Truck Architecture and Hydrogen Storage

CNHi

Turin

Oct 28th 2020

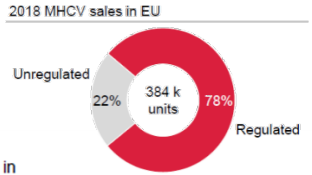
List of Contents

Decarbonization Workshop

- C02 regulation
- Vehicle architecture evolution for Hydrogen Fuel Cell Heavy Duty Vehicle
- Hydrogen Storage options Impact on vehicle architecture
- Hydrogen Fuel Cell HCV enabling factor in an ecosystem

Co2 emission target 2025 and 2030

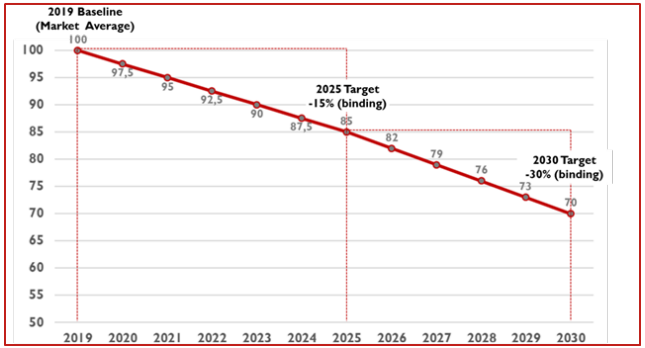
Long Haul mission relevance



Vehicle group	Axle configuration	Chassis	GVW	Included in CO_2 Regulation
0	4x2	Rigid	>3.5, <7.5	Not included*
1		Rigid (or tractor)	7.5 – 10	
2		Rigid (or tractor)	>10, 12	
3		Rigid (or tractor)	>12, 16	
4	4x2	Rigid	>16	Included
5		Tractor	>16	
6	4x4	Rigid	7.5 - 16	Not included*
7		Rigid	>16	
8		Tractor	>16	
9	6x2	Rigid	All	Included
10		Tractor	All	
11	6x4	Rigid	All	Not included*
12		Tractor	All	
13	6x6	Rigid	All	
14		Tractor	All	
15	8x2	Rigid	All	
16	8x4	Rigid	All	
17	8x6, 8x8	Rigid	All	

Cabin type	Engine power	Subgroup
All	<170 kW	4-UD
Day cab	≥ 170 kW	4-RD
Sleeper cab	≥ 170 kW and < 265 kW	
Sleeper cab	≥ 265kW	4-LH
Day cab	All	5-RD
Sleeper cab	< 265 kW	
Sleeper cab	≥ 265kW	5-LH
Day cab	All	9-RD
Sleeper cab		9-LH
Day cab	All	10-RD
Sleeper cab		10-LH

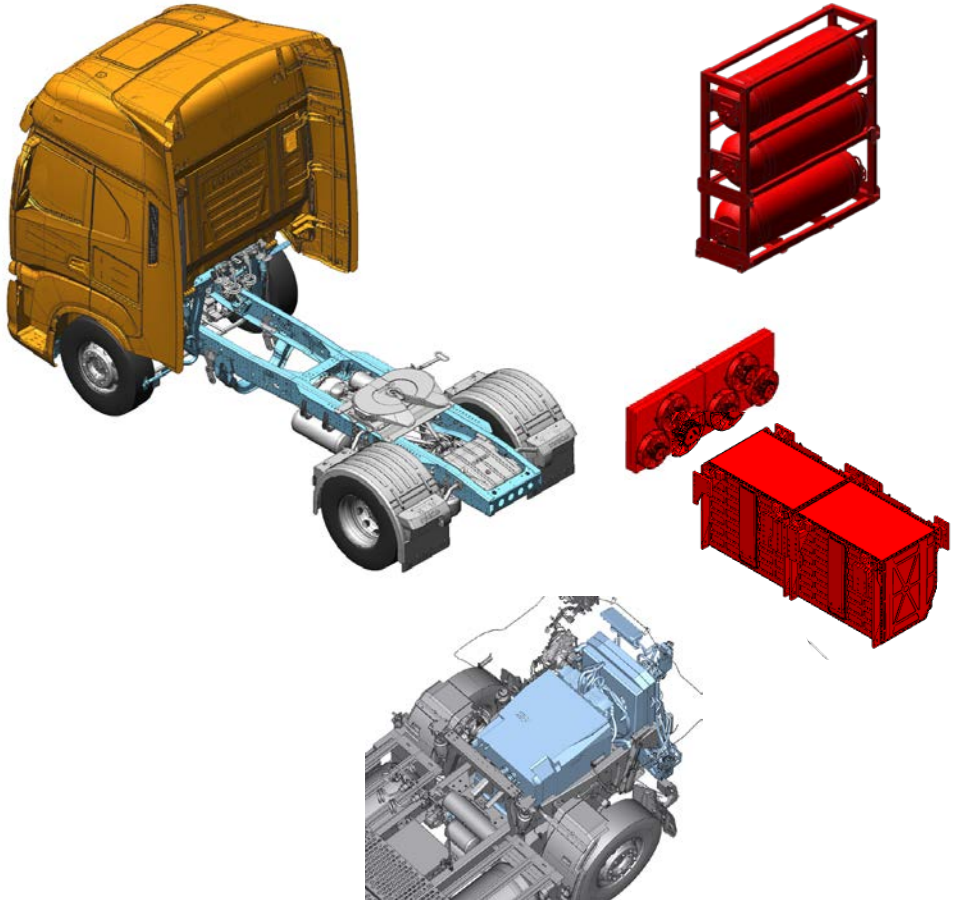
- The subgroup division is made accordingly to the typical mission profile trucks will be tested on
- For each subgroup, a typical annual mileage and payload is defined
- Using these values a MPW (Mileage and payload weighting) factor is attributed to each subgroup



Vehicle architecture

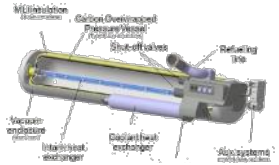
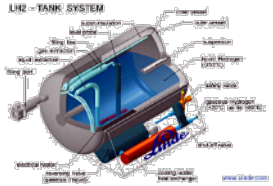
An evolution challenge

1. Artic chassis frame architecture as starting poi
2. Electrification components
3. To be added
    1. Fuel cell module
    2. Batteries
    3. Hydrogen storage
    4. E axle
4. Thermal management



Hydrogen Storage

Available options

	Compressed H2 350 BAR	Compressed H2 700 BAR	Cryo Compressed H2	Liquid H2
				
Max storage pressure	350 bar	700 bar	300 bar	4 to 6
Volumetric Density (including BoPs)*	16 g H2/L of Tank	27 g H2/L of Tank	40 g H2/L of Tank	36 g H2/L of Tank
Maturity (status Aug 2020)*	Very Mature	Very Mature	Prototype	Mature for other applications (Aerospace)
Cost Estimation 2025	reference	+10% €/kg H2	-	-35% €/kg H2

*Internal elaboration from various sources

Hydrogen Refueling Station

Truck - Station interface

	Compressed H2 350 BAR	Compressed H2 700 BAR	Cryo Compressed H2	Liquid H2
Hardware	H35 HF35F Available	H70 Available HF70H under development	-	Under discussion for HDV application
Protocol	H35 HF35F available	H70 Available HF70H under development Vehicle /Station two ways communication	-	Under discussion for HDV application
Refilling time	3.6 kg/min 7.2 kg/min	3.6 kg/min 10 kg/min	-	5 kg/min est.

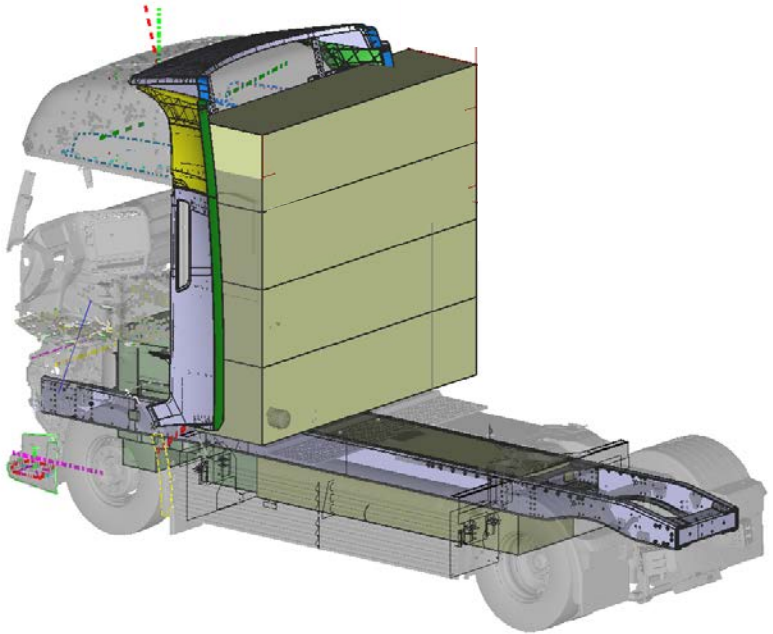
Vehicle architecture

Vehicle geometry challenge

Hydrogen HDV for long haul mission will require an extra volume

Challenges for

- Turning radius
- Overall length
- ISO trailer compatibility to have flexibility in operations



Hydrogen Value Chain

Two main possible path

Primary Energy	Production	Distribution	Refilling

Renewable/Near Zero Emission

Wind

Solar

Hydro

Nuclear

Biomass

By-product

Electrolysis

Liquefaction Unit

H2 Liquid truck
(up to 4.000 kg H_2)

CG Storage

Compressor

Heat Exchanger

Hydrogen Buffer

Compressed
H2 350 BAR

Compressed
H2 700 BAR

Fossil

Natural Gas

Coal

Steam Reforming

CG Storage

H2 Tube Trailer truck
(up to 1.000 kg H_2)

Liquid Storage

H2 Liquid Pump

Cryo Co H2

Liquid H2

Vehicle as enabling factor

TCO driven

Technology Challenge

- range
- fuel efficiency
- payload
- flexibility
- refuelling tim

TCO main CHALLENGE

- hydrogen cost