



# **FRA Decarbonization Workshop**

## **Global Trek Towards Decarbonization**

**Ian Hodgkinson, Alstom**

16<sup>th</sup> May 2023



# Rail in Europe: Context

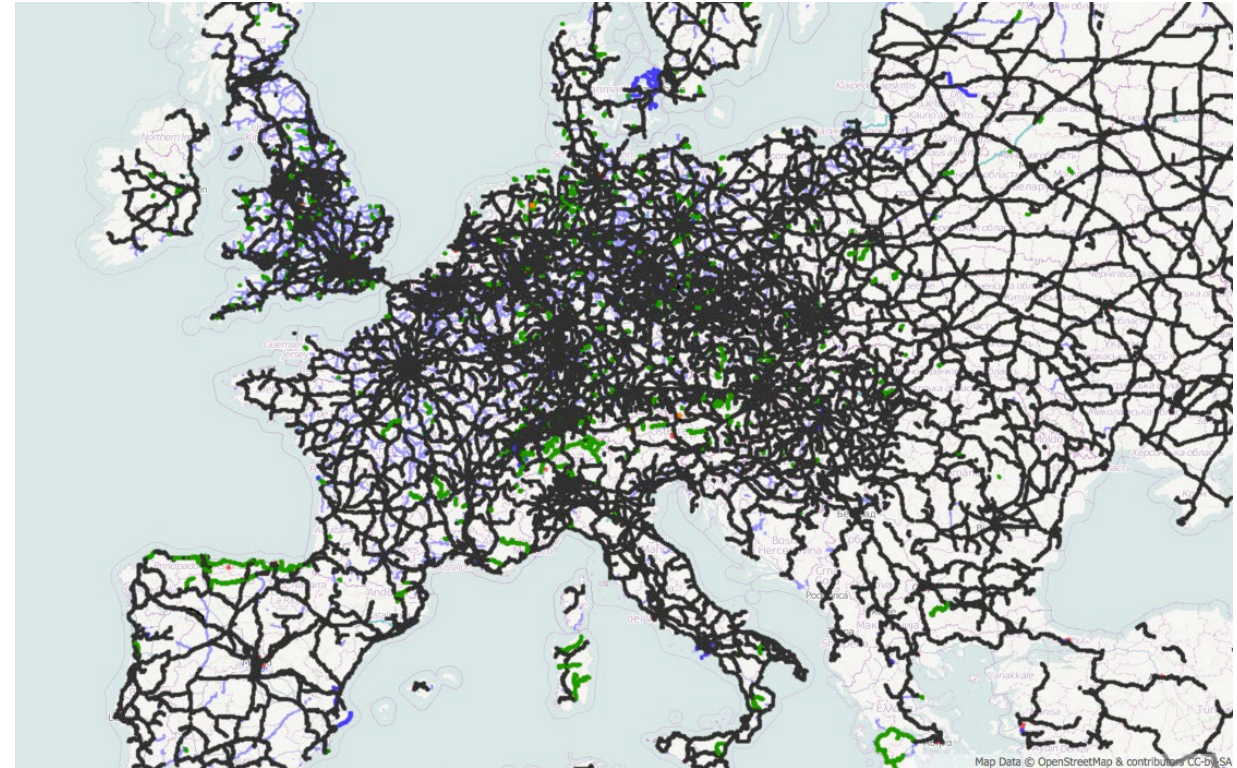
- Total rail network length: ~ 237,000 km (~142,000 miles)
- Percentage of electrification: ~ 55%
- Freight: 400 B tonne-km (274 B Ton-miles) per year (2021) vs ~ 1500 B ton-miles in US
- Passenger: 261 B passenger-km (161 B passenger-miles) (2021) vs 6.4 B passenger-miles (USA – 2019)

## Multiple Standards:

- Different gauges (Iberian, standard)
- Different signalling systems (historically nation – now converging on ERTMS)
- Different electrification standards

## Single European Railway Directive (2012)

- National railway companies split into: Infrastructure, passenger rail, and freight rail
- Provides framework for trans-border railway services



**Figure: European Rail Network** (Wikipedia)



# Europe's Rail

- EU Rail is the new European partnership on rail research and innovation established under the Horizon Europe programme and the successor of the Shift2Rail Joint Undertaking
- The vision is to deliver, via an integrated system approach, a high capacity, flexible, multi-modal and reliable integrated European railway network by eliminating barriers to interoperability and providing solutions for full integration
- The partnership aims to accelerate research and development in innovative technologies and operational solutions
- This will support the fulfilment of European Union policies and objectives relevant for the railway sector and the competitiveness of the rail sector and the European rail supply industry
- EU Rail will accelerate the penetration of integrated, interoperable and standardised technological innovations necessary to support the Single European Railway Area (SERA).

Innovation Programmes	
IP1	Cost-efficient and Reliable Trains, including high-capacity trains and high speed trains
IP2	Advanced Traffic Management and Control System
IP3	Cost efficient, Sustainable and Reliable High Capacity Infrastructure
IP4	IT Solutions for Attractive Railway Services
IP5	Technology for Sustainable and Attractive European Rail Freight
CCA	Cross Cutting Activities



**28**  
MEMBERS



**412**  
PARTICIPANTS



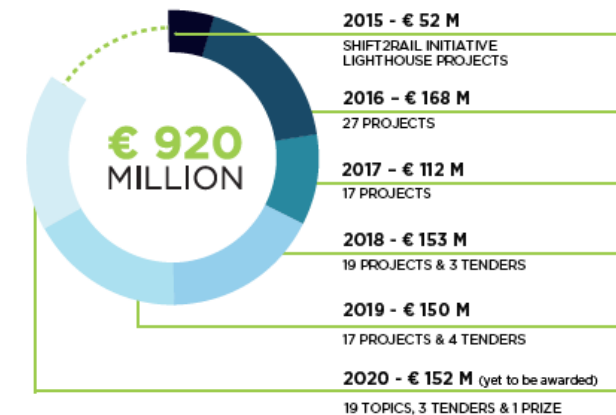
**29**  
COUNTRIES



**109**  
SMEs



**113**  
RESEARCH CENTRES  
AND UNIVERSITIES





# Shift2Rail – Decarbonisation Outputs

- Development of the new generation of traction drives **using silicon carbide technology** to TRL 7
- **A carbon free mobility road map** from 2022 to 2030 detailing the work required to develop a credible alternative for diesel traction, meeting technical performance requirements at acceptable costs.
- Basic research on **battery and hydrogen powered rolling stock**, including infrastructure and operational aspects for retrofitting existing regional trains
- **Last mile propulsion** and next generation energy efficient propulsion systems for freight vehicles
- Energy studied standardised methodology for estimation of energy consumption by simulation and measurement enabling the standardised specification of energy efficient railway systems
- Hydrogen, **“Study on the use of fuel cells and hydrogen in the railway environment”** commissioned by Shift2Rail JU and the Fuel-Cell Hydrogen JU was produced in 2019, delivering a roadmap for the R&I activities.



DELIVER AN INTEGRATED EUROPEAN RAILWAY NETWORK BY DESIGN



DEVELOP A UNIFIED OPERATIONAL CONCEPT AND A FUNCTIONAL SYSTEM ARCHITECTURE FOR INTEGRATED EUROPEAN RAIL TRAFFIC AND CCS/AUTOMATION



DELIVER A SUSTAINABLE AND RESILIENT RAIL SYSTEM



DELIVER A COMPETITIVE, GREEN RAIL FREIGHT FULLY INTEGRATED INTO THE LOGISTICS VALUE CHAIN



DEVELOP A STRONG AND GLOBALLY COMPETITIVE EUROPEAN RAIL INDUSTRY

# EUROPE'S RAIL: ONE INTEGRATED R&I PROGRAMME

## SYSTEM PILLAR

OPERATIONAL CONCEPTS

FUNCTIONAL SYSTEM ARCHITECTURE

**A SINGLE COORDINATING BODY FOR THE WHOLE SECTOR EVOLUTION**

OPEN INTERFACES TO OTHER TRANSPORT MODES AND BUSINESSES

SYSTEM REQUIREMENT SPECIFICATIONS

## INNOVATION PILLAR

TECHNOLOGICAL AND OPERATIONAL SOLUTIONS FOR SERVICES OF FUTURE

FLAGSHIP PROJECTS

LARGE-SCALE DEMONSTRATIONS

EXPLORATORY AND FUNDAMENTAL R&I

1

EUROPEAN RAIL TRAFFIC AND MOBILITY MANAGEMENT

Manage and improve rail traffic at EU level

Adjust rail traffic management in function of the mobility demand

2

DIGITALISATION & AUTOMATION IN TRAIN OPERATIONS

ATO implementation

Digital train operations

3

SUSTAINABLE AND DIGITAL ASSETS

Integrated assets testing & life-cycle framework

Zero-emission, silent rail system

4

COMPETITIVE, DIGITAL, GREEN RAIL FREIGHT

New digital customer interaction & innovative rail freight services

Multimodal and rail freight innovation integration

5

REGIONAL RAIL SERVICES IN LOW DENSITY AREAS

New system approach to regional rail services in low density areas

## DEPLOYMENT GROUP

FUTURE SOLUTIONS DEPLOYED IN A COORDINATED AND CONSISTENT WAY AT EUROPEAN LEVEL, TAKING INTO ACCOUNT ALTERNATIVE ROLLOUT SCENARIOS, BEHAVIOURAL AND ORGANISATIONAL CHANGES, SYNERGIES WITH OTHER MODES OF TRANSPORT

Flagship Area		Project	Objectives
FA1	Network management planning and control & Mobility Management in a multimodal environment	FP1-MOTIONAL	Improved planning and operational management of services The future railway system will be interoperable, resilient, able to adapt capacity and able to integrate all involved services. Rail traffic is managed as a Network with management planning and control overview at EU level, with new processes and automation for decision support. Rail management looks at the multimodal environment striving to real-time demand-driven operations, including demand from other transport modes.
FA2	Digital & Automated up to Autonomous Train Operations	FP2-R2DATO	Digital “Automated & Autonomous” Train Operations building upon the next gen Automatic Train Control based on ERTMS + enhancements on TCMS for integration at the on-board level
FA3	<b>Intelligent &amp; Integrated asset management</b>	<b>FP3-IAM4RAIL</b>	Aims to provide innovative technical requirements, methods, solutions, and services – including technical requirements and standards for future developments – based on the latest cutting-edge technologies to <b>minimise asset lifecycle costs</b> and <b>extend service life</b> while meeting safety requirements and improving the reliability, availability, and capacity of the railroad system. Both <b>infrastructure</b> and <b>rolling stock</b> are addressed.
FA4	<b>A sustainable and green rail system</b>	<b>FP4-Rail4Earth</b>	Improve the existing <b>sustainability</b> performance of railways, to build a <b>more attractive and resilient transport mode</b> and to contribute towards the objectives of a climate neutral Europe for 2050. Activities include <b>rolling stock, infrastructure, stations, and all sub-systems</b> (traction, bogies, brakes, energy storage systems, HVAC).
FA5	Sustainable Competitive Digital Green Rail Freight Services	FP5-TRANS4SM-R	Digitalization and automation of operational functions (e.g. DAC) and processes as well as increasing the efficiency of the immaterial (information/data) layer of transport in logistic
FA6	Regional rail services / Innovative rail services to revitalise capillary lines	FP6-FutuRe	Decreasing cost while offering a high quality of service and operational safety + increase customer satisfaction and attractiveness



# Europe's Rail – Decarbonisation Topics

- To complete full diesel suppression further **zero emission trains and refuel /recharge infrastructures** will be developed with the suitable technical, environmental and economical performance
- Harmonisation and standardisation, including **simplification of certification**, to simplify solutions allowing interoperable trains and lower costs for a quicker deployment
- **Batteries (BEMU long range autonomy) and Hydrogen hybrid trains** with low life cycle costs will be developed (peak power shaving, load shedding capacity).
- **Alternative fuelling solutions** for regional railways such as hydrogen, e-fuels, battery fuelling
- Sub-urban catenary trains with **on board Energy Storage System** will be developed for mass transit systems with a single power supply. Onboard systems will avoid the use of mechanical braking (energy losses, particulate matter emissions, maintenance costs). It is also a cost-efficient solution when space is limited to increase capacity)





# Europe's Rail: FA4 (Multi Annual Work Plan)

## Shift2Rail

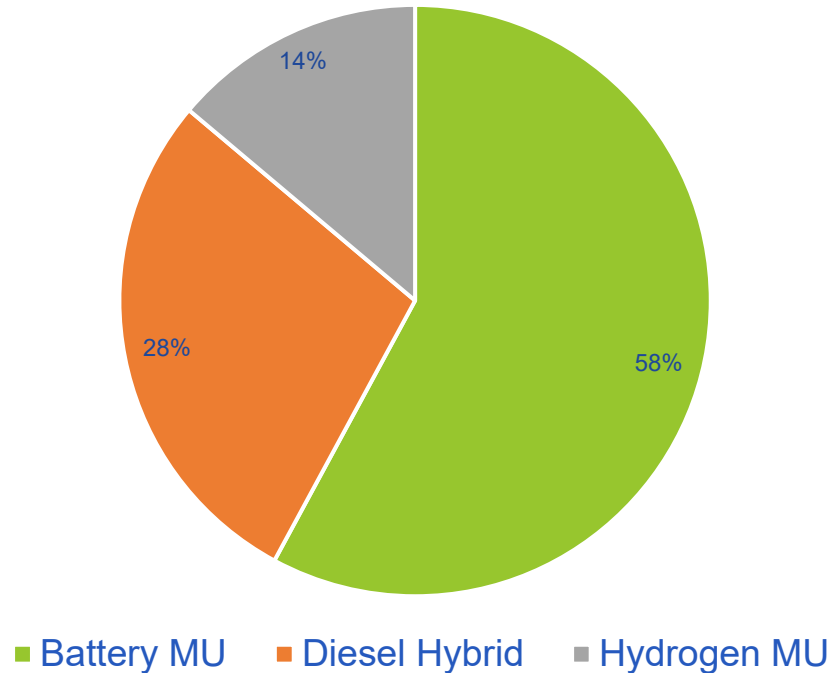
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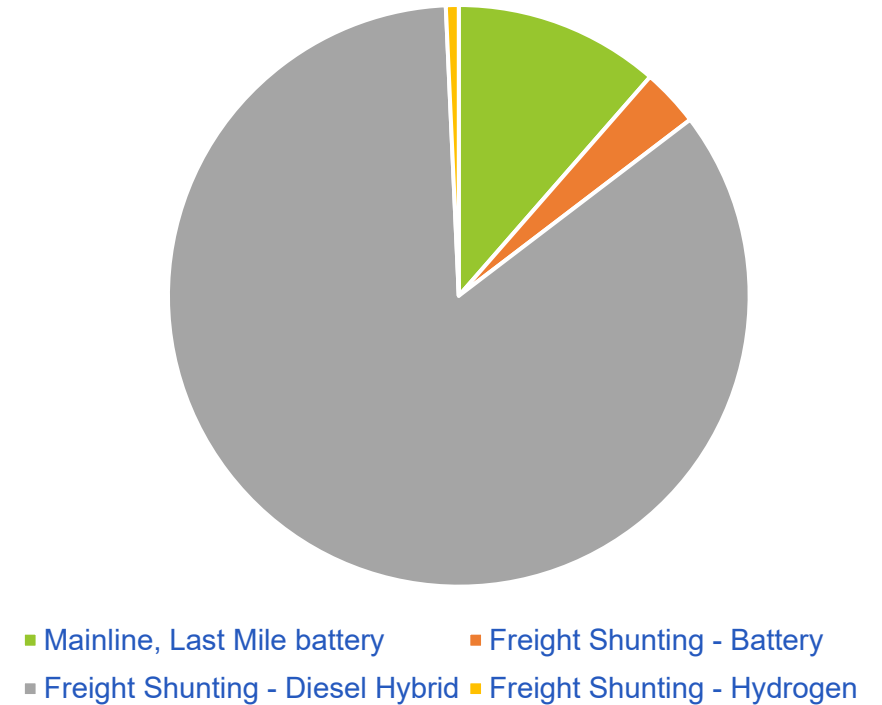
# Alternative traction – current state of play in EU

Alternative propulsion passenger rail vehicles in EU  
(In service/on order)



**But only 6% of EU Diesel Passenger Fleet**

Alternative Traction - Freight vehicles in EU  
(in service/on order)



**But only 2% of EU Freight Diesel Fleet**

Train characteristics	Battery train	Hybrid Hydrogen/Battery train	Hybrid Diesel/Battery train
Type of operation	Mainly Regional Sub-urban	Regional	Mainly Regional Freight
Maximum speed	160 km/h (Regional)	160 km/h (Regional)	160 km/h (Regional) 100 km/h (Freight)
Type of Energy supply	Traction batteries Electric (panto / 3rd rail)	Mainly H2 + Traction batteries Electric (panto)	Electric Diesel + Traction batteries Batteries only* ("Silent mode")
Range in Catenary Free Operation	80 km (from 40 – 150 km)	800 km (from 400 to > 1000 km)	> 1000 km
Traction Battery capacity per train	550 kWh	270 kWh	130 kWh
Battery technology	LTO or NMC	LTO or NMC	LTO or NMC
Fuel cell power	N.A	325 kW	N.A
Hydrogen storage	N.A	350 Bar	N.A
Combustion engine	N.A	N.A	Step IV or V

**Q: Is performance enough to displace diesel?**



# Carbon Free Mobility

- Approx 14,000 fleet of locomotives and 8,000 diesel multiple units
- **Alternative drives**
  - Passenger: battery, diesel hybrid and hydrogen (about 6%),
  - Freight: last mile battery, shunting battery, freight shunting diesel hybrid and freight shunting hydrogen (about 2%)
- **Infrastructure**
  - Standardised cost efficient solutions for interface between vehicle and infrastructure
  - Energy supply interfaces between vehicle and infrastructure (overhead, charging station., external supply stations)
- **Operation**
  - Requires extension of BEMU range, fast charging for long range, standardisation of interfaces (catenary voltage of overhead lines, plug and power for external energy supply, hydrogen refuelling, operation and battery interfaces)
- **Certification/homologation**
  - Germany first hybrid hydrogen battery (2018) and first battery train 2022). France first hybrid diesel / battery train ongoing for certification. Other countries tests in service

# Alstom: Carbon Free Mobility in the EU



**Alstom iLint Hydrogen train**



**Alstom BEMU Battery Train**



# Alstom: EU Alternative Traction in North America



**Alstom iLint will be arriving in Quebec, Canada this summer (June – September)!**



# Questions

