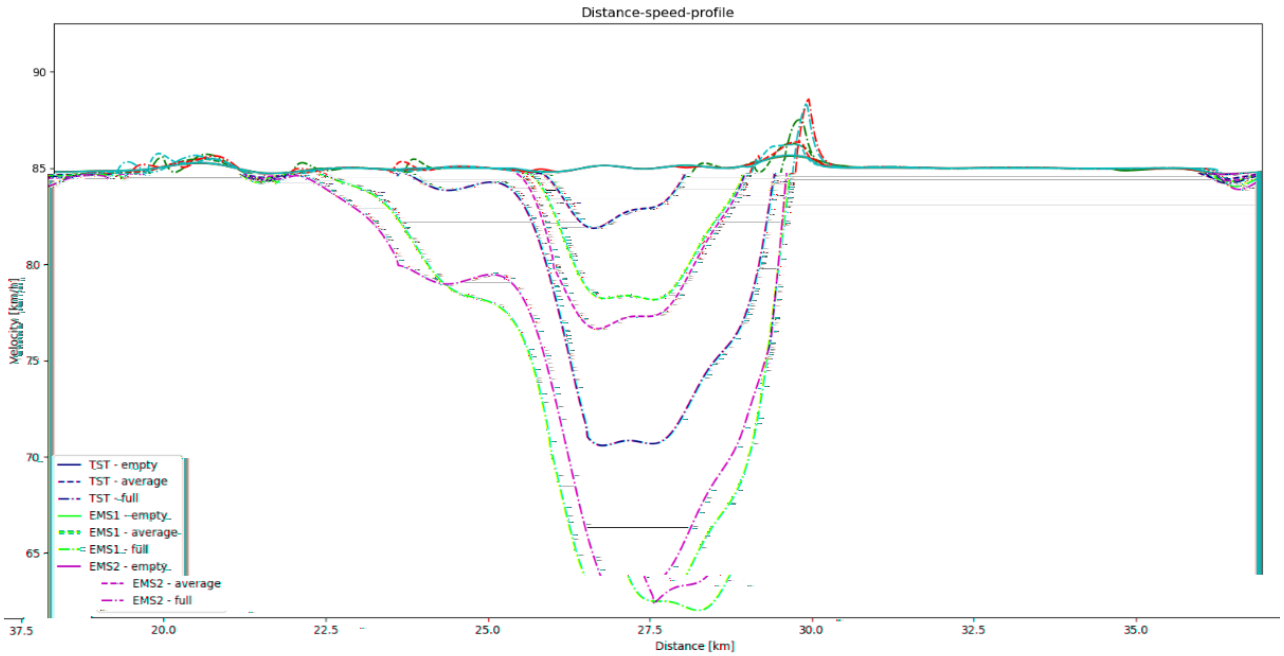

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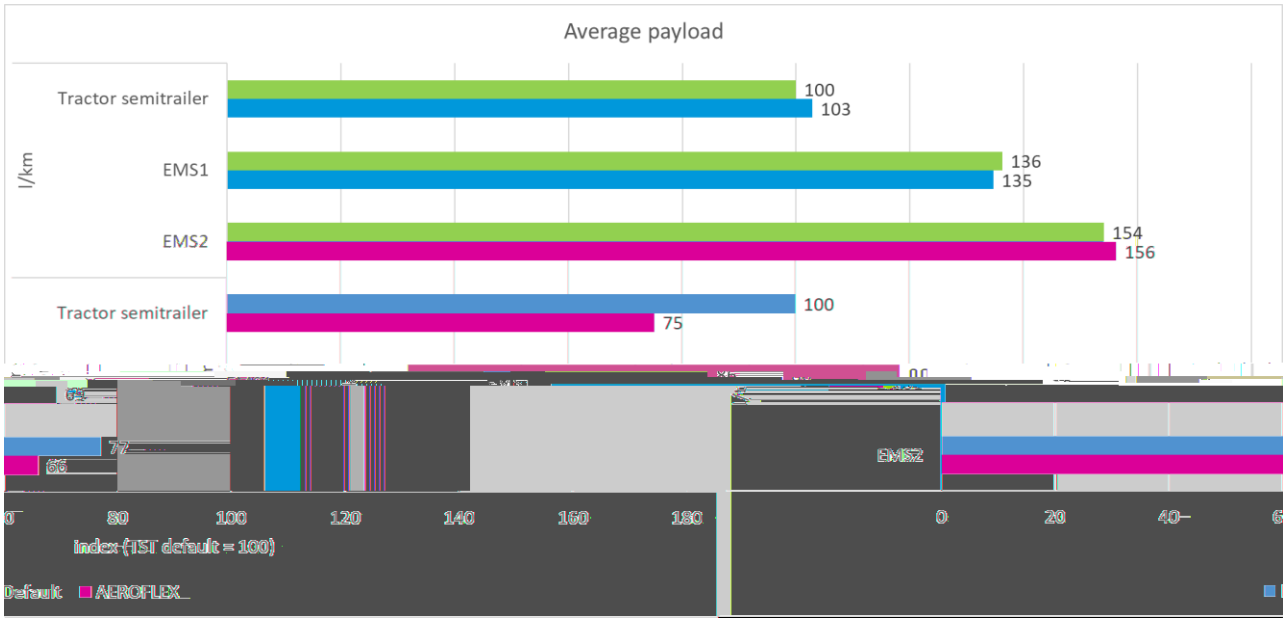

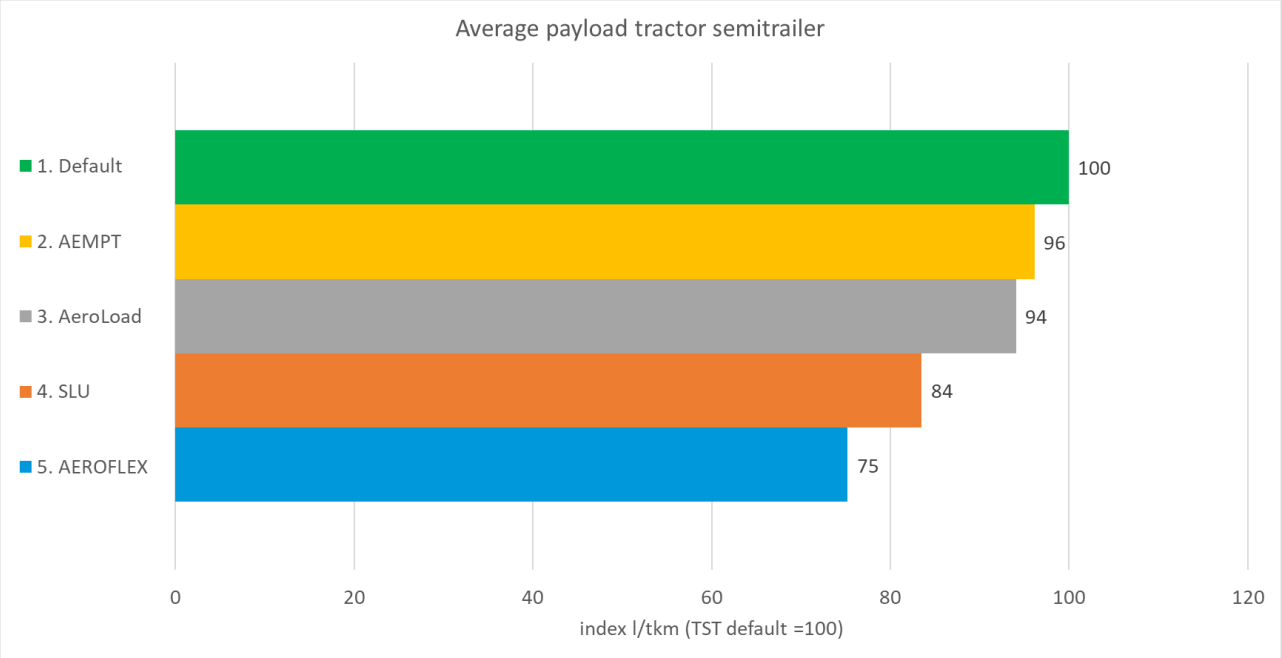

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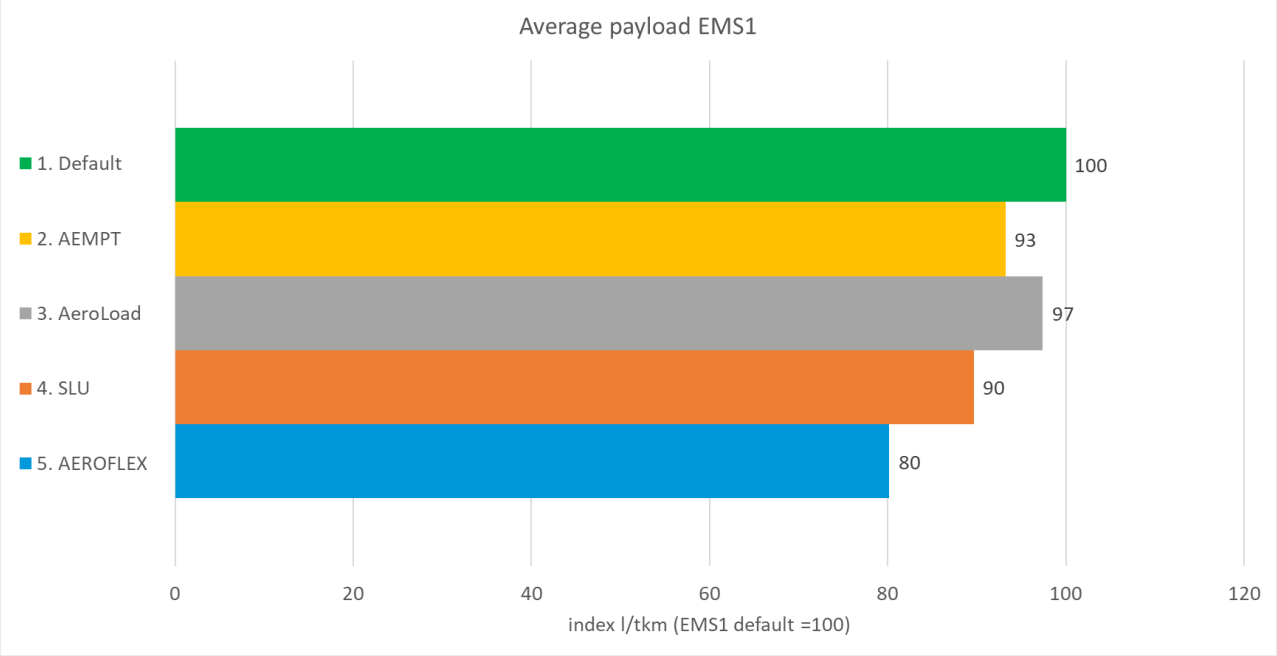

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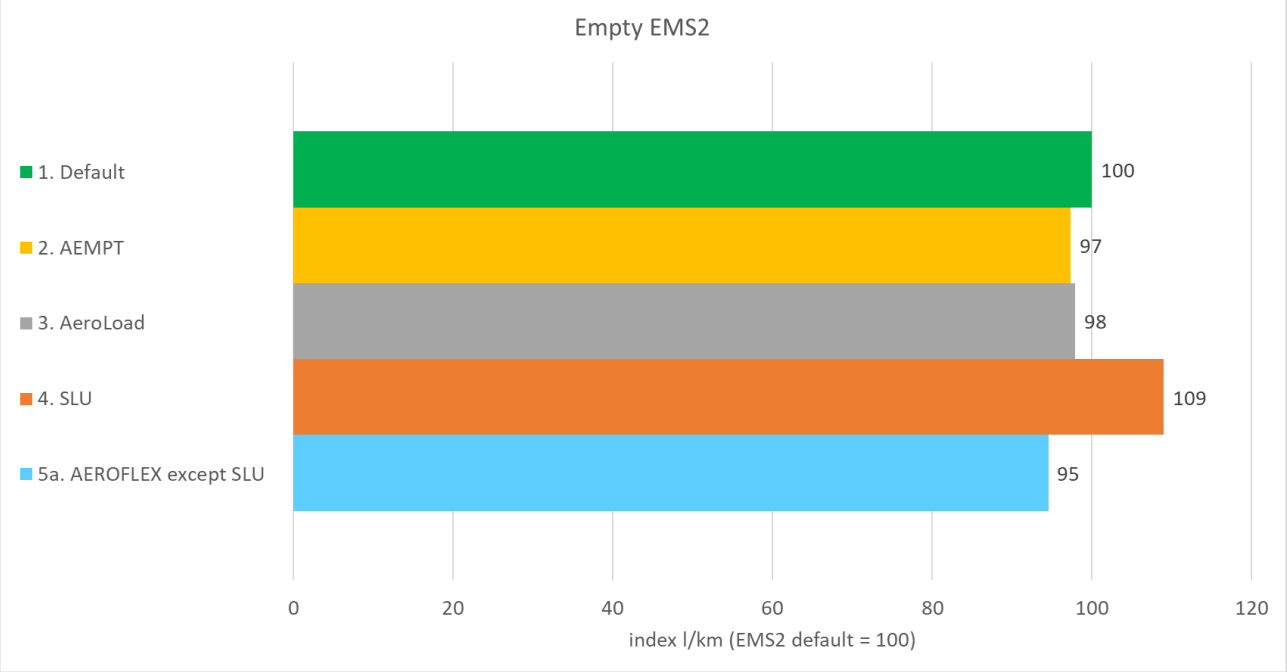

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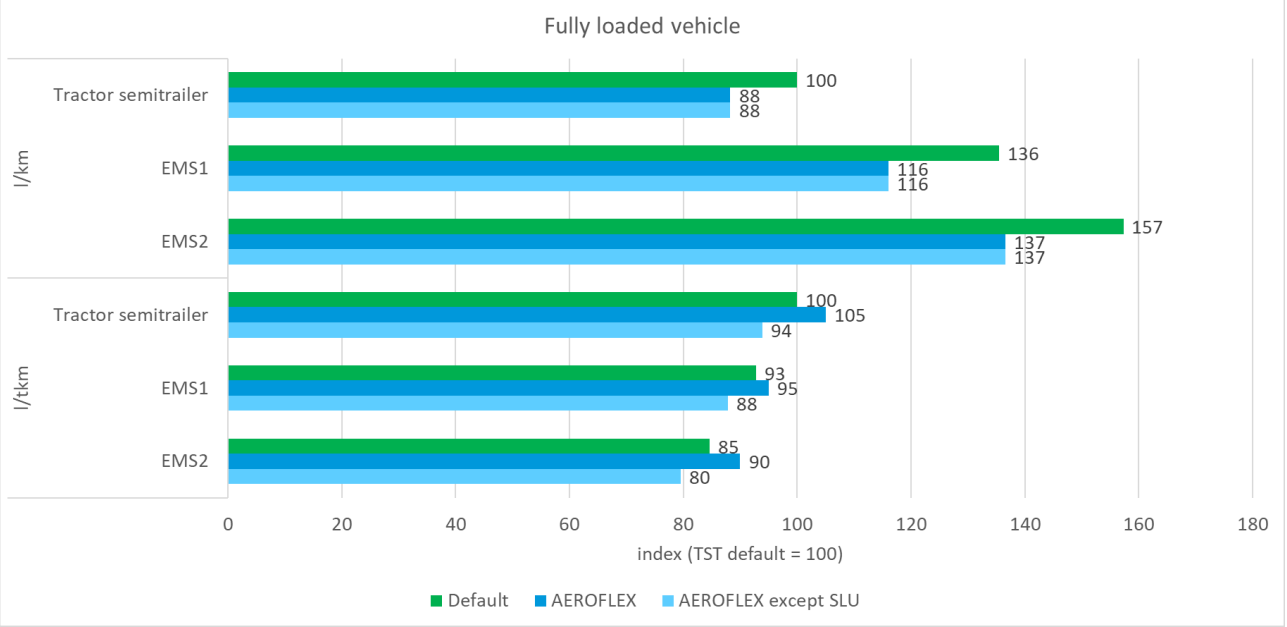

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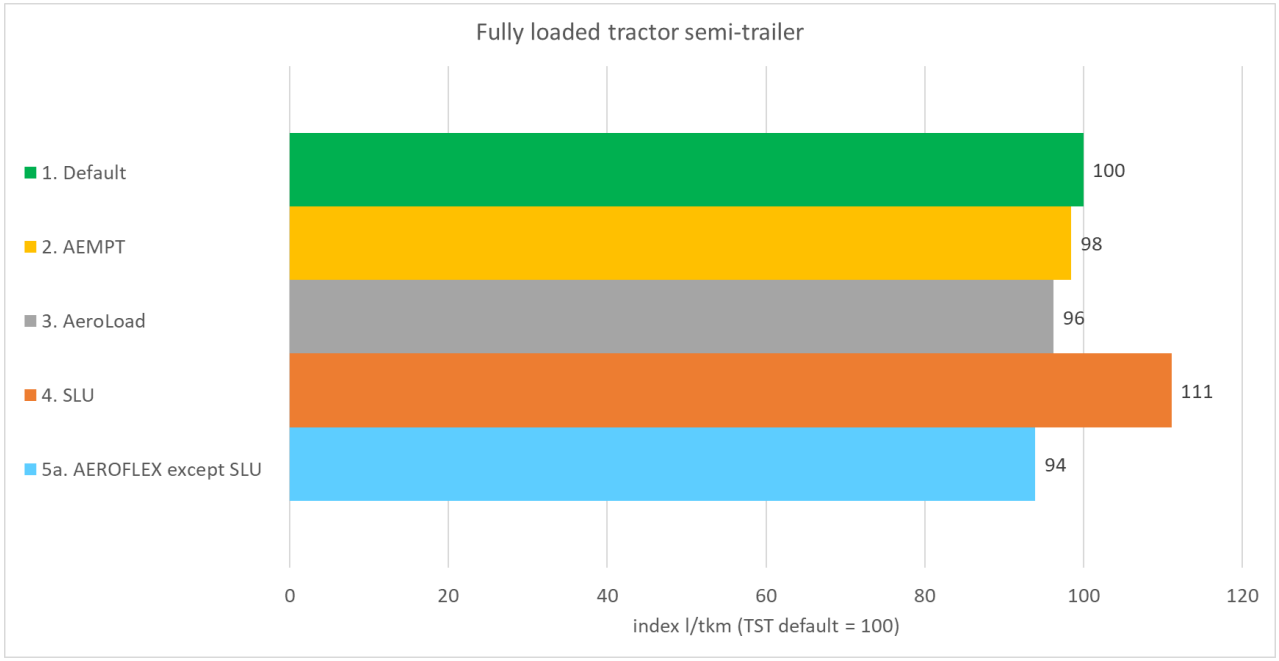
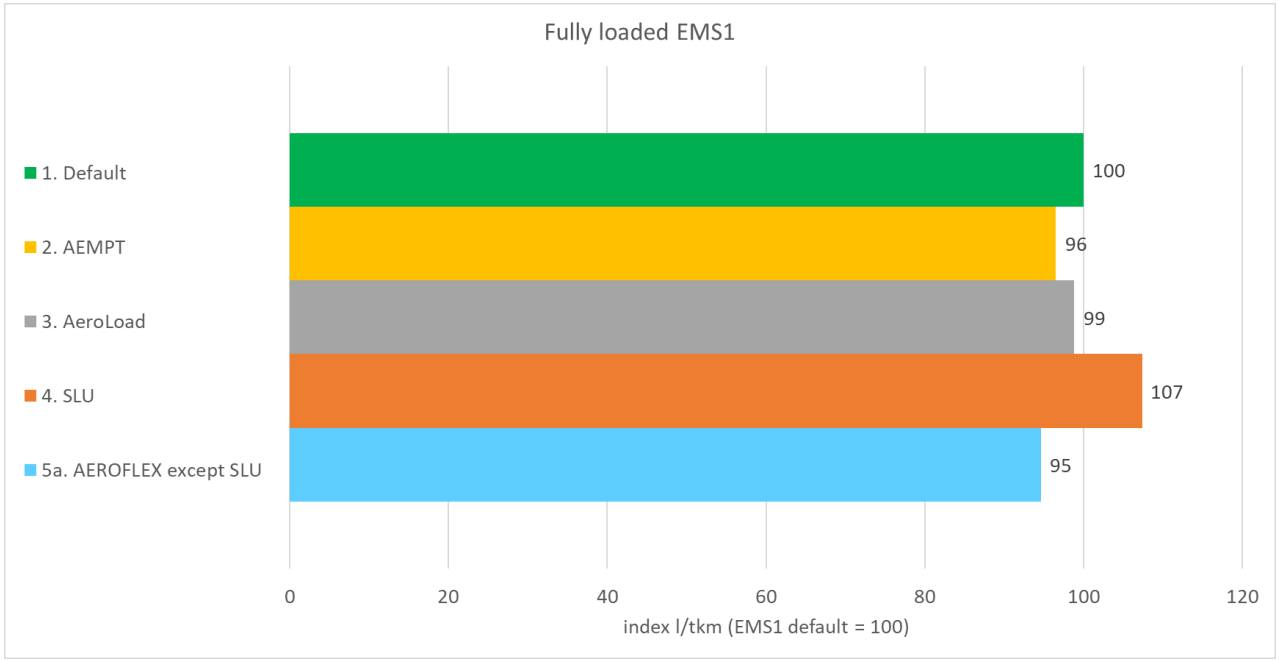

Fully loaded tractor semi-trailer
1. Default
2. AEMPT
3. AeroLoad
4. SLU
5a. AEROFLEX except SLU
100
98
96
111
94
0
20
40
60
80
100
120
index l/tkm (TST default = 100)


Fully loaded EMS1
1. Default
2. AEMPT
3. AeroLoad
4. SLU
5a. AEROFLEX except SLU
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107
95
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40
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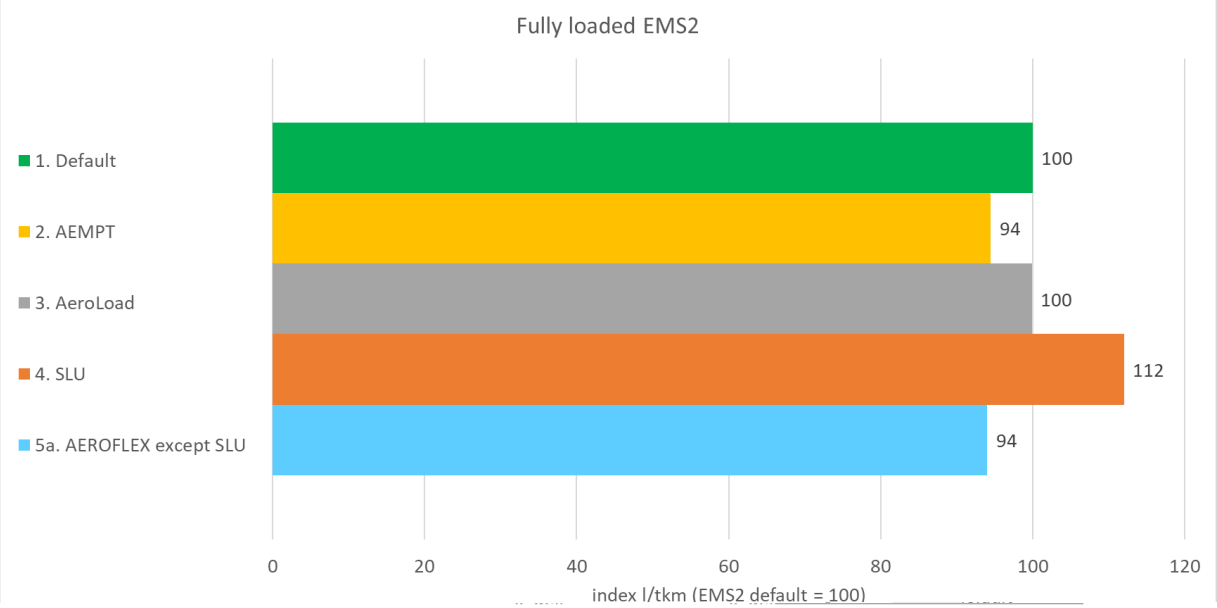
100
120
index l/tkm (EMS1 default = 100)


Fully loaded EMS2
1. Default
2. AEMPT
3. AeroLoad
4. SLU
5a. AEROFLEX except SLU
100
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100
120
index l/tkm (EMS2 default = 100)

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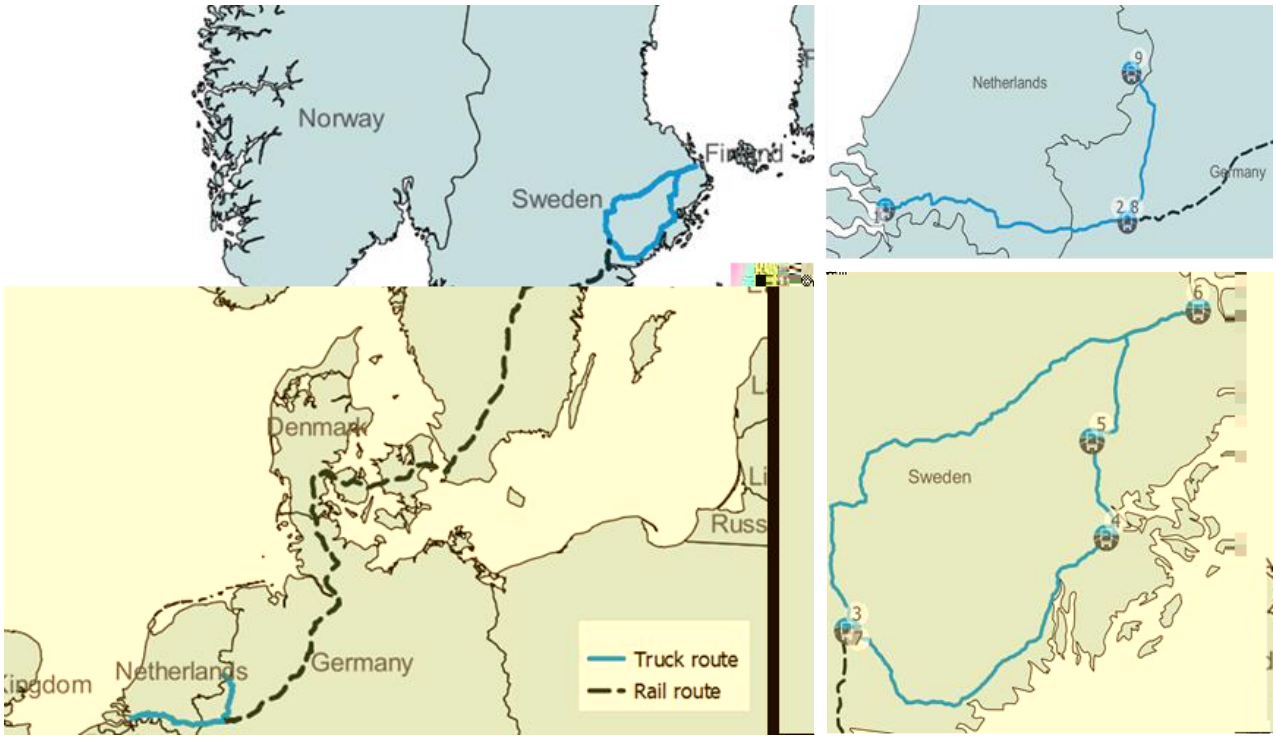

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	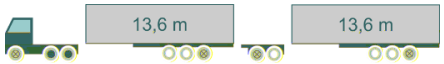					
	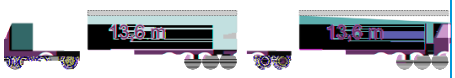					
						
						

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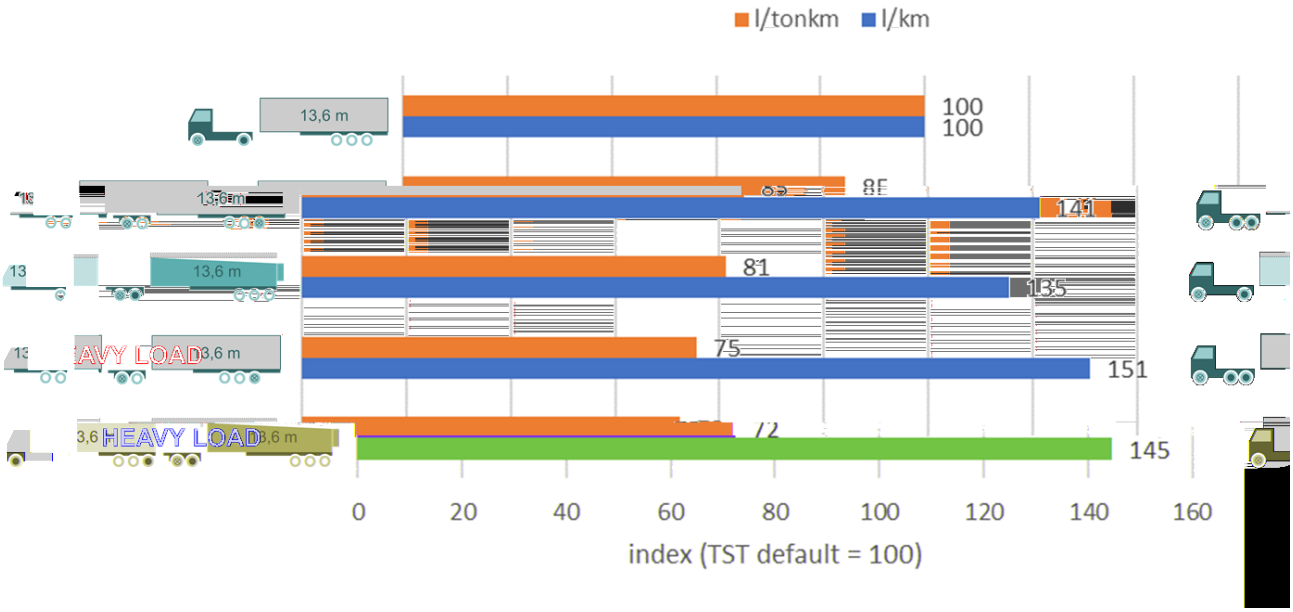

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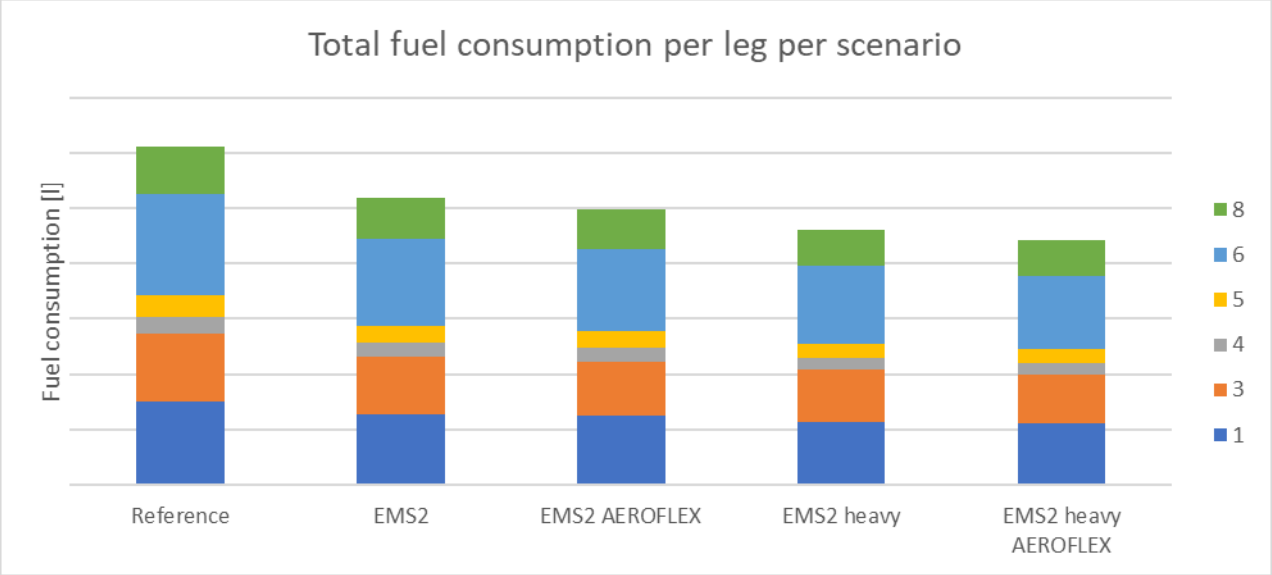

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To assess the efficiency improvement potential of AEROFLEX innovations in typical European long-haul road transport operations, building on the reference and demonstrator test results, using realistic simulations and providing input to the impact assessment of the EU freight transport and book of recommendations.

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R R R *FALCON D3.1/5/6: Definition and Validation of a Smart Infrastructure Access Policy utilising Performance-Based Standards .* D

D D D J R T J *Presented at the Math Work's International Automotive Conference.* R

D *AEROFLEX Deliverable 4.2: Description of concepts and assessment of potential efficiency improvements.* D

D D *AEROFLEX deliverable 6.1: Definition of use-cases.* D

D *AEROFLEX D3.1: Report on selection of concepts.* D

D *Aeroflex deliverable 2.1: Book of requirements AEMPT and KPIs.* D

European commission

AEROFLEX D6.3: Test program and protocol.

AEROFLEX deliverable 6.3; Test programme and protocol. D

Aeroflex project website

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Perspectives of Aerodynamic Drag and Cooling Airflow for Heavy-Duty Trucks - Reconsidering European Total-Length Legislation. R J D R T D R D J R D *SAE International*

R *Open Street Map*

Software engineering journal, 1

D D D *19th International Battery, Hybrid and Fuel Cell Electric Vehicle Symposium and Exhibition (EVS 19).*

R J T J R *Journal of Earth Sciences and Geotechnical Engineering, 7*

R R D D *TRANSFORMERS D6.4: Final report and conclusions.*

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