Les grands enjeux du ferroviaire et le rôle des partenariats académiques

Petit Déjeuner ANRT

Michael HADDAD, 03/07/2025

1. Alstom
2. Megatrends & Global Risks
3. Key Topics & Rail Challenges
4. Partnerships

01

Alstom

Au sein d’Alstom, nous concevons des solutions de mobilité qui procurent aux voyageurs une expérience agréable, et qui accompagnent les sociétés vers un futur décarboné

Un portefeuille de produits complet pour répondre aux besoins de nos clients

- Matériel roulant urbain (tramways, navettes automatisées, monorail, métros)
- Matériel roulant de grandes lignes (trains périurbain, régionaux et Intercités, trains à grande vitesse)
- Locomotives
- Composants

- Signalisation (grandes lignes, urbaine, transport minier et fret, services)
- Systèmes clés en main, Infrastructure et télécom
- IT for rail (y compris l'IA et la cybersécurité)

- Solutions de maintenance ferroviaire
- Pièces, réparations et révisions de composants
- Rénovation et modernisation
- Exploitation et maintenance de systèmes ferroviaires

Nous sommes là où la mobilité a besoin de nous

Plus de
86 000
employés

de
184
nationalités

Plus de
223
sites

dans
63
pays

Plus de
24 000
ingénieurs

Plus de
150 000
véhicules en service commercial

Au 31 Mars 2025

Points clés financiers

Au 31 Mars 2025

18,5 Md€

Chiffre d'affaires

19,8 Md€

Commandes

95 Md€

Carnet de commandes

02

Megatrends & Global Risks

Megatrends & Global Risks

- Aging & silver society
- Steady growth of urbanization
- Migrating population

- Climate change & Pollution
- Resource scarcity & increase of energy demand
- Biodiversity at risk

Global Risks

- Escalated conflicts & open war
- Catastrophes by extreme weather
- Cybersecurity breaches
- Growing inequality
- Rise of protectionism
- Disruption of global supply chains

- Living with inflation
- Geopolitical conflict & decline of democracy
- Loss of trust Rise of the individual

- Digital Revolution
- Rise of Artificial Intelligence
- Climate Technologies

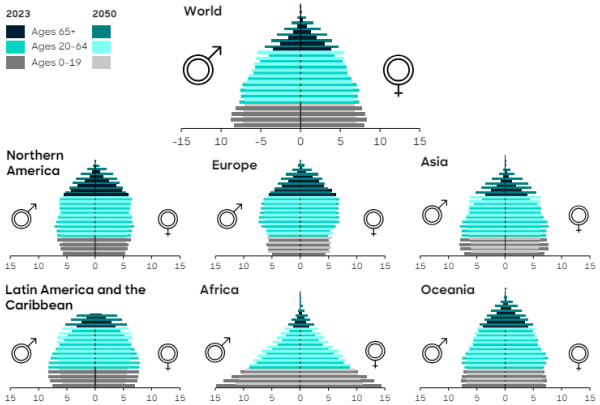
Population megatrends

The world's population is expected to increase by nearly 2 billion persons in the next 30 years, from the current 8 billion to 9.7 billion in 2050 and could peak at nearly 10.4 billion in the mid-2080s.

World Population UN 2022

Aging & Silver society

- The proportion of the population aged over 80 is set to increase from 9% (143 million people) in 2019 to 16% (426 million) by 2050
- Disparity growth: By 2050, India, Pakistan & Nigeria represent 1/3 total p.growth



UN World Population – Roland Berger

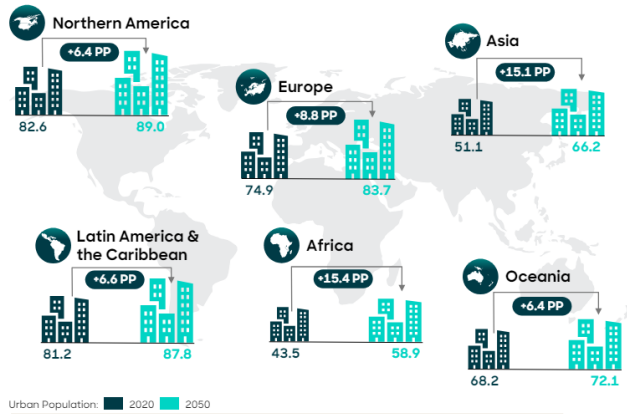
Migrating Population

- Constant migration growth towards high income countries driven by Climate change, Economic reasons, Wars
- Migration data used to influence public opinion
- International migration as sole driver of population growth for high income countries
- Migrants' growth from 246M in 2010 to 336M in 2020 +36.5% including: refugees, asylum seekers, other international and national migrants

Urbanization growth

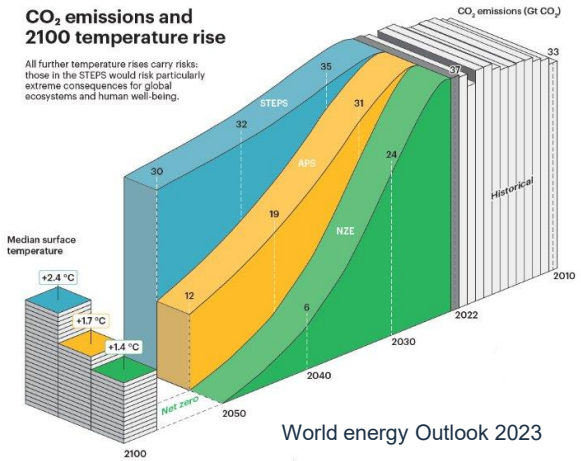
- People living in urban areas will rise from 56% to 68% by 2050 – Highest urbanization growth is expected in Asia and Africa
- Bigger cities will grow at the expense of smaller cities

Inhabitants of urban areas, 2020 and 2050 [% of total population]



UN World Population – Roland Berger

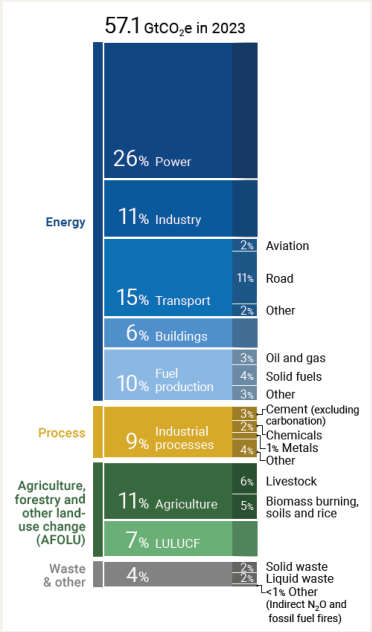
Environment megatrends



World energy Outlook 2023

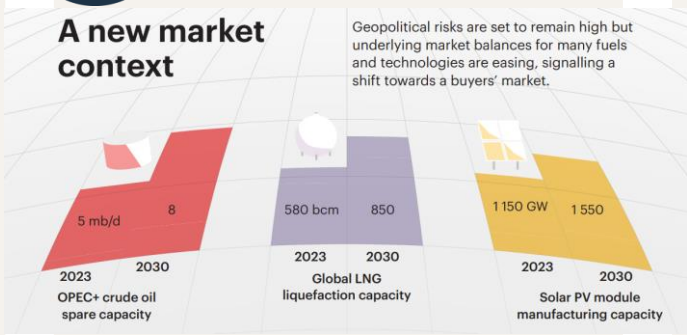
Climate change & Pollution

- Policies & actions for GHE reduction are behind all pledges and targets from the Paris agreement.

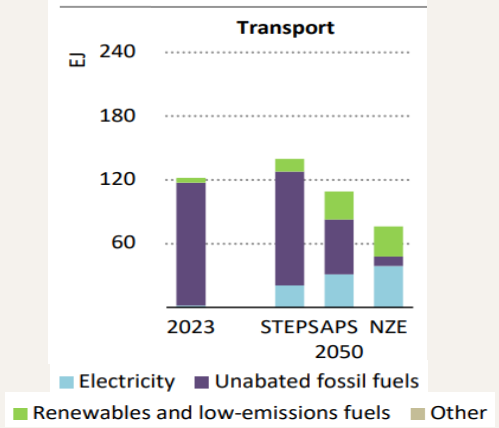


Emissions Gap Report 2024, UN

Resource scarcity & energy demand



Total final consumption by energy source in transport by scenario, 2023 and 2050

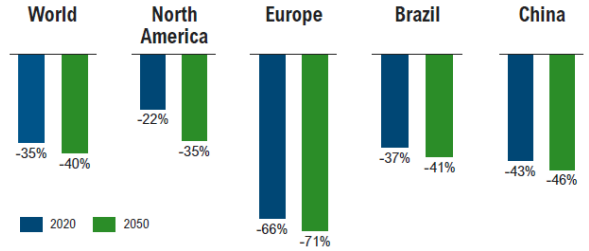


World Energy Outlook 2024

Biodiversity at risk

- COP15, GBF adopted, 30 by 30 plan, aiming to protect 30% of the planet's land and sea by 2030
- March 2023, Treaty of the High Seas, to ensure conservation and sustainable use of marine biological diversity

Terrestrial mean species abundance loss 2020 and 2050 for selected regions and countries[1] [% loss compared to pristine ecosystem]

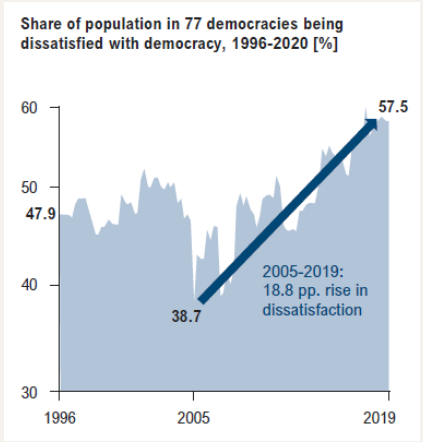


OECD; COP 15; UN/BBNJ

Geopolitics & finance megatrends

Loss of trust Rise of the individual

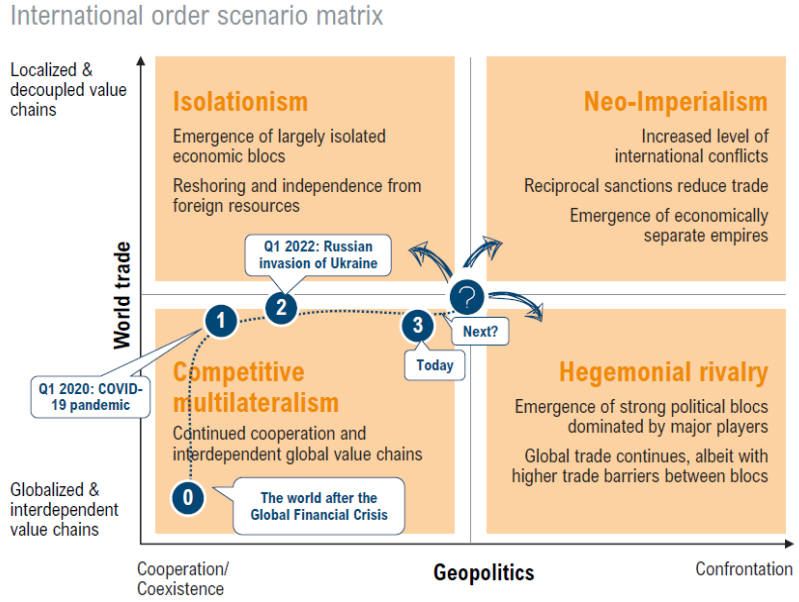
- Rise of individual empowerment to engage in decision making through social media network
- Rising level of dissatisfaction & democracy fatigue in developed countries



University of Cambridge Bennett Institute

Geopolitical conflict & decline of democracy

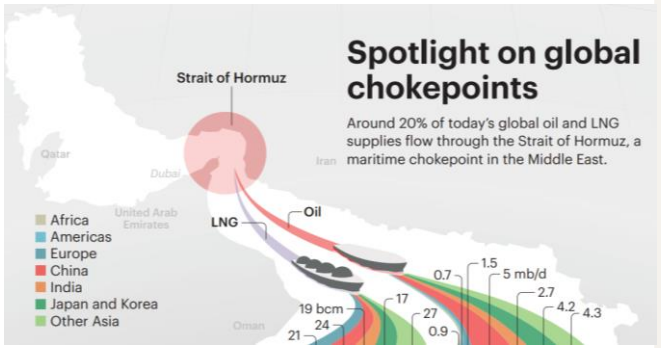
- Autocratization trends are intensifying – The future of liberal democracy is under threat



Inflation Reduction Act of 2022– Roland Berger

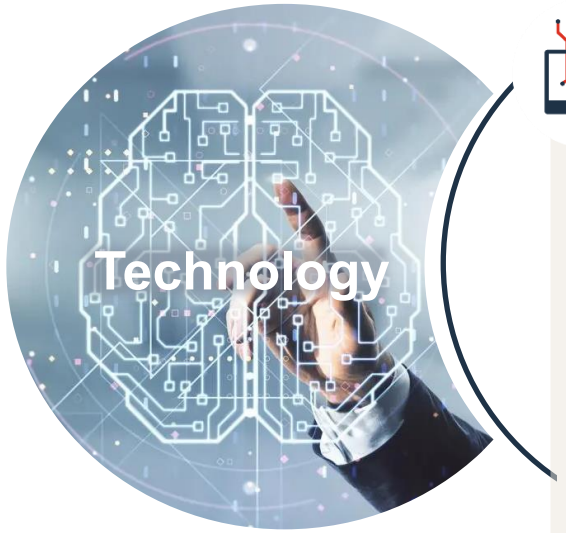
Living with Inflation

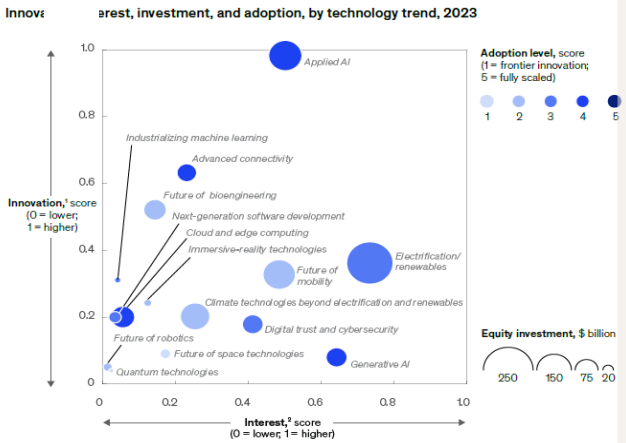
- The global economy is burdened by increasing levels of debt, governments no longer have effective mechanisms to control inflation. Energy and raw materials supply shock, logistic bottlenecks and disruption of global supply chains are foreseen having huge impacts on national and regional economies



World Energy Outlook 2024

Technological megatrends





Rise of Artificial Intelligence

- **LAM: Large Action Models** Shift to action-based AI will create autonomous systems that execute complex tasks without programming
- **Agentic AI:** autonomous systems that can set goals, make decisions in multi-agent collaboration
- Industrializing machine learning
- Improved standard of living through robotics & AI
- Human augmentation
- Digital twins
- Trusted computing

Climate Technologies

- **Metamaterials:** transforming the built environment, enabling self-cooling buildings, ultra-resilient infrastructure, and adaptive structures
- **New market for climate adaptation.** Smart resilience systems based on AI, sensors and biotechnology.
- Electrification of everything
- New battery chemistry
- Big Tech drives **nuclear renaissance _SMRs**
- Clean renewable energies
- Frugality & Recycling

Digital Revolution

- **The Cloud becomes the new battleground.** Tech giants forming strategic alliances
- Advanced connectivity
- Digital trust
- Cloud & Edge computing
- **Quantum computing** reaches its inflection point as error correction breakthroughs, enabling stable qubit operations
- Autonomous Technologies
- Digital health

03

Key Topics & Rail Challenges

Reduction of Lead Time

Driven by:

Steady growth of urbanization

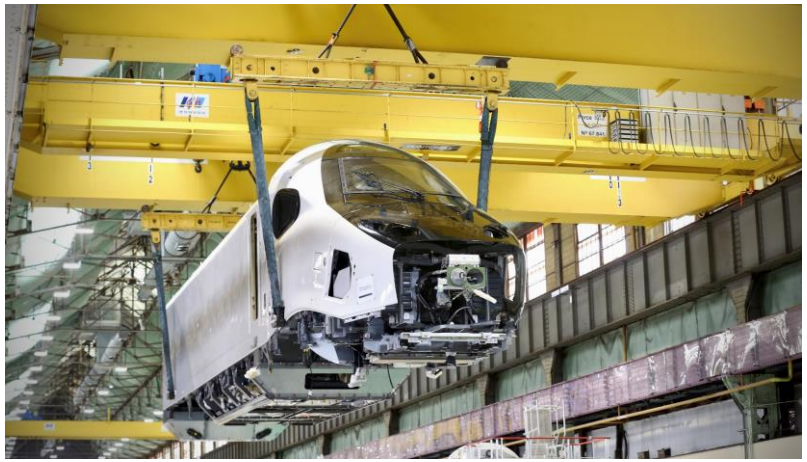
Aging & silver society

Digital Revolution

Description:

The projected surge in demand for rail transport systems, fueled by demographic growth, urbanization, and economic development, necessitates proactive measures. However, challenges such as the need for increased investments and a shortage of skilled workforce require targeted innovations.

The pressing need to address this growing demand while ensuring timely delivery of products is placing significant pressure on existing design and production capacities but also maintenance. This situation underscores the importance of implementing strategic actions to enhance efficiency and bolster capabilities within the industry.



Examples of innovation streams:

- Design Cycle:
  - Faster change introduction to base design, virtual certification
  - Rapid Prototyping
  - Model-based systems engineering (MBSE), Generative AI, Digital Twins
- Manufacturing Cycle & Supply Chain:
  - Robots & Co-bots
  - Non-Destructive Testing
- Maintenance & Retrofit:
  - Over-the-air software update
  - Spare parts management

Higher Capacity at Constant Infrastructure

Driven by:

Living with inflation

Steady growth of urbanization

Biodiversity at risk

Description:

Projected passenger demand will increase for urban, intercity, and international transport, driven by demographic growth, urbanization, and economic development. However, there are significant obstacles to enhance railway capacity:

- Saturation of existing lines: many railway lines are already at capacity with no feasible options for expansion due to environmental concerns and limited available space.
- Financial constraints: high interest rates and public debt limit the capacity for necessary investments in railway infrastructure.

Examples of innovation streams:

- Reduced dwell time:
  - Door opening
  - Faster Boarding / Deboarding
- Reduced Headway:
  - Signalling / Moving Blocks
  - Automation
  - Acceleration and braking
- Increased passenger capacity:
  - Modularity and Flexibility on board - Double deck trains
  - Weight Reduction

Reduction of Total Cost of Ownership (TCO)

Driven by:

Resource & Energy scarcity

Rise of Artificial Intelligence

Living with inflation

Description:

The reduction of total cost of ownership (TCO) for railways emerges as a critical driver in the face of limited financial resources stemming from high public debt and interest rates, alongside rising energy and labor costs. As infrastructure and fleets age, maintenance expenses also escalate, further straining budgets.

Railway operators are focusing on TCO reduction, to enhance operational efficiency, minimize long-term expenses, and optimize asset utilization. It thus impact their strategy on investment budget for new rolling stock and associated maintenance. This TCO reduction must not be associated with too important CAPEX increase.

Examples of innovation streams:

- Smart Maintenance:
  - Spare parts inventory reduction
  - Predictive Maintenance & increased RAMS
  - Automatization
  - Improved Traffic Management Systems
- Energy Efficiency:
  - Lower Resistance to Motion (Aerodynamics, Weight, …)
  - Smart Power Management
- Value for money of our solution:
  - Alstom Non-Recurring costs reduction

Robustness & Resilience

Driven by:

Catastrophes by extreme weather

Cybersecurity breaches

Disruption of supply chains

Description:

Robustness refers to the capacity of a system to withstand and remain functional in the face of disruptions, challenges, or adverse conditions. In contrast, resilience is the ability of a system to adapt, recover, and continue operating after encountering these challenges.

Climate change poses significant risks through extreme weather events and shifting environmental patterns that can disrupt operations. Rise of cyber threat is also a major concern. A robust railway system can endure these shocks, while a resilient system can adapt and recover swiftly, ensuring continuous service. Additionally, supply chains disruptions triggered by resource scarcity and protectionism are also to be considered to ensure operational continuity of industrial activities.

Examples of innovation streams:

- Resilience:
  - To climate change (extreme events / temperatures)
  - To vandalism & sabotage
  - Onboard energy storage (emergency battery…)
- Safe Connectivity:
  - Cybersecurity
  - Connectivity for remote diagnostic & operations
- Quality of execution & Supply Chain:
  - Reliability at 0km
  - Critical material free design of components

Towards Zero Emissions

Driven by:

Climate change & Pollution

Biodiversity at risk

Climate Technologies

Description:

Climate change and the imperative to preserve biodiversity are significant trends steering mobility towards zero emissions. This transition must be understood in a broad context, encompassing not only greenhouse gas emissions but also all externalities that could negatively impact the environment.

To position railways as a best-in-class mobility system, it is essential to address these wider environmental considerations, ensuring that all aspects of rail operations contribute to sustainability and ecological health from cradle to grave.

Examples of innovation streams:

- Global Emissions reduction:
  - Green House Gas (CO2, HVAC, CH4…)
  - Forever Chemicals (PFAS)
- Local Emissions reduction:
  - Local pollutants (brake particles, NOx, PM, …)
  - Noise & Vibration
  - Electromagnetic radiation (EMC)
- Reduce / Reuse / Recycle
  - Recyclable composite materials

Unique Passenger Experience

Driven by:

Rise of the individual

Aging & silver society

Climate change & Pollution

Description:

While rail is recognized as the most environmentally friendly mode of transport, it must also deliver a unique experience to attract new passengers and facilitate a necessary modal shift from air and road travel, which is essential for a successful green transition.

Emerging trends, such as the rise of individualism, the demand for personalized services, and increased connectivity, must be integrated into the design and operation of rail systems. Additionally, the needs of an aging society that seeks inclusivity should be considered from the earliest design phases. Moreover, climate change poses challenges in maintaining thermal comfort, necessitating innovative solutions that do not compromise energy efficiency.

Examples of innovation streams:

- Comfort:
  - Lighting, noise insolation, HVAC
  - Connectivity, passenger information
  - Personalised experience onboard
- Advanced Design & Branding:
  - New materials
  - Modularity
- Inclusiveness
  - Solutions for people with reduced mobility or cognitive disorders

04

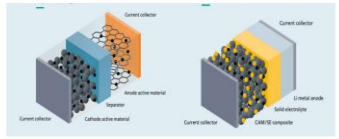
Partnerships

Using the full power of our innovation teams and external networks

Open and collaborative networks and relationships enable everyone to experiment, explore, and validate on what contributes to value creation

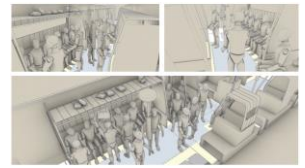
- Start up
- Technology
- Agility and co-funding
- Access to New Market
- Risk Mitigation

Solid State Batteries collaborative R&D project with SAFRAN, Airbus & Renault



Expected results in mid-long term :
- double autonomy range and reach up to 200Km
- increase level of safety

- Expertise
- Simulation & Test Facilities
- Training
- Talent Acquisition



Collaboration with Strate College Design School in Bangalore on Commuter 2030 Vision

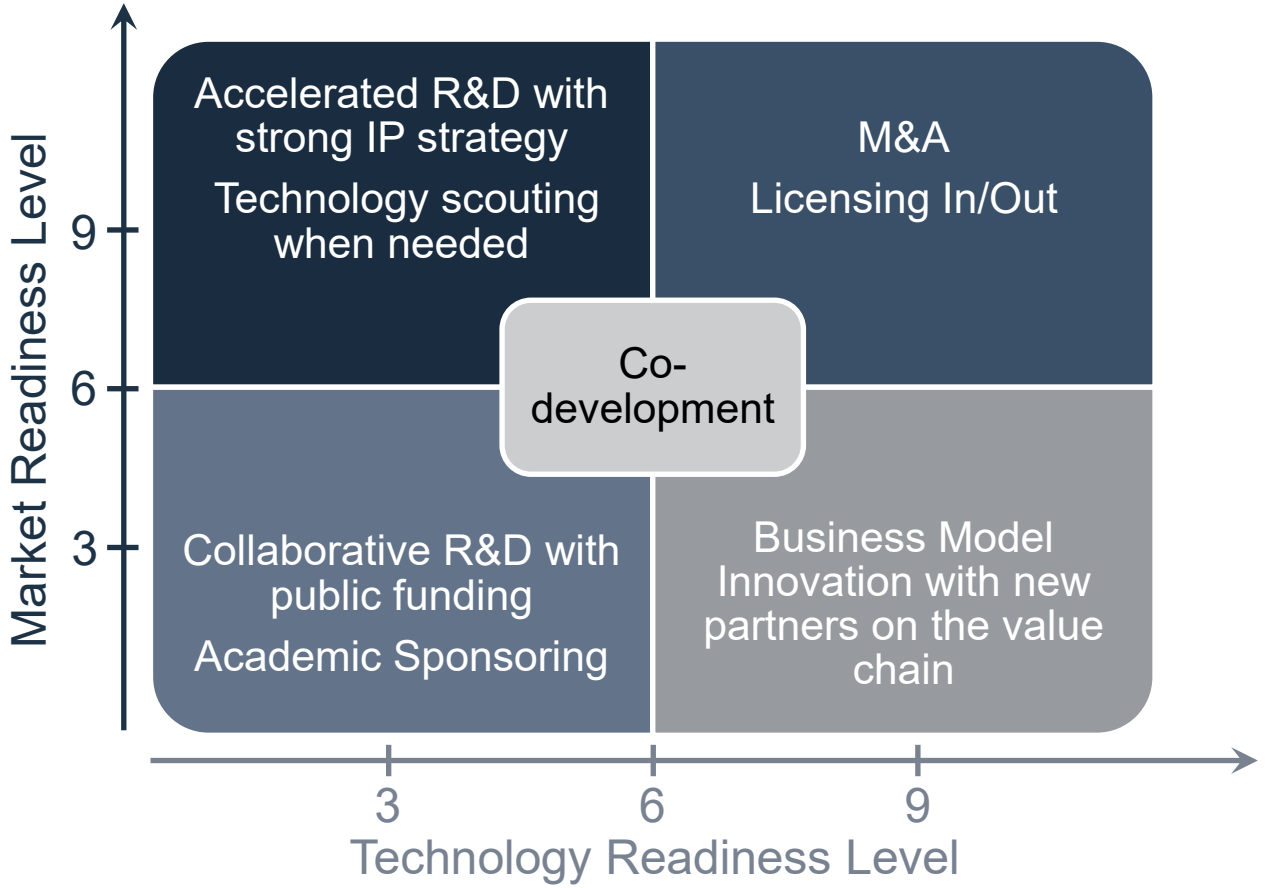
- Isolated Inventors
- Passenger Experience
- Social Trends

Collaboration with ONCE on new metro trains for Barcelona

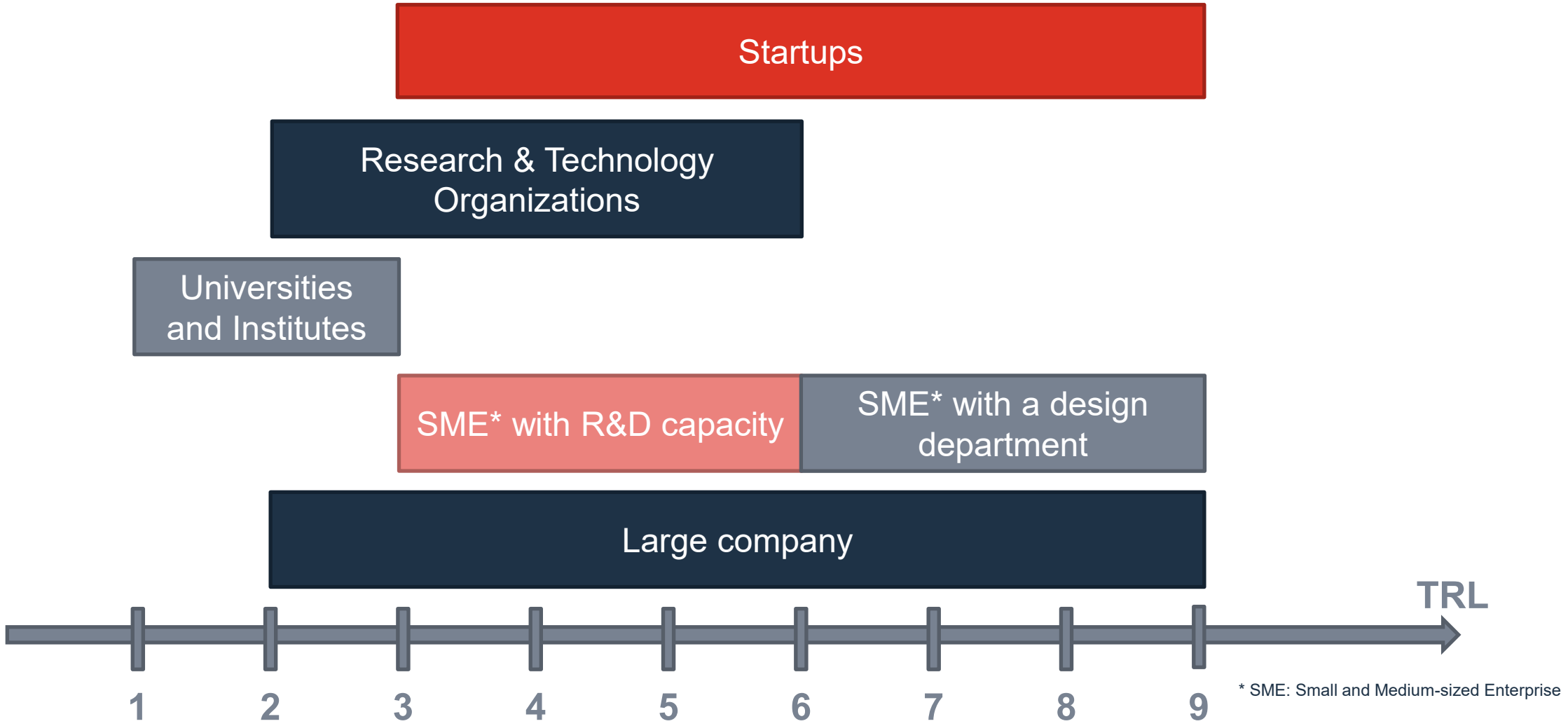
Europe's Rail

- Funding
- Experimentation
- Networking Facilitator
- Norms & Regulation

How to organize our collaborations with the innovation ecosystem?

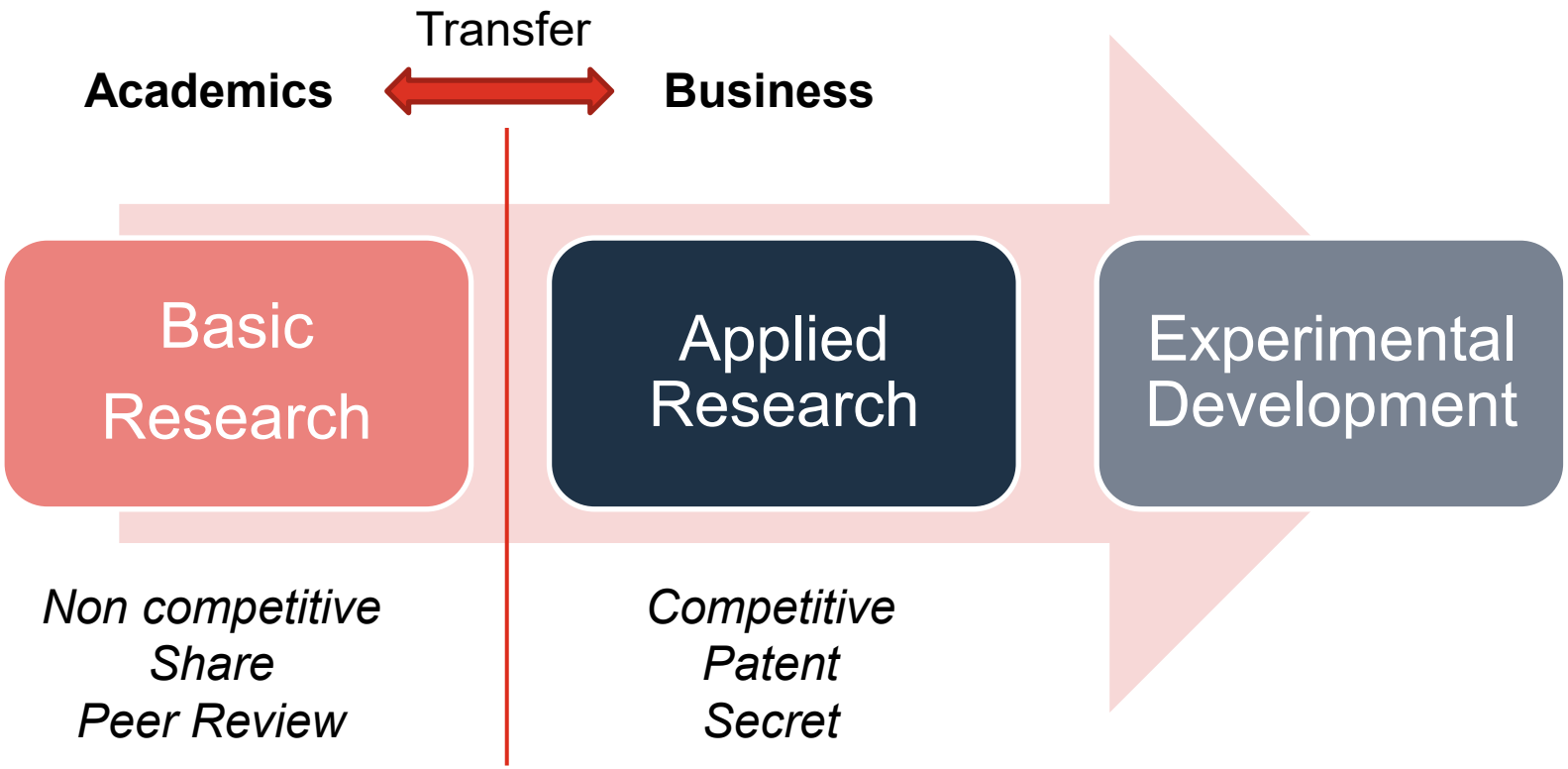


Partner selection according to TRL



* SME: Small and Medium-sized Enterprise

New knowledge is produced and spread by **Universities**



Knowledge transfer is key

Alstom, a major economic player in France - Key figure 2024-25

Valenciennes
Metros, tram-trains and RER

Saint-Ouen
Headquarters, signalling, infrastructure and services

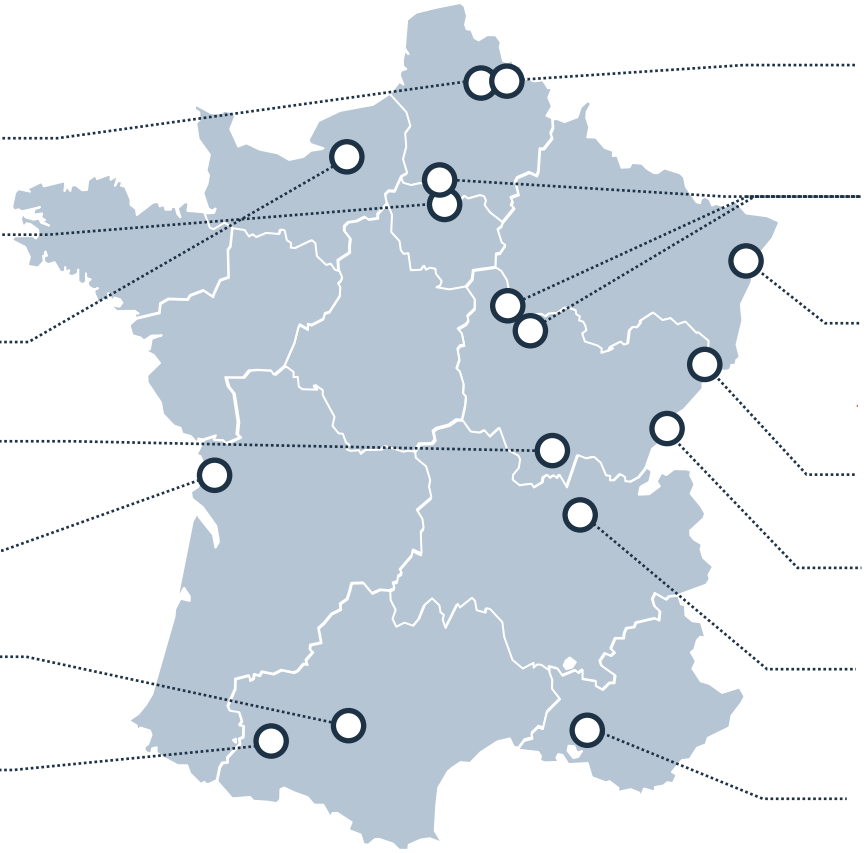
Petit-Quevilly
Traction transformers

Le Creusot
Bogies and shock-absorbers

La Rochelle
Tramways and high-speed trains

Toulouse
Railway electrical systems

Tarbes
Electrical traction drives



Crespin
Regional, intercity trains and RER

Sens (IBRE),
Gennevilliers and Saint-Florentin (Flertex)
Brakes, discs and pads

Hangenbieten et Haguenau
Translohr, services, Car Body Shell, Train Control Management System

Belfort
Locomotives and high-speed train power cars

Ornans
Traction motors and generators

Villeurbanne
Railway electronics

Aix-en-Provence
Urban signalling, ground-based charging solutions and Helion Hydrogen Power

+ 13,000 employees

€ 3.2 billion of sales
- **≃ 25% in the international market**

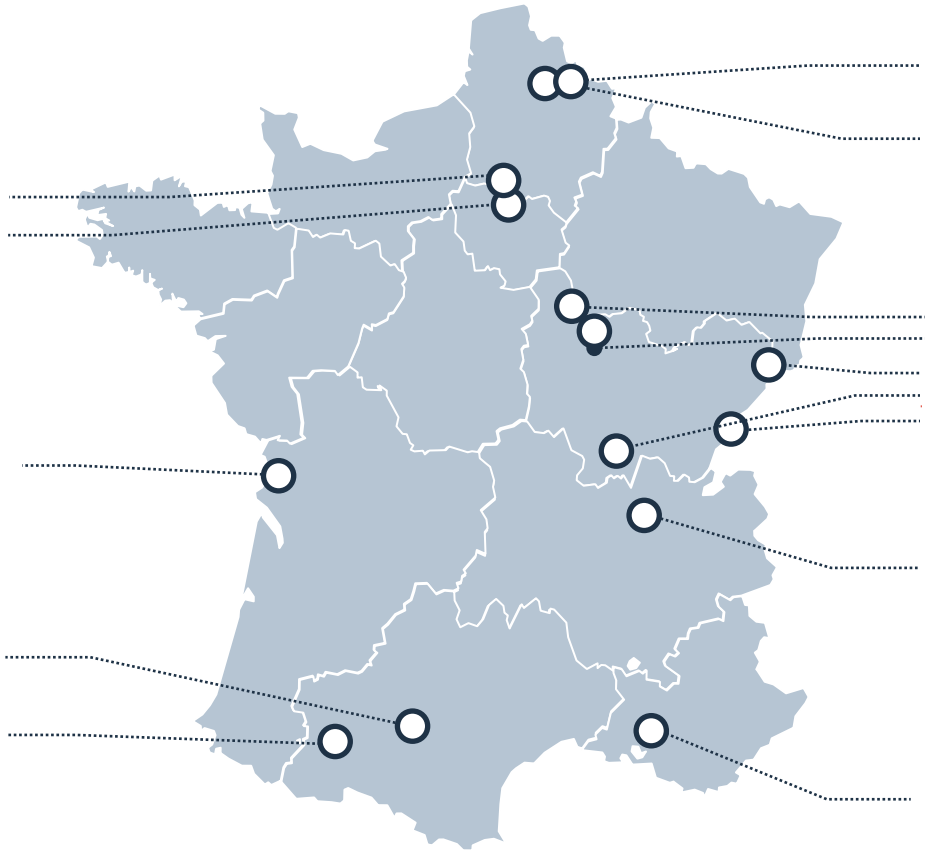
16 sites

Our “potential” French innovation ecosystem

Saint-Ouen, Gennevilliers (Flertex)
SYSTEMX, ITE VEDECOM, CEA, CETIM, INRIA, IFPEN, MINES, AIT, UGE

La Rochelle
Ferrocampus, Aquitaine Science Transfert, INRIA, ARTS, ID4MOBILITY

Toulouse, Tarbes
Aerospace Valley, IRT Saint-Exupery, Toulouse Tech Transfert, INRIA



Crespin, Valenciennes
iTrans, IRT Railenium, MEDEE, SATT Nord, ARTS, CETIM

Belfort, Le Creusot, Saint-Florentin (Flertex), Ornans, Sens
Véhicule du futur, Sayens, ARTS

Villeurbanne
ITE SuperGrid, ARTS, CETIM, INRIA, CEA, IFPEN, MINES, PULSASYS, LINKSIUM

Aix-en-Provence
Cap Energie

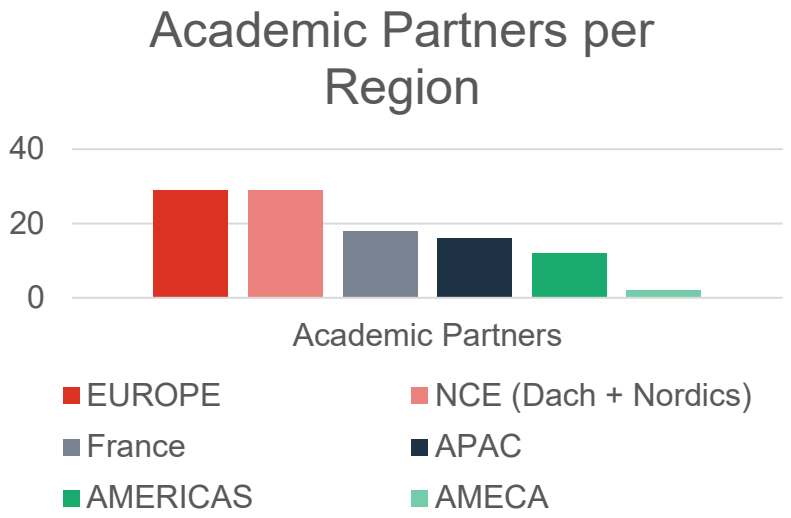
Academic Partners & Scientific PhD Thesis– Global report 2025

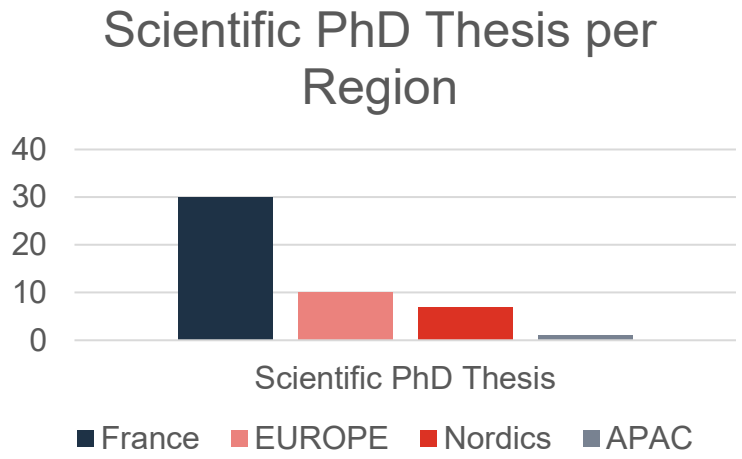
115
Partners

50
R&D Sites

20
Countries

6
Networks





Networks
CCN& Experts
Innovation (champions, stations, centers)
R&D Platforms
Marketing
Talent

Funding
Innovation Kiosk
PAB/3yr roadmap

1 platform
InnoHub
Academic Partners module

www.alstom.com

ALSTOM

• mobility by nature •