



Agenzia nazionale per le nuove tecnologie,
l'energia e lo sviluppo economico sostenibile

The role of electric railway in the transport decarbonization

Padua, November 28-30th, 2024

Silvia Orchi – ENEA Researcher



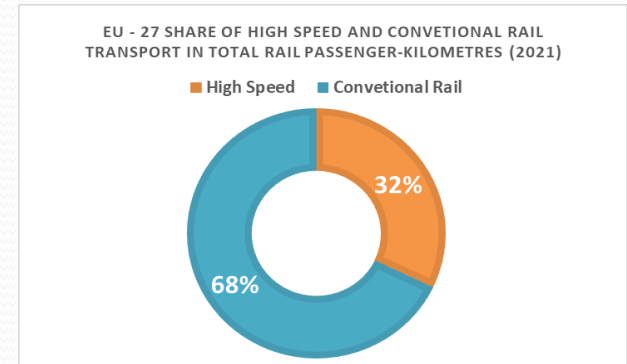
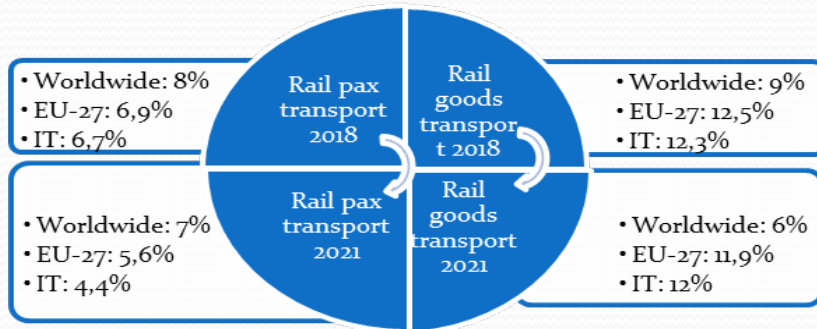
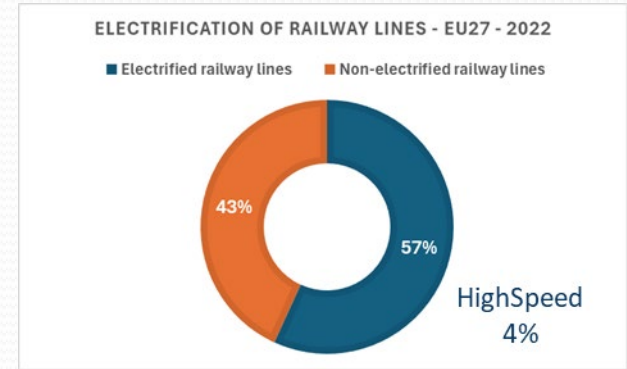
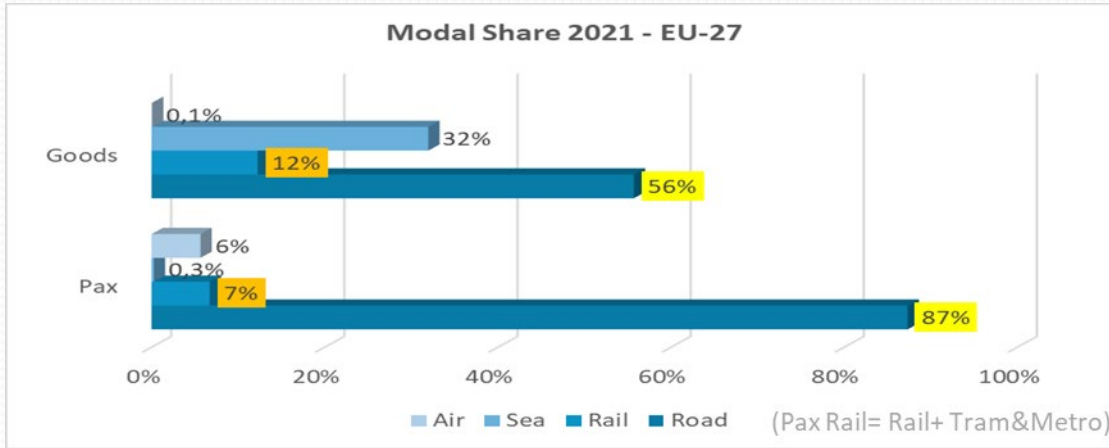
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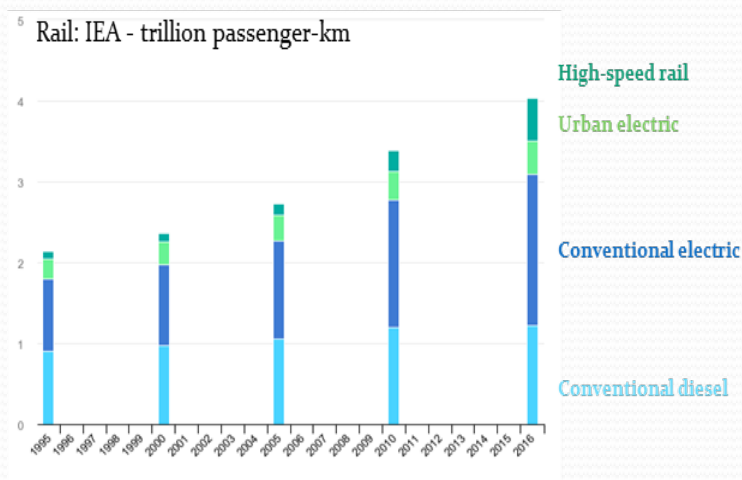
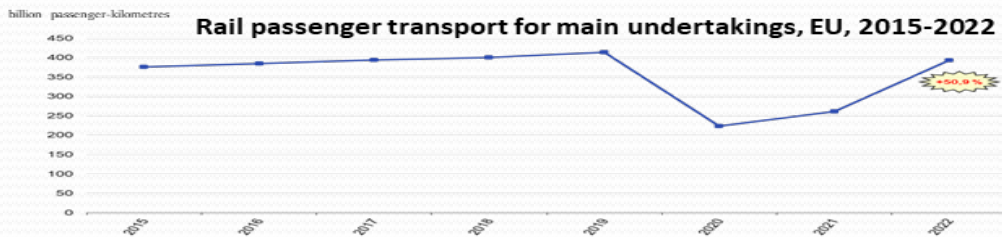
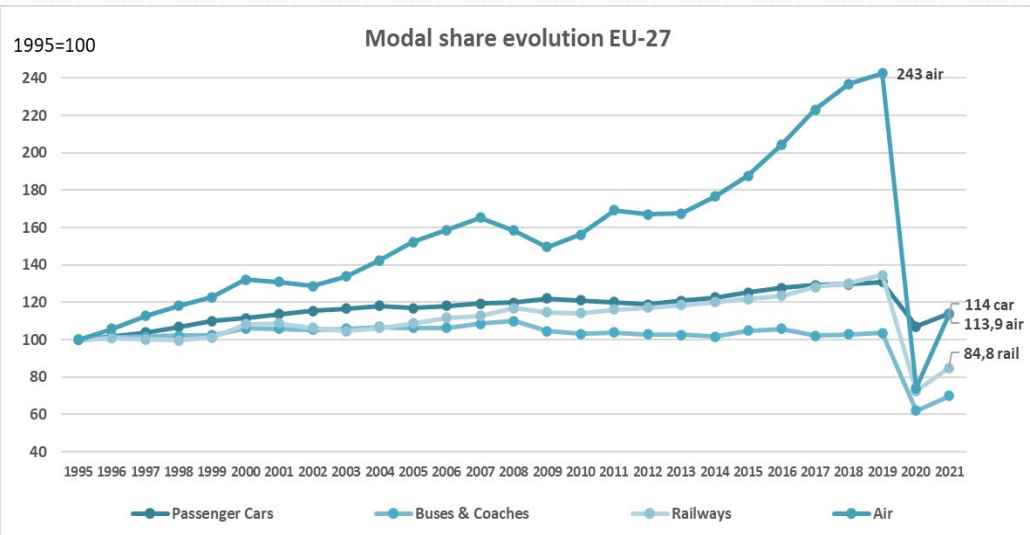
Summary

1. Overview on decarbonization of Transport sector
 - A. Transport Market Data and trends by modal share
 - B. Policy and target
2. Methods
 - A. Analysing the trend of Final Energy Consumption and GHG emissions
 - B. The improvements in rail technology performance
3. Results
 - A. Specific GHG emissions by mode
 - B. Modal shift
4. Conclusions

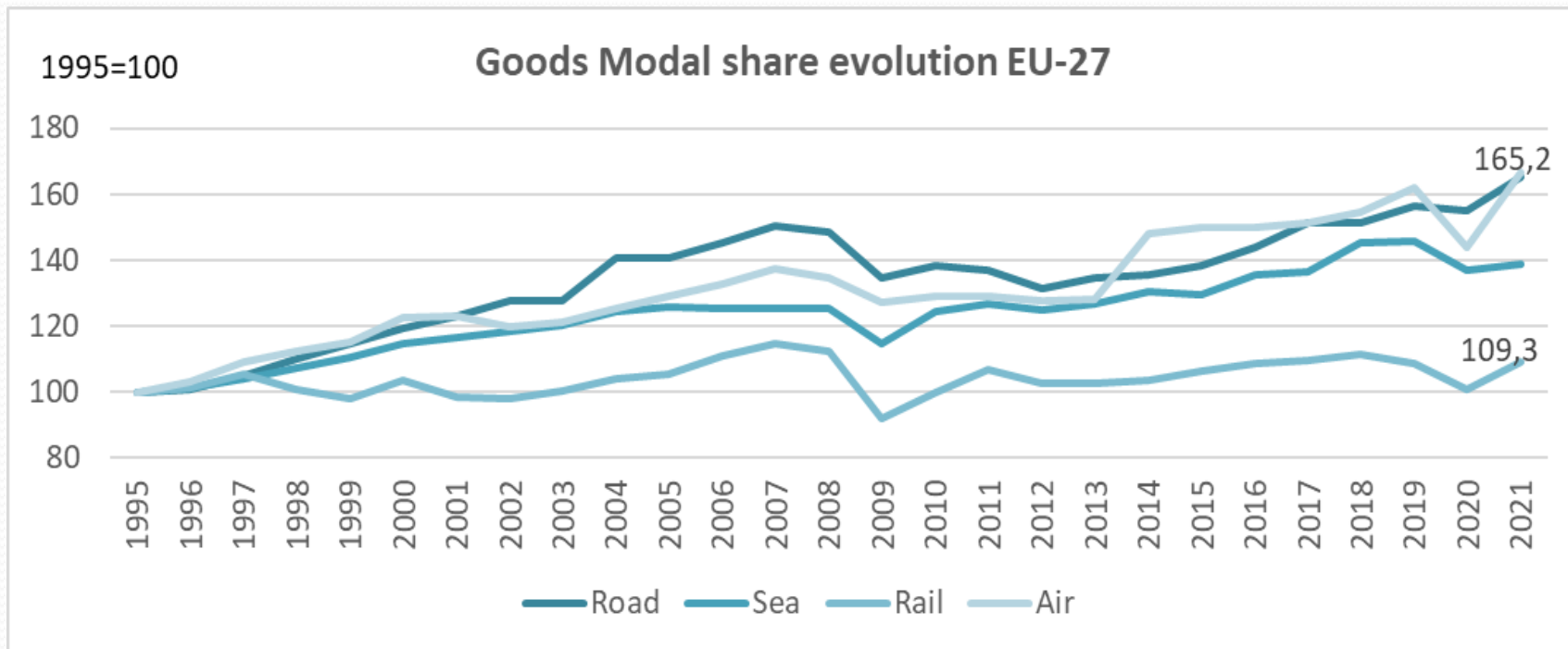
Overview: Transport Market Data and trends by modal share



Overview: Transport Market Data and trends by modal share



Overview: Transport Market Data and trends by modal share



Overview: Policy and targets

Forecast IEA

- passenger and freight activity will more than double by 2050

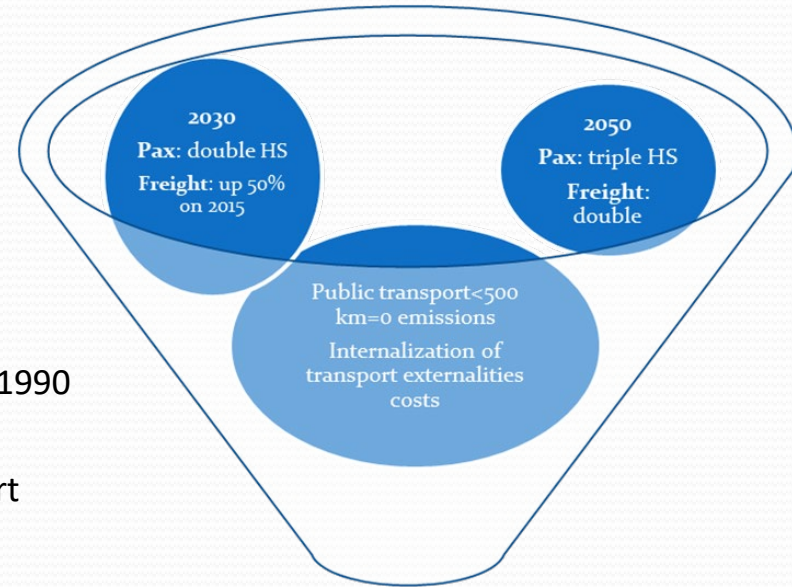
Net Zero Emissions by 2050 Scenario

- shows a pathway for the global energy sector to achieve net zero CO₂-eq emissions by 2050

European Green Deal

- calls for a 90% reduction of GHG emissions by 2050 compared with 1990
- Fit for 55% 2030
 - ETS in international aviation, maritime transport, road transport
 - Sustainable fuels in aviation and maritime transport
 - Ban on the sale of new petrol, diesel or hybrid cars from 2035
 - Renewable energy directive
 - Etc.

EU Smart Mobility Strategy



Carbon neutrality 2050

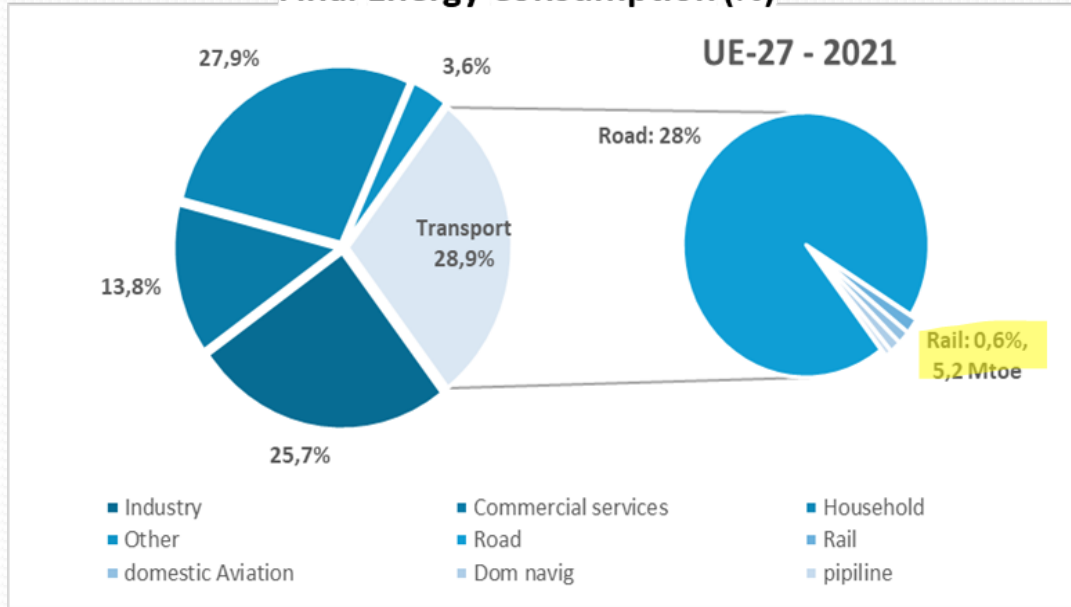
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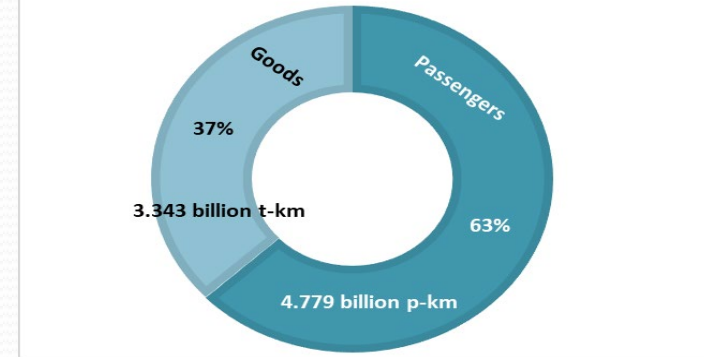
Methods: Analysing the trend of Final Energy Consumption and GHG emissions

Final Energy Consumption (%)

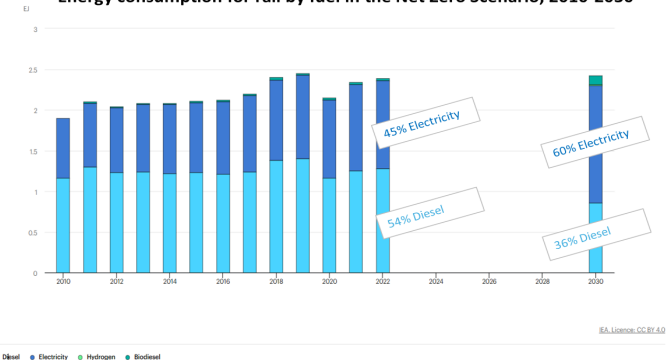
UE-27 - 2021



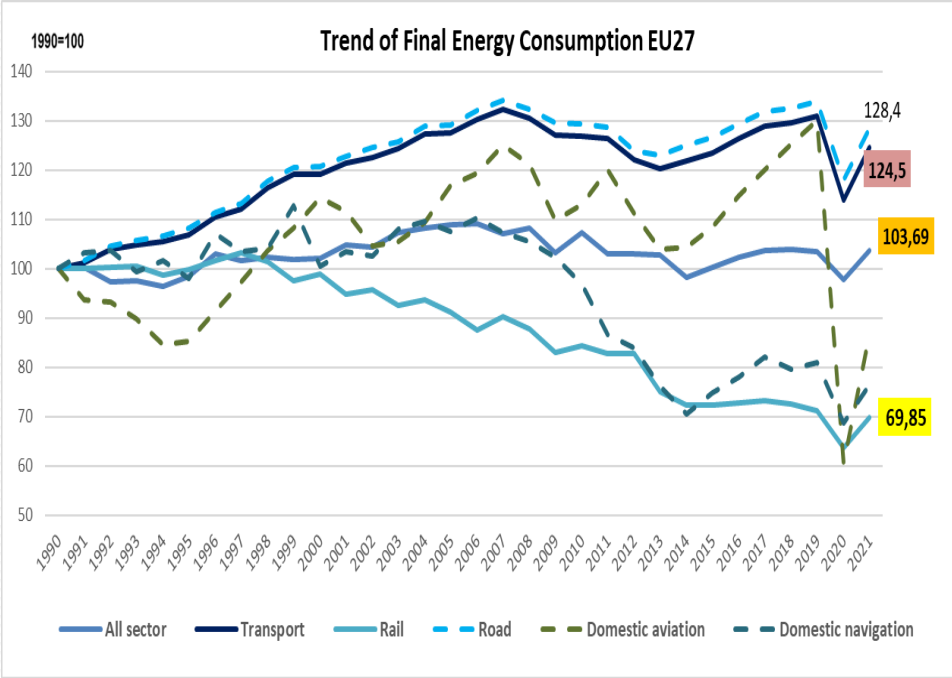
SHARE OF TRANSPORT ENERGY DEMAND EU-27



Energy consumption for rail by fuel in the Net Zero Scenario, 2010-2030

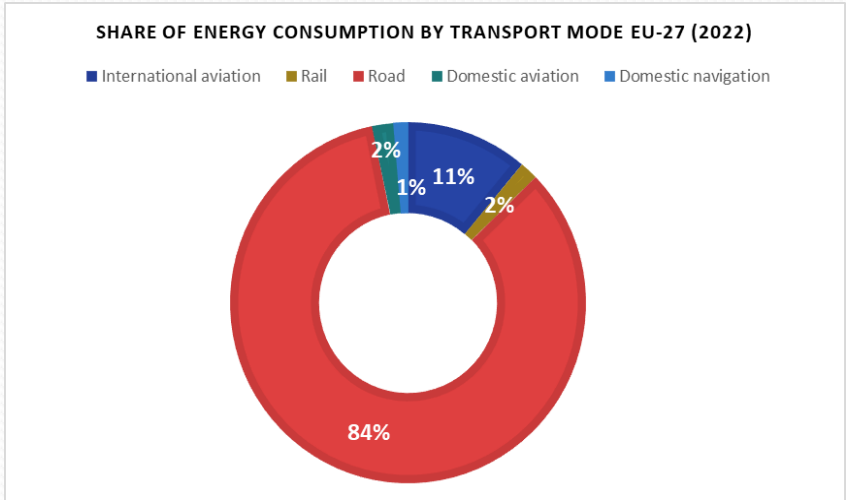


Methods: Analysing the trend of Final Energy Consumption and GHG emissions

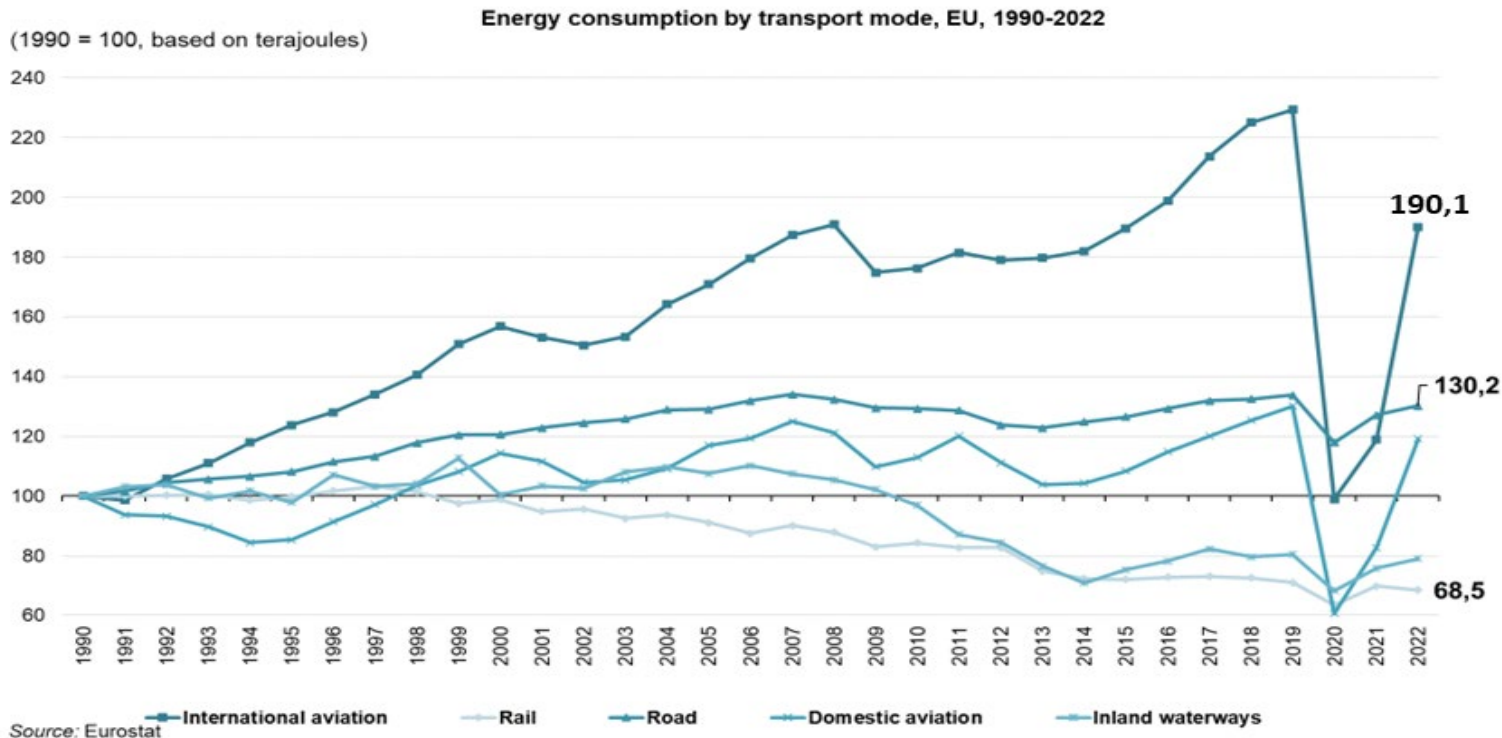


Final consumption by Sector - EU-27 (Mtoe)

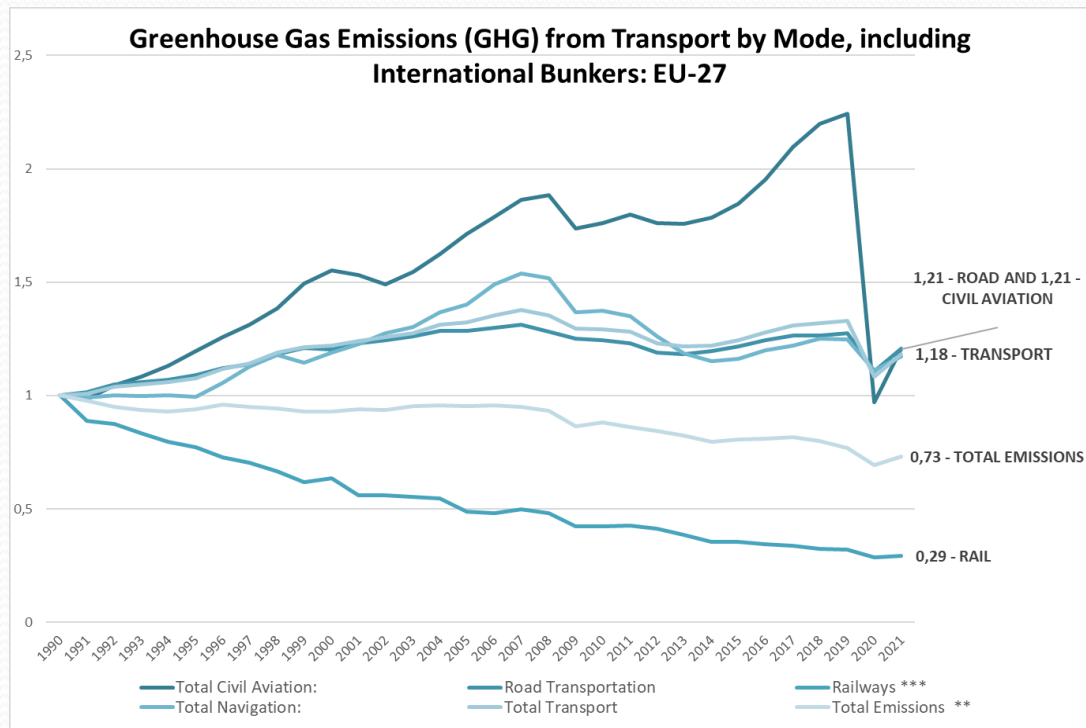
Mtoe	1990	2019	2020	2021	2022
EU-27 – All sectors	906,5	938	885,1	939,2	902,2
EU-27 - Transport	220,7	288,7	251,4	271,8	279,9
Rail	7,5			5,2	
Road	201,6			259	



Methods: Analysing the trend of Final Energy Consumption and GHG emissions



Methods: Analysing the trend of Final Energy Consumption and GHG emissions

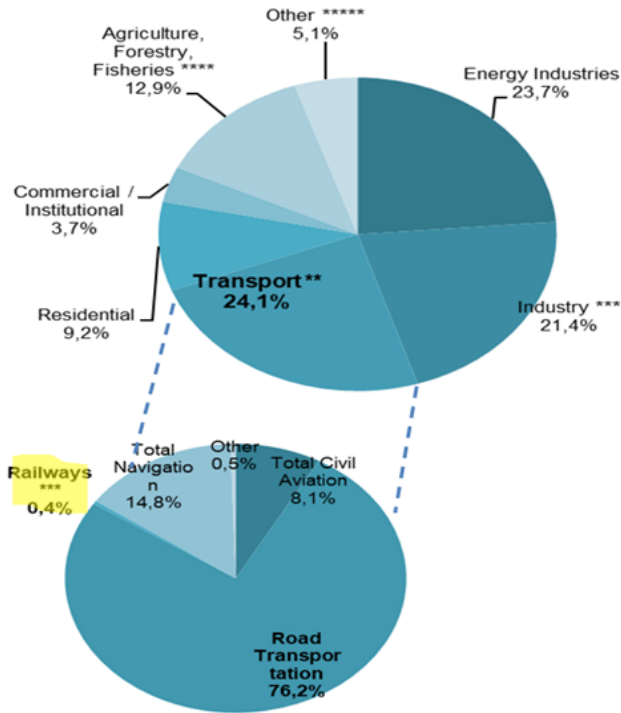


Greenhouse Gas Emissions (GHG) by Sector - EU-27
Excluding international bunker

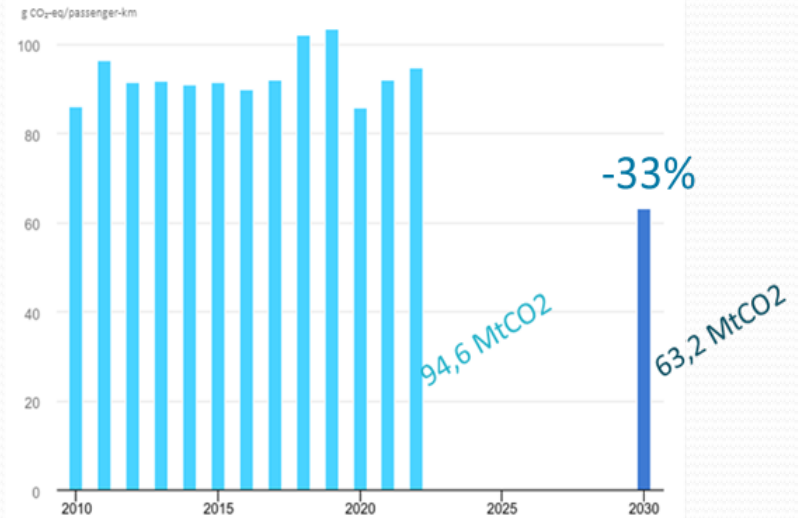
	1990	2019	2020	2021
Mt CO2-eq				
UE-27 – All sectors	4.921,1	3.724,3	3.359,7	3.541,5
EU-27 -Transport	726,6	965,7	776,3	851,9

Methods: Analysing the trend of Final Energy Consumption and GHG emissions

Greenhouse Gas Emissions (GHG)* by Sector: EU-27 (Shares of Total Emissions: 2021)



CO₂ emissions from rail in the Net Zero Scenario, 2010-2030



Methods: The improvements of rail technology performance

Technological development

Energy Recovery System

Energy Storage Systems

Chemical batteries

FC hydrogen

Supercap

Flywheel

Renewable energy sources

PV (powered train)

Wind turbines

Etc.

Information Technology

Digitalization

Innovations

Bi-mode” trains

Unattended Train Operations
(autonomous driving)

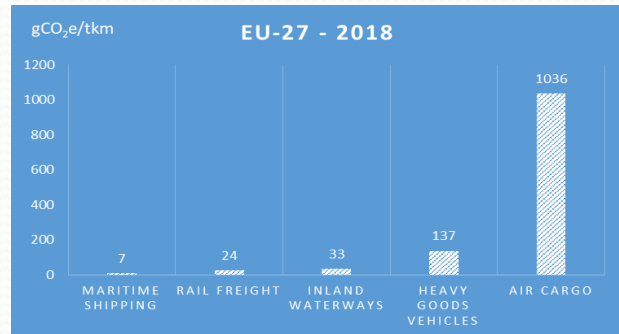
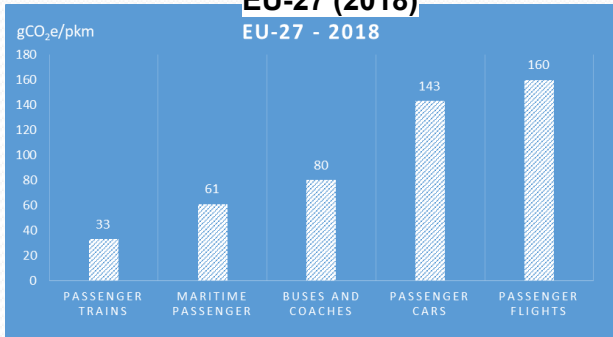
AI for optimal planning

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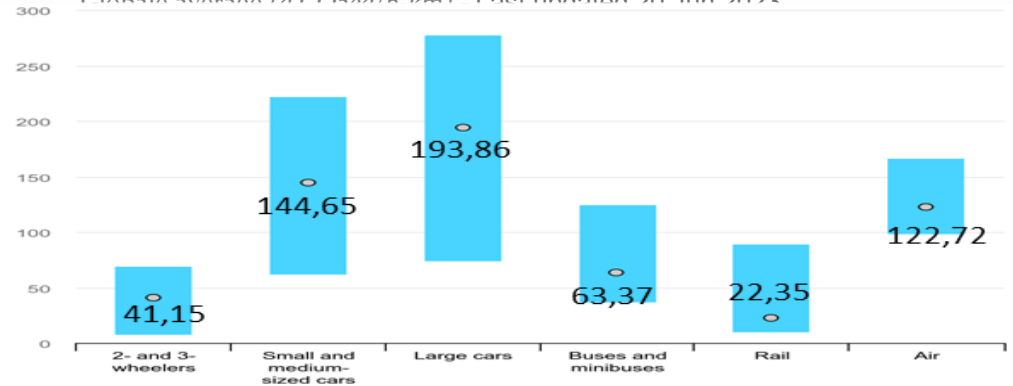
Results: specific GHG emissions by mode

Well-to-Wheel specific GHG emissions by mode of transport for passenger and goods EU-27 (2018)



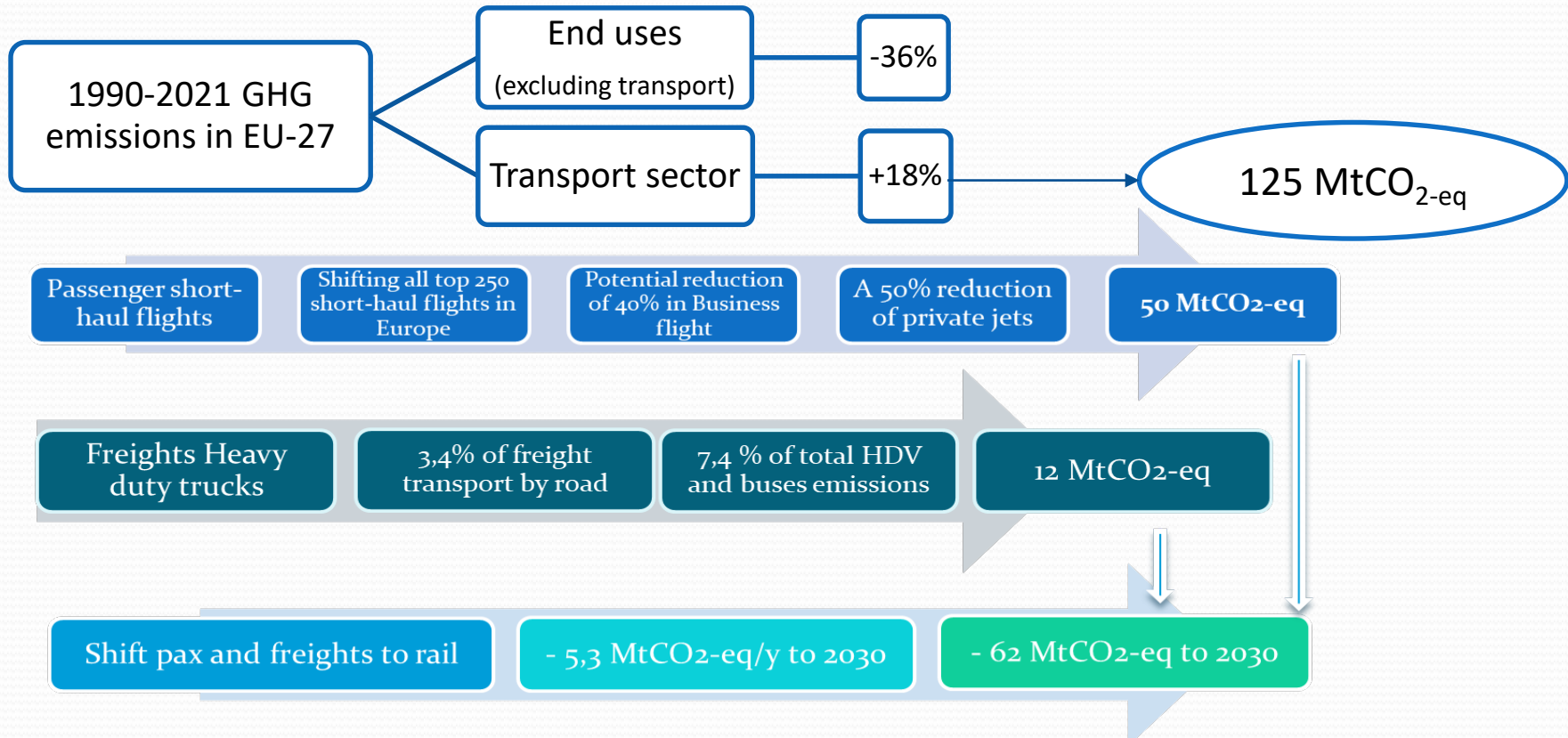
Well-to-wheel GHG intensity of motorized passenger transport modes, 2022

Global average (g CO₂eq/p-km) - Last updated 20 Jun 2023



Mode	GHG Intensity range (g CO ₂ eq/p-km)
2 and 3 wheelers	7,73-68,33
Small and medium size cars	61,98-221,31
Large cars	74,04-276,82
Buses and minibus	37-123,88
Rail	10,03-88,39
Air	98,45-165,68

Results: Modal shift



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Conclusions

How electric railway can contribute in decarbonizing transport:

- ❖ Key strategy in decarbonizing transport
- ❖ Efficient transport mode
- ❖ Improvements from technological performance and the use of renewable electricity
- ❖ Available solution to shift from less sustainable transport modes
- ❖ Reducing external cost of transport



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END THANK YOU

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ITALIAN NATIONAL AGENCY FOR NEW TECHNOLOGIES, ENERGY AND SUSTAINABLE ECONOMIC
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*Sustainable Mobility and Transport Laboratory - Technologies and Vectors for Decarbonization Division -
Energy Technologies and Renewable Sources Department*



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