COnVENienT

COmplete Vehicle ENergy-saving Technologies

EGVI European Green Vehicles Initiative

Brussels (Belgium)

31 May 2017

SP A1 – IVECO Truck

SEVENTH FRAMEWORK PROGRAMME

SP A1 *(IVECO)*
Prototype Truck 1

WP A1.1 (IVECO)
Concept analysis and simulations

WP A1.2 (CRF)
Eco-Driving HMI

WP A1.3 (CRF)
Integrated thermal system development

WP A1.4 (CRF)
Active & Passive Aerodynamics

WP A1.5 (WEBASTO)
Solar Roof Development

WP A1.6 (CRF)
Advanced Heating, Ventilation and Air Conditioning system

WP A1.7 (CRF)
Electrified Auxiliaries Integration

WP A1.8 (IVECO)
Hybrid transmission integration

WP A1.9 (IVECO)
Prototype Truck 1 build-up & calibration

WP A1.4 Active & Passive Aerodynamics

Objectives

- Reduce the aerodynamic drag of radiators by developing active shutters for the front radiator grill
- Reduce the aerodynamic drag of wheels by developing systems of the flow around the wheel arches
- Develop other active and passive means, to optimize the aerodynamics between the cabin and the trailer
- Optimize the aerodynamics devices for the semitrailer, integrated by IAM

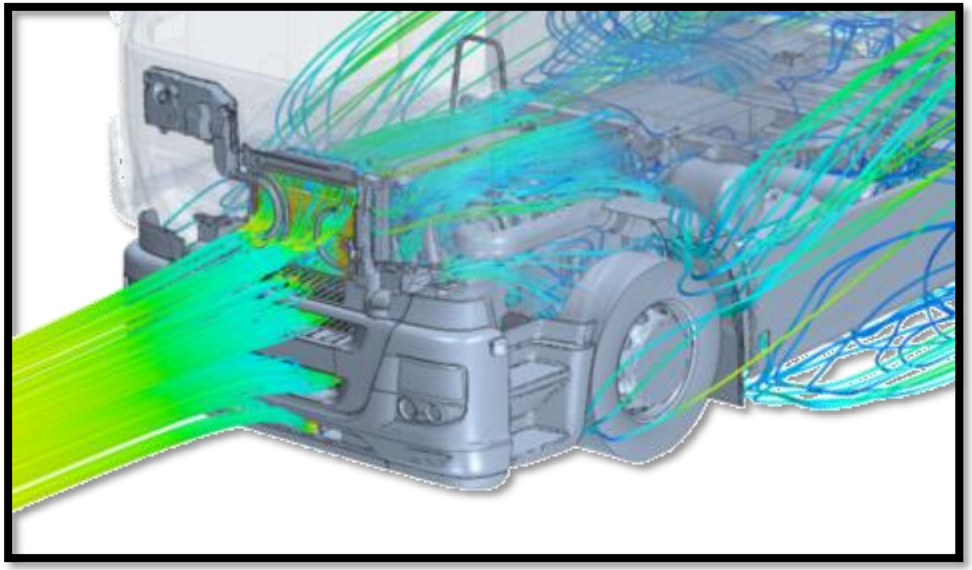
WP A1.4 Active & Passive Aerodynamics

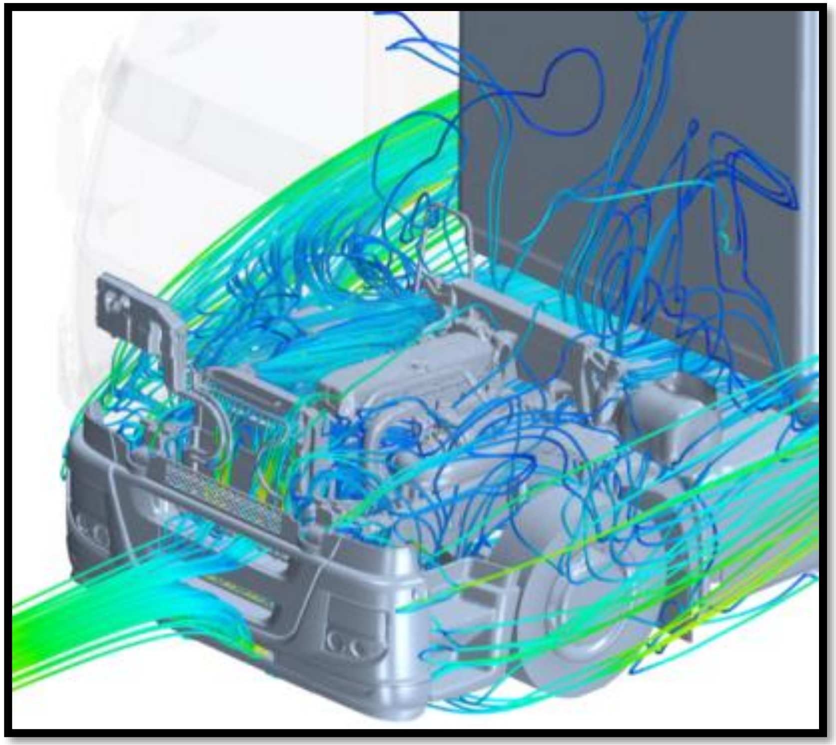
FRONT ACTIVE SHUTTER

The front shutters open only when the ICE needs to be cooled, otherwise remaining closed to improve the aerodynamics and fuel efficiency.

CFD simulations (using STAR-CMM+ tool) have been performed to find the best trade-off between engine cooling and drag reduction, considering different solutions for complete or partial closing of front grills; scope of CFD calculations was to optimize the pressure distribution around the frontend of the tractor.

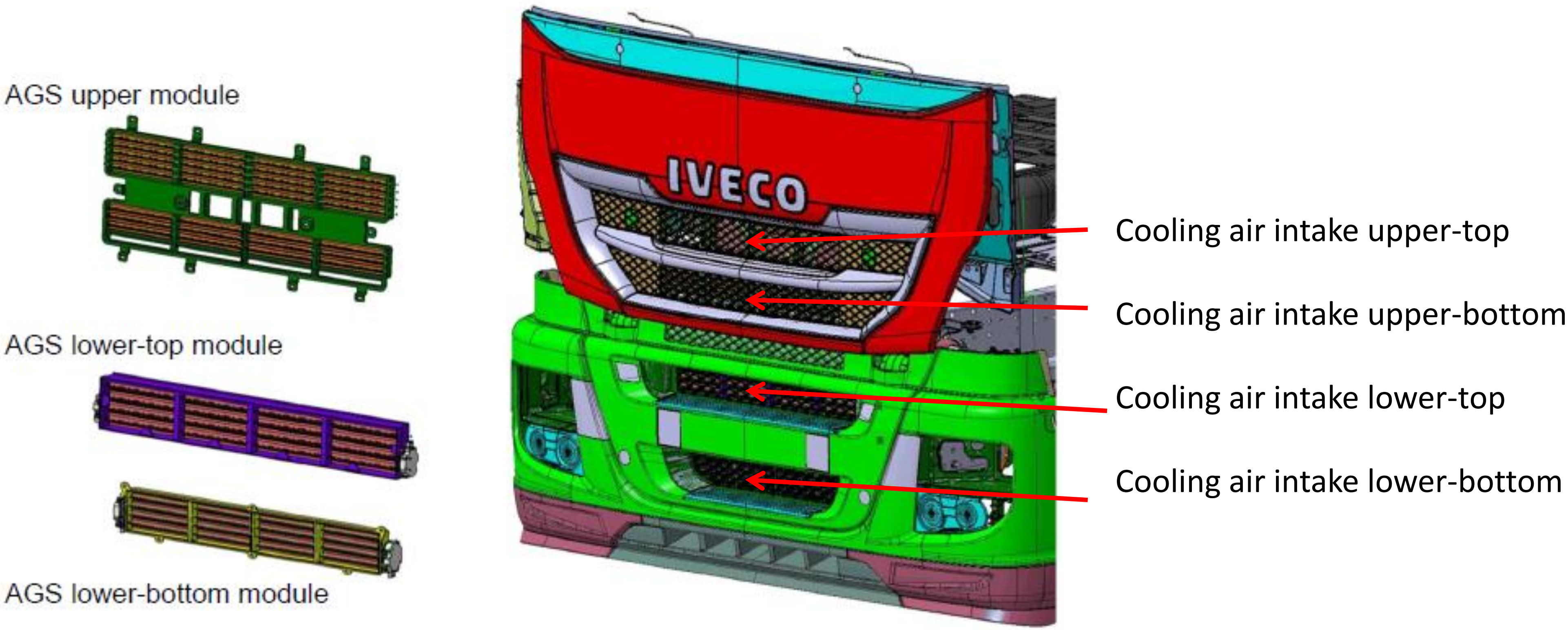
AGS - CFD simulations





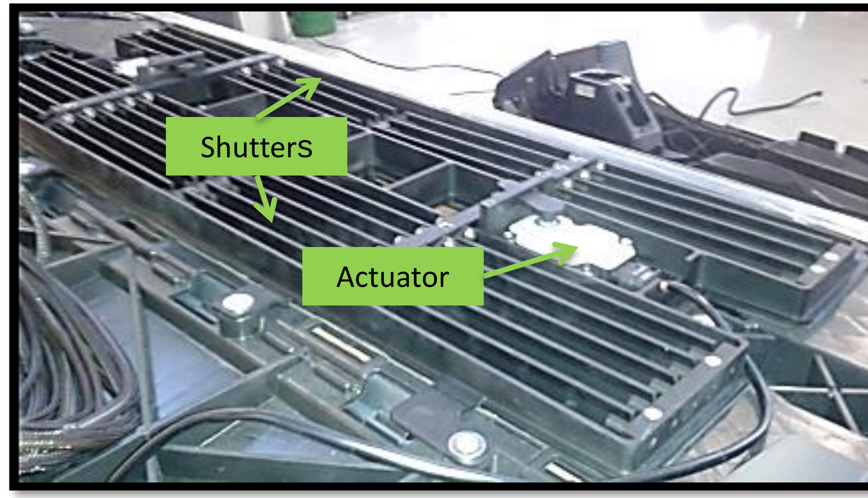
CFD aerodynamic simulations of Active Grille Shutters have been completed. Simulation results show that AGS in closed position give about **5% reduction of Cx**.

AGS - feasibility study



A feasibility study of Active Grille Shutters has been performed, including packaging/installation study .The AGS system has resulted to be a quite promising solution for reducing the aerodynamic drag coefficient in the front part of the vehicle.

AGS – System Prototyping and test



TEST	Results		NOTES
On road coast down test	**-2.5%**	ΔCx	On-road testing results.
On road fuel consumption test @ constant speed = 80km/h	**-0,7%**	Fuel consumption	On-road testing results.

WP A1.4 Active & Passive Aerodynamics

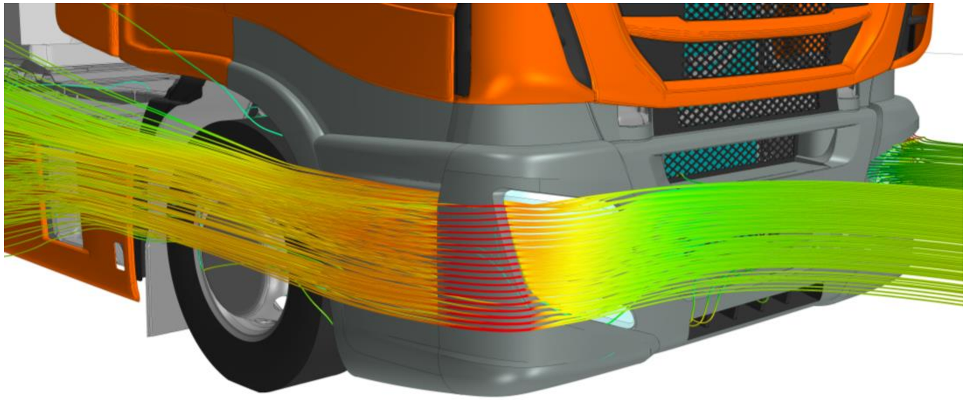
Bumper & Door Extension

A new geometry, featuring a more rounded corner and a channel to guide air flow plus a door extension, has been designed in order to reduce the frontal separation area.

The flow is further supported with an extended dam.

WP A1.4 Active & Passive Aerodynamics

The flow lines confirm that near the front bumper corner the flow remains relatively attached to the external surface.



The blue image illustrates how the more rounded corner and the channel, together with the extended door, induce the flow to move closer to the surface.

WP A1.4 Active & Passive Aerodynamics

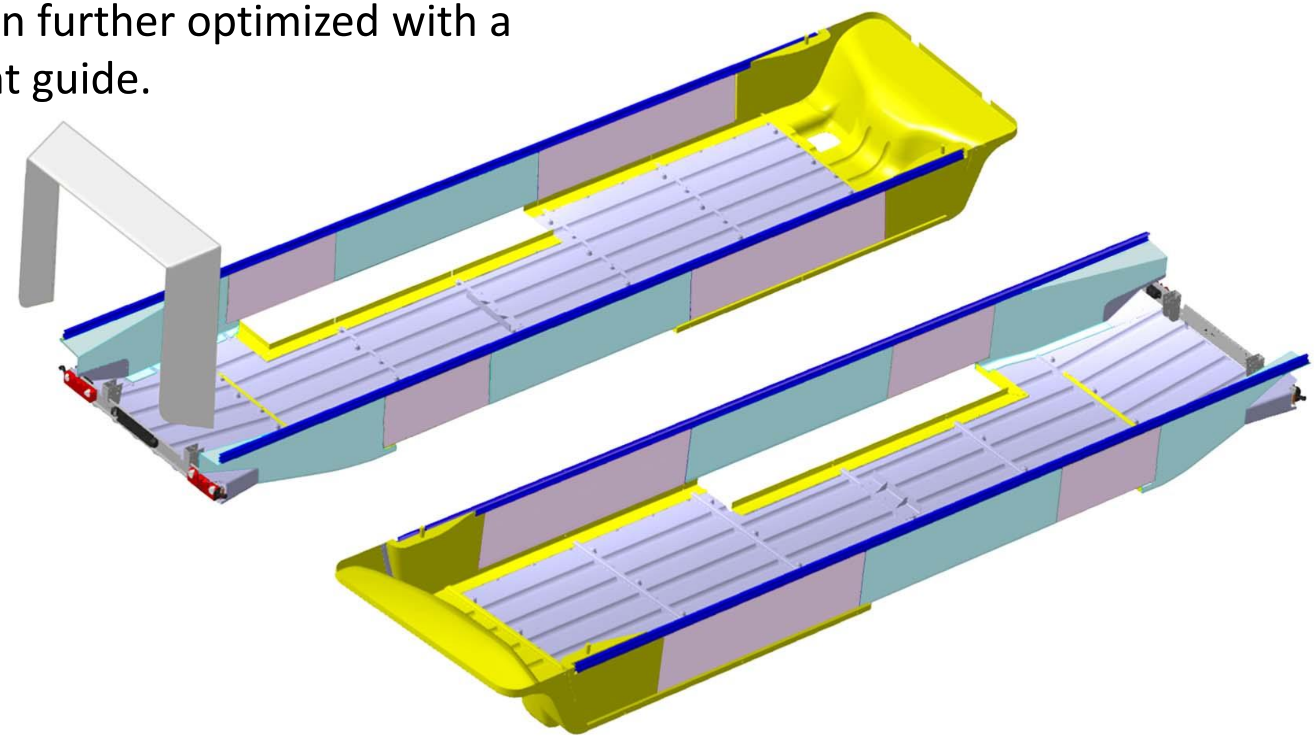
Bumper & Door Extension

TEST	Results		NOTES
On road coast down test	**-4,3%**	ΔCx	On-road testing results.
On road fuel consumption test @ constant speed = 80km/h	**-1,5%**	Fuel consumption	On-road testing results.

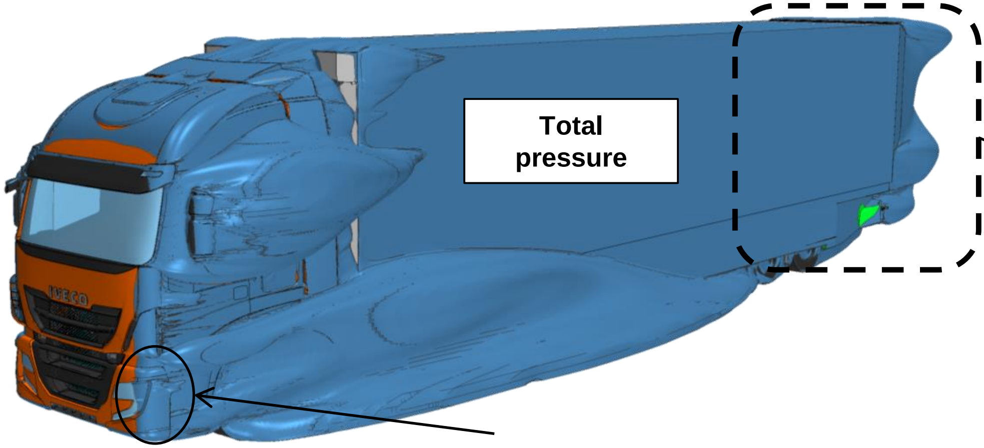
WP A1.4 Active & Passive Aerodynamics

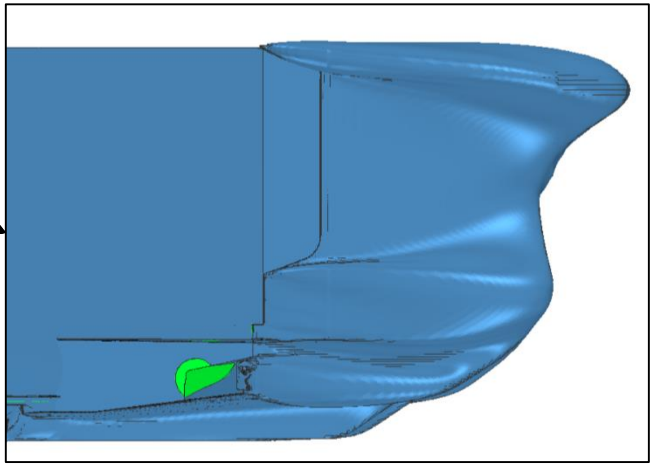
Trailer Aerokit

To drive the underbody flow in a more efficient way, a complete fairing geometry was selected. This geometry has been further optimized with a rear extractor and front guide.

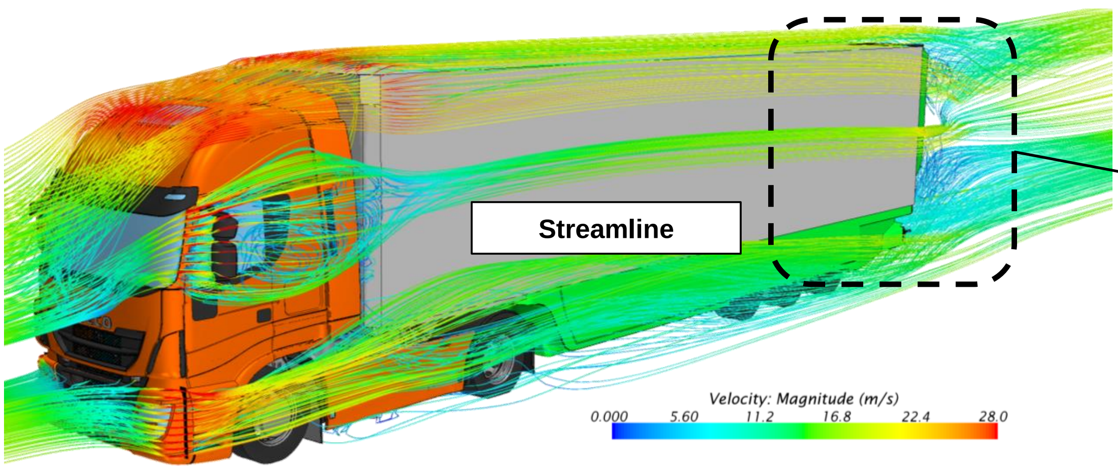


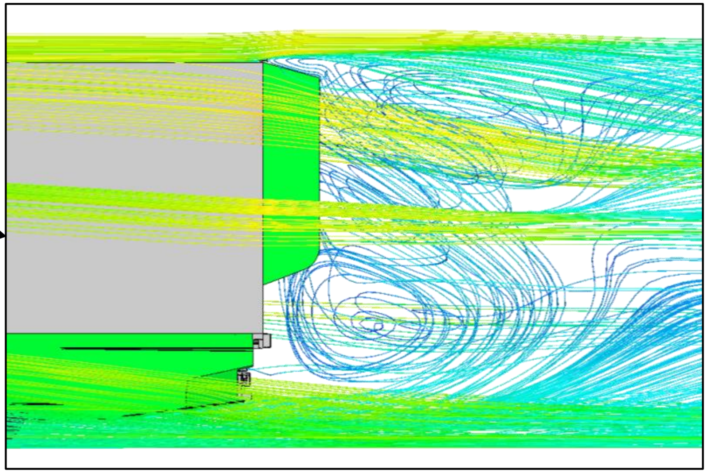
SemiTrailer Aerokit



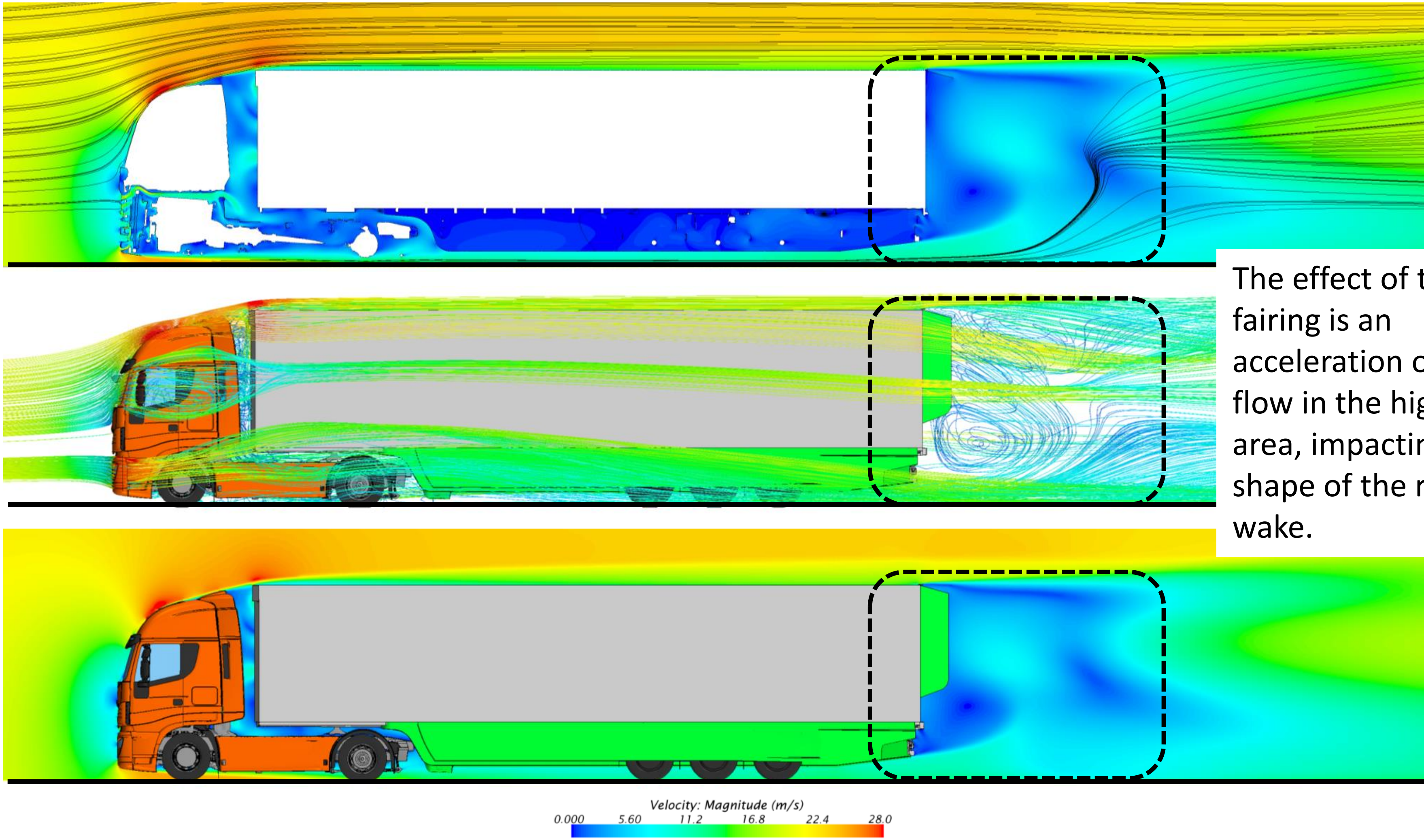


The more rounded shape of the front bumper corner, add to the new channel and to the new door extension, contribute to reduce the dimension to the wake and reduce resistance.





Trailer Aerokit



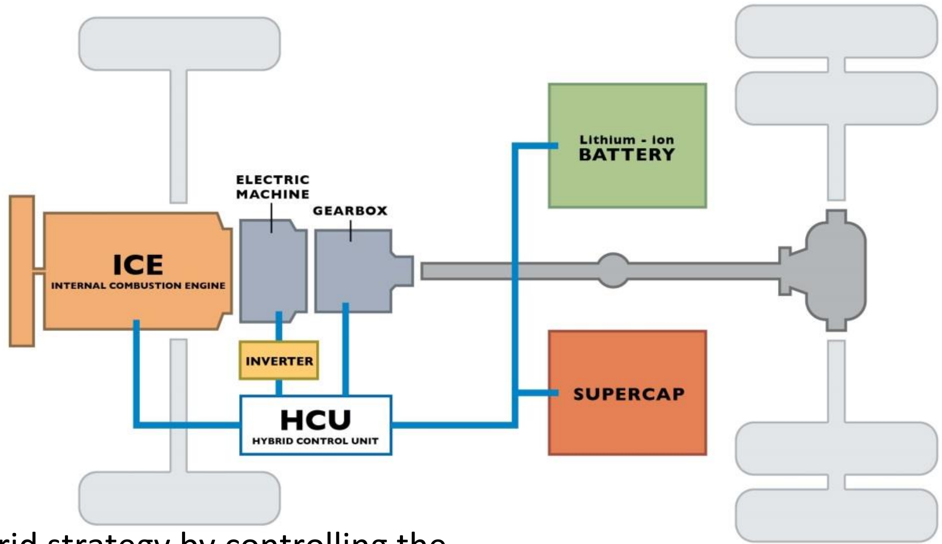
The effect of the fairing is an acceleration of the flow in the highlighted area, impacting the shape of the rear wake.

WP A1.4 Active & Passive Aerodynamics

Trailer Aerokit

TEST	Results		NOTES
On road coast down test	**-8,0%**	ΔCx	On-road results.
On road fuel consumption test @ constant speed = 80km/h	**-2,0%**	Fuel consumption	On-road results.

WP A1.8 Hybrid Transmission



HCU - Hybrid Control Unit.
The HCU implements the hybrid strategy by controlling the different sub-systems.

EM - Electric Machine
Controlled by the inverter, the EM works both as a generator during braking and as a motor during acceleration phases.

Gearbox
Managed by the HCU, the gearbox optimizes gear shifting according to the energy available.

Inverter.
The Inverter is the electronic power unit controls EM according to the HCU strategy.

DUAL ESS - Dual Energy Storage System
The Dual ESS supplies power and energy to the electric traction. It is based :

Supercap
The supercaps serve to meet the peak power needs in both drive and energy recovery phases.

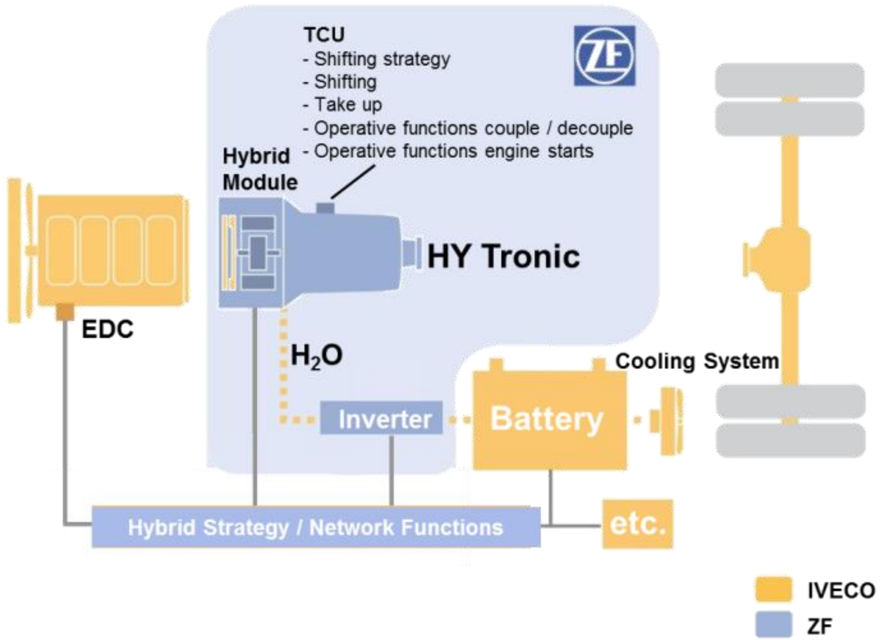
Lithium Battery
The battery supplies the baseline energy requirements and part of the power for traction and the overnight mission.

WP A1.8 Hybrid Transmission Integration

The main objective of this work package is to integrate the hybrid transmission into the IVECO Stralis truck.

Task A1.8.1:

- ZF and CRF/IVECO have jointly defined the E/E architecture / hardware interface / content of provided functions
  # completed
- ZF have started to adapt Function / Software for IVECO Stralis driveline
  # completed



WP A1.1 Concept Analysis and Simulations

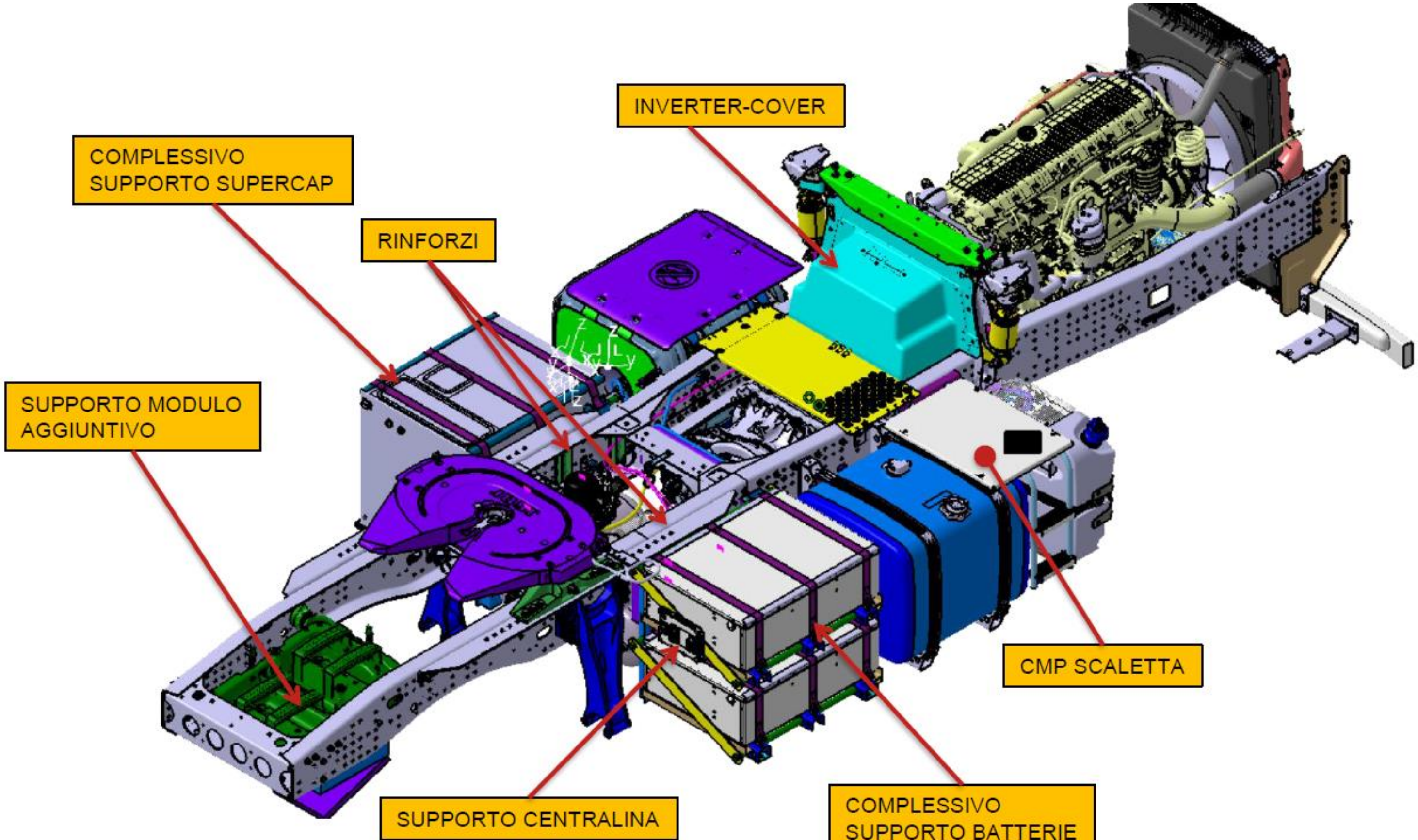
Task A1.1.1:
- ZF has provided technical data of the hybrid transmission, to allow CRF to model it **# completed**

Task A1.1.2:
- ZF has provide the updated CAD model of TraXon Hybrid transmission, Inverter & simplified battery (Continental) to IVECO **# completed**

WP A1.8 Hybrid Transmission Integration

Task A1.0.1:

- Hybrid Transmission virtual integration into IVECO Stralis truck **# completed**

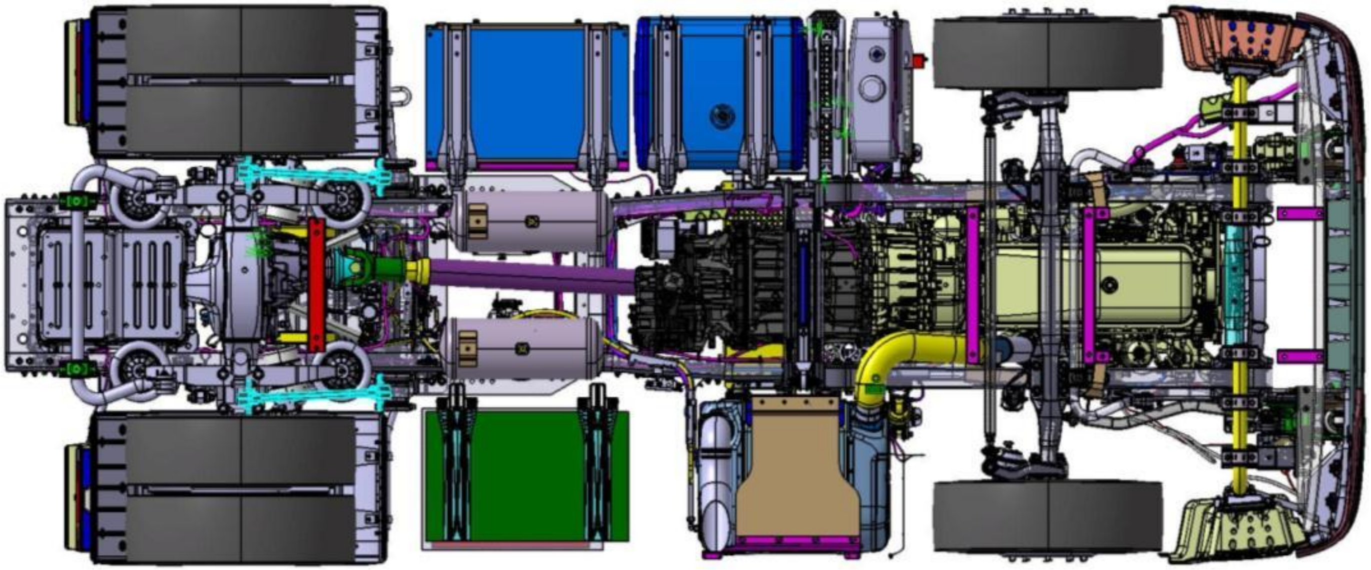


WP A1.8 Hybrid Transmission Integration

The main objective of this work package is to integrate the hybrid transmission into the IVECO Stralis truck.

Task A1.8.1:

- Hybrid Transmission integration into the IVECO Stralis truck **# done**
- Definition of a wiring diagram to purchases the harness **# done**
- Initial operation of prototype vehicle and software troubleshooting **# done**
- Optimization and calibration of function software **# done**



WP A1.9 Prototype Truck 1 building-up and calibration

IVECO

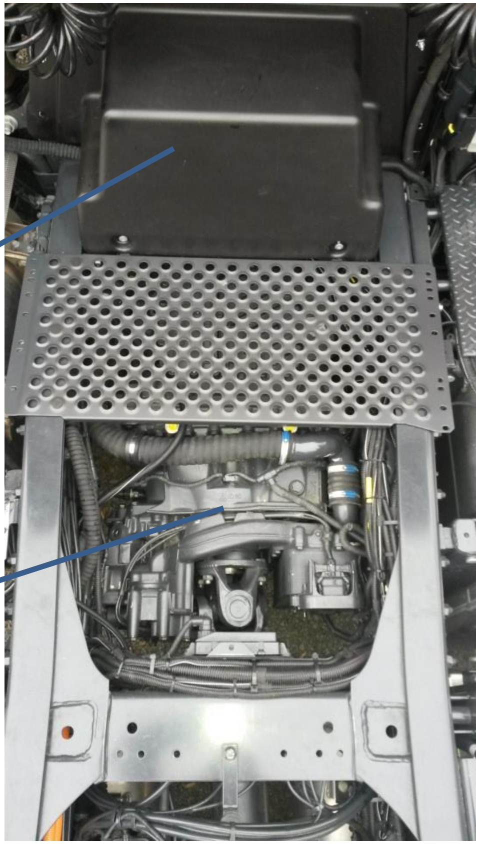
WP A1.9 Prototype Truck 1 building-up and calibration

Inverter

Hybrid transmission

Supercaps

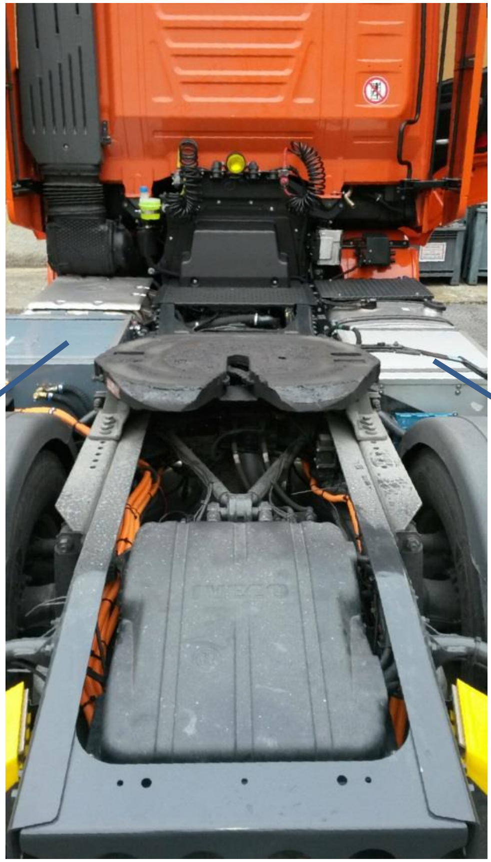
WP A1.9 Prototype Truck 1 building-up and calibration

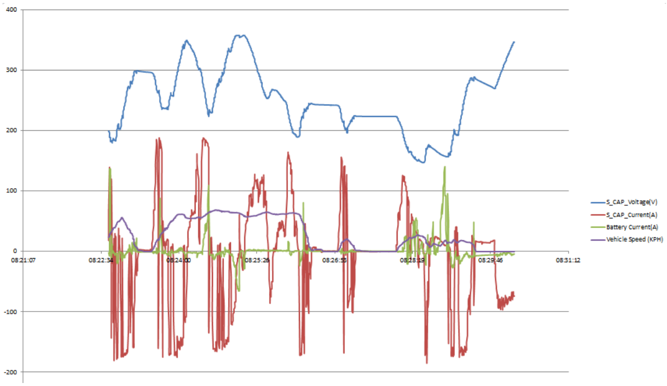


Inverter

Hybrid transmission

WP A1.9 Prototype Truck 1 building-up and calibration





Supercaps

Lithium batteries

WP A1.9 Prototype Truck 1 building-up and calibration

Recharge plug

WP A1.9 Prototype Truck 1 building-up and calibration

Battery Charger

	File	Amb. Temper. [°C]	Time [sec]	Distance [km]	Average speed [km/h]	Average rpms
Highway Mission	N106	20	1796	37,2	74,62	1166
	N107	20	1796	37,2	74,61	1221
	N108	21	1859	37,2	72,02	1152
	N109	24	1805	37,2	74,20	1219
	N110	25	1791	37,2	74,80	1167
	N111	26	1792	37,2	74,76	1161
	N112	25	1793	37,2	74,73	1214
	N113	23	1798	37,2	74,51	1216
	N114	26	1795	37,2	74,63	1155
	N115	29	1800	37,2	74,43	1210
	N116	29	1797	37,2	74,54	1195
	N117	25	1838	37,2	72,85	1216
	N118	26	1803	37,2	74,32	1157
Hybrid vehicle - DIESEL Mode	Average	24	1805	37,2	74,22	1216
HYBRID vehicle - Charge sustaining mode	Average	23	1811	37	74	1158
HYBRID vehicle - Charge depleting mode	Average	27	1797	37	75	1173

DIESEL	-
HYBRID - Charge sustaining	-0.5%
HYBRID - Charge depleting	-10%

WP A1.2 - Predictive Eco-Driving System

Predictive Cruise Control definition :

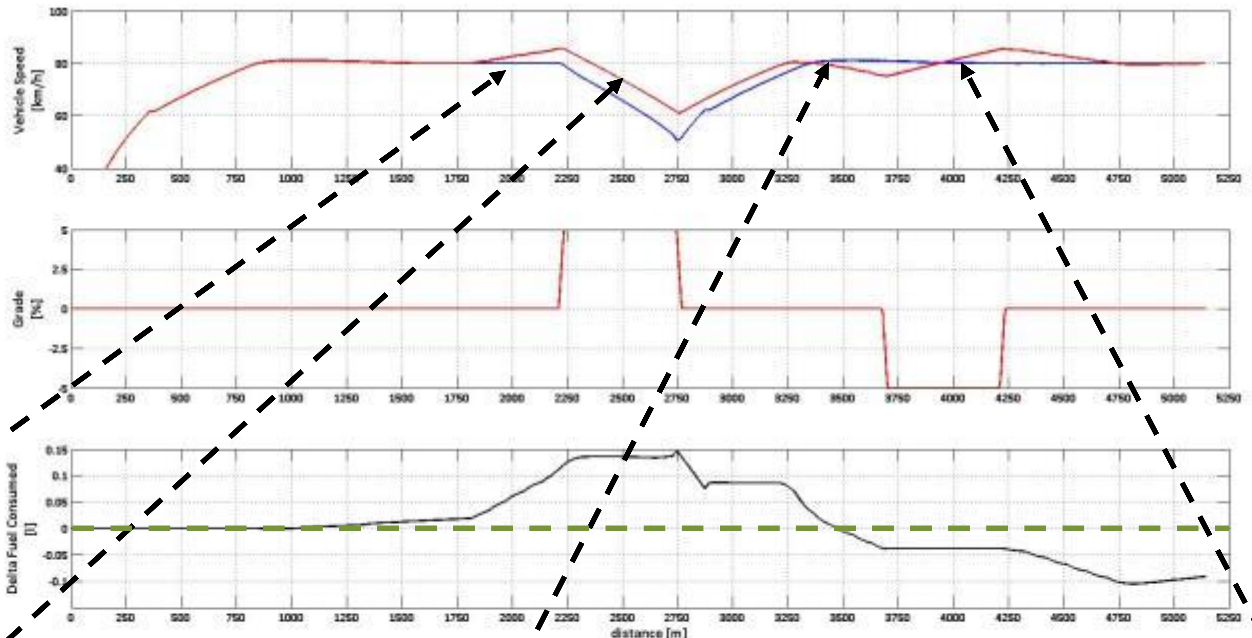
it is an Advanced Cruise Control system evolved with the adoption of electronic horizon (E-Horizon platform).
By knowing the real time position of the vehicle via GPS, the system will look onto the topographical data of the route and intelligently control the vehicle speed to be followed which in turn results in terms of fuel savings.

WP A1.2 Predictive Cruise Control simulation on Simplified Scenario

IVECO's Predictive Cruise Control has been deployed onto the vehicle model in the simulation environment. To make sure the strategy works in a desired way, we have applied a simplified mission consisting of an uphill, downhill and a flat road.

the system will foresee the increase/decrease in the gradient of the road up to 2 km

Predictive CC disabled
Predictive CC enabled



Before the increase in the gradient of the road, vehicle speed increases up to 7% so that the vehicle can climb the hill without too much stress on the engine

Once the vehicle starts climbing the uphill, the vehicle speed decreases. When the vehicle speed falls below the set threshold, the system de-activates automatically

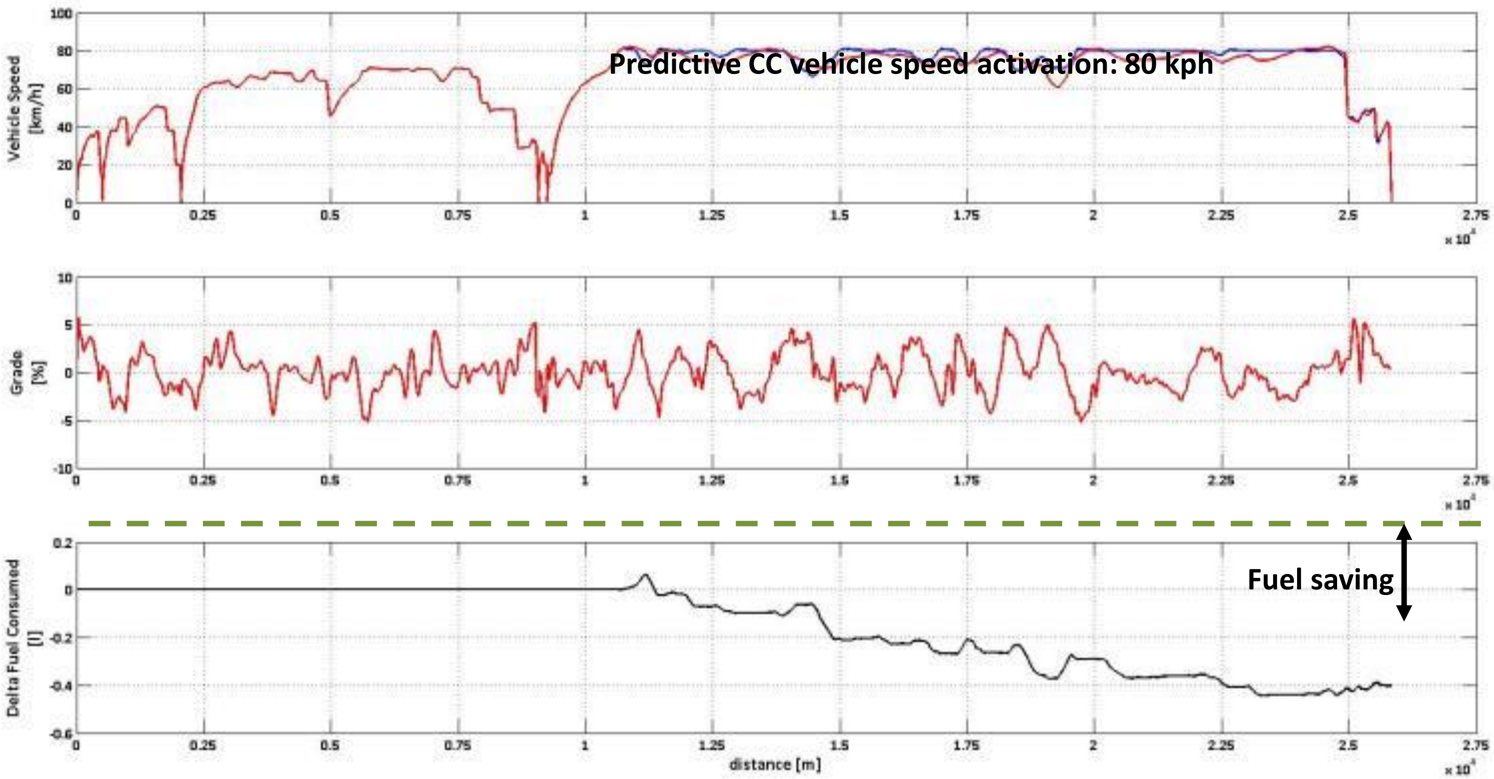
Before the decrease in the gradient of the road, vehicle speed decreases up to 7%

Once the vehicle descends down, the speed automatically increases due to its inertia. The increase in speed will be up to the defined threshold. Then the system de-activates automatically and the vehicle speed will be controlled manually by the driver

Use case: Hybrid Vehicle with e-Powertrain (139 kW 1050 Nm EM + 26 kWh HV battery)

Test cycle: ACEA Regional Delivery cycle with Italian legal speed limits

Predictive CC disabled
Predictive CC enabled



Use case: Hybrid Vehicle with e-Powertrain (139 kW 1050 Nm EM + 26 kWh OPAC HV battery)
Test cycle: ACEA Regional Delivery cycle

	Predictive Cruise Control	
Vehicle Type and Configuration	ACEA Regional Modified Cycle	ACEA Regional Cycle
	[Max Speed – 80 kph]	[Max Speed – 85 kph]
	Fuel Consumption Reduction [%]	Fuel Consumption Reduction [%]
Hybrid Configuration Predictive CC – OFF	NIL	NIL
Hybrid Configuration Predictive CC -- ON	-4.0 %	-4.3 %

The fuel save has been achieved with a negligible time increase of **30 seconds**.