Italian National Agency for New Technologies,
Energy and Sustainable Economic Development

TTG Transport Task Group

H2 as Opportunity for ZEHDVs

«2021 TTG ANNUAL MEETING»

September 30, 2021

ENEA Energy Technologies and Renewable Sources Department
V. Cigolotti and A. Genovese

A sustainable and fair path

2030 European Green Deal
- 55% GHG emissions

2050
net zero GHG emissions

1997 *Kyoto*

2012 *2020 Climate & Energy package*

2015 *Paris*

2020 *European Green Deal*

2021 *Fit for 55*

2030

2050

Energy Transition

4 key points

> Socially fair
> Economical sustainable
> Energetically reacheable
> Enviromentally friendly

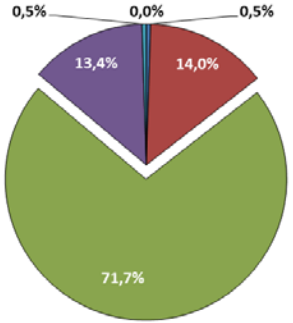
The **Just Transition Fund (JTF)** to alleviate the socio-economic costs for communities across the EU that are heavily dependent on fossil fuels or greenhouse gas-intensive industries.

"We must show solidarity with the most affected regions in Europe, such as coal mining regions and others, to make sure the Green Deal gets everyone's full support and has a chance to become a reality."

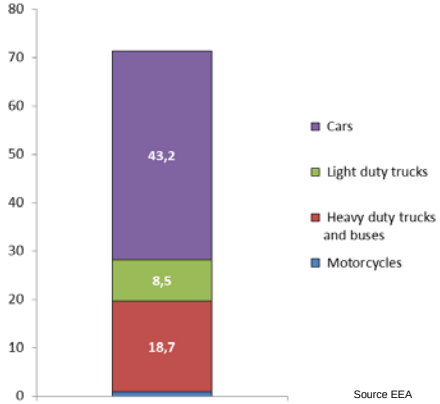
Frans Timmermans, Executive Vice-President of the European Commission

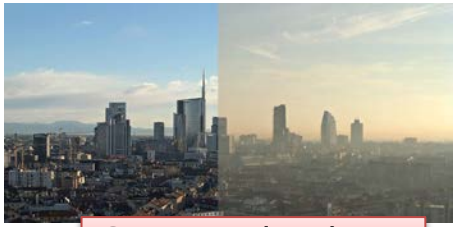
The role of transportation: from national commitments to the territory

GHG emissions by transportation



- Other Transportation
- Aviation
- Road transport
- Maritime
- Railways
- Other Road Transportation





Smog and Noise

Air pollution

GHG Transportation **29%**

GHG Road **20.8 %**

GHG Trucks & buses **5.4 %**

Trucks & buses share on overall GHG emissions

ZeroEmission HDVs: transition or transformation ?

2050
net zero GHG emissions

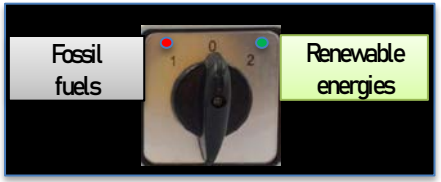
EU Transportation Target

2050
- 90% GHG emissioni

Energy system

Transition — *The process of changing from one system to another*

Transformation — *The process of changing completely the character or appearance of something in order to improve it*



HDVs for 2050
Affordable
Sustainable
Safety
Resilient

$(Neutrality)^3$ =

- Climate
- Technological
- Operational

One recipe …. more ingredients

Green Energy

Storage

Infrastructures

Renewable sources

Batteries, chemical

Charging stations

Electric network

Renewable hydrogen

Gaseous, liquid, (solid)

Bio-methane

Gaseous, liquid,

Bio-fuels e-fuels

Liquid

Refuelling stations

Distribution network (pipe, trucks, ships,..)

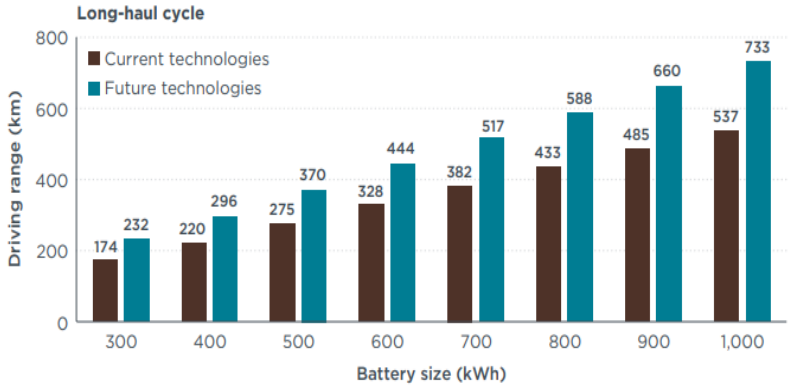
Battery Electric Truck range

Batteries Europe 04.12.2020

The range for a battery HDV depends on battery size and weight of the vehicle.

The battery range for a typical battery freight vehicle is around 100–200 km on a single charge

Some manufacturers claimed a range up 800 km



ICCT WORKING PAPER 2021-29 | BATTERY ELECTRIC TRACTOR-TRAILERS IN THE EUROPEAN UNION

Road transport: medium and heavy duty BEV*					
Typical Battery Size: 150-600 kWh (today), up to 1000 kWh (in the future)					
KPI	Operating conditions	System/Pack/ Cell level	Unit	2020	2030
PERFORMANCE					
Cell/pack weight ratio		Pack	%	70	80
Cell/pack volume ratio		Pack	%	60	75
Operating lifetime expectation	Minimum guaranteed lifetime (equivalent 80% DOD)	Pack	km	~750,000 (~Vehicle lifetime)	
Gravimetric Power density**	180s, SoC 100%-10%, 25°C	Cell	W/kg	750	1,000
Gravimetric Energy density	C/3 charge and discharge, 25°C, charging with CC and CV step	Cell	Wh/kg	~250	~450
Volumetric energy density	C/3 charge and discharge, 25°C, charging with CC and CV step	Cell	Wh/L	~500	1,000
Volumetric power density**	180s, SoC 100%-10%, 25°C	Cell	W/L	1,500	2,200
Cycle life	80% DOD, 25°C	Cell	cycles	3,000	6,000
Hazard level		Cell	-	<=4	<=4
COST					
Cost		Pack	€/kWh	~400	~150
Cost		Cell	€/kWh	~140	~75
MARKET					
Market size	Source: Avicenne Energy, 2019, IEA Global EV Outlook 2020		GWh/year	~20	~200

800 km ---> 1.25 kWh/km ---> 1 MWh battery capacity

Battery weigth & volume

Current	5.7 ton (2020)	Expected 2.7 ton (2030)
Current	3.3 m3 (2020)	Expected 1.3 m3 (2030)

Electric Battery HDV : the charging impact

3.5 MWh
Average annual electricity consumption of a household in EU

3 kW
Max load Power

1 truck charge = 1/3 annual household consumption

1 MW Ultra fast truck charge = 330 households

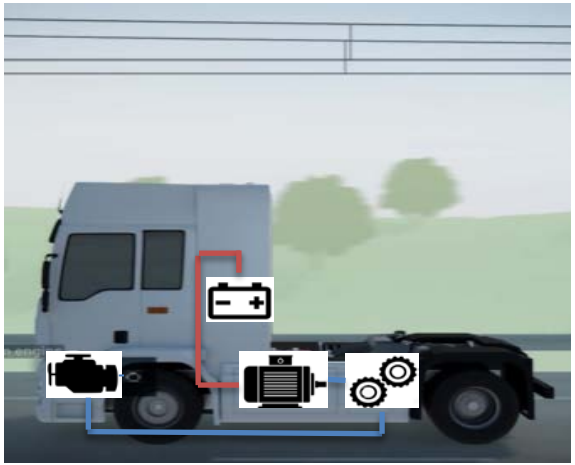
The question arises whether or not the renewable electric generation capacity and grid could cope with the new demand

The recharging time for a battery HDV depends on the type of charger, the battery capacity of each truck and battery technology

1 MWh battery capacity	350 kW Ultra Fast Charger	4 hours
	80 kW Fast charger	18 hours

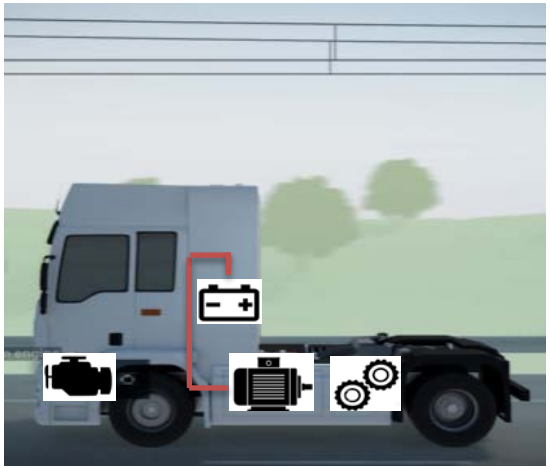
10 HDVs	Grid power	3.5 MW
		800 kW

Electric Road Systems to increase the electric range



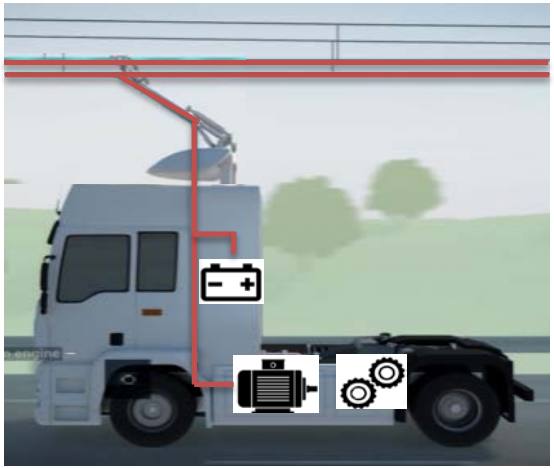
Diesel powered (also fueled with bio-fuel) in cooperation with electric motor

Hybrid configuration consent to operate as a conventional truck but with reduced emissions.



Full electric with limited range

Zero emission range is limited by battery size



Full electric with line connection

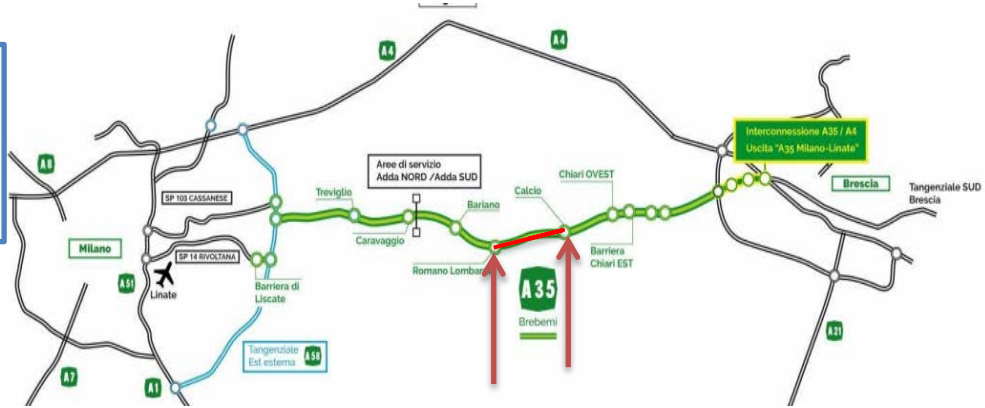
Electric energy from overhead line consent to operate battery charging and electric traction increasing full electric range

Electric Road Systems (ERS): an Italian Case Study

The pilot project is based on the electrification of about 6 km stretch for each direction on Brescia-Bergamo-Milano motorway (**A35**) beetwen **Calcio** and **Romano di Lombardia** exits.
It is based on a German-Sweden technology.

Power supply by an overhead line contact (750 V DC)

Hybrid HDV solution (SCANIA)



On electrified road sections the truck is connect to the electrical overhead line - via pantograph - receiving the energy needed to run without polluting emissions and to recharge the battery thus to increase the zero emission range.

On roads without infrastructure or when overtaking, the vehicles continue, using their own hybrid drive engine.

For a small distance (i:e. city roads) the truck can run full electric , using electric drive engine only.

Battery vs. Hydrogen ?

Competion

Energy Production

Transport

Storage

Distribution

Use

2° use

Range

Refuelling Recharging

Life span

Cost

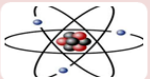
System application

Complementarity

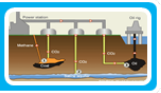
H2: Production and final use in transportation

Green
Electolysis of water using electricity from renewable energy

Pink
Electolysis of water using electricity from nuclear energy



Blue
Steam reforming of methane with CCUS



Turquoise
Thermal splitting of CH4 with solid carbon as by-product

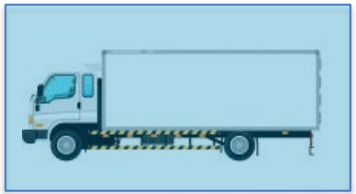
Yellow
Electrolysys using energy mix

Grey
Steam reforming by natural gas

Brown
From coal with no CO2 capture

H2 as fuel in transportation

- Long haul
- No electrified railway
- On road public transportation
- Inland navigation and ferries



H2 for HDV: first commercial vehicles

Hydrogen for road freight transport in Italy

Tab. V.4.2. - Trasporto merci su strada interno, internazionale e complessivo per titolo di trasporto[a] - Anno 2018

Titolo di trasporto	Conto proprio		Conto terzi		Complessivo	
	Tonnellate (migliaia)	Tonnellate-km (milioni)	Tonnellate (migliaia)	Tonnellate- km (milioni)	Tonnellate (migliaia)	Tonnellate-km (milioni)
Trasporti interni	153.191	7.209	743.244	104.520	896.436	111.728
Trasporti internazionali	1.753	304	22.543	12.882	24.296	13.187
Trasporti complessivi	**154.945**	**7.513**	**765.787**	**117.402**	**920.732**	**124.915**

140.000 HDVs

16.800.000.000 vehicles*km

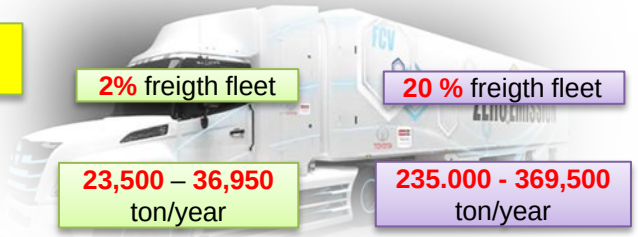
HDVs > 14 tons Km/year → 120.000

H2 specific consumption→ 70-110 g/km

2019
Electric energy generation

Solar	23.19	TWh
Wind	20.03	TWh

Annual H2 consumption x FCHDV
8.400 – 13.200 kg



2% freigth fleet

20 % freigth fleet

23,500 – 36,950 ton/year

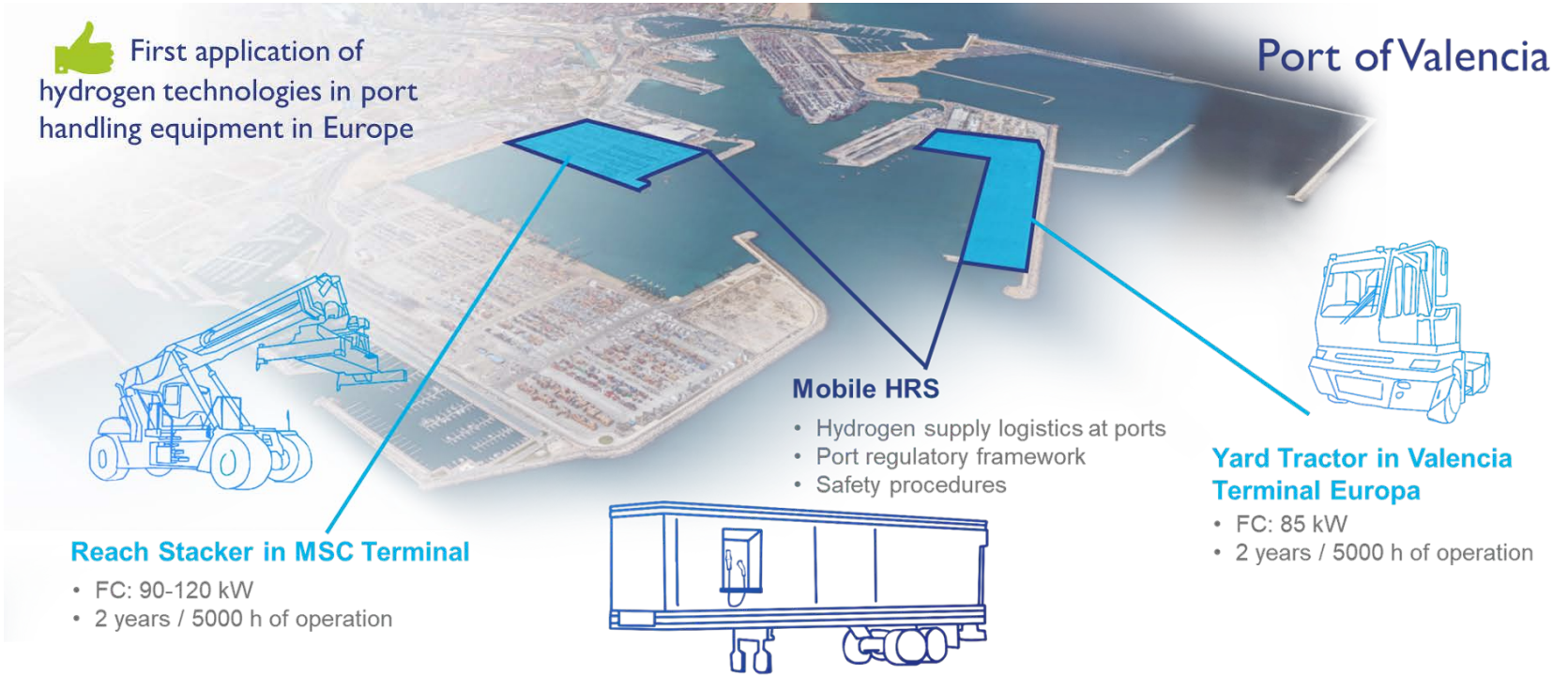
235.000 - 369,500 ton/year

Renewable energy for H2 production

1.17 – 1.84 TWh

11.76 – 18.5 TWh

H2Ports: European Project on HDV



H2Ports: European Project on HDV

Coordination: FUNDACIÓN VALENCIAPORT

Public authorities

valenciaport
Autoridad Portuaria de Valencia

Research institutions

Centro Nacional del Hidrógeno

ATENA
FUTURE TECHNOLOGY

End users

msc TERMINAL VALENCIA

GRIMALDI GROUP

Industry

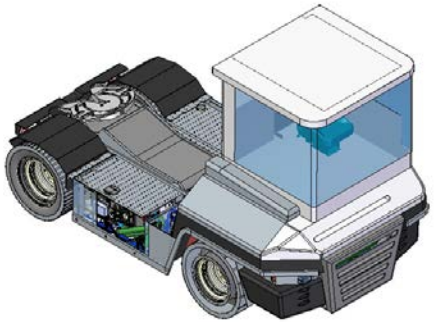
HYSTER-YALE GROUP

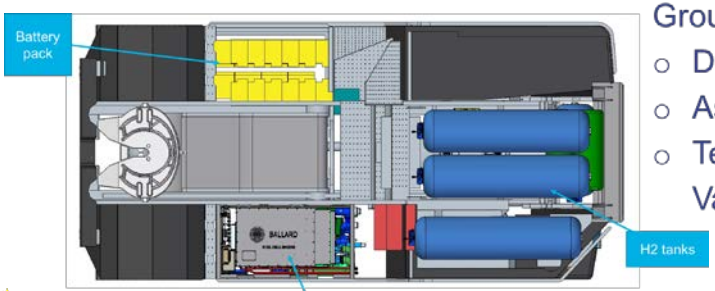
BALLARD

enagas

H2Ports: European Project on HDV

4x4 FC Yard Truck @ Grimaldi Terminal





FCHJU funding € 1,100,000 approx.

ATENA, Grimaldi Group, Ballard, National Hydrogen Centre, Fundacion Valenciaport

Development and deployment a 4x4 Yard Tractor equipped with a Fuel Cells and test it in Valencia Terminal Europa (Grimaldi Group). It involves three tasks:

- Design of the new FCEV YT
- Assembling of new components in the YT
- Testing and Piloting of the FCEV YT in Valencia, Spain

ENEA

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