European Commission

Monitoring industrial ecosystems

MOBILITY, TRANSPORT AND AUTOMOTIVE

Analytical report – 2024 edition

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Executive Summary

This report has been prepared within the '**European Monitor of Industrial Ecosystems' (EMI)** project with the objective to analysing the green and digital transformation of industrial ecosystems and progress made over time, in this specific case mobility, transport and automotive.

The second edition of the Industrial Ecosystems series has divided the analysis into two sections meaning, 'green transition' and 'digital transition' followed by three subsections each showing: a) industry efforts, b) framework conditions and c) the impact on the environment and on productivity.

The key findings of this year's analysis are being presented below:

Green Transition

What progress has the industry made in taking action for the environment?

- In 2024, **25% of companies** in the mobility ecosystem **have implemented a concrete strategy to reduce their carbon footprint or achieve climate neutrality or negativity**.

- The most frequently employed types of green technologies focus on energy efficiency, with **41% of surveyed companies reporting the implementation of energy-saving technologies**.

- **Green transition related patent applications made up less than 10% of all patents in the mobility ecosystem** in the EU remaining stable over the period from 2010-2021, although showing a slight recent decrease.

- **Clean production technologies have shown a steady increase**, while renewable energy technologies experienced a decline from 2010 to 2015, followed by a recovery after 2015.

- **Electric mobility and mobility services are attracting the most scale-ups and venture capital**, indicating significant growth potential in these areas. The large number of e-mobility scaleups clearly shows the confidence of investors, signalling the high relevance of this business model in the future.

- **Advanced materials play a critical role in enabling innovations** in electric mobility and high-tech automotive manufacturing. Investment peaks in 2018 and 2021 likely reflect periods of significant breakthroughs or the scaling up of new materials technologies.

To what extent do framework conditions such as public financing and skills support the green transition?

- **37% of the European Regional Development Fund dedicated to the mobility ecosystem amounting to EUR 33 bn was allocated to projects focused on the green transition** during the 2014–2020 period.

- **Horizon 2020 dedicated over EUR 253 m to the green transition** of the mobility ecosystem. The subsequent Horizon Europe programme has intensified this focus, earmarking half that amount within just two years (2022-2024), with **73% of the total funds directed toward the green transition.**

- The Recovery and Resilience Fund (RRF) contributes with EUR 87.9 bn, making up 25.7% of total green expenditure in the plans.

- There are significant **challenges in up-skilling and re-skilling the workforce** for the green transition in the mobility ecosystem. In the automotive industry, 25% of the workforce is over 50 years old, and 2.4 million workers will need retraining or upskilling by 2030.

- The share of professionals with skills relevant to the green transition was 7.36% in 2024, with a 114% increase in self-reported green skills since 2022.

- In 2023, only 0.7% of online job advertisements required skills related to the green transition. However, there is still a high demand for expertise in EV and battery technologies in Europe.

- While demand for electric vehicles has increased over the last decade, future demand remains uncertain due to potential changes in incentive schemes.

- The majority of maritime vessels still rely on fossil fuels due to cost disadvantages of alternative fuels, and the future fuel mix in waterborne transport is uncertain.

How is the industrial ecosystem's impact on the environment changing?

- In terms of environmental impact, domestic transport accounts for approximately 22% of total CO2 emissions in the EU27, primarily from passenger and light commercial vehicles.

- Greenhouse gas emissions continue to rise, driven by increasing demand for mobility services. Although PM2.5 and PM10 particulate matter emissions have remained stable across the mobility ecosystem, significant reductions in air pollutants have been observed within the transport sector alone.

- Indicators such as land use, resource use, and water extraction show no significant improvements over the past decade, indicating that the overall impact of the mobility ecosystem on the environment remains substantial.

Digital Transition

What is the progress of industrial efforts towards digitalisation?

- Approximately **one-third of companies within the mobility ecosystem have established a concrete strategy for digital transformation**, which is significantly below the targets set by the EU's Digital Decade Policy Programme for 2030.

- While digital transition-related patent activities showed an increasing trend up to 2020, there was a notable drop in innovation in 2021 due to a **general reduction in R&D activities among companies** as a result of the COVID-19 pandemic.

- The **growth in patent applications related to advanced manufacturing and robotics** filed from the mobility ecosystem indicates a strong focus on innovation and efficiency in automated manufacturing processes.

- There has been an **increase in patent filings for artificial intelligence** (AI) technologies, signifying a shift towards the use of AI and big data for enhanced mobility analytics and management solutions, such as advanced route planning and charging infrastructure optimisation.

- Despite their relevance for digital and sustainable sector transitions, the **Internet of Things (IoT), augmented and virtual reality (AR/VR), and blockchain technologies remain significantly underrepresented** in overall patent applications from the mobility ecosystem.

- Among digital technologies in the mobility ecosystem, **cloud solutions have the highest adoption rate, while the adoption of AR/VR and blockchain technologies is currently low.** In recent years, AI and big data have shown growing importance for business models of startups in the mobility ecosystem.

- Although **investments in big data, AI, and AR/VR are recognised as essential, they represent a smaller proportion of annual turnover**, whereas robotics, along with cloud technologies and IoT, is projected to attract significantly higher investment levels. A significant decline in venture capital investments in digital platforms, AI technologies, and autonomous driving was observed in 2023, following a notable increase in 2022.

To what extent do framework conditions such as public financing and skills support the digital transition?

- Regarding framework conditions supporting the digital transition, **there is a significant disparity in public investment**, as a higher percentage of funding is directed towards projects promoting the green transition compared to those focused on digital transformation.

- Only **5% of funds under the ERDF is allocated to digitalisation initiatives in the mobility sector** (contributing to digital transition within the mobility ecosystem focus on advanced digital technologies, primarily involving AI, big data, and analytics), and approximately 20% of ERDF-related projects leaving them relatively underfunded.

- Over 50% of surveyed organisations identified the acquisition of new skills as a very important driver of change within the mobility industrial ecosystem.

- **56% of the surveyed mobility, transport, and automotive companies have at least one full-time employee in roles directly relevant to the digital transition**.

What is the impact of digital technologies on competitiveness?

- Digital technologies such as **cloud computing, IoT, AI, and robotics are transforming the mobility ecosystem,** enabling real-time data use, automation, and smarter operations across sub-sectors from ports to logistics and autonomous transport.

- Collaborative EU initiatives and **corporate pilots are driving innovation, promoting data sharing, and demonstrating real-world applications** of emerging tech in improving efficiency, sustainability, and safety.

- While advanced technologies like AR/VR, blockchain, and edge computing hold potential, their adoption remains low, hindered by implementation challenges and unsuccessful pilots, though they remain relevant for experimental and decentralised use cases.

1. Introduction

1.1. Objectives

This report has been prepared within the '**European Monitor of Industrial Ecosystems' (EMI)** project, initiated by the European Commission, Directorate General for Internal Market, Industry, Entrepreneurship and SMEs and the European Innovation Council and SMEs Executive Agency (EISMEA). The overall objective of the project is to **contribute to the analysis of the green and digital transformation of industrial ecosystems** and progress made over time.

The EU's updated industrial strategy[1] has identified 14 industrial ecosystems[2] – one of them being **'Mobility, Transport an Automotive'**[3] - that is in the focus of this report. The industrial strategy defined industrial ecosystems as encompassing all players operating in a value chain: from the smallest startups to the largest companies, from academia to research, service providers to suppliers. The notion of ecosystems captures the complex set of interlinkages and interdependencies among sectors and firms across the EU. Industrial transition is driven by technological, economic, and social changes, and by the adoption of green and digital technologies and that move towards sustainable competitiveness. The process is however characterised by complex, multi-level, and dynamic developments. To make transition sustainable, technological change needs to be coupled with new business models, the necessary investments and financial tools, skills, regulatory framework conditions and behavioural change across the ecosystem.

The indicator framework includes a **set of traditional and novel data sources that allow shedding new light on ongoing transformation patterns.** The novelty of the analysis lies in the exploratory and innovative data sources used across the different chapters of the report. **Due to its effort to analyse industrial ecosystems using a standardised set of indicators, the study cannot address all aspects of the green and digital transition.** Therefore, additional analysis and industry-specific data sources should be used to supplement a full assessment.

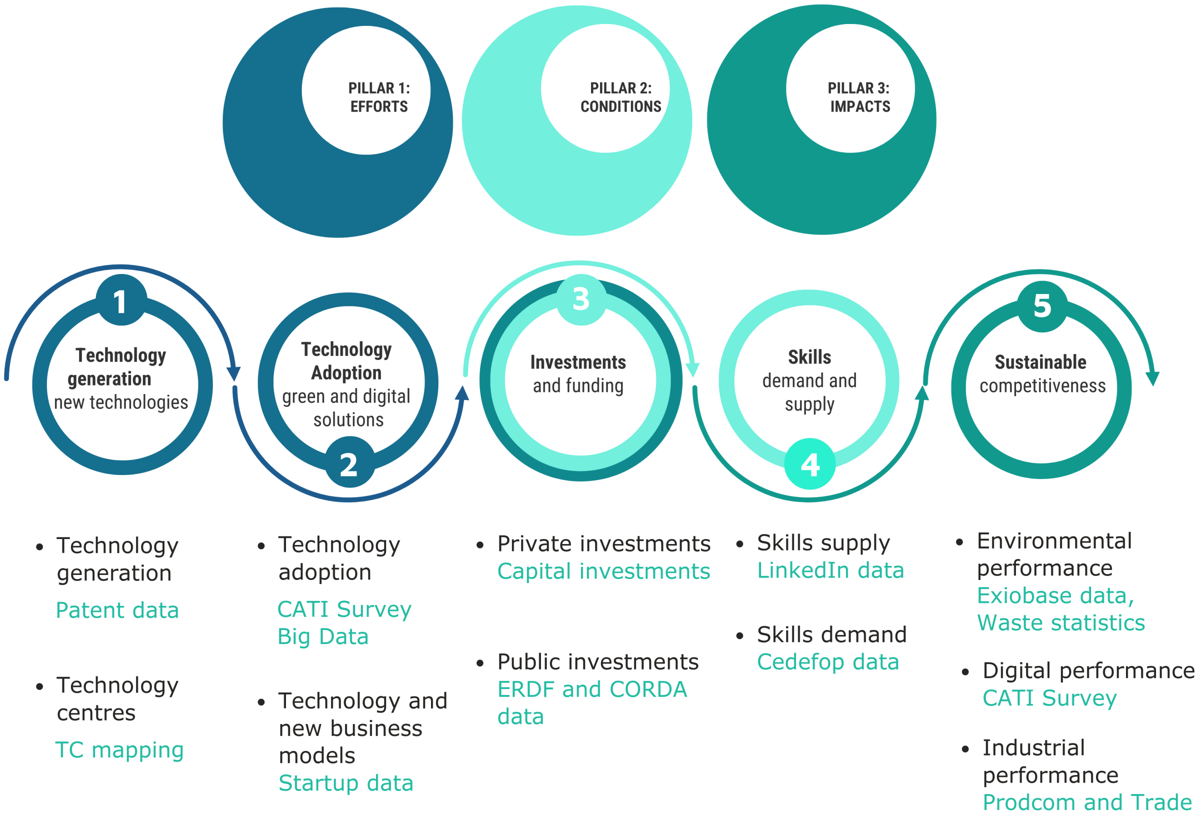
Measuring performance and change is vital to allow policymakers and industry stakeholders to track progress over time and get feedback whether the system is moving in the desired direction. To measure performance, a dedicated **monitoring and indicator framework** has been set up for the purposes of this project with an aim to capture them in regular intervals (see the overview of the monitoring framework in Figure 1).

The **methodological report** that sets the conceptual basis and explains the technical details of each indicator is found in a separate document uploaded on the EMI website. Moreover, some of the specific industry codes used throughout this analysis have been also included in Appendix B. The green and digital technologies considered in this study include the following:

- *Green transition technologies*: advanced materials, biotechnology, clean production technologies, energy saving technologies, recycling technologies, renewable energy.
- *Advanced digital technologies*: advanced manufacturing and robotics, artificial intelligence and big data, augmented and virtual reality, blockchain, cloud computing, Internet of Things, digital security.

[1] European Commission (2020). A New Industrial Strategy for Europe, COM/2020/102 final and European Commission (2021). Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery, COM(2021) 350 final
[2] The 14 industrial ecosystems include: construction, digital industries, health, agri-food, renewables, energy intensive industries, transport and automotive, electronics, textile, aerospace and defence, cultural and creative culture industries, retail, proximity and social economy, and retail
[3] Including NACE: 27, 29, 30, 45, 49, 50, and 52 sectors.

Figure 1: Overview of monitoring industrial ecosystems and relevant data sources



Source: Technopolis Group, IDEA Consult and Fraunhofer ISI

This report contributes to the analysis of the **key pillars put forward in the 'Blueprint for the development of transition pathways'**[4] of the Industrial Forum developed in 2022.

The updated **EU Industrial Strategy underscores the importance of a swift green and digital transition of all European industrial ecosystems**. As a result, each ecosystem must transform its business practices, business models and value chains in support of a green, digital, and resilient European economy. **A concrete and actionable plan** to enable this transition for the mobility ecosystem **is outlined in the Transition Pathway for the EU Mobility Industrial Ecosystem**[5]**.** The Transition Pathway was developed in a joined effort, based on a Staff Working Document (SWD) by the European Commission, a public consultation and workshops with key stakeholders.

Additionally, this report builds upon other European Commission strategies, such as the **Sustainable and Smart Mobility Strategy** (COM/2020/789)[6]. Data and information from other European and international agencies and organisations, such as the International Environmental Agency, the European Environment Agency and Eurostat were also consulted.

A key input to the report has also been a stakeholder workshop held on the 10th of October 2024, as well as follow-up exchanges on relevant insights to be reflected on in the report with stakeholders and experts.

[4] https://ec.europa.eu/docsroom/documents/49407/attachments/1/translations/en/renditions/native

[5] European Commission (2024). Transition pathway for the EU mobility industrial ecosystem. Retrieved from: https://ec.europa.eu/docsroom/documents/57674

[6] European Commission (2020). Sustainable and Smart Mobility Strategy. Retrieved from: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0789

1.2. Scoping the mobility industrial ecosystem

As defined by the European Industrial Strategy[7], the Annual Single Market Report[8], the Transition Pathway[9], and in line with last year's version of this report, the EU mobility ecosystem comprises the following four segments: **automotive, rail, waterborne, and cycling**, along with their heterogenous value chains.

The ecosystem consists of a heterogeneous set of intertwined and globally dispersed supply chains, where each subsector of the ecosystem presents its own specific characteristics and challenges. Several of the mobility ecosystem's value chains (i.e. automotive or rail) are dominated by multinational manufacturers of original equipment (OEMs). Beyond these global players, however, the ecosystem includes a large number of small and locally rooted companies, such as material and component suppliers, retailers and providers of aftersales products and services. The vast majority of the ecosystem's companies are hence small and medium-sized enterprises (SMEs), which comprise about 99.7% of all companies active in the ecosystem[10].

The data presented in this report largely align – to the extent possible – with the ecosystem's definition, as specified in the Annual Single Market Report, and encompasses the following sectors, as well as their subsectors, both partially and fully:

- C27: Manufacture of electrical equipment (weighted share of 3%)
- C29: Manufacture of motor vehicles, trailers and semi-trailers (fully relevant)
- C30: Manufacture of other transport equipment (weighted share of 32%)
- G45: Wholesale and retail trade and repair of motor vehicles and motorcycles (fully relevant)
- H49: Land transport and transport via pipelines (weighted share of 52%)
- H50: Water transport (weighted share of 78%)
- H52: Warehousing and support activities for transportation (weighted share of 39%)

More detailed information on the ecosystem's boundaries, defined through NACE sector classifications, as well as data coverage across various industrial ecosystems, is available in the methodological report[11].

The mobility ecosystem is a **major driver of growth** in the European economy and job market, **employing more than 17.6 million people**, and **generating approximately EUR 1.2 trillion**, which contributes about 7.6% of the EU's total GDP[12].

Production value has shown a steady increase from 2012 to 2023, highlighting the growing importance of the mobility ecosystem for the European Union's overall economic growth and prosperity. Figure 2 below provides an overview of the total production value for the mobility industrial ecosystem from 2012 to 2023, offering insights into its production performance over recent years. The data was extracted from the Eurostat's PRODCOM database[13], which tracks the total value of production of manufactured goods produced by enterprises located in EU27. The graph presents the weighted sum of production of manufactured goods, aggregated at NACE 2-digit level for the mobility ecosystem (EUR billion).

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[7] European Commission (2024). Transition pathway for the EU mobility industrial ecosystem. Retrieved from: https://ec.europa.eu/docsroom/documents/57674

[8] European Commission (2021) Annual Single Marlet Report 2021. Retrieved from: https://commission.europa.eu/system/files/2021-05/swd-annual-single-market-report-2021_en.pdf

[9] European Commission (2024). Transition pathway for the EU mobility industrial ecosystem. Retrieved from: https://ec.europa.eu/docsroom/documents/57674

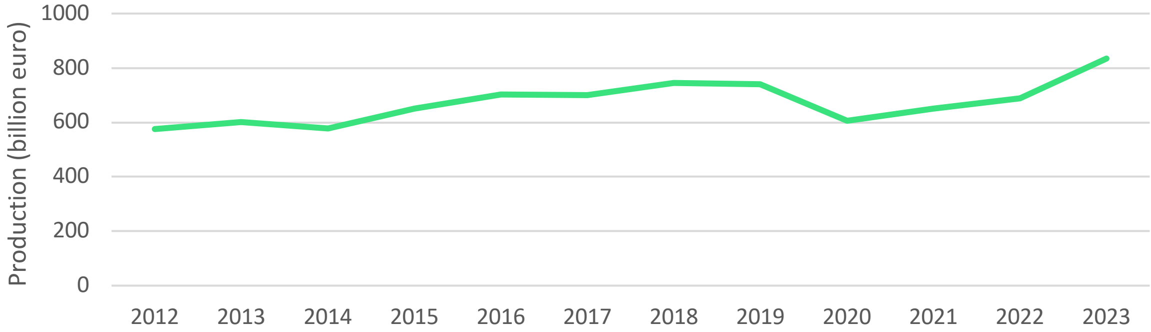
[10] Ibid.

[11] European Commission (2023). Monitoring European industrial ecosystems. Retrieved from: https://monitor-industrial-ecosystems.ec.europa.eu/sites/default/files/2023-12/EMI%20Methodological%20Report.pdf

[12] European Commission (2024). Transition pathway for the EU mobility industrial ecosystem. Retrieved from: https://ec.europa.eu/docsroom/documents/57674

[13] Eurostat (n.d.). Retrieved from: https://ec.europa.eu/eurostat/databrowser/view/ds-056120__custom_12435412/default/table

Figure 2: Evolution of the production value in the mobility industrial ecosystem



Source: IDEA Consult based on Eurostat (prom)

The sustained growth in production output was only interrupted by a period of contraction between 2019 and 2020 due to the impact of the COVID-19 pandemic, evident in the dip depicted in the graph during that timeframe. From 2020 onwards, a strong recovery to pre-pandemic values can be observed, which appears to have continued into 2023, ultimately surpassing pre-pandemic levels.

A quick overview of the subsectors of the mobility ecosystem, based on the definitions provided in the transition pathway[14], completes this first scoping of the ecosystem:

- **Automotive:** The automotive sector (including passenger and commercial vehicle manufacturing and road transport) is a major driver of the EU's economy, employing 13.2 million people (approximately 6.8% of total EU employment)[15]. The sector contributes roughly EUR 1 trillion to the EU's GDP (7% of total GDP)[16] and accounts for one-third of private-sector R&D investments, totalling EUR 73 bn[17]. Producing around 12.1 million passenger cars, 2 million light commercial vehicles, and over 600 000 trucks and buses, in 2023, the EU accounts for 20% of global car production and 25% of commercial vehicle production[18].
- **Rail:** The EU rail value chain provides employment for 2.3 million workers[19]. The sector makes a significant contribution of EUR 143 bn to the EU economy[20]. In 2023, passenger rail capacity peaked at a total of 429 billion passenger-kilometres, equivalent to 8 billion passengers using the EU railways[21], whereas rail freight experienced a 5% decline in 2023, amounting to 480 billion tonne-kilometres. The European rail supply industry remains internationally competitive, with an export surplus of EUR 4.5 bn[22]. Furthermore, the EU successfully exports its standards for rail digitisation, with the European Rail Traffic Management System (ERTMS) now deployed in 53 countries[23].

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[14] European Commission (2024). Transition pathway for the EU mobility industrial ecosystem. Retrieved from: https://ec.europa.eu/docsroom/documents/57674
[15] ACEA (2024). The automotive industry pocket guide 2024-2025. Retrieved from: https://www.acea.auto/files/ACEA-Pocket-Guide_2024-2025.pdf
[16] European Commission (2024). Transition pathway for the EU mobility industrial ecosystem. Retrieved from: https://ec.europa.eu/docsroom/documents/57674
[17] ACEA (2024). The automotive industry pocket guide 2024-2025. Retrieved from: https://www.acea.auto/files/ACEA-Pocket-Guide_2024-2025.pdf
[18] Ibid.
[19] UNIFE (2024). On the move to a net-zero EU: The European Rail Supply Industry priorities for 2024-2029. Retrieved from: https://www.unife.org/wp-content/uploads/2024/03/UNIFE_Priorities_2024-2029.pdf
[20] European Commission (2024). Transition pathway for the EU mobility industrial ecosystem. Retrieved from: https://ec.europa.eu/docsroom/documents/57674
[21] Eurostat (2024). Railway passenger transport statistics - quarterly and annual data. Retrieved from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Railway_passenger_transport_statistics_-_quarterly_and_annual_data#EU_rail_passenger_transport_performance_peaked_in_2023
[22] Policy Department for Structural and Cohesion Policies Directorate-General for Internal Policies (2023). Research for TRAN Committee – Perspectives for the rolling stock supply in the EU. Retrieved from: https://www.europarl.europa.eu/RegData/etudes/STUD/2023/747263/IPOL_STU(2023)747263(SUM01)_EN.pdf
[23] UNIFE (2024). On the move to a net-zero EU: The European Rail Supply Industry priorities for 2024-2029. Retrieved from: https://www.unife.org/wp-content/uploads/2024/03/UNIFE_Priorities_2024-2029.pdf

- **Waterborne:** The EU waterborne value chain encompasses shipbuilding, repair, conversion, maintenance and related equipment, the transport of goods and passengers via maritime and inland waterways, as well as port operations[24]. About 40% of intra-EU trade[25] and over 75% of the EU's external trade are conducted by sea[26]. EU shipping accounts for 39.5% of global tonnage[27], with 350 million passengers passing through European ports annually[28]. With around 150 large shipyards[29], the EU leads in complex ship construction[30], producing just below 10% of new ships[31]. The European maritime technology sector is estimated to generate EUR 125 billion, or 23.8% of global maritime production value[32].
- **Cycling:** The EU cycling value chain covers bicycle manufacturing, infrastructure development, cycle tourism, hiring, logistics, and other services, contributing EUR 21 bn to the EU GDP and supporting 1.3 million jobs[33]. In 2023, 11.7 million bicycles were sold in the EU, with an increasing share of E-bikes[34]. The EU further is a global pioneer in bike-sharing initiatives.

[24] European Commission (2024). Transition pathway for the EU mobility industrial ecosystem. Retrieved from: https://ec.europa.eu/docsroom/documents/57674

[25] https://transport.ec.europa.eu/transport-modes/maritime_en

[26] European Commission (2024). Waterborne transport for a green future - A synergy info pack by CORDIS. Retrieved from: https://op.europa.eu/en/publication-detail/-/publication/cbbb70a7-247f-11ef-a195-01aa75ed71a1/language-en

[27] ECSA (2024). Ensuring Europe's security: A strong maritime industrial cluster for the green and digital transition. Retrieved from: https://ecsa.eu/wp-content/uploads/2024/09/FINAL_ECSA-Position-Paper-on-an-EU-Maritime-Industrial-Strategy-2024.pdf

[28] https://www.emsa.europa.eu/eumaritimeprofile/section-1-overview-on-the-eu-maritime-economy.html

[29] The EU Maritime Profile - Section 2: the maritime cluster in the EU - EMSA - European Maritime Safety Agency

[30] European Commission (2024). Transition pathway for the EU mobility industrial ecosystem. Retrieved from: https://ec.europa.eu/docsroom/documents/57674

[31] The EU Maritime Profile - Section 2: the maritime cluster in the EU - EMSA - European Maritime Safety Agency

[32] European Commission (2024). Transition pathway for the EU mobility industrial ecosystem. Retrieved from: https://ec.europa.eu/docsroom/documents/57674

[33] Ibid.

[34] https://www.conebi.eu/industry-market-reports/

2. Green transition

2.1. Industry efforts to green the mobility value chain

What progress has the industry made in taking action for the environment?

- In 2024, **25% of companies** in the mobility ecosystem **have implemented a concrete strategy to reduce their carbon footprint or achieve climate neutrality or negativity**.

- The most frequently employed types of green technologies focus on energy efficiency, with **41% of surveyed companies reporting the implementation of energy-saving technologies**.

- **Green transition related patent applications made up less than 10% of all patents in the mobility ecosystem** in the EU remaining stable over the period from 2010-2021, although showing a slight recent decrease.

- **Clean production technologies have shown a steady increase**, while renewable energy technologies experienced a decline from 2010 to 2015, followed by a recovery after 2015.

- **Electric mobility and mobility services are attracting the most scale-ups and venture capital**, indicating significant growth potential in these areas. The large number of e-mobility scaleups clearly shows the confidence of investors, signalling the high relevance of this business model in the future.

- **Advanced materials play a critical role in enabling innovations** in electric mobility and high-tech automotive manufacturing. Investment peaks in 2018 and 2021 likely reflect periods of significant breakthroughs or the scaling up of new materials technologies.

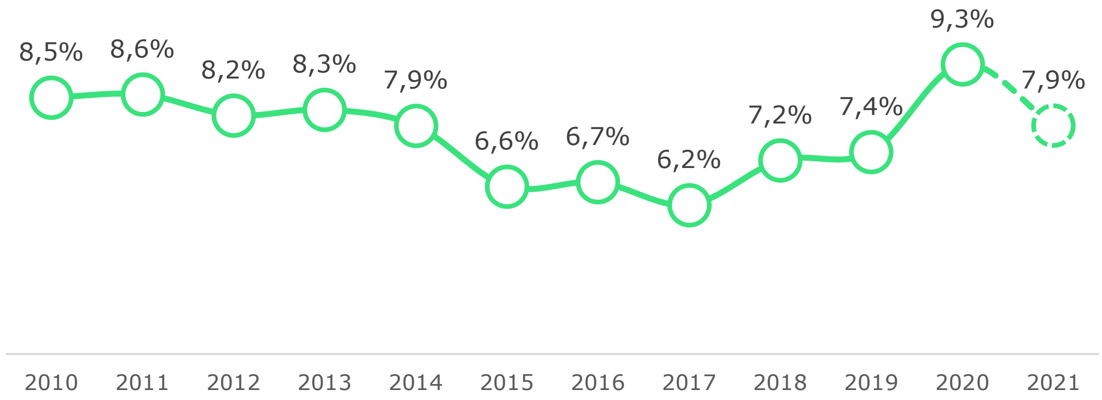
This section reports on the progress of firms within the industrial ecosystem towards the green transition. The first section focuses on green technology generation. The second section analyses the adoption of environmental technologies and circular business practices. The third section analyses how trends in green technology focused startups and scale-ups have unfolded in the mobility ecosystem over the last decade. Lastly, it examines the level of funding towards these green startups by venture capital investors.

2.1.1. Green technology generation

Green technology generation was investigated by the share of green technologies among total patent applications submitted by companies within the European mobility ecosystem. Our analysis, summarised in Figure 3, illustrates these shares from 2010 to 2021. The data for 2021 are based on a statistically derived estimate.

Green transition related patent applications made up less than 10% of all patents in the mobility ecosystem in the EU from 2010-2021. Over the last decade, this share remained approximately stable at 8.5% in 2010 and 9.3% in 2020, with a slight dip to a low of 6.2% in 2015. However, estimates for 2021 suggest a recent decline in the share of green patents, dropping to 7.9% of all mobility patent applications.

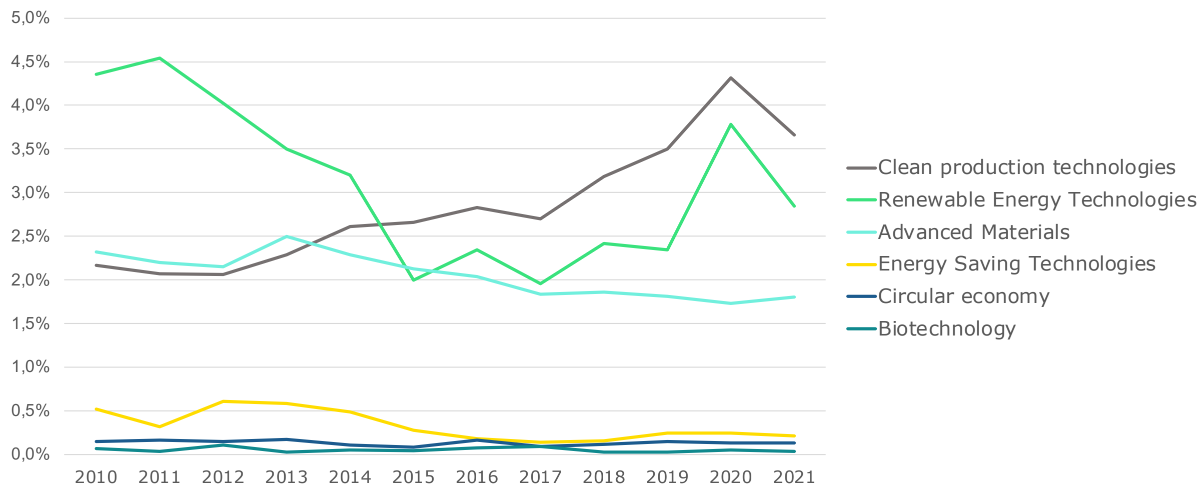
Figure 3: Share of green patent applications over total in the mobility, transport and automotive ecosystem (2021 estimated)



Source: Fraunhofer based on PATSTAT, 2021 estimated as mean of 2019-20

In addition to analysing the general trend in patenting activities, the most relevant green technologies that drive the sustainable transition in the mobility ecosystem were identified. Figure 4 provides a comprehensive overview of the evolution of patenting activities across several sustainability-related technology fields from 2010 to 2021.

Figure 4: Share of green transition related patents in overall patent applications filed from the mobility ecosystem (2021 estimated)



Source: Fraunhofer based on PATSTAT

Two key technology groups exhibit significant trends in patenting activities over the past decade:

First, **clean production technologies** have seen a sharp increase in patent filings, particularly from 2012 onwards. By 2020, these technologies emerged as the leading area in terms of R&D activities, underscoring their growing importance in facilitating the green transition. The steady growth in this category reflects the increasing focus on cleaner and more efficient industrial processes, as businesses and policymakers prioritise sustainability in manufacturing and production practices.

Second, **renewable energy technologies** present a different trajectory. Although this sector initially held a relatively high share of patenting activities in 2010, it experienced a noticeable and steady decline until 2018. This downturn may reflect saturation in certain areas of renewable energy innovation or shifting investment priorities. However, a marked increase in patenting activities from 2019 and again in 2020 suggests a resurgence in innovation, potentially driven by advancements in new renewable energy sources or improvements in the efficiency and integration of existing technologies.

Other technologies, such as advanced materials and energy-saving technologies, have maintained relatively stable shares of patent filings throughout the decade. Particularly noteworthy is the lower share of energy-saving technologies, despite their critical role in the green transition. This lower representation in patent filings may indicate that innovation in this sector is progressing at a slower rate, or that the technologies are more mature compared to other areas of green innovation.

In contrast, **biotechnology and circular economy technologies** represent areas with the lowest patenting activity within the green technology space. While these technologies are recognised for their potential contributions to the sustainable transition, they currently seem to play a less significant role in terms of innovation. However, given the rising importance of circular economy principles and biotechnology in future green innovations, these fields may experience more substantial growth in the coming years.

2.1.2. Uptake of green technologies and circular actions

The uptake of green technologies and circular actions was assessed by means of two large scale surveys: the 2024 versions of the EMI enterprise survey and the 2024 version of the Flash Eurobarometer (549)[35]. The EMI survey is a large-scale CATI survey conducted as part of the EMI project over the period from July-September 2024. The sample includes a total of 625 companies from the mobility, transport and automotive industrial ecosystem[36].

According to the 2024 Eurobarometer survey results, **25% of the companies active in the mobility ecosystem had a concrete strategy in place to reduce their carbon footprint or become climate neutral or negative in 2024**. This finding is corroborated by the 24% reported in the EMI enterprise survey (see Figure 5) and by a number of pledges submitted by stakeholders in the context of the Mobility Transition Pathway's co-implementation[37].

Figure 5: Share of companies in the mobility ecosystem that have adopted a concrete strategy to reduce their carbon footprint

Does your company have a concrete strategy in place to reduce carbon footprint and become climate neutral or negative?

Source: EMI enterprise survey 2024

Furthermore, the first round of pledges following the publication of the 'Transition Pathway for Mobility' report in January 2024 illustrates a growing commitment of the mobility ecosystem's stakeholders towards the green transition.

During this first round, **80 pledges** were published **by a total of 45 organisations** (mostly from the realm of business, but not excluding public authorities, academic or research institutions, social partners and financial institutes), **covering 19 of the 21 topics outlined in the Transition pathway**. Organisation from 10 EU27 Member States publicly committed to one of these cases, with the highest number of pledges from France followed by Germany, Portugal and Spain[38]. Pledges to reduce carbon and other greenhouse gas (GHG) emissions can be found across all subsectors of the mobility ecosystem:

- **In the automotive sector,** ZF Group (a German supplier for mobility systems for passenger and commercial vehicles) has committed to: 1) reduce absolute scope 1

[35] Directorate-General for Communication (2024). Flash Eurobarometer FL549: SMEs, resource efficiency and green markets. Retrieved from: https://data.europa.eu/data/datasets/s3221_fl549_eng?locale=en
[36] See Appendix B for an overview of the sample.
[37] https://single-market-economy.ec.europa.eu/news/publication-first-group-eu-mobility-pledges-and-new-call-pledges-2024-12-16_en
[38] https://ec.europa.eu/docsroom/documents/63874/attachments/1/translations/en/renditions/native

and 2 GHG emissions by 80% by 2030; 2) vows to increase its annual sourcing of renewable electricity from 10% to 100% by 2030; and 3) reduce scope 3 GHG emissions 40% per million euros in sales by 2030; all compared to the 2019 as the base year[39].

- **In the rail sector**, CAF (a Spain manufacturer of railway vehicles and equipment) pledges to develop technically and economically feasible zero emissions rail solutions, substituting the diesel train fleets. To do so, CAF aims to increase the range of battery powered trains by more than twice the current state of the art, by 2028[40].
- **In the waterborne sector,** Damen Shipyards Group (a Dutch shipbuilding and engineering company) pledges to upgrade its ship-repair drydock facilities to shore power by 2030, leading to significant reductions in yearly particulate matter, noise, CO2 and NOx emissions.
- **In the cycling sector**, Decathlon (a French retailer and manufacturer of sports equipment, including bicycles), pledges to reach net-zero greenhouse gas emissions across the value chain by 2050, with decarbonisation milestones (scopes 1, 2 & 3) at 42% reduction in absolute CO2 emissions in 2030, compared to emission levels of 2021[41].

Green technology adoption

The results of the EMI enterprise survey, in Figure 6, indicate that **the most frequently employed types of green technologies serve the purpose of energy efficiency,** as 41% of the surveyed companies indicated to have implemented a type of energy saving technology. This is followed by specific technologies for waste management, clean production technologies and advanced materials, with adoption rates of 29%, 21% and 20% respectively.

Figure 6: Green technology adoption by companies in the mobility ecosystem

Green Technology	Contribution to Transformation (2024)
Energy Saving Technologies	41 %
Waste Management Technology	29 %
Clean Production Technologies	21 %
Advanced Materials	20 %
Carbon Capture Technologies	7 %
Biotechnology	3 %

Source: EMI enterprise survey 2024

Adoption and impact of circular actions

Beyond green technologies, also the uptake of circular activities was assessed for this report, by relying on the data from the Eurobarometer survey[42]. In comparison to the green technologies above, circular activities refer to generic strategies to reduce the resource and waste intensities of a firm’s business operations, reuse used materials and products, as well as generic recycling activities. These actions can involve both technological solutions and non-technological measures. Consequently, the adoption rates for these circular actions are expected to be higher than the adoption rates of green technologies found in the EMI survey.

Figure 7 provides an overview of the most frequently employed circular actions by firms within the mobility ecosystem, based on data from the Eurobarometer survey. The surveyed activities can be broadly categorised into resource-saving initiatives and

[39] https://single-market-economy.ec.europa.eu/sectors/automotive-industry/mobility-transition-pathway/pledges_en
[40] Ibid.
[41] Ibid.
[42] https://europa.eu/eurobarometer/surveys/detail/3221

additional measures aimed at enhancing the circularity of the mobility ecosystem. These include activities such as recycling and selling waste, switching to green suppliers and renewable energy sources, and implementing environmental product design.

Figure 7: Share of firms indicating the adoption of circular actions

Action	***Adoption Share (2021)***	***Adoption Share (2024)***
Saving energy	57.2%	68.5%*
Minimising waste	57.7%	64.1%
Saving materials	52.1%	58.3%
Saving water	44.0%	53.8%*
Recycling, by reusing material or waste within the company	42.1%	46.8%
Switching to greener suppliers of materials	27.1%	30.6%
Designing products that are easier to maintain, repair or reuse	26.0%	30.4%
Selling your residues and waste to another company	31.2%	27.7%
Using predominantly renewable energy	18.8%	19.9%

*Source: Eurobarometer 2024 - Note: *Statistically significant increase at p<0.05*

Similarly to efforts aimed at reducing carbon and other greenhouse gas emissions, several pledges related to circular economy actions have been made in response to the first round of the Mobility Transition Pathway:

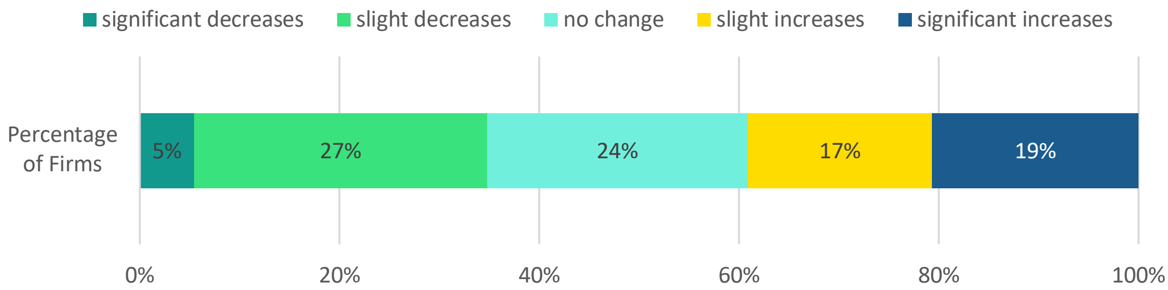
- **In the automotive sector,** LKQ Europe (a Belgium-based supplier of vehicle parts and services) pledges to upskill 24,000 workshop technicians in the maintenance and repair of hybrid and electric vehicles, by 2028, in order to support the longevity of these vehicles.
- **In the rail sector**, Alstom (a French manufacturer of railway vehicles) pledges to develop a strategy making second-hand parts available on the marketplace, as part of their circular economy strategy[43].
- **In the waterborne sector,** Circular Maritime Technologies (a Dutch company aiming at implementing circular economy principles in the waterborne sector) pledges to improve the efficiency of its circular activities[44].
- **In the cycling sector**, Decathlon (a French retailer and manufacturer of sports equipment, including bicycles) pledges to implement a wide range of circular measures, such as reaching 60% preferred metal usage (i.e. recycled, low carbon/hydro energy usage) by the end of 2024, and committing to support the uptake of recycled aluminium for the production of bicycles[45].The Eurobarometer results suggests that the most frequently implemented circular practices are resource efficiency measures, such as saving energy, minimising waste, saving materials and water, with adoption rates between 53% and almost 70%. Furthermore, when comparing the results of this year's survey with the previous round of the survey in 2021, we note that especially energy and water saving practices have seen the biggest increases.

Beyond the adoption of these technologies, also their effect on the cost structure of the adopting companies was evaluated in the Eurobarometer survey. The results in Figure 8, below show, that despite these increases in the implementation of resource efficiency measures, only 30% of the sampled companies reported direct positive impacts of these measures on their production cost (slight or significant decreases), while about 40% even

[43] Ibid.
[44] Ibid.
[45] Ibid.

reported increasing production cost. These results suggest that for almost half of the companies active in the mobility ecosystem the transition to greener practices may initially involve higher investments or operating costs, which could challenge their competitiveness, at least in the short term. However, the long-term effects could still offer potential competitive advantages, compliance with regulations, and alignment with consumer preferences for sustainability[46]. Consequently, within the next two years, in the areas of saving energy, water and materials, as well as minimising waste, more than 50% of the mobility ecosystem's companies are planning to dedicate additional efforts.

Figure 8: Impact of undertaken resource efficiency actions on production costs over the past two years



Source: Eurobarometer 2024

2.1.3. Sustainable startups in mobility

The analysis of mobility startups that drive the green transition in the ecosystem presented in this section has been compiled using data from Crunchbase and Net Zero Insights[47]. Figure 9 depicts the evolution of the number of environmentally focused startups in the mobility ecosystem founded each year between 2015 and 2021. The figure shows that the European mobility startup ecosystem has seen two distinct phases of expansion and decline over the past decade. Namely, between 2015 and 2019 the sector saw a strong increase in the number of green startups founded each year, while the years after 2020 have seen a marked decline.

While a substantial share of this decline may be attributed to methodological limitations of the Crunchbase data, the trend is consistent with other analyses, reflecting a broader global decrease in startup activity in recent years[48]. This slump is likely explained by a general increase in geopolitical and economic uncertainty due to the COVID-19 pandemic and its aftermath, the war in Ukraine, and a worsening economic outlook.

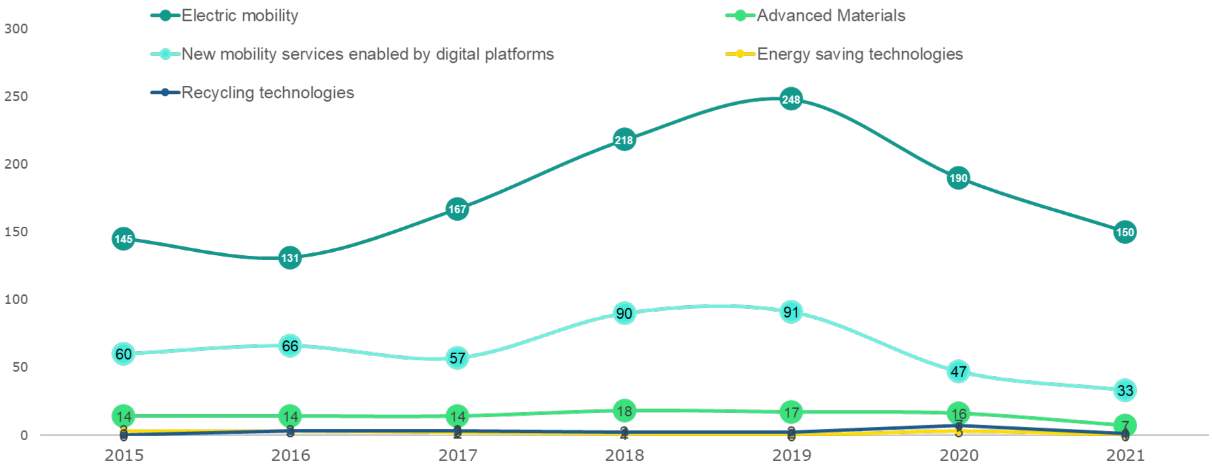
The most important segments for green mobility startups have been in the fields of electric mobility and new mobility services. In line with the overall decline in startup rates in recent years, both of these segments have experienced significant decreases in the number of startups founded each year since peaking in 2019.

[46] For example, Hermundsdottir, F., & Aspelund, A. (2021). Sustainability innovations and firm competitiveness: A review. Journal of Cleaner Production, 280, 124715.

[47] www.crunchbase.com and https://netzeroinsights.com/

[48] https://news.crunchbase.com/venture/startup-creation-challenges-opportunities-charts-sagie/ and https://www.wirtschaftsdienst.eu/inhalt/jahr/2024/heft/1/beitrag/das-gruendungsgeschehen-in-deutschland.html

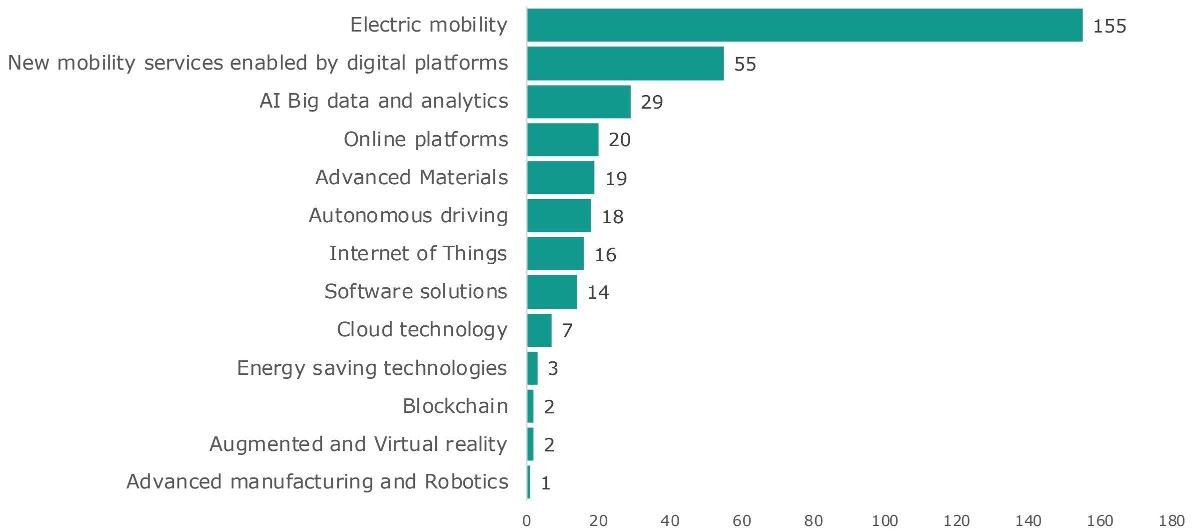
Figure 9: Environmentally focused startups in the mobility ecosystem



Source: Technopolis Group based on Crunchbase and Net Zero Insights [49]

Beyond startup rates alone, looking at the number of scaleups in the mobility ecosystem is a good proxy for the survivorship and growth potential of novel businesses in the ecosystem. Figure 10 indicates that more than half of all successful (fast growing) mobility startups (i.e. scaleups) are related to electric mobility.

Figure 10: Distribution of scale ups by tech



Source: Technopolis Group based on Crunchbase

The large number of e-mobility scaleups clearly shows the confidence of investors that these fast-growing startups can disrupt extant markets and challenge traditional OEMs, and current market leaders in the field of e-mobility, signalling the high relevance of this business model in the future. Examples for successful e-mobility scaleups include:

- **Polestar:** Founded in 2017, Polestar is a manufacturer of electric vehicles focused on providing a sustainable and efficient driving experience, with an emphasis on extended range. Since its inception, Polestar has raised a total of EUR 3.41 bn across six funding rounds, with EUR 2.54 bn secured in 2022 alone over four rounds. The company has rapidly established itself as a key player in the electric

[49] Due to time-lags with new companies being added to Crunchbase, the number of new startups listed for 2022 and 2023 is very likely not yet complete and the apparent decrease thus overestimated. For more information see: https://news.crunchbase.com/venture/startup-creation-challenges-opportunities-charts-sagie/

vehicle market, attracting significant investment to support its growth and technological innovation[50].

- **Rimac Automobili:** Rimac Automobili, a pioneer in electric car development and manufacturing, raised EUR 720 m in 2022 through a Series A and growth equity funding round. Renowned for its high-performance electric hypercars, Rimac has gained global recognition for pushing the boundaries of electric mobility. The company continues to draw substantial investment, driving the development of cutting-edge automotive technologies and expanding its presence in the electric vehicle market[51].

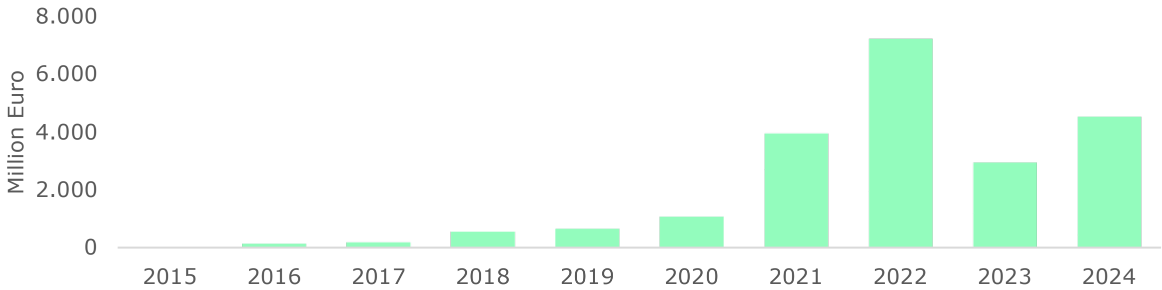
Further exemplary scaleups in the fields of advanced materials and new mobility that attracted a substantial amount of venture capital funding in recent years include:

- **Forsee Power:** Forsee Power specialises in advanced lithium-ion battery systems for various mobility applications. Its smart battery systems are built around essential electrochemical cells, forming the core energy storage component. The company has raised a total of EUR 235 m in venture capital.[52].
- **TIER Mobility:** TIER Mobility is a micro-mobility company providing sustainable ride-sharing solutions. It has raised a total of EUR 606 m in venture capital[53].
- **HysetCo**: Founded in 2020, HysetCo is a pioneering hydrogen mobility start-up, that offers access to an ecosystem of hydrogen-based mobility services. In early 2024, the company raised approx. EUR 200 m, managing a fleet of over 500 hydrogen vehicles and distributing nearly 30 tons of hydrogen per month[54].

2.1.4. Private investments

This section further analyses the financing situation of innovative businesses in the mobility ecosystem, by looking at venture capital investments in green transition related mobility startups and young companies. Figure 11 to Figure 13 illustrate the evolution of venture capital investments, measured in millions of euros, in three major sub-sectors of the mobility ecosystem: electric mobility (e-mobility), advanced materials, and mobility services enabled by digital platforms, spanning the period from 2015 to 2023.

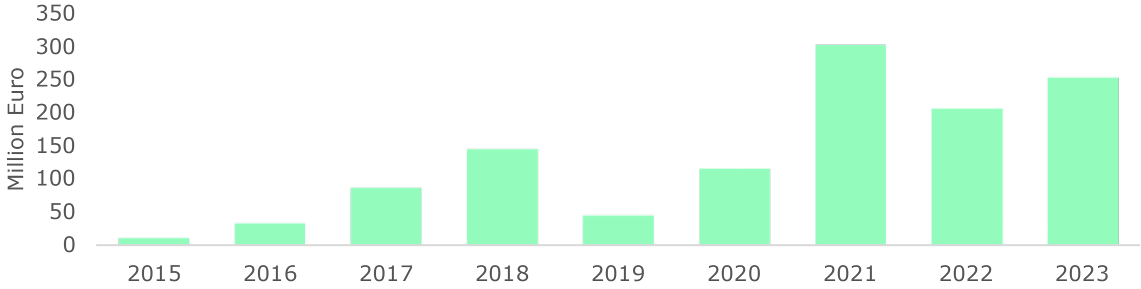
Figure 11: Venture capital raised by electric mobility startups (total raised since 2015 EUR 21.37 m)



Source: Technopolis Group based on Crunchbase and Net Zero Insights

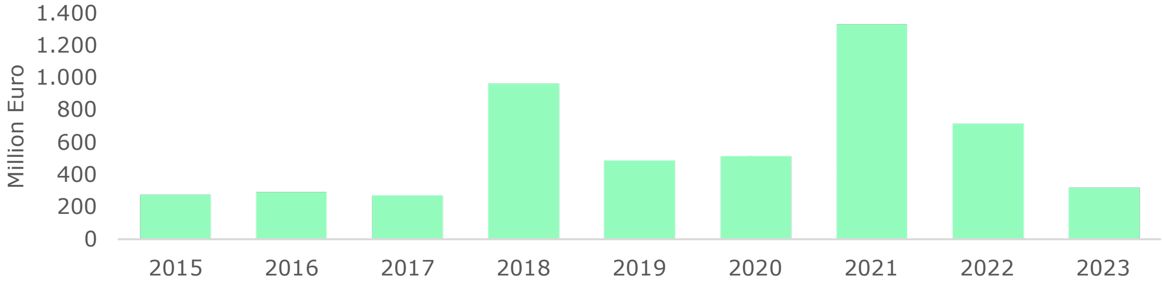
[50] https://www.polestar.com/de/
[51] https://www.rimac-automobili.com/
[52] https://www.forseepower.com/
[53] https://www.tier.app/de/
[54] https://carboncredits.com/hydrogen-attracts-over-1-billion-in-vc-funding-per-crunchbase-data/ and HysetCo - Crunchbase Company Profile

Figure 12: Venture capital raised by advanced materials startups



Source: Technopolis Group based on Crunchbase and Net Zero Insights

Figure 13: Venture capital raised by startups offering new mobility services enabled by digital platforms



Source: Technopolis Group based on Crunchbase and Net Zero Insights

Despite the decrease in the absolute number of startups in the mobility sector, as observed in the Crunchbase data from the previous section, **venture capital investments in mobility startups continued to rise until as recently as 2021 across all three sub-sectors** (and until 2022 for e-mobility).

Figure 11 reflects a pronounced rise in investments in the electric mobility sector. From 2015 to 2019, investment levels remained below the threshold of EUR 1 bn. However, starting in 2020, there was a strong surge with investments exceeding EUR 4 bn in 2021 and peaking at over EUR 7 bn in 2022. Despite a slight dip in investments in 2023, projected figures for 2024 suggest a rebound, with sustained robust investment levels.

This trend indicates a significant shift in market confidence and prioritisation of electric mobility solutions. The sharp rise aligns with the global push for greener technologies and transportation solutions, driven by policy incentives, climate change goals, and advancements in electric vehicle technology and infrastructure. The peak in 2022 and the continued strong investment activity underscore the central role of electric mobility in the broader sustainable transition, as well as investors' confidence in e-mobility business models.

Figure 12 depicts a moderate but steady increase in investments in the advanced materials sector. Between 2015 and 2017, investments rose steadily, surpassing EUR 100 m. The most significant growth occurred in 2018, with investments peaking at over EUR 300 m. Following a slight dip in 2019, the sector rebounded in 2021, reaching levels similar to 2018, before experiencing another decline in 2022 and a modest recovery in 2023.

Advanced materials play a critical role in enabling innovations across various industries, including electric mobility, renewable energy, and high-tech manufacturing. The peaks in 2018 and 2021 likely reflect periods of significant breakthroughs or the scaling up of new materials technologies. The fluctuations in investment suggest that the sector is influenced by market cycles and project-specific dynamics, such as the adoption of advanced materials in energy storage and lightweight construction.

Figure 13 demonstrates fluctuating investment activity in companies focused on mobility services enabled by digital platforms, including ridesharing, car-sharing, and mobility-as-a-service (MaaS) platforms. Starting at approximately EUR 200 m in 2015, investment levels rose steadily, exceeding EUR 1 bn in 2018. Following a decline in 2019 and 2020, investments peaked again in 2021, reaching over EUR 1.2 bn, before decreasing in 2022 and 2023. The cyclical nature of investments in this sector reflects the rapid evolution of digital mobility services and the changing dynamics of transportation options. The peaks in 2018 and 2021 likely correspond to periods of significant growth or scaling of digital platforms, driven by increased demand for flexible and sustainable mobility solutions. The decline after 2021 suggests market saturation, consolidation, or shifting investor priorities as the sector matures and key players establish dominance[55].

2.2. Framework conditions – assessment of the broader ecosystem supporting the green transition

To what extent do framework conditions such as public financing and skills support the green transition?

- Public funding plays a crucial role in supporting the green transition of the mobility ecosystem. **37% of the European Regional Development Fund dedicated to the mobility ecosystem amounting to EUR 33 bn was allocated to projects focused on the green transition during the 2014–2020 period.**

- **Horizon 2020 dedicated over EUR 253 m to the green transition** of the mobility ecosystem. The subsequent Horizon Europe programme has intensified this focus, earmarking half that amount within just two years (2022-2024), with **73% of the total funds directed toward the green transition**.

- The Recovery and Resilience Fund (**RRF**) contributes with **EUR 87.9 bn**, making up 25.7% of total green expenditure in the plans.

- There are significant **challenges in up-skilling and re-skilling** the workforce for the green transition in the mobility ecosystem. In the automotive industry, 25% of the workforce is over 50 years old, and 2.4 million workers will need retraining or upskilling by 2030.

- The share of **professionals with skills relevant to the green transition was 7.36%** in 2024, with a 114% increase in self-reported green skills since 2022.

- In 2023, **only 0.7% of online job advertisements required skills related to the green transition. However, there is still a high demand for** expertise in EV and battery technologies in Europe.

- While **demand for electric vehicles has increased over the last decade, future demand remains uncertain** due to potential changes in incentive schemes.

- The majority of **maritime vessels still rely on fossil fuels** due to cost disadvantages of alternative fuels, and the future fuel mix in waterborne transport is uncertain.

2.2.1. Public investments supporting the green transition

Public funding is essential to advancing the green transition, reinforcing the efforts and investments of the private sector. It addresses several key challenges of the green transition, particularly by mitigating the financial risks associated with innovative projects. Many mobility initiatives require significant infrastructure improvements that may not be

[55] Via ID and Dealroom.co (2024). State of European Mobility Startups 2023. Retrieved from https://dealroom.co/uploaded/2024/01/European-Mobility-report-2023_-Dealroom_Via-ID.pdf?x30228

financially viable for private companies to undertake alone; public funding helps to bridge this critical gap.

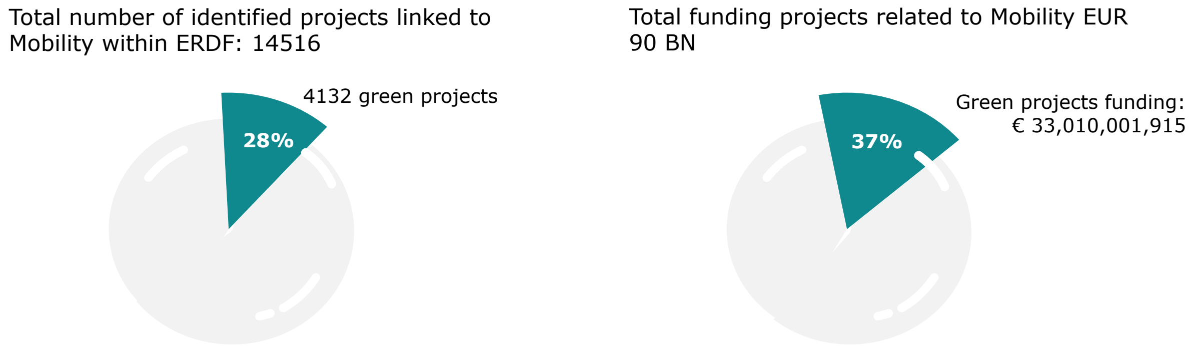
Accordingly, this chapter evaluates public investments directed toward the green transition of the mobility ecosystem with a particular emphasis on EU public policy initiatives. The funding under the **European Regional Development Fund (ERDF), the Horizon 2020 and Horizon Europe programmes**, as well as the **Recovery and Resilience Facility (RRF), the Innovation Fund and Connecting Europe Facility for Transport (CEF-F)** and their **Alternative Fuels Infrastructure Facility (AFIF)** are part of this analysis. Lastly, the report looks at the extent of loans provided by the **European Investment Bank (EIB)** for projects related to the green transition of the mobility ecosystem.

European Regional Development Fund (ERDF)

The analysis of public investments from the European Regional Development Fund (ERDF) into the mobility, transport, and automotive transition relies on data from the Cohesion Dataset of the European Commission. This dataset includes detailed descriptive, categorical, and financial information on ERDF and Cohesion Fund (CF) operations across 215 Operational Programmes and 73 Cooperation Programmes, covering all thematic objectives for the 2014-2020 programming period. While this dataset provides a comprehensive overview of investments made during this period, data for the 2021-2027 programming period is anticipated to become available only toward the end of this year, which will enable future analyses of the evolving funding landscape for mobility and transport innovation.

The total funding allocated by the ERDF to the mobility ecosystem amounts to approximately EUR 90 bn across a total of 14 516 projects. An analysis of this funding reveals the following distribution (see Figure 14): 28% of all mobility related projects under the ERDF and **37% of the available funding (EUR 33 bn) were dedicated to projects that supported the green transition of the mobility ecosystem**.

Figure 14: ERDF funded projects supporting the green transition within the mobility ecosystem



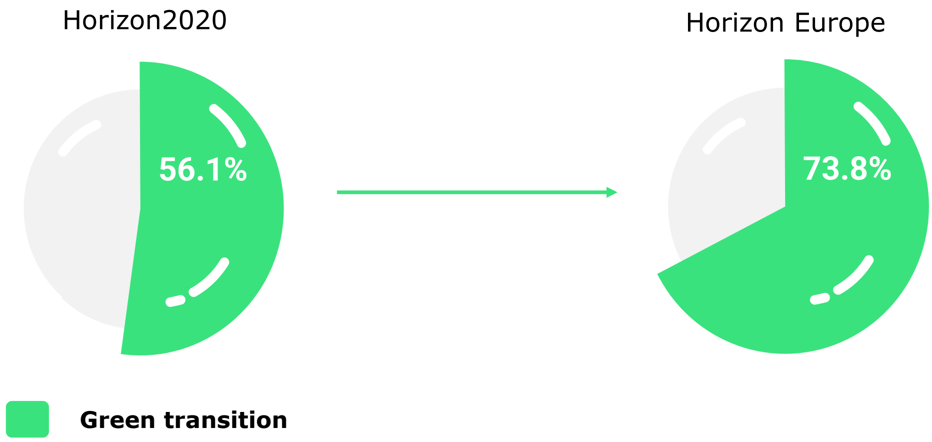
Source: Technopolis Group based on Cohesion

Horizon 2020 and Horizon Europe

The analysis of green projects under the Horizon 2020 and Horizon Europe programmes was based on data extracted from the EU's CORDIS database. This dataset offers insights into EU investments in research and innovation for the mobility sector's industrial transition, allowing a nuanced view of funding allocation and thematic focus. To map projects to relevant scientific themes—particularly within the context of the green and digital transitions—EuroSciVoc data was utilised, which classifies projects by associated scientific concepts. This methodology enhances our understanding of the research focus within these transitions.

Additionally, three core indicators were employed to analyse the research and innovation (R&I) ecosystem: total project costs, funding received, and project count. Together, these indicators illustrate the scale and focus of EU investment in fostering sustainable and digital mobility innovations.

Figure 15: EU R&I funding spent on Horizon projects related to the twin transition



Source: Technopolis Group based on CORDA

The Horizon 2020 and Horizon Europe programmes reflect a still growing commitment by the European Union to fund the green transition within the mobility sector, highlighting the sectors increasing importance for achieving environmental sustainability.

Horizon 2020, which ran from 2014 to 2021, dedicated over EUR 253 m to the green transition of the mobility ecosystem, which constituted 56% of the total funding. The subsequent Horizon Europe programme has intensified this focus, earmarking half that amount within just two years (2022-2024), with **73% of the total funds directed toward the green transition**. The share of funding dedicated to green initiatives has risen sharply from 56% to 73%, underscoring the EU's intensified prioritisation of the green transition in its mobility and broader innovation agendas.

Recovery and Resilience Facility

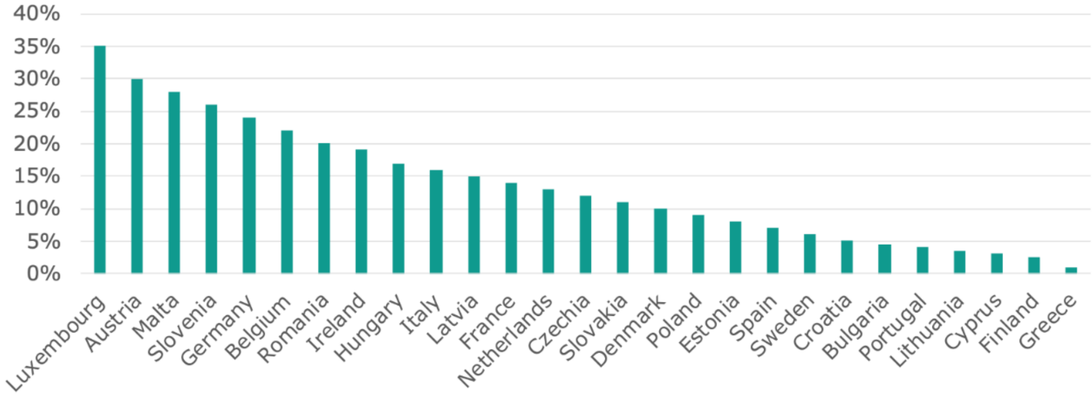
Besides the ERDF, the **Recovery and Resilience Fund (RRF)[56],** established as part of the EU's response to the COVID-19 pandemic, contributes also to the transport, mobility and automotive sector by providing financial support aimed at driving the green and digital transitions. This fund is particularly focused on helping businesses to recover from the economic impacts of the pandemic while enhancing their resilience to future challenges.

Overall, total estimated expenditure on sustainable mobility amounts to **EUR 87.9 bn**, across 27 member states, which corresponds to **25.7% of the total green expenditure in the plans** (grants and loans included). This expenditure is matched with 77 reforms and 311 investments across the EU27 Member States[57]. The figure below provides a distribution of expenditure on sustainable mobility in the Member State Recovery and Resilience Plans (RRPs).

[56] European Commission (n.d.). The recovery and Resilience Facility. Retrieved from: https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility_en

[57] European Commission (2024). RECOVERY AND RESILIENCE SCOREBOARD. Retrieved from: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_sustainable_mobility.pdf

Figure 16: Share of expenditure on sustainable mobility in RRPs



Source: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_sustainable_mobility.pdf

The RRFs investments in sustainable mobility initiatives, are distributed across several thematic foci, including investments in **railway infrastructure, urban mobility transport** (including rail, cycling and waterborne transportation), as well as the **promotion of zero or low emission mobility** and **alternative fuels infrastructures**.

The investments in railway infrastructure constitute the largest category and represent almost 46% of total expenditure on sustainable mobility (EUR 40.1 bn)[58]. These investments are used for **modernising railway infrastructure and networks** by financing the construction, renovation and electrification of train lines and procurement of **zero-emission trains** (electric and hydrogen-fuelled).

The second largest cluster of investments concern **urban transport mobility** (30% of the total expenditure, EUR 26.8 billion)[59]. Investments in this section relate to infrastructure investments in urban metro and tram network expansions, but also the electrification of public transportation fleets (i.e. buses), the construction of cycling paths, or the creation of waterborne passenger transportation, such as ferry lines and coastal transportation lines.

Furthermore, the **promotion of zero or low emission mobility** through support to electric vehicles and the deployment of electric charging stations is an instrumental part of the funding under the sustainable mobility section of the RRF. In this respect, EUR 4.44 billion have been allocated, to create incentive schemes for the purchase of zero emission vehicles, such as the implementation of scrapping schemes of the emission-heavy cars, or financial incentives for purchasing electric vehicles.

Lastly, the RRF aims to provide measures for funding the construction of more than 1.3 million **recharging and refuelling points** for low- and zero-emission vehicles for public and private usage[60], as well as the development of alternative fuels infrastructures, such as hydrogen and biomethane refuelling stations.

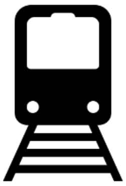
Specific examples of RRF investments across different member states and thematic foci are provided below in

[58] Ibid.
[59] Ibid.
[60] Ibid.

Figure 17.

Figure 17: Examples of RRF investments in sustainable mobility

Rail



Austria is using its RRP to improve the TEN-T Core Network Corridors. Through the investment, the plan will support the construction of a new railway line, and electrification of existing regional railway line.

Urban mobility

Belgium will finance the electrification of the bus fleet for public transportation in Flanders and Brussels (145 new electric buses). Belgium's RRP also includes measures to substantially invest in its cycling, walking, rail, urban transport and inland waterways infrastructure.

Zero emission vehicles

Czechia uses part of its RRF allocation as a stimulus to the electromobility market, providing investment aid to increase demand for electric vehicles, as well as other low emission alternatives.
France supports the demand for clean vehicles, mainly from households, by introducing an 'ecological bonus' for light vehicles to support the purchase of an electric, hydrogen or plug-in hybrid vehicle with CO_2 emissions less than or equal to 50 g/km

Recharging and hydrogen refuelling infrastructure

Italy's charging infrastructures' measure consists of supporting the development of 7 500 fast public charging infrastructure points on public roads by 2025, 13 755 fast public charging infrastructure points in urban centres, and 100 experimental charging stations connected to energy storage facilities, 10 Train Hydrogen facilities and 40 hydrogen refuelling stations for trucks.

Source: Examples of RRF investments in sustainable mobility. Available: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_sustainable_mobility.pdf

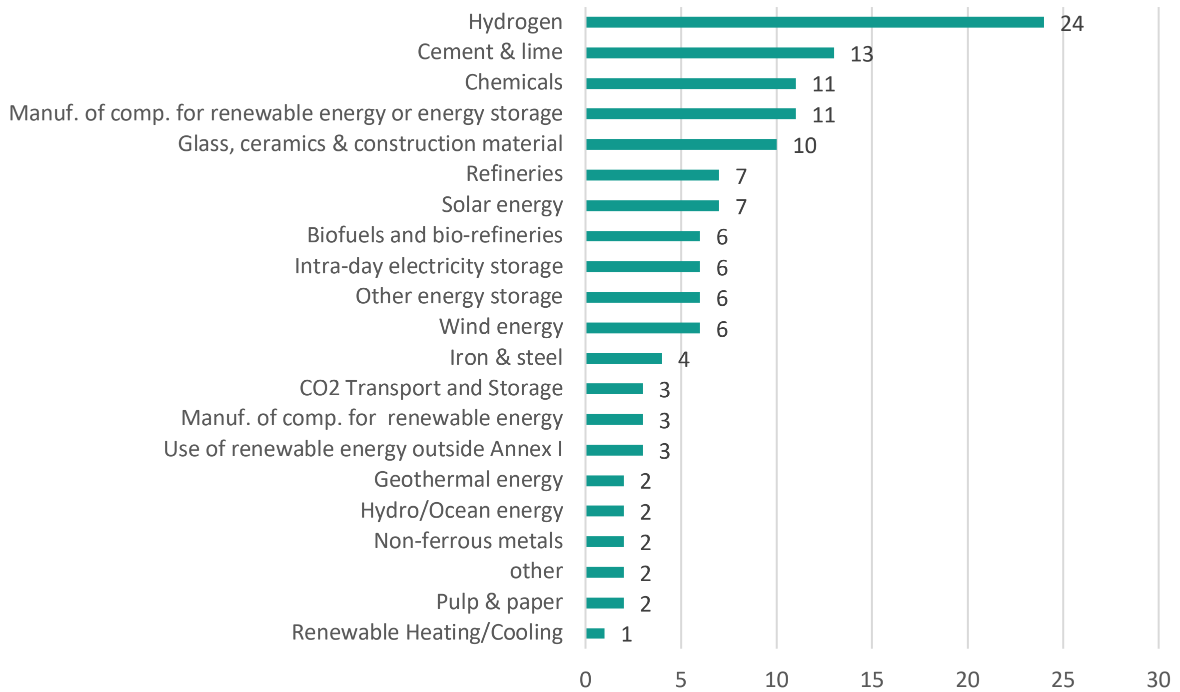
The Innovation Fund (IF)

The Innovation Fund is one of the world's largest funding programmes for the deployment of net-zero and innovative technologies, with a particular emphasis on several mobility sectors. The IF is equipped with a budget of approximately **EUR 40 bn for the period from 2020 to 2030, which is financed by revenues from the European Union Emissions Trading System (EU ETS).** The fund aims to support businesses invest in clean energy and bring technologies to market that can decarbonise European industry, while fostering its competitiveness[61].

To date, a total of 131 projects have been funded under the IF since 2020, with a total contribution of EUR 7.4 bn[62]. Among these projects, the largest number (24 in total) has been related to the development of hydrogen technologies and production capabilities (see Figure 18 for an overview of the sectoral distribution of the IF project portfolio).

[61] https://climate.ec.europa.eu/eu-action/eu-funding-climate-action/innovation-fund/what-innovation-fund_en
[62] https://dashboard.tech.ec.europa.eu/qs_digit_dashboard_mt/public/sense/app/6e4815c8-1f4c-4664-b9ca-8454f77d758d/sheet/bac47ac8-b5c7-4cd1-87ad-9f8d6d238eae/state/analysis

Figure 18: Sectoral distribution of Innovation Fund (IF) project portfolio



Source: https://dashboard.tech.ec.europa.eu/qs_digit_dashboard_mt/public/sense/app/6e4815c8-1f4c-4664-b9ca-8454f77d758d/sheet/bac47ac8-b5c7-4cd1-87ad-9f8d6d238eae/state/analysis

In October 2024, for the latest round of IF funded projects, the Commission selected 85 projects to receive EUR 4.8 bn in grants from Innovation Fund (the largest amount since its inception in 2020)[63]. Anong these projects, and with respect to **net-zero mobility,** the **maritime sector** was the one benefitting the most (6 selected out of 18 maritime projects presented), receiving a total of **over EUR 200 million**. Selected maritime projects involved **building and retrofitting vessels for RFNBO fuels and electricity use.**

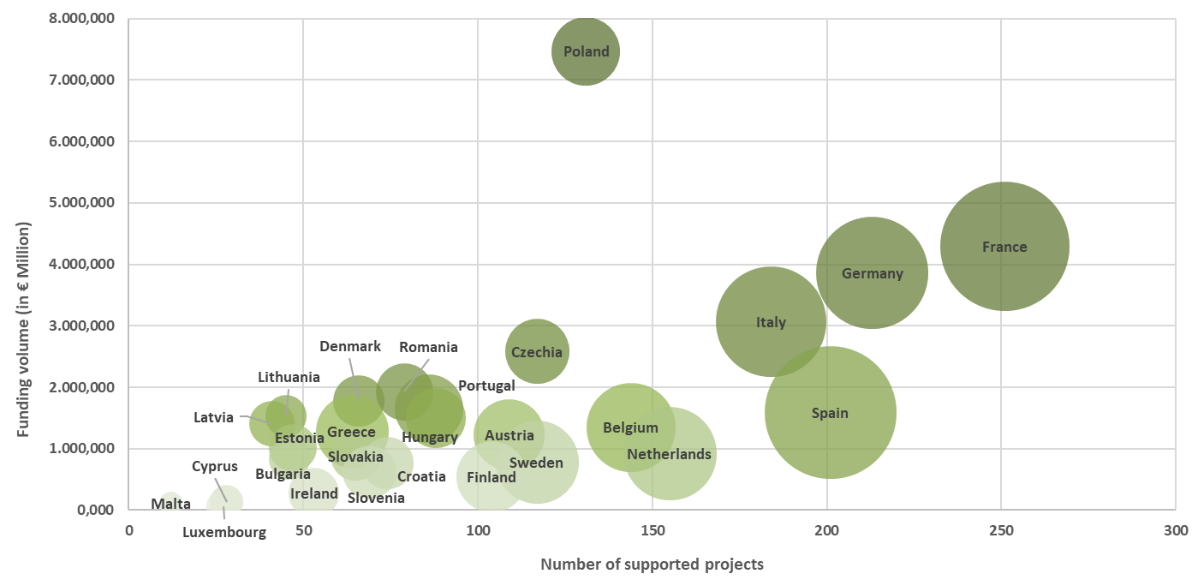
Connecting Europe Facility for Transport (CEF-T)

The Connecting Europe Facility for Transport (CEF-T) finances the construction of new transport infrastructure projects, as well as the upgrading existing infrastructure. The focus is removing extant bottlenecks in Europe's transport network and bridging missing links, especially in cross-border connections[64].

As of today, CEF-T has invested EUR 43.98 bn on a total of 1 666 projects in the EU27 Member States and beyond (89 projects supported non-member states, with an expenditure of over EUR 500 m)[65]. Figure 19 shows a distribution of the funds across the EU27 member states, including the number of funds per projects (X-axis) and allocated funds per country (Y-axis).

[63] https://ec.europa.eu/commission/presscorner/detail/en/ip_24_5423
[64] https://cinea.ec.europa.eu/programmes/connecting-europe-facility/transport-infrastructure_en
[65] https://dashboard.tech.ec.europa.eu/qs_digit_dashboard_mt/public/sense/app/3744499f-670f-42f8-9ef3-0d98f6cd586f/sheet/d2820200-d4d9-4a26-b23b-58e323c803c2/state/analysis

Figure 19: Regional distribution of CEF-T funded projects



Source: https://dashboard.tech.ec.europa.eu/qs_digit_dashboard_mt/public/sense/app/3744499f-670f-42f8-9ef3-0d98f6cd586f/sheet/d2820200-d4d9-4a26-b23b-58e323c803c2/state/analysis

The main beneficiary of CEF-T funding has been the railway sector, where CEF-T funds contribute to the advancement of the Trans-European Transport Network (TEN-T). Since 2014 more than EUR 32 billion have been invested in the expansion and modernisation of Europe's railway infrastructure, including the deployment of European Rail Traffic Management System (ERTMS)[66].

In the waterborne sectors, both the modernisation of port infrastructure and projects supporting the development of inland waterways have been strongly supported under CEF-T. More than EUR 3 billion in grants has been awarded to projects that develop and modernise basic port infrastructure, improving more than 150 European maritime ports by providing safe port access, strengthening connections between maritime ports and other transport infrastructure, as well as ensuring year-round navigability of EU waters[67]. Furthermore, another EUR 3 billion of CEF-T funds has been invested in supporting inland waterway projects upgrading more than 70 European inland waterway ports, 1,200 km of inland waterways and 370 locks, dams, bridges and other interventions[68].

CEF-T furthermore supports the decarbonisation of road transport through financing the deployment of recharging stations for electric vehicles (EV) and hydrogen refuelling stations for commercial vehicles. 50,000 EV-recharging points (including more than 30,000 high-power capacity recharging points) and more than 300 hydrogen refuelling stations across 16 Member States are supported, which correspond to a supply capacity of more than 125 tonnes of hydrogen per day[69]. Further support for the diffusion of alternative fuels across Europe is CEF-Ts **Alternative Fuels Infrastructure Facility (AFIF)**, which placed a call for proposals to further support the deployment of alternative fuels supply infrastructure, contributing to decarbonising transport along the TEN-T network[70]. EUR 1 bn is available under this call[71].

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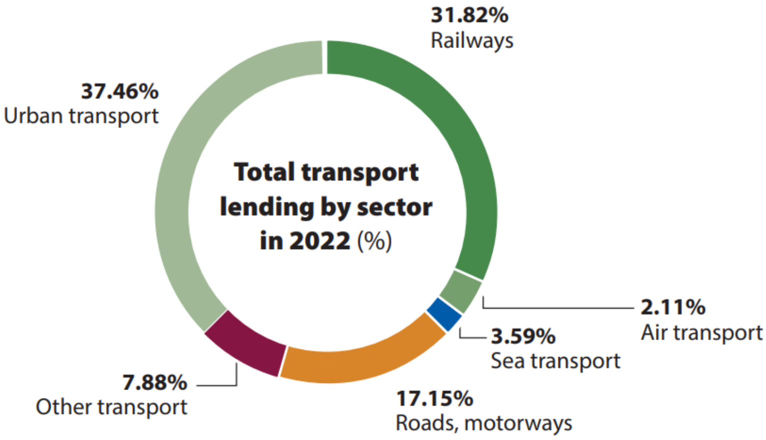
[66] https://webgate.ec.europa.eu/cineaportal/apps/storymaps/stories/48c1f6a4ce33415fb4ec40dd2aa836bd
[67] Ibid.
[68] Ibid.
[69] Ibid.
[70] CEF Transport Alternative Fuels Infrastructure Facility (AFIF) call for proposal - European Commission
[71] Ibid.

European Investment Bank (EIB)

The EIB funds projects for building sustainable infrastructure projects for the mobility sector, around the world. In its last report on sustainable transport lending[72], the **EIB reports to have provided a total of EUR 11 bn for sustainable mobility both within the EU27 countries and beyond**.

Figure 20 shows the split of supported projects by sector. The largest number of supported projects was related to urban transport and railways, with 37.46% and 31.82% respectively.

Figure 20 Total transport lending by sector, by EIB in YEAR 2022



Source: https://www.eib.org/attachments/lucalli/20230266_sustainable_transport_overview_2023_en.pdf

Exemplary projects in the railway sector, founded by the EIB include:

- The EIB supported the Danish State Railways with a loan of EUR 500 m to replace their diesel-driven roll stock with 100 new electric passenger trains.
- Furthermore, EIB supports the construction of a new metro line in Greece's capital Athens with a loan of EUR 580 m, to improve the urban mobility of the city.

The city of Florence received a loan of EUR 200 m to support "urban regeneration, energy efficiency in public buildings, sustainable mobility and digital infrastructure"[73].

2.2.2. Skills supply and demand underpinning the green transition

This section analyses the supply and demand side of the labour market for green transition skills. The analysis of green transition related skills followed the definition of Cedefop, notably "*the knowledge, abilities, values and attitudes needed to live in, develop and support a sustainable and resource-efficient society*"[74]. Accordingly, green skills have been defined as skills related to environmental protection, environmental services, resource efficiency, biodiversity, low carbon technologies, renewable energy, the circular economy, waste management, management of food waste, and clean production technologies and business models related skills (the list of keywords that have been used and are possible to track with the algorithm of LinkedIn is included in Appendix B).

The green transition of the mobility ecosystem is accompanied by significant up-skilling and re-skilling challenges, that impact all its subsectors across their entire value chains – and is accordingly a major challenge for millions of workers across the EU27. For instance, in the automotive sector alone around 15 million Europeans directly and indirectly

[72] https://www.eib.org/attachments/lucalli/20230266_sustainable_transport_overview_2023_en.pdf
[73] https://www.eib.org/attachments/lucalli/20230266_sustainable_transport_overview_2023_en.pdf
[74] https://www.cedefop.europa.eu/en?etransnolive=1

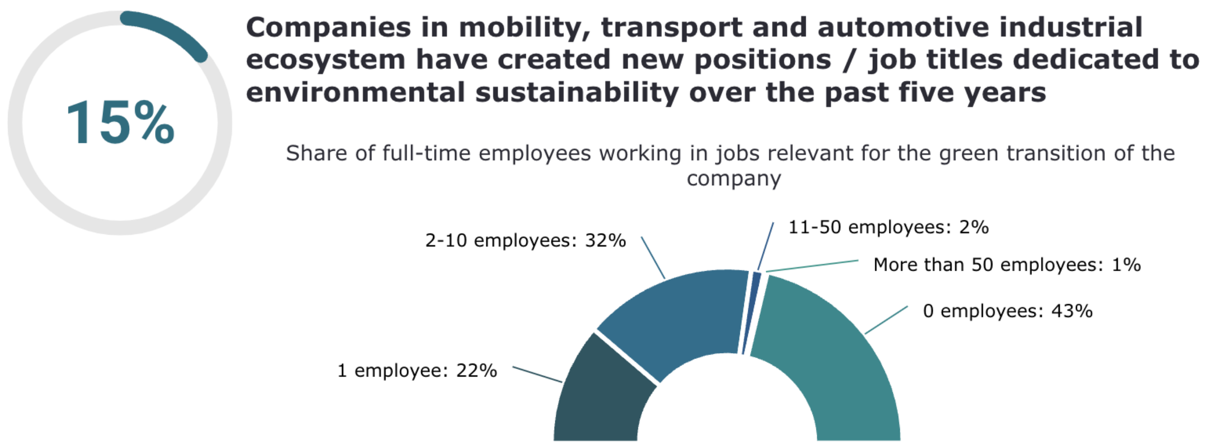
employed in the automotive value chain are expected to be impacted by the skills transition[75].

Furthermore, also the demographic change poses another challenge to the mobility ecosystem. In the automotive industry, 25% of the workforce is over 50 years old. In the passenger car industry alone, it is estimated that 2.4 million automotive workers will need to be retrained or upskilled by 2030. As regards shipbuilding and maritime equipment, 40% of the workforce is expected to retire in the next 10 years. The Pact for Skills' dedicated large-scale partnership estimated that there is a need for 234,000 new entrants in the shipbuilding sector by 2030. Besides, the green and digital transition will require to upskill and reskill 800.000 seafarers in the next 10 years internationally to handle new clean fuels and technologies onboard vessels[76]. Lastly, also European rail suppliers are confronted with an ageing workforce, with 30% of the workforce expected to retire in the next 10 years.

2.2.2.1. Supply of skills relevant for the green transition

The Eurobarometer 2024 found that **the share of enterprises that employ between one and five employees (full time equivalents) working in green jobs some or all the time has increased over time. More specifically, the share increased from 31% in 2021 to 38% in 2024[77]**.

Figure 21: Share of surveyed companies that have created new positions related to environmental sustainability and share of employees working in jobs relevant for the green transition.



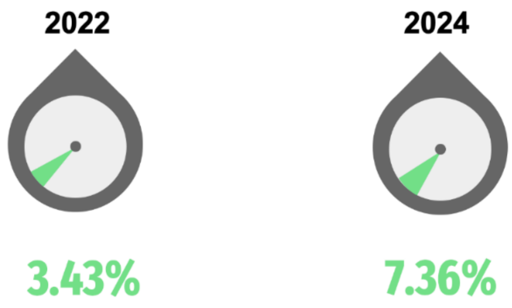
Source: Eurobarometer 2024 and EMI enterprise survey

The supply of professionals with skills for the green transition in mobility, transport and automotive was assessed using LinkedIn data. In April 2024, there were **2 500 301 professionals** with profiles on LinkedIn, which represents approximately **25% of the workforce in the industrial ecosystem**. This data reflects a moderate engagement with the platform by a quatre of those employed in the sector, indicating the presence of a digital footprint and the potential for analysis and skill tracking. Out of this total, 1 899 355 professionals worked in automotive, 289 327 in maritime and 168 542 in rail transport.

[75]https://s.c36f8cbe1721ebab5173e17520132910.entry.domains/fileadmin/user_upload/ACE_Mobility_Automotive_Dashboard_online.pdf
[76] https://ecsa.eu/wp-content/uploads/2024/09/FINAL_ECSA-Position-Paper-on-an-EU-Maritime-Industrial-Strategy-2024.pdf
[77] https://europa.eu/eurobarometer/surveys/detail/3221

According to LinkedIn data, the share of professionals with skills relevant for the green transition in 2024 was 7.36%. The share of green self-reported skills grew by 114% in 2024 compared with 2022.

Figure 22: Share of professionals with green transition skills in Mobility, Transport and Automotive as reported on LinkedIn profiles



Source Technopolis Group based on LinkedIn data

Supply of the green skills can also be assessed following the results of the survey carried out within the framework of Development and Research on Innovative Vocational Educational Skills (DRIVES) project. The figure below indicates the share of graduates that poses specific green skills important for mobility, transport and automotive industrial ecosystem.

Figure 23: Supply of green skills in transport, mobility and automotive industrial ecosystem

Green skills	**Supply** (% of graduates prepared each year that possess digital skills)
Materials sciences	4.20%
Sustainability	0.7%
Batteries	0.34%
Energy management	0.31%

Source: https://pact-for-skills.ec.europa.eu/document/download/6dbcf2f6-c5ee-4a0d-aac3-a52137a18193_en?filename=Skill%20needs%20and%20gaps.pdf

Box 1: Supply and demand for battery-skills and battery-related job creation

Europe's shift to e-mobility has highlighted a critical shortage of battery-related skills, both in terms of specialised battery researchers, as well as skilled workers across the entire battery value chain. Researchers at Fraunhofer ISI estimate that currently only about 30 000 to 40 000 specialised battery researchers are available in Europe. As demand for electric vehicles and domestic battery production accelerates, it is projected that about 200 000 battery researchers will be needed by 2030, highlighting a significant skill gap, potentially impeading Europe’s battery development capacities.

Furthermore, across the entire battery value chain, it is estimated that establishing a successful battery ecosystem in Europe could ultimately support 4–5 million new jobs in the long term. Establishing such an ecosystem is futhermore estimated to require training, re-skilling, and up-skilling of up to 1.5 million workers across the EU by 2030.

Accordingly, more and more training programmes are needed to satisfy this skill demand. The European Battery Academy, created by the European Battery Alliance, is just one of the programmes that were set up in response to this skill gap. Supported by EUR 10 million from the European Commission under REACT-EU, and as part of the EU's Skills Agenda, this Academy coordinates large-scale re-skilling and up-skilling initiatives across EU27 member states to meet the industry-wide demand skilled battery workers. To date, the Battery Academy has provided battery-specific training to approximately 67 000 individuals across the EU member states.

Source : https://www.isi.fraunhofer.de/en/blog/2024/batterieforschung-kuerzung-foerderung-folgen-aufbau-oekosystem-europa-deutschland-fachkraefte-mangel.html;

https://single-market-economy.ec.europa.eu/news/european-battery-alliance-moves-ahead-new-european-battery-academy-launched-boost-skills-fast-2022-02-23_en#:~:text=Supported%20through%20funding%20from%20REACT-EU,%20the%20European%20Battery

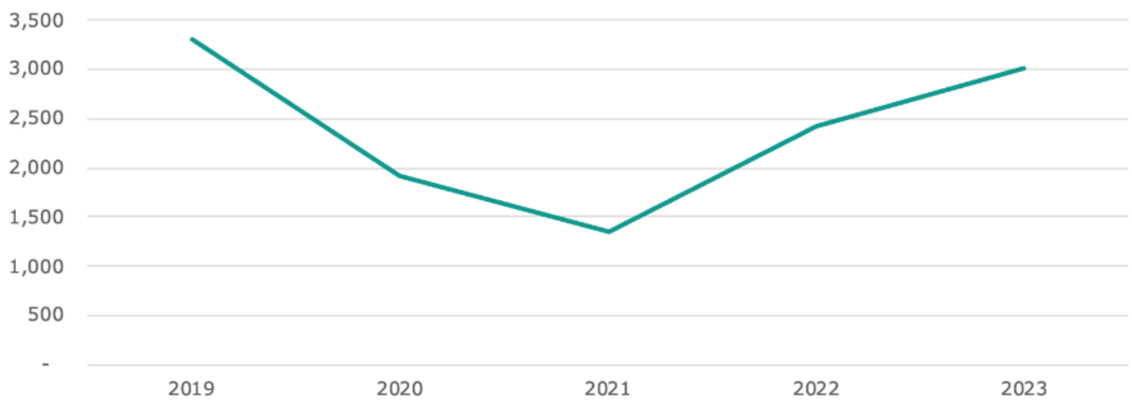
2.2.2.2. Demand for skills relevant for the green transition

Skills demand in the in mobility industrial ecosystem has been analysed following the skills intelligence insights of Cedefop, the European Centre for the Development of Vocational Training[78]. This dataset covers the EU27 Member States (plus UK) and is based on the collection and analysis of more than 530 online job advertisement sources (424 distinct websites) which are open-access sites. The dataset provides information on most requested occupations and skills across European countries based on established international classifications, e.g., ISCO-08 for occupations, ESCO for skills, and NACE rev. 2 for sectors.

Specific to the in Mobility industrial ecosystem[79], there were **449 590 unique job advertisements** from companies between 2019-2023 in the EU27. These job advertisements have been text-mined and the required skills analysed from the perspective of the green transition.

The share of online job advertisements requiring skills related to the green transition in 2023 was minimal, appearing in only 0.7% of cases that is just a very slight change compared to 2022 where this share was 0.6%. There is a drop from 2019 to 2021 however this is due to the overall drop in the total number of online job advertisements that is related to COVID-19 pandemic. The number of online job advertisements with a requirement for environmental skills in 2023 almost reached the 2019 value.

Figure 24: Number of online job advertisements with a requirement for environmental skills



Source: Technopolis Group based on analysis of Cedefop data

The Automotive Manufacturing Outlook Survey 2023 has identified that in Europe, 52% of respondents stated that there is shortage of electric vehicle & battery expertise[80].

Intelligence gathered among stakeholders within the EU project called 'DRIVES'[81] identified the needs to face upcoming challenges and drivers of change in the automotive sector. The

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[78] Cedefop (n.d.) Skills-Ovate. Retrieved from: https://www.cedefop.europa.eu/en/tools/skills-online-vacancies
[79] In the case of the Mobility industrial ecosystem the dataset was filtered for the NACE industries as defined in the Annual Single Market Report.
[80] Ams and ABB (2023). Automotive Manufacturing Outlook Survey 2023. Retrieved from: https://campaign-ra.abb.com/AutomotiveSurvey
[81] https://www.project-drives.eu/en/aboutus

project identified 30+ emerging job roles. For these job roles, skillset's descriptions, training material, exercises, examines and official certificates recognised by the DRIVES framework have been prepared. Sustainability manager is the only emerging job profile related to sustainable transition. The skills that are essential for this emerging role include[82]:

- **Understanding of Basic Natural Science:** including understanding of general chemistry, basis of materials, energy management, air and water pollution, waste treatment, textile and leather treatment.
- **Data Science Fundamentals:** including the analysis of environmental data.
- **Industrial Automotive Sustainability:** methods for waste treatment and disposal, metal and aluminium recycling, paper in plastic recycling, electronics recycling and textiles and leather recycling.
- **Advanced Management Sustainability:** including the understanding of product lifecycles and assessments and audits.
- **Sustainable Design:** including the sustainable methods in design.

Box 2: Potential impact on jobs through e-mobility in the automotive and truck value

The transition to e-mobility is expected to significantly impact the labor market within Germany's automotive industry. A study by Prognos, commissioned by the Verband der Automobilindustrie (VDA), projects a potential reduction of approximately 190 000 jobs by 2035, with 46 000 positions already lost between 2019 and 2023. This decline is primarily attributed to the shift from internal combustion engines to electric drivetrains, which require less labor-intensive production processes. Notably, roles in mechanical engineering, operations technology, and metalworking are experiencing the most substantial decreases, while positions in automotive engineering, technical research, and IT are on the rise. The study emphasises the necessity for strategic political support and targeted workforce development initiatives to manage this transformation effectively.

On the other hand, a study by BCG on behalf of the European Federation for Transport and Environment (T&E) project an overall positive employment impact of the shift to Battery Electric Trucks (BETs) in the medium and heavy duty trucking (MHDT) value chain, due to an increase in MHDT-related utilities, despite significant decreases in employment at European Truck OEMs.

Sources : https://www.vda.de/dam/jcr:ab6e46dd-1088-4d06-b36b-058b44d6198e/241029_Studie%20Beschaeftigungsperspektiven%20in%20der%20Automobilindustrie.pdf?mode=view ;

https://www.transportenvironment.org/uploads/files/20230919-Transport-Environment_EU-Truck-CO2-Standards_Final_Report_TE_vF.pdf

2.2.3. Demand for green products

This section explores the demand for green products within the mobility industrial ecosystem. Specifically, it examines the demand for battery electric vehicles (BEVs) for passenger transport (M1) and battery electric trucks (BETs) for commercial road transport (N1 and N2&3). Furthermore, the section looks at the current fleet size of battery vessels in the waterborne industries.

Demand for BEVs for passenger transportation

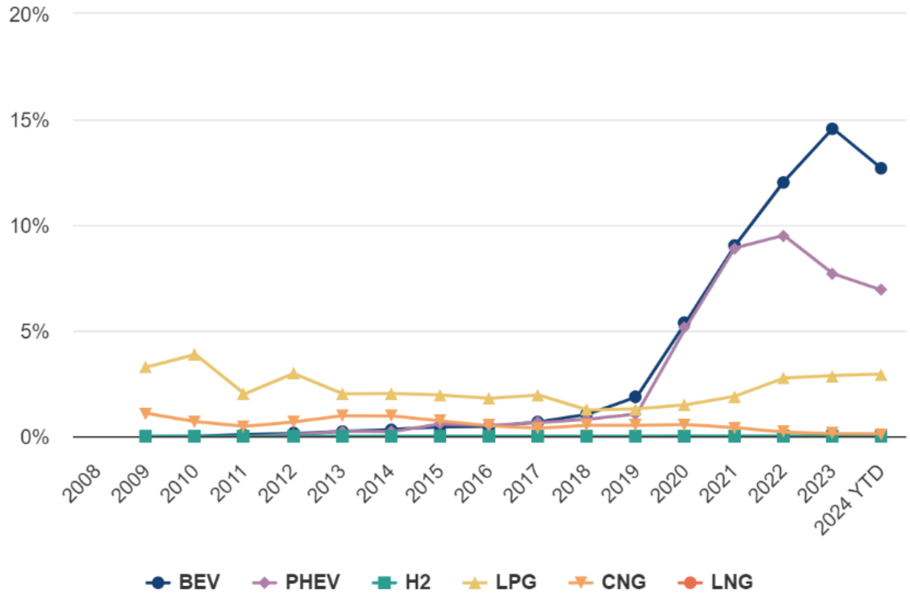
The demand for battery electric passenger vehicles (BEVs) in Europe has seen a steady increase in market share over recent years, driven by strong policy support, technological advancements, and growing consumer interest in sustainable mobility. As of 2023, BEVs made up approximately 15% of EU27-wide new vehicle sales in the M1 category, reflecting a consistent rise in adoption[83]. However, recent trends reveal mixed signals, with countries

[82] Drives project (2020). Sustainability manager Job Role Skills Definition. Retrieved from: https://www.project-drives.eu/Media/Publications/173/Publications_173_20200923_111616.pdf

[83] European Commission (n.d.). European Alternative Fuels Observatory – Vehicles and fleet. Retrieved from: https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/european-union-eu27/vehicles-and-fleet

like Germany experiencing a downturn in BEV sales in early 2024 due to factors such as the discontinuation of purchase incentives[84]. While growth continues in other European markets, the challenges in Germany highlight the sensitivity of demand to policy shifts and economic conditions[85].

Figure 25: Demand for battery electric passenger vehicles in EU27 (M1)



Note: BEV: Battery Electric Vehicles, PHEV: Plug-in Hybrid Vehicles, H2: Hydrogen-powered Vehicles, LPG: Liquefied Petroleum Gas, CNG: Compressed Natural Gas, LNG: Liquefied Natural Gas –

Source: https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/european-union-eu27/vehicles-and-fleet

Beyond current market shares, the attitude towards the purchase of BEVs was assessed in the Consumer Monitor 2023[86] by the European Alternative Fuels Observatory. The survey finds that only around 33% of non-BEV drivers considers buying a BEV in the next 5 years. Furthermore, according to the report, still the most relevant inhibiting factors are the high cost of BEV, range limitations, and limited recharging options.

Demand for BETs for commercial road transportation

The demand for battery electric trucks (BETs) in the light commercial vehicle (N1) and medium and heavy-duty vehicle (N2 & N3) segments in Europe has shown notable growth. In 2023, BETs in the N1 category achieved the highest market share among commercial vehicles, capturing approximately 6% of all new registrations within their category[87]. This growth reflects technological advancements, favourable cost structures, and increased adaptability for a variety of applications. In contrast, BETs in the N2 and N3 segments accounted for around 2% of new registrations, marking a significant increase from previous

[84] Fraunhofer ISI (2024). Electric car sales figures: temporary weakness or turnaround? Retrieved from: https://www.isi.fraunhofer.de/en/blog/themen/batterie-update/elektroautos-verkaufszahlen-hybrid-flaute-deutschland-europa.html

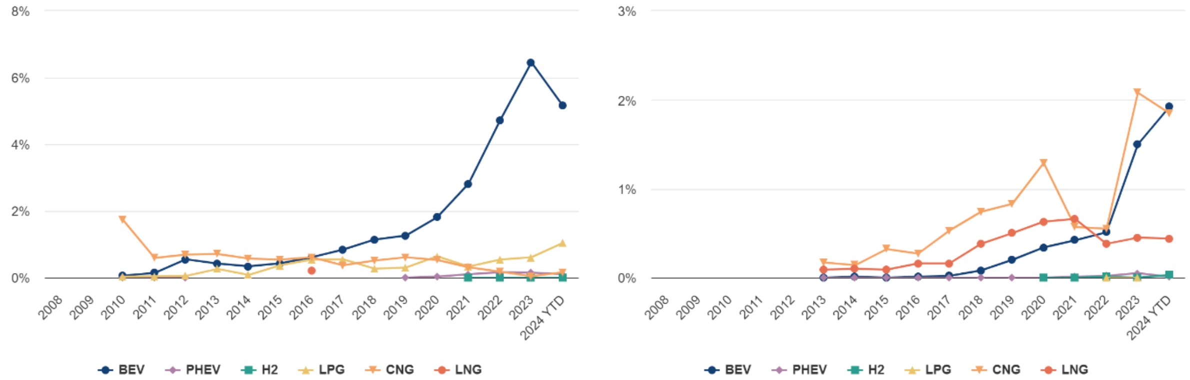
[85] European Alternative Fuels Observatory (2024). Dissecting the Drop: How Policy Changes Affect BEV Sales Data in the EU. Retrieved from: https://alternative-fuels-observatory.ec.europa.eu/general-information/news/dissecting-drop-how-policy-changes-affect-bev-sales-data-eu

[86] European Alternative Fuels Observatory (2024). Consumer Monitor 2023. European Aggregated Report. Retrieved from: https://alternative-fuels-observatory.ec.europa.eu/system/files/documents/2024-06/EU%20Aggregated%20Report%202023_0.pdf

[87] European Commission (n.d.). European Alternative Fuels Observatory – Road. European Union (EU27). Vehicles and fleet. Retrieved from: https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/european-union-eu27/vehicles-and-fleet

years[88]. Adoption in these heavier segments has been slower due to high purchase costs, insufficient charging infrastructure across many parts of the EU27, and the challenging economic dynamics faced by long-haul freight operators. Despite these obstacles, demand for BETs across all categories is projected to rise as the total cost of ownership declines and technology becomes more cost-competitive and efficient[89].

Figure 26: Demand for battery electric commercial vehicles in EU27 (left: N1; right: N2&3)



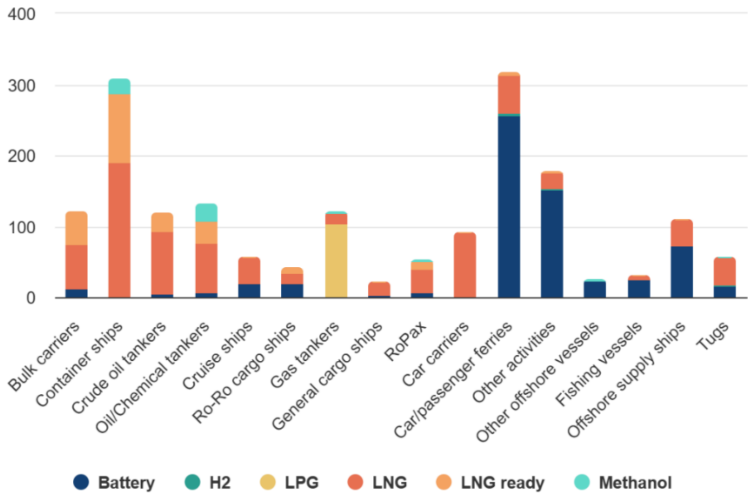
Source: https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/european-union-eu27/vehicles-and-fleet

Demand for battery-powered vessels in waterborne industries

To decarbonise the maritime sector, new sustainable energy sources, such as alternative fuels and battery technologies, are being actively explored. However, the transition to these alternative propulsion technologies requires significant investment and time, as currently more than 98% of vessels world-wide are still propelled by conventional fuels[90].

As of today, the future energy and technology mix developments for the maritime sector are still uncertain, as exemplified by Figure 27, which depicts the distribution of the current global uptake of alternative fuels in for different types of maritime vessels.

Figure 27: Global uptake of alternative fuels in case of maritime vessels (Total number of ships, both in operation and on order)



[88] Ibid.
[89] Transport & Environment and BCG (2023). Impact Assessment of the transition to Zero-Emission Trucks in Europe. Retrieved from: https://www.transportenvironment.org/uploads/files/20230919-Transport-Environment_EU-Truck-CO2-Standards_Final_Report_TE_vF.pdf
[90] Unctad (2023). Review of Maritime Transport 2023. Retrieved from: https://unctad.org/system/files/official-document/rmt2023_en.pdf

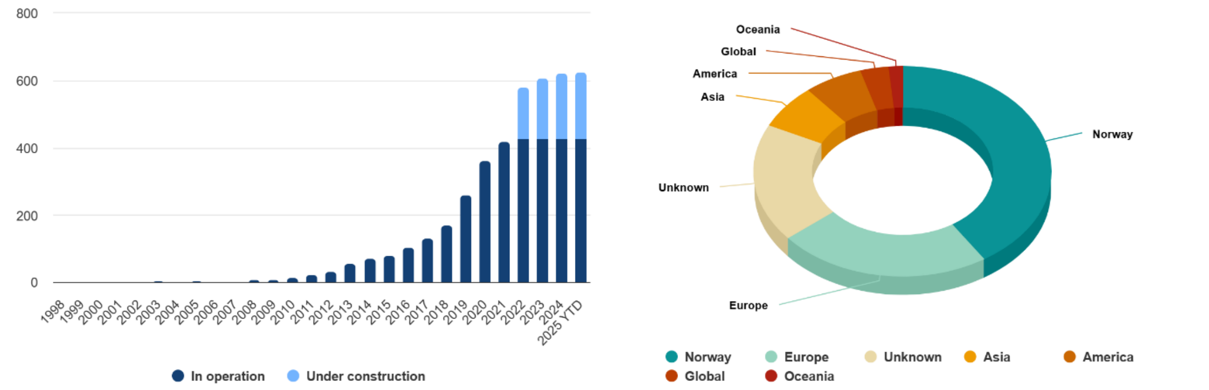
Source: https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/european-union-eu27/vehicles-and-fleet

Maritime transport is going to face huge decarbonisation challenges in the next decades, due to current lack of market-ready zero-emission technologies, long development timeframes and life cycles of vessels[91]. Technologies to produce zero-emission fuels and vessels are to a large extent available but in most instances not-market ready. The early years of this transition are challenged by the existence of several alternative fuel options and a wide gap, in terms of cost, with the fossil fuels used today. Hence, the smooth deployment of these energy-efficient technologies will depend largely on several factors, such as costs, availability, maturity, reliability and level of environmental sustainability[92]. Alternatively powered vessels are more expensive to build and are therefore expected to increase the capital invest for purchasing new vessels by least 20%[93], Furthermore, fuel cost makes up the largest fraction of variable cost in the maritime transport sector. Lastly, due to technological and regulatory uncertainty and lack of availability at scale of new sustainable alternative fuels, shipowners are reluctant to replace their fleets, which could slow down the speed of the transition.

Recent EU measures (FuelEU Maritime Regulation, extension of EU ETS to maritime, Alternative Fuels Infrastructure Regulation (AFIR) and Renewable Energy Directive (RED) revision) will contribute to increasing the availability and uptake of alternative and clean maritime fuels and to developing market-ready zero-emission technologies, by creating regulatory certainty and conditions to bridge the price gap between traditional fossil fuels and renewable and low-carbon fuels, and provide for development of port and fuel supply infrastructure.

Beyond alternative fuels, another way to decarbonise the maritime transport sector is via the development and deployment of battery-powered vessels. According to data provided by the European Alternative Fuels Observatory, has the global number of battery vessels in operation and under construction been steadily increasing in recent years[94], with Europe accounting for the second biggest fleet, see Figure 28.

Figure 28: Development and geographical and current distribution of the global fleet of battery vessels (including both ships in operation and under construction)



Source: https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/european-union-eu27/vehicles-and-fleet

[91] Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions (2020) Sustainable and Smart Mobility Strategy – putting European transport on track for the future. COM (2020) 789. Retrieved from: eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52020DC0789

[92] European Commission, Directorate-General for Maritime Affairs and Fisheries, Joint Research Centre, Borriello, A., Calvo Santos, A., Ghiani, M. et al. (2023) The EU blue economy report 2023. Publications Office of the European Union. Retrieved from: https://data.europa.eu/doi/10.2771/7151

[93] Unctad (2023). Review of Maritime Transport 2023. Retrieved from: https://unctad.org/system/files/official-document/rmt2023_en.pdf

[94] https://alternative-fuels-observatory.ec.europa.eu/transport-mode/maritime-sea/vessels

As of 2024, the total fleet size of battery driven vessels in the EU is 143, which includes both ships currently in service as well as those on order[95]. However, the application areas of such vessels still remain rather limited to car and passenger ferries and offshore supply ships (see Figure 27, above)[96].

2.3. The impact of the industrial ecosystem on the environment

How is the industrial ecosystem's impact on the environment changing?

- **Domestic transport accounts for approximately 22% of total CO2 emissions in the EU27**, with over half of these emissions coming from passenger and light commercial vehicles. **Medium- and heavy-duty vehicles contribute an additional 20% of emissions** from the transport sector, while **aviation and maritime transport account for 14% and 13%, respectively**.

- **Greenhouse gas (GHG) emissions from the transport sector continue to rise**, driven by **increasing demand** for mobility services. Consumption-based accounting shows that GHG emissions from the entire mobility ecosystem are increasing, whereas production-based accounting indicates a decline due to lower emission production technologies adopted by domestic manufacturers.

- **PM2.5 and PM10 particulate matter emissions have remained stable** across the entire mobility ecosystem, but significant reductions in air pollutants have been observed within the transport sector alone.

- Indicators such as **land use, resource use, and water extraction show no significant improvements** over the past decade. The **recycling share in the automotive industry remains high**.

Overall, the impact of the mobility ecosystem on the environment continues to be substantial.

This chapter summarises the development of the Mobility ecosystem's environmental impact across the dimensions specified in the EMI methodological framework[97], including greenhouse gas (GHG) emissions, particulate matter emissions, resource use (water pollution and material extraction), land use and generated waste. The section will reflect on the progress made over time and assess the extent to which targets set by the European Commission have been met. To achieve this, this section of the report primarily relies on indicators derived from the Exiobase dataset[98]. This dataset enables the measurement of the environmental impact of the industrial ecosystem through both production and consumption. Further information on this dataset and the constructed indicators is provided in the methodological report[99].

GHG Emissions

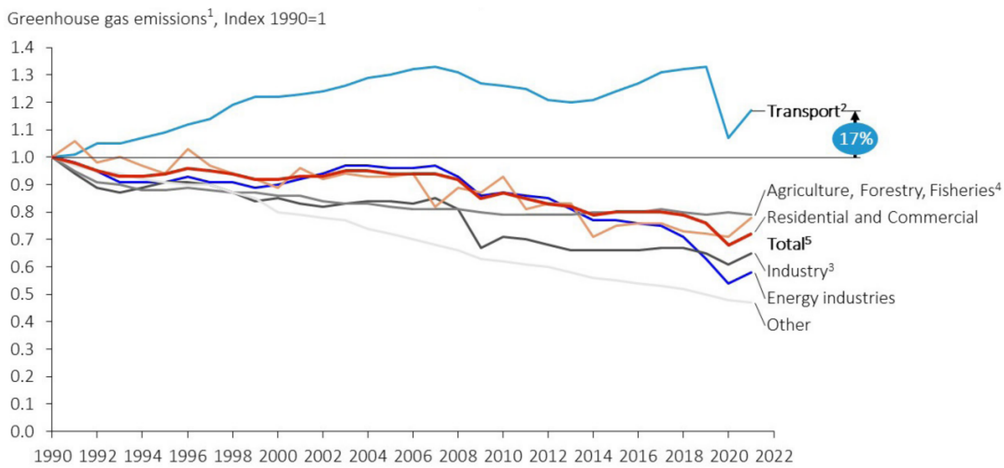
The mobility ecosystem is one of the primary contributors to GHG emissions globally, with over 20% of worldwide emissions attributed to the transport sector alone[100]. The emission

[95] European Commission (n.d.). European Alternative Fuels Observatory – Maritime. Vessels. Retrieved from: https://alternative-fuels-observatory.ec.europa.eu/transport-mode/maritime-sea/vessels
[96] Ibid.
[97] European Commission (2023). Monitoring European industrial ecosystems. Retrieved from: https://monitor-industrial-ecosystems.ec.europa.eu/sites/default/files/2023-12/EMI%20Methodological%20Report.pdf
[98] About Exiobase. Retrieved from: https://www.exiobase.eu/index.php/about-exiobase
[99] European Commission (2023). Monitoring European industrial ecosystems. Retrieved from: https://monitor-industrial-ecosystems.ec.europa.eu/sites/default/files/2023-12/EMI%20Methodological%20Report.pdf
[100] European Commission (2024). GHG emissions of all world countries. Retrieved from: https://edgar.jrc.ec.europa.eu/report_2024

profile of the European Union follows a similar pattern. Domestic transport accounts for approximately 22% of total CO2 emissions of the EU27 countries, with more than half of these emission arising from passenger vehicles and light commercial vehicles. Medium- and heavy-duty vehicles contribute another 20% of the transport sector's emissions, followed by aviation and maritime transport, which account for 14% and 13%, respectively[101]. Rail, on the other hand, is the greenest mode of mass transportation available, accounting for less than 0.5% of transport-related greenhouse gas emissions, and 90% of rail transport (in volume) already being electrified.

To mitigate the climate impact of these CO2 emissions, the **EU Green Deal** aims cut transport-related GHG emissions by 55% by 2030 (compared to 1990 levels) and reach net zero by 2050[102]. To reach this target, **the transport sector alone will be required to reduce its emissions by 90% by 2050[103]**. A recent analysis in The Future of European Competitiveness report[104] however shows that while the average of the European industrial sectors has reduced their total CO2 emissions compared to the levels of 1990, **the transport sector appears to be the only sector with significant increases in CO2 emissions** (Figure 29).

Figure 29: Evolution of GHG emissions in the EU by sector



1 Excluding LULUCF emissions and international maritime, including international aviation and indirect CO_2; 2 Excluding international maritime (international traffic departing from the EU), including international aviation.3 Emissions from Manufacturing and Construction, Industrial Processes and Product Use; 4 Emissions from Fuel Combustion and other Emissions from Agriculture; 5 Emissions from Fuel Combustion in Other (Not elsewhere specified), Fugitive Emissions from Fuels, Waste, Indirect CO_2 and Other.

Source: European Commission (2024)[105]

Figure 30 shows the development of GHG emissions emitted by stakeholders of the entire mobility ecosystem from 2016 to 2022, measured in megatons, based on data from the

[101] Transport & Environment and BCG (2023). Impact Assessment of the Transition to Zero-Emission Trucks in Europe: Retrieved from: https://www.transportenvironment.org/uploads/files/20230919-Transport-Environment_EU-Truck-CO2-Standards_Final_Report_TE_vF.pdf

[102] European Commission (n.d.). The European Green Deal. Retrieved from: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

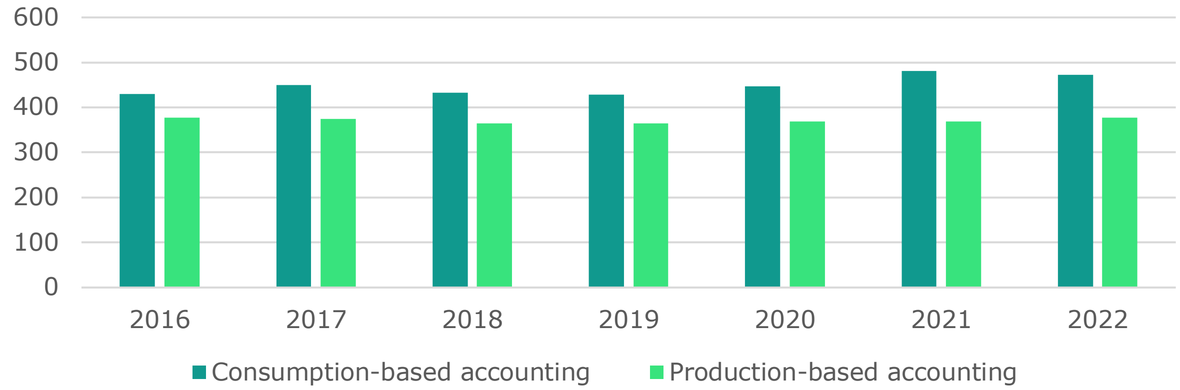
[103] European Commission (n.d.). Transport and the Green Deal. Retrieved from: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/transport-and-green-deal_en

[104] European Commission (2024) The future of European competitiveness. Retrieved from: https://commission.europa.eu/document/download/ec1409c1-d4b4-4882-8bdd-3519f86bbb92_en?filename=The%20future%20of%20European%20competitiveness_%20In-depth%20analysis%20and%20recommendations_0.pdf

[105] European Commission (2024). The future of European competitiveness. Part B: In-depth analysis and recommendations. Retrieved from: https://commission.europa.eu/document/download/ec1409c1-d4b4-4882-8bdd-3519f86bbb92_en?filename=The%20future%20of%20European%20competitiveness_%20In-depth%20analysis%20and%20recommendations_0.pdf

Exiobase dataset[106]. The figure distinguishes between two accounting approaches: production-based and consumption-based. The production-based accounting captures GHG emissions generated during the production of goods within the EU27 territory, irrespective of whether these goods were destined for domestic consumption or exported outside the EU. In contrast, the consumption-based accounting approach captures all emissions associated with products consumed within the EU, including both domestically produced goods and services as well as imported ones.

Figure 30: CO2 emissions of the mobility industrial ecosystem in megatons (2016-2022)



Source: Technopolis Group based on Exiobase

First, it is notable that emissions recorded under the consumption-based accounting method are generally higher than those of the production-based approach. Additionally, while emissions under **the production-based accounting approach remained relatively stable from 2016 to 2022, the CO2 emissions measured under the consumption-based accounts actually increased in the same period**. These findings may be attributed to three main causes:

1. The EU27 countries appear to import a large share of high-emissions products and services related to the mobility sector, resulting in a larger CO2 footprint under the consumption-based accounting method.
2. Given that the total production output of the mobility ecosystem has increased over the past decade (see chapter 1.3), stable production-based emissions suggest that the domestic production of the European mobility sector is indeed switching to more CO2-efficient production methods as well as lower emission products and services.
3. In addition to the increase in production output, both passenger and freight transportation have been on the rise in recent years. For example, total passenger travel in the EU has grown by nearly 25%, while freight transport grew by over 44% when comparing data from 2022 with 1995 as base year[107]. This indicates that any potential reductions in CO2 emissions at the aggregate ecosystem level are offset by the increase in both its consumption and production values.

Air pollution

The impact of the mobility ecosystem on air quality is of particular interest. Accordingly, this section analyses the particulate matter emissions of the mobility industrial ecosystem, focusing on PM2.5 and PM10 emissions, using data obtained from Exiobase.

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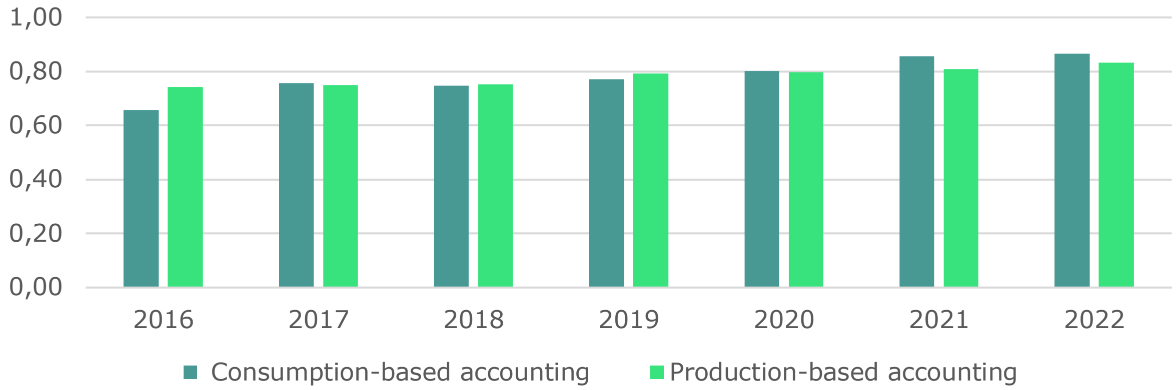
[106] The sectors included in this analysis follow the definition of the mobility ecosystem in the Annual Single Market Report including specifically: Manufacture of motor vehicles, trailers and semi-trailers; Manufacture of other transport equipment; Sale, maintenance, repair of motor vehicles, motor vehicles parts, motorcycles, motor cycles parts and accessories; Transport via railways; Other land transport; Transport via pipelines; Sea and coastal water transport; Inland water transport; Supporting and auxiliary transport activities and activities of travel agencies.

[107] European Environment Agency (2024). Transport and mobility. Retrieved from: https://www.eea.europa.eu/en/topics/in-depth/transport-and-mobility#:~:text=Relative%20to%20other%20economic%20sectors,most%20notably%20in%20energy%20production

Figure 31 below illustrates the trend in particulate matter emissions (measured in megatons) across the entire mobility ecosystem between 2016 and 2022, using again both consumption-based and production-based accounting methods. The figure reveals a slight but steady increase in particulate matter emissions over time across both accounting methods. Consequently, **we must conclude that there have been no significant reductions in PM2.5 and PM10 emissions in recent years at the level of the aggregate mobility ecosystem.**

Figure 31: Particulate matter emissions in megatons (2016-2022)



Source: Technopolis Group based on Exiobase

Further examining the subsectors of the mobility ecosystems and considering other types of air pollutants adds important nuances to this finding. In the following, the report focusses on the transport sector. According to the European Environment Agency (EEA), the transport sector is one of the largest emitters of several types of air pollutants, including particulate matter (PM2.5 and PM10). For example, in 2022, the transport sector was responsible for 29.3% of all PM2.5 and PM10 emissions in the EU27[108].

Figure 32 below, obtained from the Transport and Environment Report (2022)[109], shows that the European transport sector has significantly reduced its environmental impact in terms of several air pollutants over the past two decades. This finding is supported by the most recent EEA report on the "Sustainability of Europe's mobility systems"[110]. These reports indicates that trends **in air pollutant emissions are highly dependent on the type of pollutant** being investigated and **may vary according to the different subsectors of the mobility ecosystem.**

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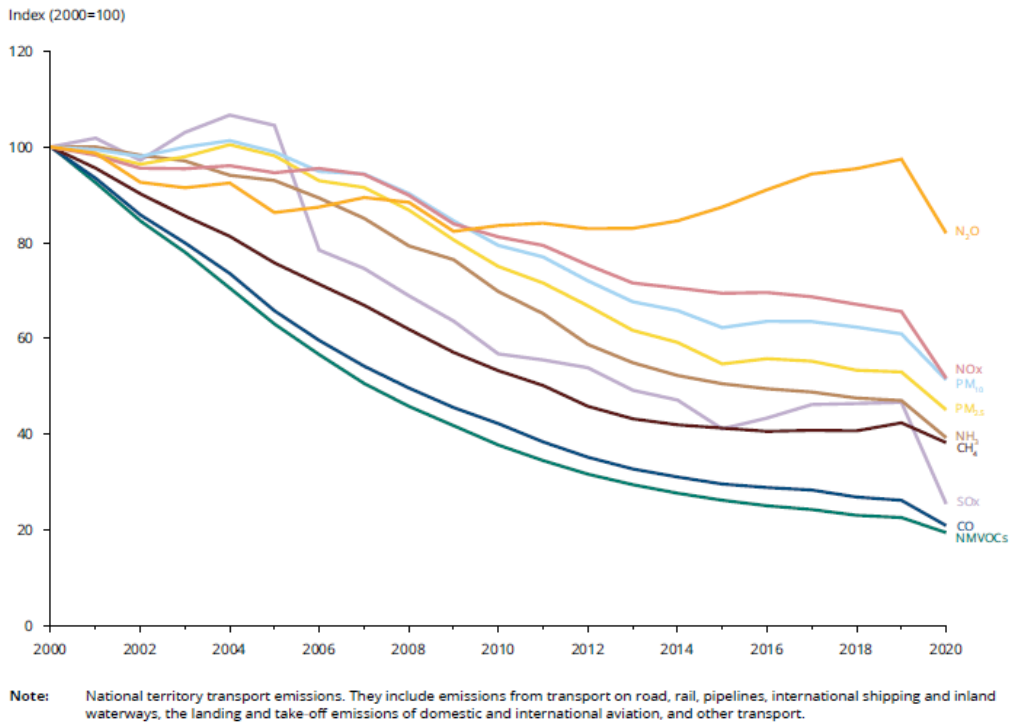
[108] European Environment Agency (2024). Sustainability of Europe's mobility system (Web Report) – Air Pollution. Retrieved from: https://www.eea.europa.eu/en/analysis/publications/sustainability-of-europes-mobility-systems/air-pollution

[109] European Environment Agency (2022). Transport and Environment Report. Retrieved from: https://www.eea.europa.eu/publications/transport-and-environment-report-2022/transport-and-environment-report/view

[110] European Environment Agency (2024). Sustainability of Europe's mobility system (Web Report) – Air Pollution. Retrieved from: https://www.eea.europa.eu/en/analysis/publications/sustainability-of-europes-mobility-systems/air-pollution

Figure 32: Trends in emissions of air pollutants in the transport sector of the EU27



Source: European Environment Agency (2022)[111]

Land use

One of the many ways in which the mobility ecosystem impacts the environment is via the conversion of natural spaces, such as forests, grasslands and agricultural land, into various types of transport and production infrastructure, such as roads, production facilities, and other types of sealed spaces. These sealed surfaces directly contribute to the destruction of natural habitats for many species. Furthermore, these spaces lose their natural ability to regulate local microclimates, thereby increasing the likelihood of seasonal floodings or overheating, which poses further harm to local wildlife, flora and fauna, and humans alike[112].

Figure 33 below plots the land use of the mobility ecosystem (in km^2) from 2016 to 2022, based on Exiobase data. The Exiobase indicator for land use shows that the mobility ecosystem's land use has remained approximately stable from 2016 to 2022, ranging from around 1 500 km^2 in 2016, and 1 600km^2 in 2022.

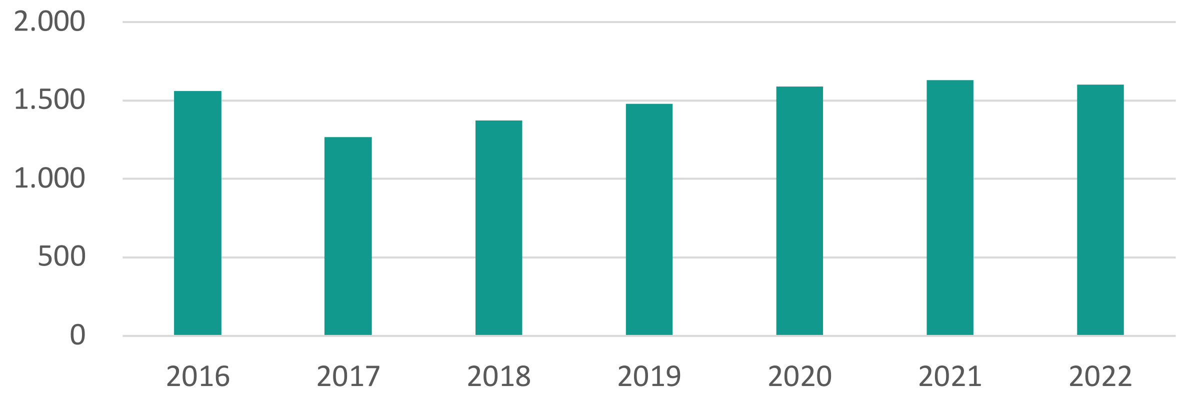
With respect to its biodiversity protection goals, the EU set a concrete target within its Roadmap for a Resource Efficient Europe (COM/2011/0571)[113] that no additional land should be repurposed for the activities of industrial ecosystems by 2050. Accordingly, it needs to be concluded that **in recent years, the mobility ecosystem has not made progress to reduce its land use in a significant manner.**

[111] European Environment Agency (2022). Transport and Environment Report 2022. Retrieved from: https://www.eea.europa.eu/publications/transport-and-environment-report-2022/transport-and-environment-report/view

[112] Umweltbundesamt (2024). Indicator: Land-take for settlements and transport infrastructure. Retrieved from: https://www.umweltbundesamt.de/en/data/environmental-indicators/indicator-land-take-for-settlements-transport#at-a-glance

[113] European Commission (2011). Roadmap to a Resource Efficient Europe. Retrieved from: https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1573551946736&uri=CELEX%3A52011DC0571

Figure 33: Land use by EU27 (km²)

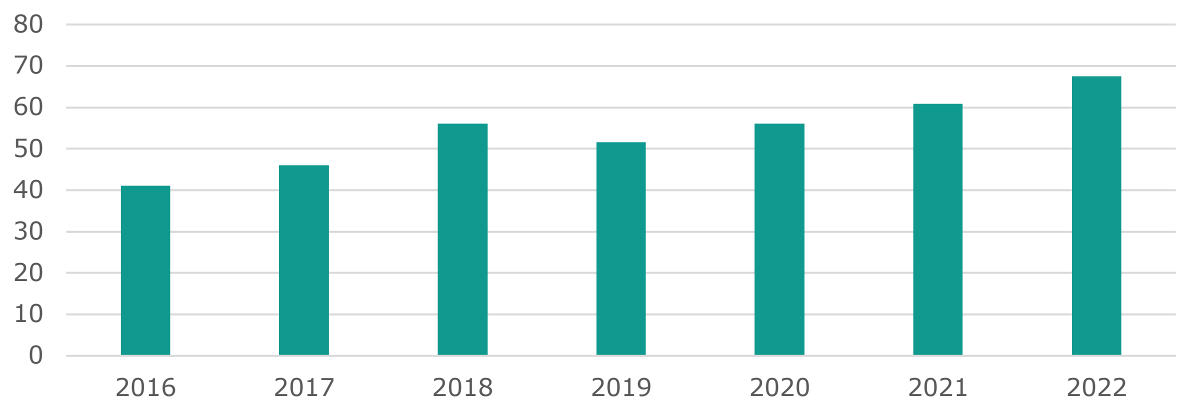


Source: Technopolis Group based on Exiobase

Resource use

The Exiobase indicators provide insights into the resource usage of the stakeholders of the mobility ecosystem. In this section, we will look at **the raw material extraction and water usage** in the production of goods in the mobility ecosystem. Figure 34 and Figure 35 show the amount of raw material extracted for production within the mobility ecosystem in megatons and water usage in million cubic meters (m^3), respectively.

Figure 34: Material extraction/ EU27 (megatons) – production-based accounting



Source: Technopolis Group based on Exiobase

Figure 34 shows that **material extraction for the production of goods in the mobility ecosystem is increasing in recent years**, rising from approximately 40 megatons in 2016 to just under 70 megatons in 2022. This development is primarily driven by the continued rising demand for products and services within the mobility ecosystem, as well as the heightened need for raw materials in the production of batteries for electric vehicles (BEVs)[114]. The production of such BEVs requires not only entirely new types of raw materials but also greater quantities of them. For example, raw materials such as lithium, cobalt, nickel, manganese, and graphite are essential for battery production. These materials, however, are largely new to many actors within the mobility ecosystem's value chains.[115]

Additionally, also **the use of water for the production of goods and services in the mobility ecosystem has increased in recent years**.

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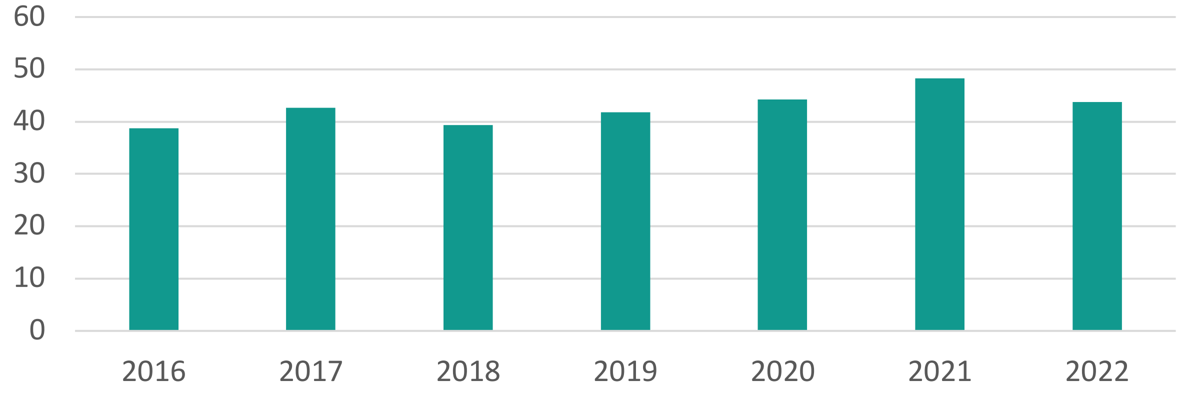
[114] https://www.vda.de/en/topics/economic-policy/raw-materials
[115] Ibid.

Figure 35: Water extraction of EU27 (million m^3)



Source: Technopolis Group based on Exiobase

Waste

One of the most significant sources of waste and recyclable materials in the mobility ecosystem is **end-of-life vehicles (ELVs)**. Each year, more than six million vehicles (M1) reach the end of their life cycle in the EU, resulting in substantial amounts of waste. When properly recycled, these ELVs present a great opportunity to recover materials for the production of new vehicles, thereby reducing the need for raw material extraction.

The European Commissions Directive 2000/53/EC[116] on end-of life vehicles "sets out measures to prevent and limit waste from end-of-life vehicles (ELVs) and their components by ensuring their reuse, recycling and recovery and aims to improve the environmental performance of all economic operators involved in the life cycle of the vehicles"[117].

Among other requirements, Directive 2000/53/EC[118] mandates OEMs of vehicles and components to incorporate recycling principles in their product designs and account for the dismantling, reuse and recovery of the vehicles and components. The directive stipulates that new vehicles must be reusable and/or recyclable to a minimum of 85% by weight per vehicle and reusable and/or recoverable to a minimum of 95% by weight per vehicle.

Figure 36 shows the reuse/recovery and reuse/recycling rates of all EU27 Member States, as well as the EU aggregate (on the left), with Norway, Iceland and Liechtenstein included for comparison. The plot shows that in 2021, **the EU has already met its reuse/recycling targets for vehicles**, achieving a value of 88% compared to the 85% target, and is close to **meeting its reuse/recovery targets** with a value of 93%, compared to a target of 95%.

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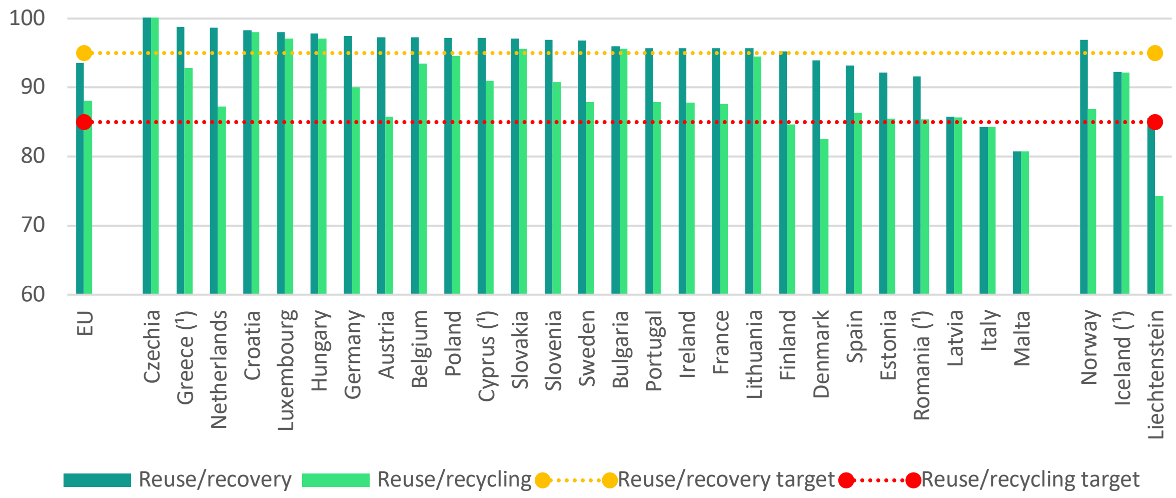
[116] EUR-Lex (2000). Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on end-of life vehicles - Commission Statements. Retrieved from: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32000L0053
[117] Ibid.
[118] Ibid.

Figure 36: Reuse/recovery and reuse/recycling rate for end-of-life vehicles (M1) in 2021 for EU27 member states



Note: Countries are ranked in decreasing order by the reuse/recovery rate. (¹) Rates from 2020 -
Source: adopted from Eurostat (online data code: env_waselvt)[119]

[119] https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fec.europa.eu%2Feurostat%2Fstatistics-explained%2Fimages%2F7%2F7a%2F23.11.10_Main_Document_SE_End-of-life_vehicle_statistics_2023_11_Rev.xlsx&wdOrigin=BROWSELINK

3. Digital transition

The digital transition plays a crucial role in the future of value creation and in maintaining Europe's competitive position and prosperity. Accordingly, Section 3.1 will examine the impact of the digital transition on the competitiveness of the EU27 mobility industrial ecosystem. Furthermore, Section 3.2 will explore the various efforts companies are undertaking to drive the digital transition within the mobility ecosystem. Lastly, Section 3.3 will assess different indicators, such as public funding, digital skills, and market demand, to determine whether the Mobility ecosystem faces favourable framework conditions for accelerating the digital transition.

3.1. Industrial efforts into the digital transition

What is the progress of industrial efforts towards digitalisation?

- Approximately **one-third of companies within the mobility ecosystem have established a concrete strategy for digital transformation**, which is significantly **below the targets set by the EU's Digital Decade Policy Programme for 2030**.

- While digital transition-related patent activities showed an increasing trend up to 2020, there was a **notable drop in innovation in 2021 due to a general reduction in R&D activities** among companies as a result of the COVID-19 pandemic.

- The growth in patent applications related to **advanced manufacturing and robotics** filed from the mobility ecosystem indicates a strong focus on innovation and efficiency in automated manufacturing processes.

- There has been an increase in patent filings for **artificial intelligence (AI)** technologies, signifying a shift towards the use of AI and big data for enhanced mobility analytics and management solutions, such as advanced route planning and charging infrastructure optimisation. Despite their relevance for digital and sustainable sector transitions, the **internet of things (IoT), augmented and virtual reality (AR/VR), and blockchain technologies remain significantly underrepresented** in overall patent applications from the mobility ecosystem.

- Among digital technologies in the mobility sector, **cloud solutions have the highest adoption rate, while the adoption of AR/VR and blockchain technologies is currently low**. In recent years, A**I and big data have shown growing importance for business models of startups** in the mobility ecosystem, while online platforms have been losing relevance since 2015.

- Although investments in big data, AI, and AR/VR are recognised as essential, they represent a smaller proportion of annual turnover, whereas robotics, along with **cloud technologies and IoT, is projected to attract significantly higher investment levels**. A significant **decline in venture capital investments in digital platforms, AI technologies, and autonomous driving** was observed in 2023, following a notable increase in 2022.

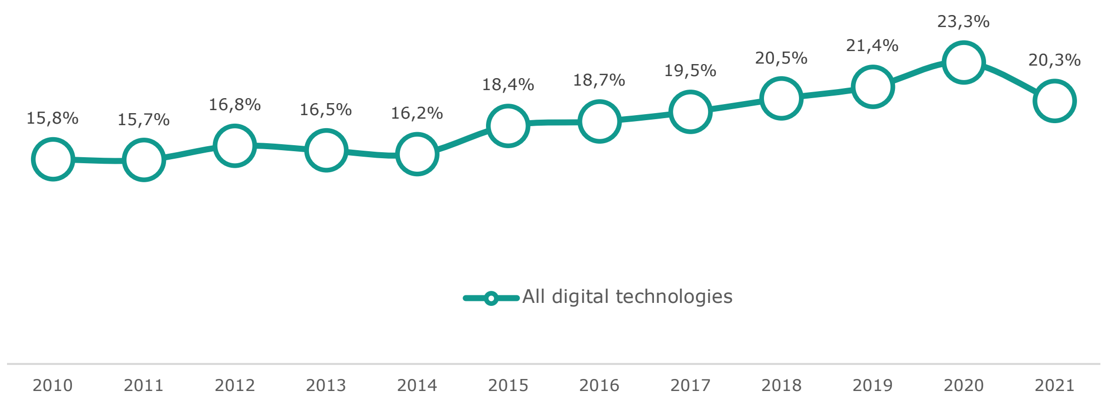
In this section, we examine the efforts of firms in the mobility ecosystem to drive the digital transition. First, we look at the uptake of digital technologies in the ecosystem. Furthermore, we focus on startup activities in the mobility ecosystem, as well as private investment in digital technology adoption and venture financing.

3.1.1. Technology generation

Our analysis, summarised in Figure 37, illustrates the share of digital technologies among total patent applications submitted by companies in the European mobility ecosystem from

2010 to 2021. In the EU27, the share of digital transition-related patent activities within the mobility industrial ecosystem has shown an increasing trend leading up to 2020. However, in 2021, there was a notable drop in patent filings. This decline can be attributed to a general reduction in R&D activities among companies as a result of the COVID-19 pandemic[120]. Many organisations shifted focus to daily operations to mitigate financial losses, leading to the suspension of innovation projects and, consequently, a decrease in patent filings[121].

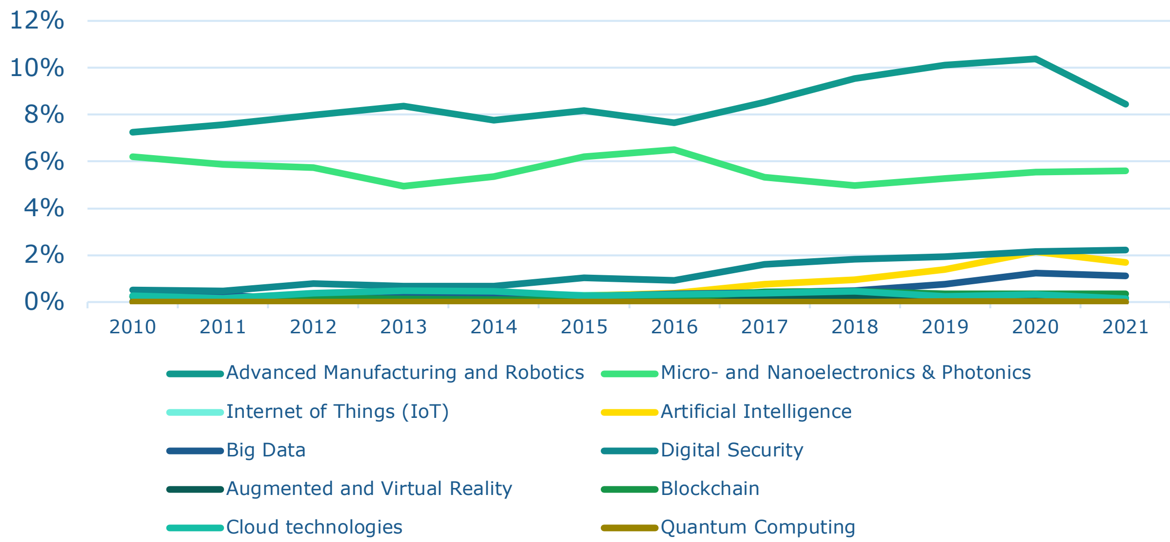
Figure 37: Share of digitalisation-related patents in the mobility industrial ecosystem in all patents filed in EU27 industrial ecosystems



Source: Fraunhofer based on PATSTAT

Beyond the general trend across all types of digital patents developed in the mobility ecosystem, we further scrutinised the development of several specific types of digital technology patents, including advanced manufacturing and robotics, micro- and nanoelectronics, IoT, artificial intelligence, big data and digital security, AR/VR, blockchain, cloud technologies and quantum computing (see **Error! Reference source not found.**).

Figure 38: Share of respective digital transition technologies in overall patents filed in mobility industrial ecosystem



Source: Fraunhofer based on PATSTAT

[120] Oliver Wyman (n.d.). Decreased Investments in Mobility Startups. Retrieved from: https://www.oliverwyman.com/our-expertise/insights/2020/jun/automotive-industry-at-the-crossroads/customers-sales-and-services/decreased-investments-in-mobility-startups.html

[121] Carsten Fink, Yann Ménière, Andrew A. Toole and Reinhilde Veugelers (2022). Resilience and Ingenuity: Global Innovation Responses to COVID-19. CEPR Press.

Among the analysed technology groups, advanced manufacturing and robotics, as well as micro- and nanoelectronics & photonics, exhibit the highest shares of overall patent applications within the examined technology fields. The growth in patents related to advanced manufacturing and robotics highlights a notable trend towards innovation in automated manufacturing processes, particularly regarding enhanced efficiency and cost-effectiveness. These technologies promise companies significantly reduce waste, optimise resource utilisation, and lower emissions during production, thereby aligning with broader EU policies focused on sustainability and climate change mitigation. Moreover, the continuous development of cutting-edge methods and technologies in this sector is expected to strengthen production capabilities, improve product quality, and shorten production times. These advancements not only gain operational efficiency but also enable companies to secure a competitive edge in the rapidly evolving market landscape.

Similarly, advancements in micro- and nanoelectronics & photonics highlight the rising importance of sophisticated electronic components and photonic technologies fundamental to the development of advanced communication systems, enabling improved connectivity between vehicles, infrastructure, and users. This connectivity supports customisation and smart mobility solutions enhancing traffic management, safety, and efficiency. Moreover, these technologies can lead to more efficient power management systems, improving the performance of electric and hybrid vehicles. These advancements contribute to longer battery life, faster charging times, and overall enhanced energy efficiency, aligning with sustainability goals.

In contrast, all other analysed categories demonstrated significantly lower shares of overall patent applications. Among those, **the increasing importance of artificial intelligence (AI) technologies is reflected in the growing number of patent filings, indicating a shift towards utilising AI for enhanced mobility analytics** and management solutions enabling advanced route planning and charging infrastructure optimisation as well as energy savings and capacity optimisation[122]. Similarly, the rising proportion of patents in big data underscores the essential role of analysing large datasets to facilitate effective decision-making and improve efficiency in mobility. Furthermore, as interconnected systems become more prevalent, the demand for robust security solutions is also increasing, as evidenced by the uptick in patent applications in this area. This shift not only emphasises the need for innovative analytics but also illustrates a growing focus on security as mobility systems become more interconnected.

Other relevant technology fields, such as the internet of things (IoT), augmented and virtual reality, and blockchain technologies, remain significantly underrepresented in overall patent applications from the mobility ecosystem despite their relevance for digital and sustainable sector transitions. Overall, these statistics indicate that while technology fields like advanced manufacturing lead innovation, rapidly growing areas like AI and big data demonstrate significant potential. In contrast, the growth in innovation performance related to other emerging technologies, such as cloud technologies, augmented reality (AR), and virtual reality (VR), remains moderate.

3.1.2. Uptake of digital technologies

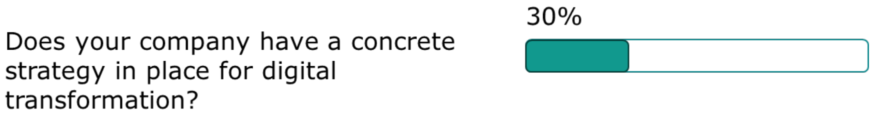
This section will analyse the uptake of several key digital technologies, as identified and discussed in chapter 3.1, within the mobility ecosystem, based on the results of the EMI survey. It will also reflect on industry targets and the progress made over time.

The EMI enterprise survey data reveals that approximately one-third of companies within the mobility ecosystem have established a concrete strategy for the digital transformation of their businesses (see Figure 39), which is significantly below targets of the EU's Digital

[122] https://solidstudio.io/blog/artificial-intelligence-in-the-emobility-ecosystem

Decade Policy Programme 2030[123]. This indicates a significant gap, suggesting that many organisations may be lagging in their efforts to adapt to digital advancements. Companies with a defined strategy are likely better positioned to leverage technology for growth and efficiency, while those without may face challenges in remaining competitive in an increasingly digital landscape.

Figure 39: Share of companies in the mobility ecosystem with a concrete digital transformation strategy



Source: EMI enterprise survey 2024

The adoption rates of these technologies amongst the companies of the mobility ecosystem are listed in Figure 40, below.

Figure 40: Share of businesses in the mobility ecosystem that have adopted digital technologies

Digital Technologies	Share of adoption (2023)	Share of adoption (2024)
Cloud	20.24%	38.07%
Internet of Things	12.55%	31.47%
Artificial Intelligence	10.23%	19.29%
Big Data	11.02%	19.29%
Augmented and Virtual Reality		5.08%
Robotics	7.8%	14.92%
Blockchain	2.2%	4.06%
Edge Computing		6.09%

Source: EMI enterprise survey 2024

As Figure 40 depicts, **cloud solutions have the highest adoption rate among digital technologies in the mobility sector**. In 2023, approximately 20% of mobility companies had implemented cloud solutions, while this figure surged to nearly 40% in 2024. This significant increase indicates a growing recognition of the importance of cloud technologies in driving digital transformation within the mobility sector. The upward trend suggests that businesses are increasingly prioritising cloud-based solutions to enhance their operational efficiency and adapt to the evolving digital landscape.

The data reveals a **significant increase in the adoption of IoT relevant technologies within the mobility sector**. While only around 13% of companies utilised these technologies in 2023, this figure has jumped to nearly 32% in 2024. This rise indicates a growing awareness among companies of the benefits that IoT can offer, such as enhanced data-driven insights and improved operational capabilities. The transition from a minority to nearly one-third of companies adopting IoT technologies reflects a critical shift towards more connected and intelligent mobility solutions, highlighting the sector's commitment to embracing digital transformation.

[123] European Commission (n.d.) Europe's Digital Decade: digital targets for 2030. Retrieved from: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/europes-digital-decade-digital-targets-2030_en

The statistics from the EMI enterprise survey highlight also a **significant increase in the adoption of AI technologies within the mobility sector**. In 2023, the adoption rate stood at approximately 10%, which has nearly doubled to around 20% in 2024 (see Figure 40). This trend parallels the growth of Big Data technologies, highlighting a growing recognition of the potential of data-driven analytics to improve operational performance. The increase indicates that more companies are formulating concrete strategies to integrate AI into their operations, demonstrating a commitment to leveraging advanced technologies for digital transformation. Our in-depth analysis reveals that within this ecosystem, 57% of businesses that adopted AI did so in the past two years, while 19% have been utilising AI for a decade. Additionally, 13% of companies develop AI systems in-house, while 37% depend on external service providers. Notably, 33% of AI-utilising businesses rely on US service providers. Regarding application, 15% use AI in service provision and another 15% in production processes.

Our statistics, in Figure 40, indicate a **notable increase in the adoption of robotics across the mobility sector**. The uptake rose from approximately 8% in 2023 to nearly 15% in 2024. This upward trend reflects a growing recognition of the benefits that robotics can bring to operational workflows. As companies increasingly invest in robotic solutions, particularly manufacturing companies, they are better positioned to enhance their competitive edge.

Other digital technologies, including **augmented and virtual reality (AR/VR), blockchain, and edge computing**, are emerging within the mobility ecosystem but currently show low adoption rates, with only about 5% of companies implementing these solutions in 2024 (see Figure 40, above). Despite their significant potential to enhance customer experiences, streamline operations, and bolster data security, the slow uptake suggests that many organisations are still in the initial stages of exploring their applications. This may reflect a cautious stance among companies, influenced by factors such as high implementation costs, a lack of understanding of these technologies, and uncertainty regarding their return on investment. However, as awareness and expertise grow, it is anticipated that more organisations will start integrating these digital technologies into their strategies, paving the way for future innovations in the mobility sector.

For the digital transformation of the mobility ecosystem, several tangible pledges have been made under the Mobility Transition Pathway initiative, spanning the subsectors of the mobility ecosystem:

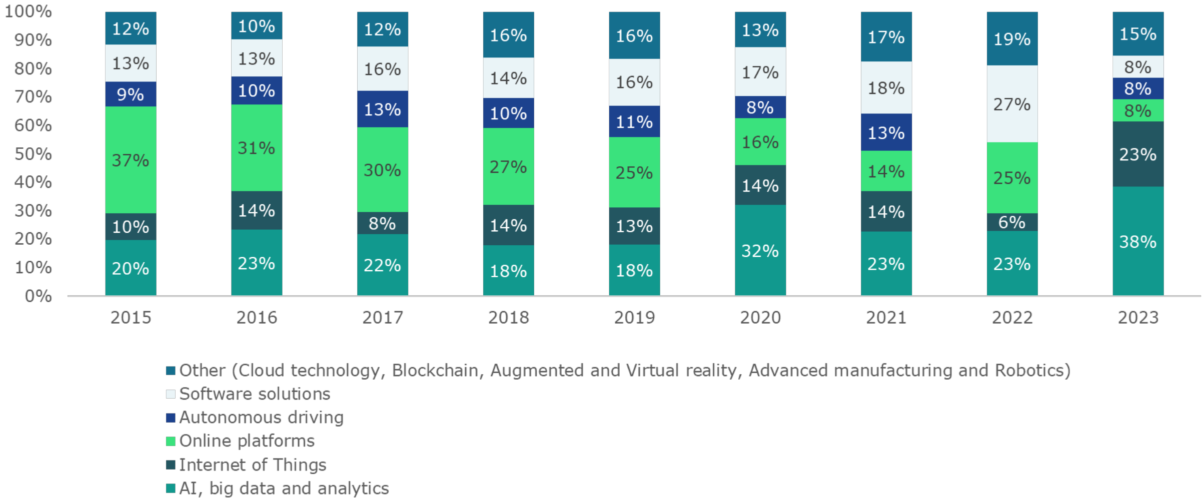
- **In the automotive sector, ERTICO – ITS Europe** (a Belgium based association for the automotive industry) pledges "to provide a test data sharing space with common principles for data recording, reporting and monitoring and harmonised data formats, allowing CCAM projects to easily share and re-use data in a federated system […]. The Data space will include at least 5 CCAM project data sets by end 2025"[124].
- **In the waterborne sector,** the Waterboren Technology Platform (TP) (a Belgium-based business association for the waterborne industries) pledges to develop and publish a RD&I strategy regarding the digitalisation of the waterborne sector by the the first half of 2025[125].
- **In the cycling sector**, Cycling Industries Europe's Market Intelligence and Impact Expert Group (MIIEG) (a Belgium-based business association for the cycling industry) "pledges to improve the existing corpus of cycling mobility data available to policy and business deciders via the following actions to be undertaken by the end of 2025[126].

[124] https://single-market-economy.ec.europa.eu/sectors/automotive-industry/mobility-transition-pathway/pledges_en
[125] Ibid.
[126] Ibid.

3.1.3. Mobility tech startups

In addition to evaluating digital technology uptake, we examined the significance of these technologies for startups within the EU27 mobility ecosystem, using data from Crunchbase (see **Error! Reference source not found.**).

Figure 41: Technologies underpinning digital tech startups in the mobility industrial ecosystem



Source: Technopolis Group based on Crunchbase and Net Zero Insights

Error! Reference source not found. gives an overview of the fraction of new startups founded per technology field, from 2015 to 2023. The figure reveals that the mobility ecosystem has witnessed significant shifts in the relevance of various digital technologies for startups over recent years[127].

AI, big data, and analytics have shown a growing importance not only in mobility industry, but also in almost all industry ecosystems, reflecting increasing reliance on data-driven insights, for decision-making and automated activities[128]. This trend in the mobility ecosystem highlights also a maturation in how mobility startups utilise technology to optimise operations and enhance customer experiences.

In contrast, **online platforms** have been losing relevance since 2015. Despite a notable hype around these platforms in 2015, their significance has declined sharply, reaching the lowest level in 2023. This trend suggests a saturation of online platform solutions in the market, leading to a shift towards more integrated and innovative approaches.

Autonomous driving technologies exhibit certain volatility, with relevance fluctuating year by year. This inconsistency may indicate the challenges and complexities associated with developing and deploying autonomous solutions in the mobility sector, making it a dynamic area of interest for startups.

Similarly, the **Internet of Things (IoT)** has experienced a rollercoaster journey in terms of relevance. However, it regained significant importance in 2023, suggesting that as connectivity and smart devices evolve, startups are increasingly recognising the value of IoT in enhancing mobility solutions.

Examples of startups[129] from the fields of Autonomous Driving, IoT and online platforms include:

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[127] McKinsey & Company (2024). What technology trends are shaping the mobility sector? Retrieved from: https://www.mckinsey.com/features/mckinsey-center-for-future-mobility/our-insights/what-technology-trends-are-shaping-the-mobility-sector

[128] McKinsey & Company (n.d.). Retrieved from: https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/the-top-trends-in-tech#tech-trends-2024

[129] For further examples see https://startupprize.eu/2022/01/25/europes-top-50-clean-mobility-startups-for-2022/

- **Einride AB** (autonomous driving technologies), headquartered in Stockholm, Sweden, is a pioneering company in the transport industry, focusing on electric and autonomous vehicle solutions. The company leverages self-driving technology combined with remote operation to enhance its autonomous electric trucks, enabling drivers to oversee multiple vehicles and intervene remotely when necessary. Einride also offers a comprehensive digital platform for carriers, streamlining logistics processes such as planning, scheduling, routing, invoicing, and billing[130].
- **SharingOS** (online platform and IoT) is a British startup specialising in shared mobility solutions aimed at improving last-mile connectivity in urban areas. The company develops both software and hardware systems for shared electric vehicles, including e-cycles, e-scooters, and e-mopeds. These IoT-enabled vehicles are seamlessly connected via the SharingOS platform, providing users with on-demand, plug-and-play mobility options. By addressing urban density and transportation challenges, SharingOS promotes cost-efficient, eco-friendly transportation while contributing to economic growth and greater environmental awareness[131].
- **COMODULE** (IoT) is a company from Estonia empowers micromobility by providing flexible and comprehensive connectivity solutions to bike manufacturers and sharing fleets[132].

As the mobility ecosystem continues to advance, understanding these trends will be crucial for future strategies and innovations.

3.1.4. Private investments

In addition to examining the number of startups and the digital technologies on which they depend, we analysed the investment levels of companies within the mobility industrial ecosystem in selected digital technologies, as well as venture capital investments in digital mobility startups. Figure 42below illustrates the average current and planned investments in advanced digital technologies within the mobility industrial ecosystem, as reported in the EMI enterprise survey 2024.

Figure 42below illustrates the average current and planned investments in advanced digital technologies within the mobility industrial ecosystem, as reported in the EMI enterprise survey 2024.

Figure 42: Level of investment of businesses in mobility ecosystem into digital technologies

	Cloud	Robotics	IoT	Big Data	AI	AVR	Blockchain
Less than 1% of annual turnover	39.62%	13.64%	49.02%	53.13%	44.83%	83.33%	50%
1-5% of annual turnover	50.94%	22.73%	27,45%	28.13%	24.14%	16.67%	
6-10% of annual turnover	9.43%	31.82%	3.92%		3.45%		
11-30% of annual turnover							
More than 30% of annual turnover		4.55%					

Source: EMI survey 2024

130 https://www.einride.tech/
131 https://www.sharingos.com/
132 https://www.comodule.com

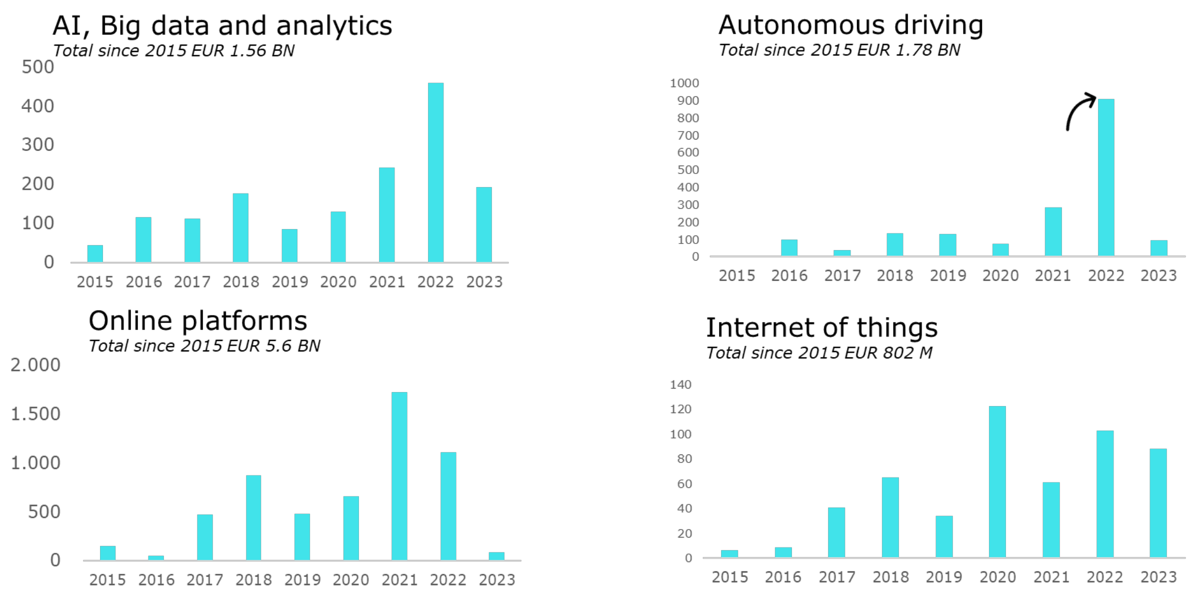
The data indicates that mobility companies are strategically prioritising different digital technologies based on the scale of their planned investments. While investments in big data, AI, and augmented and virtual reality (AR/VR) are recognised as essential, they represent a smaller proportion of annual turnover. In contrast, robotics, along with cloud technologies and the internet of things (IoT), is projected to attract significantly higher investment levels, with a considerable portion expected to fall within the 1-10% range of annual turnover.

Venture capital investments

According to Mobility Startup Radar, using data from Crunchbase, global investment in mobility sector startups has seen a sharp decline since the peak in 2021. In 2023, funding totalled EUR 37,2 billion, closely matching the previous year's EUR 38 bn. This decline in investor enthusiasm highlights the broader challenges startups now face, including difficulties securing financial support amid ongoing global economic uncertainty, regional conflicts, and political instability. Given the significant capital required for mobility startups to bring new innovations to market, these conditions suggest a potential slowdown in the pace of technological advancements within the industry[133].

Considering Europe, the Crunchbase and Net Zero Insights dataset provides valuable insights into venture capital investments in startups, specifically highlighting the funding associated with the broader digital transition and the selected technologies that support it. Generally, the analysis highlights the shifting priorities within the startup ecosystem. Figure 43 indicates a strong investment in digital platforms startups in 2021, emphasizing their pivotal role in revolutionising service delivery, enhancing user engagement, and driving growth. By 2021, Investors still viewed these platforms as essential for reshaping the mobility landscape. Concurrently, rising investments in AI, big data, and analytics underscore the growing dependence on data-driven technologies for optimising operations and improving decision-making, further accelerating the sector's digital transition.

Figure 43: Venture capital investment into mobility young companies – digital transition



Source: Technopolis Group based on Crunchbase and Net Zero Insights

However, a sharp shift occurred in 2023, characterised by a significant decline in Venture Capital (VC) investments in digital platforms, AI technologies, and autonomous driving. A similar trend was observed in the autonomous driving sector, where a notable increase in 2022 was followed by a steep downturn in 2023. This drastic decline in VC within the

[133] Oliver Wyman's "Mobility Startup Radar" (2024). Retrieved from: https://www.oliverwyman.com/our-expertise/insights/2024/jan/mobility-startup-investment-favors-ev-related-tech.html

mobility ecosystem aligns with the broader drop in global VC investments in 2023, which nearly reached levels seen during the COVID-19 pandemic. In Europe, VC funding decreased by approximately 60% in 2023,[134] closely mirroring the decline in investments related to the digital transformation of mobility companies.

In contrast, funding for IoT technologies has exhibited steady but moderate growth compared to other digital technologies, as well as a much lower level of over-all funding. This indicates that while IoT contributes to the digital transition, it has not yet garnered the same strategic focus or investor enthusiasm as AI and digital platforms, and potential investors lack seeing its monetisation potentials. These trends highlight a preference for immediate, scalable digital solutions over more complex, long-term innovations such as autonomous driving and IoT.

3.2. Framework conditions

To what extent do framework conditions such as public financing and skills support the digital transition?

- The findings indicate a significant **disparity in public investments, as a higher percentage of funding is directed towards projects promoting the green transition** compared to those focused on digital transformation. There is **only a 5% allocation of funding towards digitalisation initiatives** in the mobility sector, which raises concerns about potential underinvestment.

- Approximately **20% of ERDF-related projects that contribute to the digital transition** within the mobility ecosystem are focused on **advanced digital technologies**, primarily involving AI, big data, and analytics, with some attention to IoT.

- More than **50% of surveyed organisations** identified the acquisition of ne**w skills as a very important driver of change** within the mobility industrial ecosystem.

- Furthermore, **56%** of the mobility, transport, and automotive companies surveyed **have at least one full-time employee in roles that are directly relevant to the digital transition** of the company.

- The results indicate that the **share of professionals with advanced digital skills**, including artificial intelligence, big data, cloud technologies, augmented and virtual reality, and robotics, **has significantly increased between 2022 and 2024**.

- By **2024, artificial intelligence has become the most relevant advanced digital skill** in the Mobility, Transport, and Automotive sectors, as professionals increasingly list these skills on their profiles.

- On the demand side, the analysis shows that **16.6% of job advertisements included a requirement for advanced digital skills**, such as AI and big data, while a higher share, specifically 25.6%, required moderate digital skills; big data/data analytics is identified as the most demanded skill in the ecosystem, followed by software development.

3.2.1. Public investments supporting the digital transition

In the evolving landscape of the mobility industrial ecosystem, public funding for digital transformation is vital alongside private investments. This funding addresses several key challenges, particularly by mitigating financial risks associated with innovative projects, which in turn encourages private entities to pursue groundbreaking technologies. Many

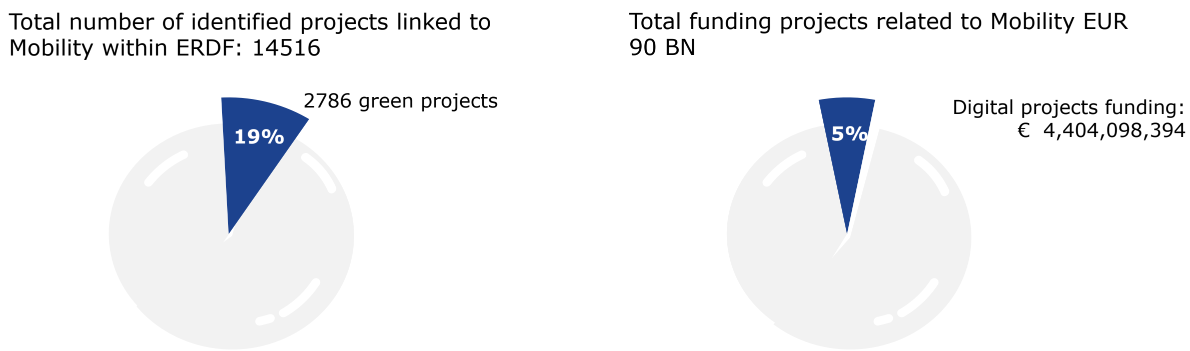
[134] KPMG (2023). Retrieved from: https://kpmg.com/de/en/home/media/press-releases/2023/07/drastic-decline-inworldwide-risk-capital-investment.html

mobility initiatives necessitate significant infrastructure improvements that may not be financially viable for private companies on their own; public funding serves to bridge this crucial gap.

This chapter evaluates the investments directed toward the digital transition of the mobility ecosystem, with a particular emphasis on public policy initiatives by the European Regional Development Fund (ERDF), the Horizon 2020 and Horizon Europe programmes. The analysis leverages the latest available data, including Cohesion data and metrics from Horizon funding, to provide a comprehensive overview of public contributions to the digital transformation in mobility.

The total funding allocated by the ERDF amounts to approximately EUR 90 bn. As seen in the previous chapter on green transition, 37% percent of the funding by the ERDF went to projects related to the green transition. Only 5% of the funding went to projects specifically focusing on digitalisation of the mobility sector, see Figure 44.

Figure 44: ERDF funded projects supporting the digital transition within the mobility ecosystem

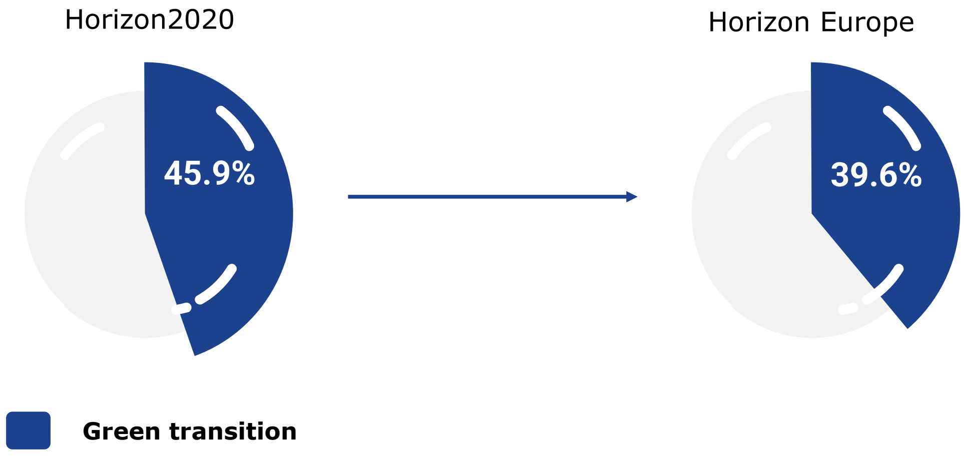


Source: Technopolis Group based on Kohesio

The primary aim of public investments via the ERDF has been to facilitate the green transition, showcasing a strategic commitment to sustainability. However, the limited 5% allocation towards digitalisation initiatives in the mobility sector raises concerns regarding potential underinvestment. In terms of allocation of resources, a total of 14 516 projects related to mobility have been identified under the ERDF. While 28% of these went to green projects, only 19% was for projects related to digital transition (see **Error! Reference source not found.**). The finding also indicates a significant disparity in public investments, with a higher percentage of funding directed towards projects promoting the green transition compared to those focused on digital transformation.

In addition to ERDF, we examined EU funding allocated to Horizon projects focused on the twin transition. A comparison between Horizon 2020 and Horizon Europe reveals a notable decline in the share of R&I funding dedicated to the digital transition, decreasing from approximately 46% to 40% (see Figure 45). In contrast, the share of Horizon funds for the green transition has seen a substantial increase, rising from 56% to 74%, as discussed in the chapter 2.3.2.

Figure 45: Share of EU funding spent on Horizon projects related to the digital transition



Source: Technopolis Group based on Kohesio

Overall, our analysis highlights a strong commitment to funding the green transition through EU funds. However, the relatively low investment in digitalisation, particularly within the mobility sector comparing to other ecosystems, poses a risk of hindering comprehensive industrial transition efforts. As digitalisation increasingly supports sustainable practices, it is essential that future funding strategies balance investments in both green and digital initiatives to ensure a holistic approach to industrial transition. Moving forward, policymakers should reassess funding priorities to enhance support for digitalisation, recognising its role as a critical enabler of the green transition.

Box 3: Funding Cooperative, connected, and automated mobility

"Automation in road transport is at the forefront of the European Commission's agenda, aligning with key policy objectives such as the greening and digitalisation of the transport sector. Cooperative, connected, and automated mobility (CCAM) plays a central role in this transition, promising safer and more inclusive road transportation, while enhancing the competitiveness of European industries. The European Commission, through Horizon Europe, invests EUR 500 million in a public-private partnership on CCAM, which has been topped up by the private members by the same amount. Since 2021, EUR 159 million have been invested in research and innovation (R&I) activities to support 19 European projects to deliver on CCAM."

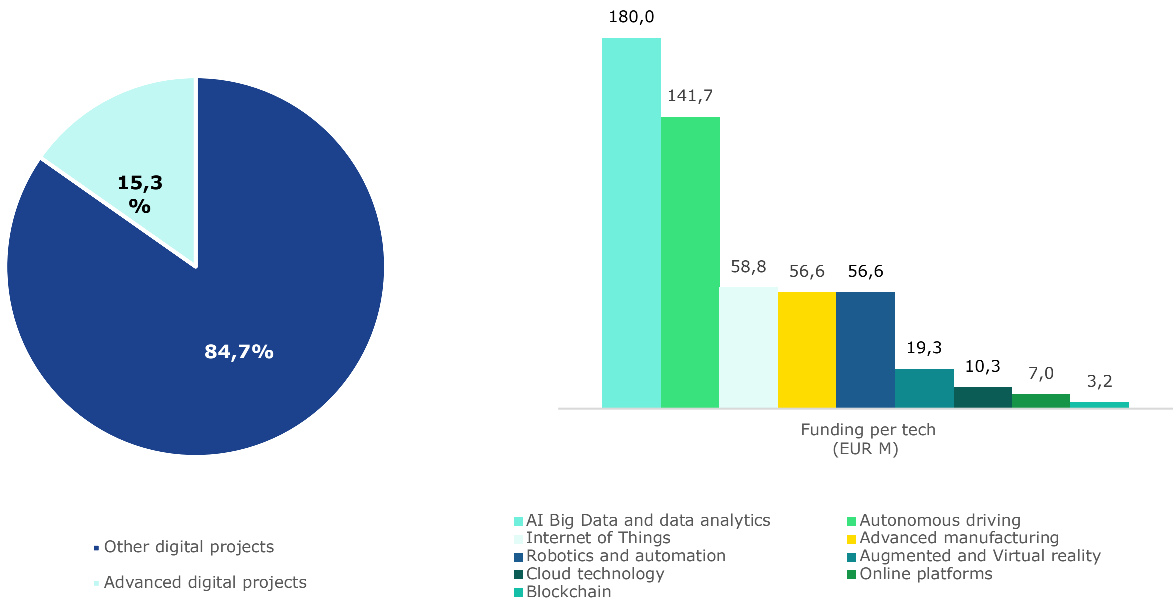
Source: https://research-and-innovation.ec.europa.eu/new (17 April 2024)[135]

In addition to a rather general analysis, we conducted an in-depth examination of the ERDF-related projects that contribute to the digital transition within the mobility ecosystem. Approximately 20% of the funding for these projects is allocated to initiatives involving advanced digital technologies (see Figure 46). The majority of these projects focus on AI, big data, and analytics, followed by IoT [136].

[135] European Commission (2024). Directorate-General for Research and Innovation: Automated mobility in Europe: where are we now? Retrieved from: https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/automated-mobility-europe-where-are-we-now-2024-04-17_en

[136] As identified for the purpose of this project, e.g., projects related to IoT, AI, Cloud, Blockchain, advanced manufacturing etc.

Figure 46: Share of funding contributing to the digital transition in the mobility ecosystem by category[137]



Source: Technopolis Group based on Kohesio

[137] * The percentages do not add up due to rounding up

Box 4: The EU funded 'TransformingTransport' project

The TransformingTransport project demonstrated the **impact of Big Data on the mobility and logistics sectors**. It aimed to validate the technical and economic feasibility of Big Data in revolutionising transport processes and services. By enhancing operational efficiency and improving customer experiences, the project supported the development of innovative business models.

TransformingTransport focused on seven critical pilot areas within Europe:

1. Smart Highways
2. Sustainable Vehicle Fleets
3. Proactive Rail Infrastructures
4. Ports as Intelligent Logistics Hubs
5. Efficient Air Transport
6. Multi-modal Urban Mobility
7. Dynamic Supply Chains

The consortium united leading European ICT and Big Data technology providers with industry experts, fostering collaboration that drove advancements in the mobility and logistics landscape.

Budget: Total cost EUR 18 703 369; EU contribution EUR 14 631 935

Duration: January 2017 – July 2019

Source: https://cordis.europa.eu/project/id/731932

3.2.2. Digital skills underpinning the digital transition

This section analyses the demand and supply side of the labour market in terms of skills relevant for the digital transition. The transport, mobility and automotive industrial ecosystem is a major European employer and the impact on the workforce resulting from the digital transition will be significant. The demand for new skills and experience will contrast with a fall in demand for other more traditional skills. This implies a need for a skill restructuring that balances out existing skills mismatches and which in turn, will require significant investment in new technologies, production processes and in the reskilling and training of the workforce[138].

More than 50% of surveyed organisation identified acquisition of new skills as a very important driver of change in mobility industrial ecosystem[139]. Overall, the impact of the transition to automation and digitalisation on the labour force in transport will be substantial and occur in many different areas. Employers expect automation and digitalisation to **create, transform, and reduce jobs** in the transport sector[140].

3.2.2.1. Supply of digital Skills

According to the results of the EMI survey in 2024, 56% of the mobility, transport and automotive companies surveyed have at least one full-time employee in jobs directly relevant for the digital transition of the company (see Figure 47 below). 37% of the respondents said they employ between 2-5 people in digital roles.

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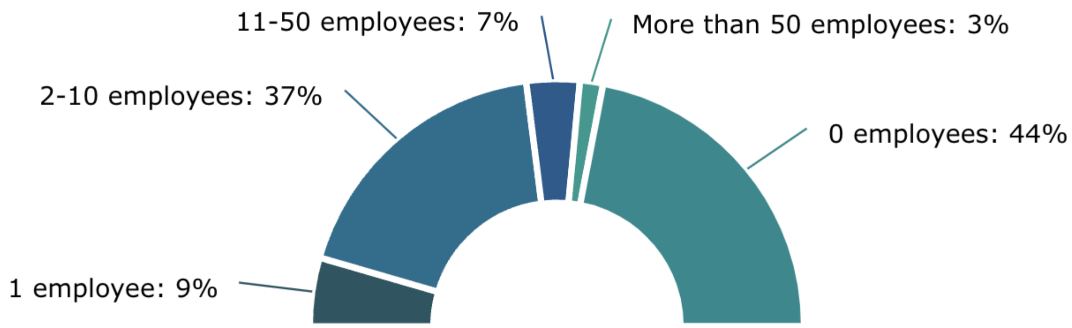
[138] Drives (2020). Skill needs and gap. Retrieved from: https://pact-for-skills.ec.europa.eu/document/download/6dbcf2f6-c5ee-4a0d-aac3-a52137a18193_en?filename=Skill%20needs%20and%20gaps.pdf

[139] Ibid.

[140] European Commission, Directorate-General for Mobility and Transport, (2021). Study on the social dimension of the transition to automation and digitalisation in transport, focusing on the labour force: final report. Publications Office. Retrieved from: **https://data.europa.eu/doi/10.2832/95224**

Figure 47: Share of full-time employees working in jobs relevant for the digital transition of the company



Source: EMI survey 2024

To better reflect the characteristics of the EU mobility, transport and automotive labour markets, moderate and advanced digital skills were analysed.

Moderate digital skills have been defined following Cedefop[141] notably including "*five types of skills under the digital skills umbrella such as information processing (e.g. using a search engine and storing information and data); communication (including teleconferencing and application sharing); content creation (such as producing text and tables, and multimedia content); security (e.g. using a password and encrypting files); and, problem solving (e.g. finding IT assistance and using software tools to solve problems)"*. (The list of keywords that have been used to track LinkedIn is included in Appendix B).

Advanced digital skills have been defined as a specific group of digital skills in the context of the main digital technologies captured in this project notably in artificial intelligence, cloud computing, connectivity, robotics, Internet of Things, augmented and virtual reality and blockchain (the list of keywords that have been used and are possible to track with the algorithm of LinkedIn is included in Appendix B). LinkedIn data must be interpreted in the light of its representativeness for the mobility IE and across the EU. An analysis of representativeness is provided in Appendix B and in the related methodological report.

In order to analyse trends in the skills of professionals working in the mobility, transport and automotive industrial ecosystem, data from LinkedIn has been used. LinkedIn data provides a proxy about self-reported supply of digital skills including moderate and advanced digital skills.

The results indicate that both the share of professionals with advanced digital skills - including artificial intelligence, big data, cloud technologies, augmented and virtual reality, Internet of Things, robotics – **have increased between 2022 and 2024.** (see Figure 48 below).

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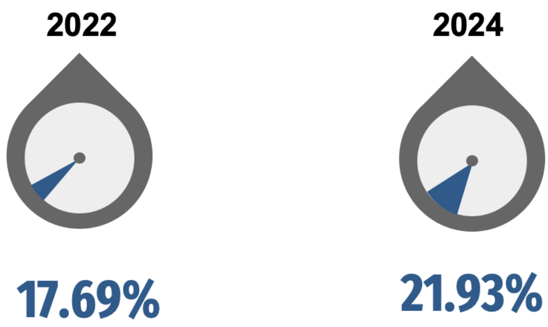
[141] https://www.cedefop.europa.eu/de

Figure 48: Share of professionals with advanced digital skills in Mobility, Transport and Automotive

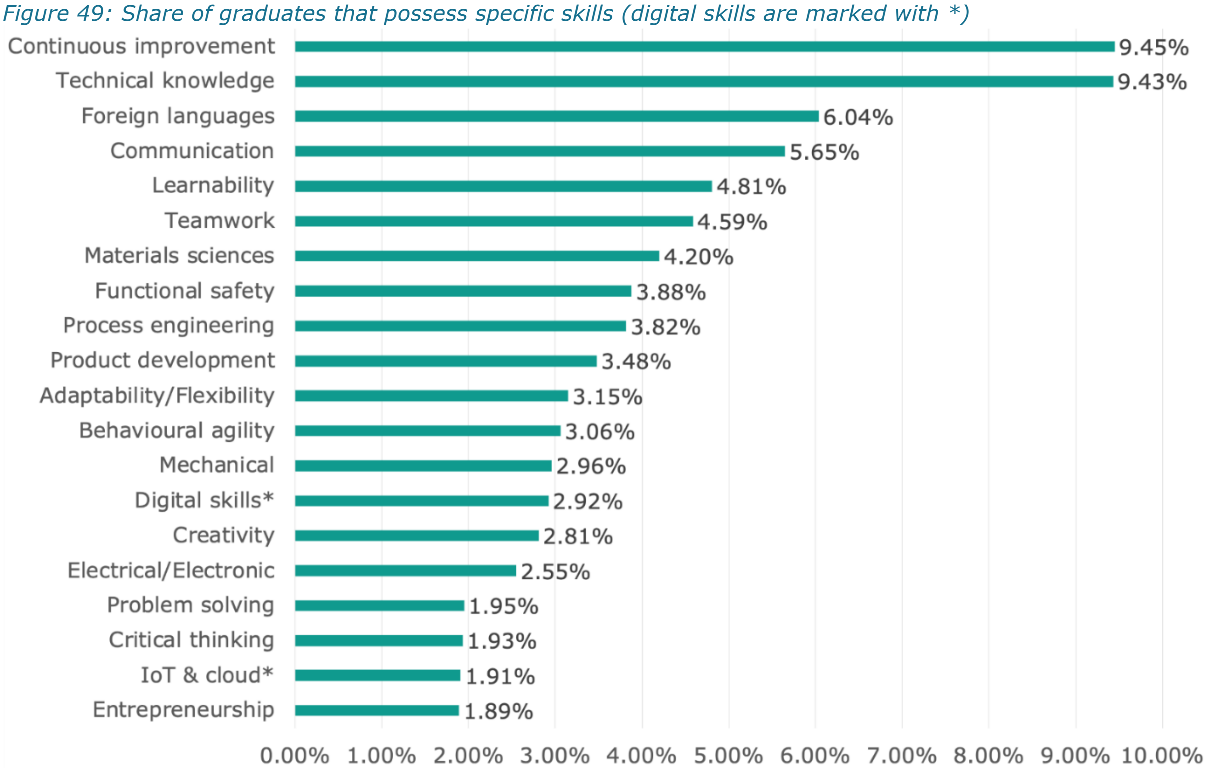


Source: Technopolis Group based on analysis of LinkedIn data

The most relevant advanced digital skill in Mobility, Transport and Automotive in 2024 has become artificial intelligence, as professionals have increasingly listed these skills on their profiles. As AI applications continue to grow and prove their value, professionals have increasingly highlighted AI skills to remain competitive and meet the growing demand for digital expertise.

Supply of the digital skills was also assessed within the framework of Development and Research on Innovative Vocational Educational Skills (DRIVES) project that is co-funded by the Erasmus+ Programme of the EU. Within the project a survey of vocational educational training institutions was carried out. The figure below indicates the share of graduates that poses specific skills important for mobility, transport and automotive industrial ecosystem.

*Figure 49: Share of graduates that possess specific skills (digital skills are marked with *)*



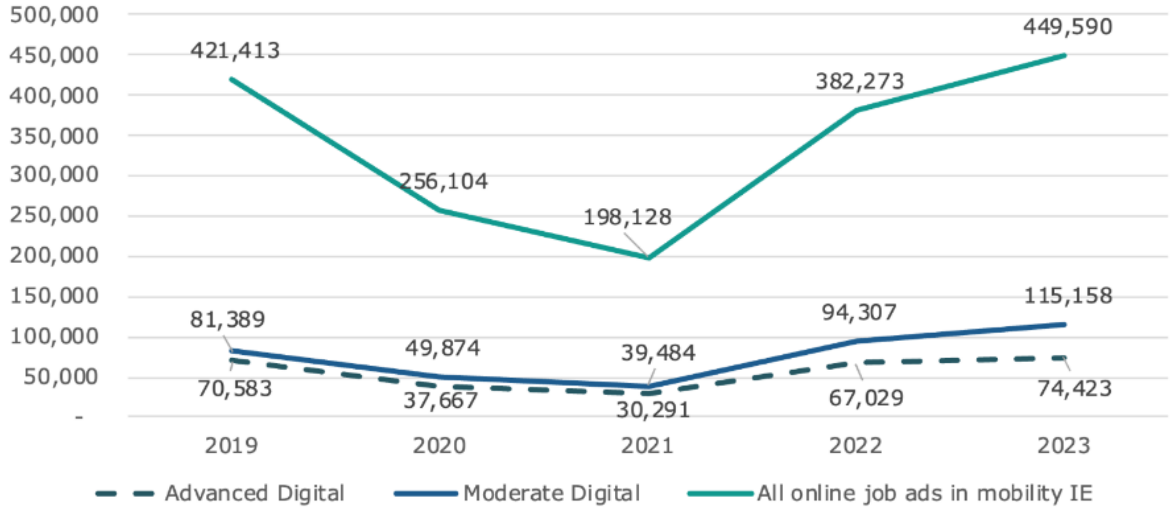
Source: https://www.project-drives.eu/Media/Publications/208/Publications_208_20210207_20596.pdf

The Figure shows that 2.92% of graduates possess general digital skills. IoT & cloud computing skills are adopted by 1.91% of graduates.

3.2.2.2. Demand for Digital Skills

On the demand side, the requirements for digital skills listed on online job advertisements within mobility, transport and automotive has been growing over the period from 2021-2023, as shown by the data from Cedefop Skillsovate. The total number of online job advertisements in Mobility amounted to 449 590 in 2023 in the EU27. The results of the data analysis show that **16.6% of the job ads included a requirement of advanced digital skill** such as AI, big data, augmented and virtual reality, cloud. A higher share notably **25.6% of the job ads required moderate digital skills** (more than simple Microsoft or web skills but not necessarily artificial intelligence). Germany has the highest share of online job ads with both advanced and basic digital skill in mobility, followed by France and Netherlands.

Figure 50: Share of online job advertisements with a requirement for digital skills

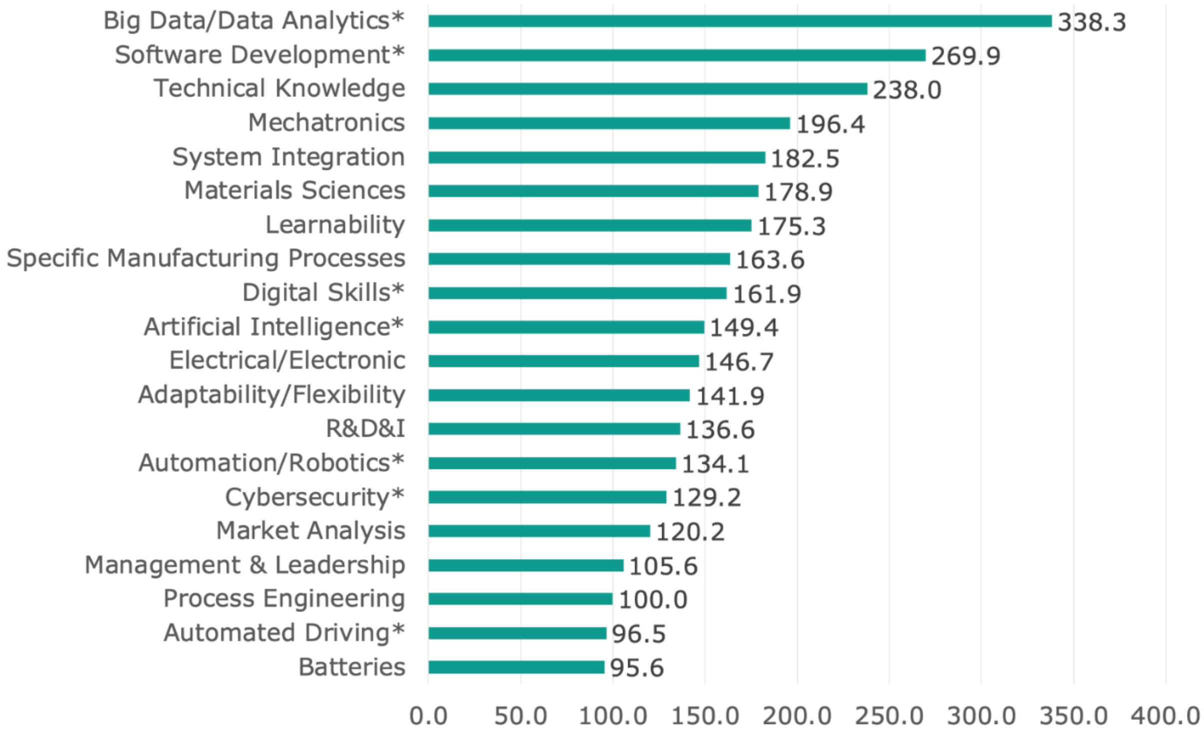


Source: Technopolis Group based on analysis of Cedefop data

To further assess the specific demand for skills in transport, mobility and automotive industrial ecosystem a skill demand index was created within the framework of Development and Research on Innovative Vocational Educational Skills (DRIVES) project. The skill demand index was developed by surveying private companies and calculating the number of times the skill has been mentioned by respondent and the priority/importance score assigned to that specific skill[142]. The figure below provides an overview of top 20 most in demand skills.

[142] To assess the priority, the respondents were given the opportunity to indicate for each skill, the related Drivers of Change in the ecosystem. The drivers of change include change in the way people use cars, climate goals, environmental and health challenges, globalisation and emergence of new players, new technologies and business models and structural changes.

Figure 51: Top 20 most important skills for automotive sector (SkillIndex)



Source: https://pact-for-skills.ec.europa.eu/document/download/6dbcf2f6-c5ee-4a0d-aac3-a52137a18193_en?filename=Skill%20needs%20and%20gaps.pdf
Note. Skills Index = $\sum Skill\,[occurence]\; n\; i{=}1\; i * AVG\ DoC\ priority\ index\ i$, where i = number of responses to the questionnaire, Skill [occurrence]i = number of times the i skill has been mentioned; AVG DoC priority index i = the average of the priority DoC index linked to the Skill identified by the respondent.

Big data/data analytics is the most demanded skill in the ecosystem followed by software development. Demand for basic digital skills is ranked in then 9th place followed by AI in the 10th place. Automation/robotics, cybersecurity and automated driving are digital skills that are placed on 14, 15 and 19 place. In general, the table below that combination of digital and technical (e.g., mechatronics, system integration) are the most demanded skills.

Comparing the demand for specific skills with the skill supply in the ecosystem, a gap is evident. The table below lists the demand for digital skills from skills and share of graduates that possess the specific digital.

Figure 52: Demand and supply of digital skills in transport, mobility and automotive industrial ecosystem

Demand (ranking based on the Skills Index)	**Supply (% of graduates prepared each year that possess digital skills)**
Rank 1 Big data/Data analytics	0.27%
Rank 2 Software development	0.61%
Rank 9 Basic digital skills	2.92%
Rank 10 AI	0.41%
Rank 14 Automation/Robotics	0.85%
Rank 15 Cybersecurity	0.21%
Rank 19 Automated driving	0.26%

Source: https://www.project-drives.eu/Media/Publications/207/Publications_207_20210207_205852.pdf

For almost all digital skills that are among top 20 most demanded skills there are less than 1% of graduates prepared each year (with the expectation of basic digital skills).

Additionally, Automotive Manufacturing Outlook Survey 2023 has identified that globally, over half of the respondents are concerned about specific skill shortages in robotics & automation[143]. These findings are related to survey carried out within the project TRIREME. The respondents were asked "What kind of training do [they] believe is needed in view of the evolutions of the automotive-mobility sector?" and identified a broad range of training needs. AI/ML training was the most frequently mentioned, reflecting the growing importance of **artificial intelligence**, **machine learning technologies and big data** in the industry. **Digital transformation and related skills** appeared frequently, signifying the need for digital literacy and transformation across all levels of the automotive sector. Other significant areas include **cybersecurity training**, energy engineering, and automation training, which reflect the sector's focus on securing new technologies and automating processes[144].

As the ecosystem navigates digital transition, proactive measures in upskilling and reskilling will be essential to ensure a resilient and future-ready workforce. To address the digital skill gaps, companies have implemented skill development programmes. Majority of the respondents stated that the necessary training is available, most of them stated so with a reservation, pointing out lack of awareness amongst the companies and the workforce. This expression of the largest share of respondents clearly points out the need for a spread of awareness in the regard of training availability[145].

3.2.3. Demand for digital services by consumers

Smart and shared mobility services and automated driving are two of the main digital trends in the mobility ecosystem[146]. Accordingly, this section focuses on the consumer demand for shared mobility services, as well as consumer attitudes on automated driving.

Demand for smart mobility sharing

A recent study on the shared mobility service portfolio of 115 European cities by fluctuo[147] revealed that in 2023 shared mobility services saw an 11% increase in user numbers compared to 2022, as they bounce back following pandemic disruptions, driven by rising consumer demand for diverse, sustainable, and flexible mobility options. The strength of such mobility services lies in facilitating door-to-door journeys, as they fill for potential gaps in the coverage of public transportation services[148]. Furthermore, these on-demand mobility services offer an easy and convenient alternative to car ownership[149].

The integration of these mobility services with existing public transportation systems promises to further increase the potential ridership of shared mobility services. Accordingly, the International Association of Public Transport (UITP) projects the size of the global vehicle sharing market to double by 2030 (compared to 2019), with the total smart mobility sector will growing 5-fold in the same period[150].

Demand for connected and automated vehicles

As automated road vehicles for passenger transportation are starting to move from pilots to commercial applications, and legislation following suit both at national and international

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[143] Ams and ABB (2023). Automotive Manufacturing Outlook Survey 2023. Retrieved from: https://campaign-ra.abb.com/AutomotiveSurvey
[144] TRIREME (2024). SURVEY ON TRENDS IMPACTING THE AUTOMOTIVE-MOBILITY ECOSYSTEM IN 2024. Retrieved from: https://project-trireme.eu/Media/Deliverables/37/Deliverables_37_20241002_91547.pdf
[145] Ibid.
[146] Strategy& (2023). Digital Auto Report 2023 (Volume 2). Assessing global mobility market dynamics. Retrieved from: Digital Auto Report 2023 (volume 2) | Strategy&
[147] Fluctuo (2024). European Shared Mobility. Annual Review 2023. Retrieved from: https://european-index.fluctuo.com/
[148] UITP (2023). What on-demand and shared mobility looks like today (and where it's going). https://www.uitp.org/news/shared-mobility-market-today/
[149] Giesel and Nobis (2016). The Impact of Carsharing on car Ownership in German Cities. Retrieved from: https://doi.org/10.1016/j.trpro.2016.12.082
[150] UITP (2023). What on-demand and shared mobility looks like today (and where it's going). https://www.uitp.org/news/shared-mobility-market-today/

levels[151] (e.g. in 2023 Mercedes-Benz introduced a pilot for an automated driving system for highway application with globally valid approval for conditionally automated driving in accordance with SAE Level 3[152,153]).

Despite significant improvements in recent years, consumer trust in automated driving still appears rather low in countries for where there is data available. A recent study on the acceptance of automated driving with respondents from Germany, the US and China, conducted by Strategy&[154], showed a significant lack of trust in automated vehicles for both respondents from Germany and the US. More than 70% of respondents from Germany (and more than 60% of respondents from the US) indicated feeling rather uncomfortable or not comfortable at all with vehicles with automation level higher than SAE Level 4[155]. In contrast, almost 90% of Chinese respondents indicated to feel comfortable with such an automation level.

3.3. Impact of digital technologies on industrial competitiveness

What is the impact of digital technologies on competitiveness?

- Digital technologies such as **cloud computing, IoT, AI, and robotics** are transforming the mobility ecosystem, enabling real-time data use, automation, and smarter operations across sub-sectors from ports to logistics and autonomous transport.

- **Collaborative EU initiatives and corporate pilots are driving innovation, promoting data sharing**, and demonstrating real-world applications of emerging tech in improving efficiency, sustainability, and safety.

- While advanced technologies like **AR/VR, blockchain, and edge computing hold potential**, their adoption remains low, hindered by implementation challenges and unsuccessful pilots, though they remain relevant for experimental and decentralised use cases.

To focus on the digital technologies with the most significant role for the mobility ecosystem, the following eight key areas have been selected that contribute to digital transitions and industrial transformations, see Table 53.

[151] https://www.kba.de/EN/Themen_en/Marktueberwachung_en/Produktpruefungen_en/AutomatisiertesAutonomesFahren_en/Gesetzgebung_en/gesetzgebung_autonomes_fahren_node_en.html

[152] https://group.mercedes-benz.com/dokumente/innovation/sonstiges/2023-03-06-vssa-mercedes-benz-drive-pilot.pdf

[153] https://group.mercedes-benz.com/innovation/case/autonomous/legal-framework.html

[154] https://www.strategyand.pwc.com/de/en/industries/automotive/digital-auto-report/volume1.html

[155] SAE Level 4 refers to an automation level where: `The system is able to take over the driving task completely within its domain. If the system is no longer able to perform the driving task (e.g. immediate departure from the domain) and a driver does not take over control of the vehicle, the system automatically initiates the vehicle to engage a minimum-risk state.' See e.g. https://www.kba.de/EN/Themen_en/Marktueberwachung_en/Produktpruefungen_en/AutomatisiertesAutonomesFahren_en/Automatisierungsstufen_en/Automatisierungsstufen_node_en.html and SAE Standard J3016 https://www.sae.org/blog/sae-j3016-update

Figure 53: Eight key technological areas contributing to digital transition and industrial transformation

Digital Technology	Contribution to Transformation
Cloud Technologies	Enhances scalability and data accessibility
Internet of Things (IoT)	Enables connectivity and data exchange
Artificial Intelligence (AI)	Improves decision-making and automation
Big Data	Facilitates data-driven insights and analytics
Augmented and Virtual Reality	Enhances user experience and training
Robotics	Increases efficiency and operational capability
Blockchain	Ensures transparency and security in transactions
Edge Computing	Reduces latency and processes data closer to the source

Source: own analysis and illustration

Cloud technologies play a crucial role in the mobility sector[156] by providing scalable solutions that enhance data storage, processing, and accessibility. They enable companies to manage vast amounts of data generated by vehicles and infrastructure while supporting real-time analytics and decision-making. This flexibility allows organisations to innovate rapidly, reduce operational costs, and improve customer experiences through seamless integration of services and applications. Cloud is seen as enabler in many application areas such as connected vehicles, shared mobility or autonomous driving systems[157]. Consequently, the European Commission has positioned cloud computing as a central element of its Digital Decade goals, aiming for 75% adoption by 2030[158].

Box 5: MobiDataLab

The MobiDataLab was an EU-funded project under the Horizon 2020 research programme, running from January 2021 to January 2024. Its objective was to establish a cross-thematic knowledge base and a cloud-based service platform for the mobility sector, emphasizing data sharing and innovation. By organising both physical and virtual labs, it successfully brought together stakeholders from various fields, including public authorities, private companies, and research institutions, to promote the development of smart mobility solutions. Additionally, the project identified best practices in data sharing and defined further market potentials for data-sharing businesses.

Source: https://mobidatalab.eu/about/

Internet of Things (IoT) technologies are revolutionising the mobility sector by enabling devices and vehicles to communicate and share data seamlessly. This connectivity enables and facilitates real-time monitoring, predictive maintenance, and enhanced operational efficiency[159]. Hence, the European Commission identified the following application areas for IoT in the mobility context: smart multi-modal mobility and smart road infrastructure,

[156] McKinsey & Company (2024). What technology trends are shaping the mobility sector? Retrieved from: https://www.mckinsey.com/features/mckinsey-center-for-future-mobility/our-insights/what-technology-trends-are-shaping-the-mobility-sector
[157] https://www.theparliamentmagazine.eu/partner/article/the-future-of-mobility-is-in-the-cloud
[158] European Commission (n.d.) Europe's Digital Decade: digital targets for 2030. Retrieved from: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/europes-digital-decade-digital-targets-2030_en
[159] See e.g. https://www.softwareag.com/en_corporate/resources/iot/guide/internet-of-things.html?utm_source=google&utm_medium=cpc&utm_campaign=iot_smart-products&utm_region=hq&utm_subcampaign=stg-1&utm_content=stg-1_guide_iot-practical-guide&gad_source=1&gclid=Cj0KCQjwveK4BhD4ARIsAKy6pMId9JPYaOX3BhuB2nPO4a179mSU0qKnPt1NtO7UPHbKsuaBfFVaPOQaAs9vEALw_wcB

smart transportation and logistics[160]. IoT applications, such as smart traffic management systems and connected vehicles, not only improve safety and user experience but also optimise resource allocation and reduce costs. As IoT continues to evolve, it is becoming an essential component for companies aiming to innovate and stay competitive in the rapidly changing mobility landscape. Furthermore, the data collected in this way, may form the basis for different data sharing and dataspace initiatives of the future, collaboratively improving the competitiveness of the ecosystem as a whole[161].

Box 6: Digital transformation of the Port of Rotterdam

The Port of Rotterdam is evolving into a fully digitalised hub where machines and infrastructure, such as ships, cranes, and containers, can communicate directly without human input. This shift is being powered by a network of sensors and advanced digital tools that enable real-time data exchange (IoT). The port is building a digital counterpart that integrates advanced digital technologies. This allows operations to become more automated and efficient, reducing delays and optimising logistics. By leveraging data-driven decision-making, the port can improve cargo flows, boost sustainability, and minimise energy waste. As part of this transformation, the Port Authority is working closely with technology providers, local businesses, and research institutions to build a cutting-edge innovation ecosystem that will cement Rotterdam's position as a global leader in smart and sustainable port operations.

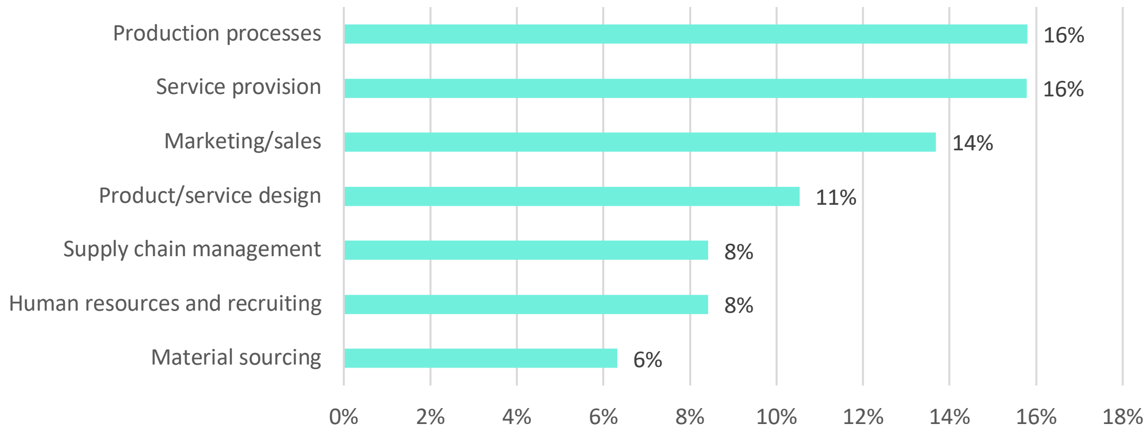
Source: https://www.portofrotterdam.com/en/to-do-port/futureland/the-digital-port

Artificial Intelligence (AI) is transforming the mobility sector by facilitating advanced data analysis, automation, and enhanced decision-making, often in conjunction with **Big Data**. Together, these technologies drive data-driven analytics in areas like predictive traffic management, autonomous vehicles, and personalised customer experiences, becoming essential for companies seeking to enhance efficiency and foster innovation. By leveraging AI, businesses can better respond to market demands, optimise their operations, and develop smarter, safer mobility solutions. As technology advances, AI is expected to play an increasingly pivotal role in the sector's future[162,163].

[160] Alliance for IoT and Edge Computing Innovation: https://aioti.eu/mapping-internet-of-things-innovation-clusters-in-europe/
[161] European Commission (n.d.). Unlocking the potential of mobility data. Retrieved from: https://digital-strategy.ec.europa.eu/en/policies/mobility-data
[162] McKinsey & Company (2024). What technology trends are shaping the mobility sector? Retrieved from: https://www.mckinsey.com/features/mckinsey-center-for-future-mobility/our-insights/what-technology-trends-are-shaping-the-mobility-sector
[163] MIT Sloan (2024). How artificial intelligence is transforming logistics. Retrieved from: https://mitsloan.mit.edu/ideas-made-to-matter/how-artificial-intelligence-transforming-logistics

further depicts the most frequent use cases of AI according to the business operation stage. We find that among all companies in the mobility ecosystem, AI is most frequently applied in production processes, followed by service provision and marketing/sales analytics.

Figure 54: Share of companies in the mobility ecosystem using AI according to the business operation stage



Source: EMI Enterprise Survey 2024

Box 7: Volvo Truck's autonomous transport system between a logistics centre and a port

Volvo Trucks has launched its autonomous, electric vehicle Vera in a real-world application, transporting goods between a logistics centre and a port terminal in Gothenburg, Sweden. This marks the first operational use of Vera, developed in collaboration with DFDS, a logistics and ferry company. The project aims to establish a fully automated and connected transport system that enables a seamless flow of goods between the logistics hub and the port, allowing for quick adaptation to demand changes and improving efficiency.

Vera is designed to handle large quantities of goods over short distances with precision. Multiple Vera vehicles will be coordinated via a central control tower, enabling continuous and flexible transport operations. This collaboration is a significant step towards implementing autonomous transport solutions in industrial areas with predefined routes, enhancing sustainability and reducing emissions. The experience gained from this project is expected to contribute to broader applications of autonomous transport in similar environments, potentially supplementing traditional logistics solutions.

Source: https://www.volvotrucks.de/de-de/news/press-releases/2019/jun/Volvo-Trucks-Vera-erster-Einsatz.html

By automating various tasks—ranging from manufacturing processes to logistics and maintenance—**robots** are streamlining operations and reducing human error. This integration of robotics allows organisations to respond swiftly to market demands and optimise resource utilisation, ultimately leading to improved productivity and cost-effectiveness. In addition, the use of robotics and automation can significantly enhance workplace safety by performing hazardous tasks that might pose risks to human workers, such as handling toxic substances or operating in extreme conditions.

Digitalisation and robotics also enable predictive maintenance through the collection and analysis of real-time data from connected sensors and devices. This predictive capability helps reduce downtime, lower maintenance costs, and extend the lifespan of equipment, thereby increasing the operational efficiency of the mobility ecosystem. Moreover, the implementation of automated systems supports just-in-time production models, reducing excess inventory, minimising waste, and fostering more sustainable production cycles.

Box 8: Using robots for rail automation:

The deteriorating condition of global transportation infrastructure has prompted innovative solutions, such as the automated rail maintenance system developed by ROBEL Rail Automation GmbH, in collaboration with FANUC Corp. This system uses advanced industrial robot arms to perform complex rail and track section repairs, addressing the growing labour shortage in the rail industry, especially the lack of skilled workers like welders.

This technology is seen as a solution to the challenges faced by transport networks, particularly in Europe, where the task of inspecting and repairing thousands of miles of rail is becoming increasingly difficult due to labour shortages. ROBEL's system has already been demonstrated at its facility in Freilassing, Germany, and is being tested by European rail networks.

Source: https://www.therobotreport.com/rbr50-company-2024/robel-repairs-railways-using-fanuc-robots/

Other digital technologies, including **augmented and virtual reality (AR/VR), blockchain, and edge computing**, are emerging within the mobility ecosystem but currently show low adoption rates, with only about 5% of companies implementing these solutions in 2024. The implementation of blockchain technology in the mobility sector is multifaceted, offering significant potential for various use cases, from autonomous payment systems to secure data management. One promising area is the development of payment systems for autonomous vehicles, where cars can automatically pay for services like parking or charging without human intervention. Blockchain ensures the security and transparency of these automated financial transactions[164]. However, despite these promising opportunities, many pilot projects have unfortunately failed, eroding the reputation of the technology[165]. Blockchain is most effective in decentralised, thrustless environments where multiple actors share and update a common database but lack mutual trust or a reliable intermediary. It is particularly valuable when an independent platform without central control is needed or when testing and experimentation are desired without the need for optimal problem-solving, making it ideal for innovation in distributed systems.

Box 9: Further applications for blockchain in mobility

Another application is parking management, where companies like trive.me are piloting machine-to-machine payment systems. These systems automatically calculate and pay parking fees, reducing the need for manual processes and enhancing operational efficiency. In the logistics sector, blockchain-based payments can support platooning technology, which enables semi-autonomous trucks to drive in close formation. The trucks in the convoy can automatically compensate the lead vehicle for fuel savings achieved through slipstreaming.

Blockchain also facilitates the creation of platforms that integrate multiple mobility services. ZF Car eWallet GmbH, for example, is developing a transaction network that simplifies payments for services like charging, tolls, and parking, offering a seamless experience for drivers. Beyond payments, blockchain can be used to store and manage digital twins—virtual representations of vehicles—allowing for immutable tracking of ownership, repair history, and mileage, which enhances transparency across the automotive ecosystem.

Source:https://emagazin.bayern-innovativ.de/en/emagazine/detail/en/page/blockchain-for-mobility

[164] https://emagazin.bayern-innovativ.de/en/emagazine/detail/en/page/blockchain-for-mobility
[165] Ibid.

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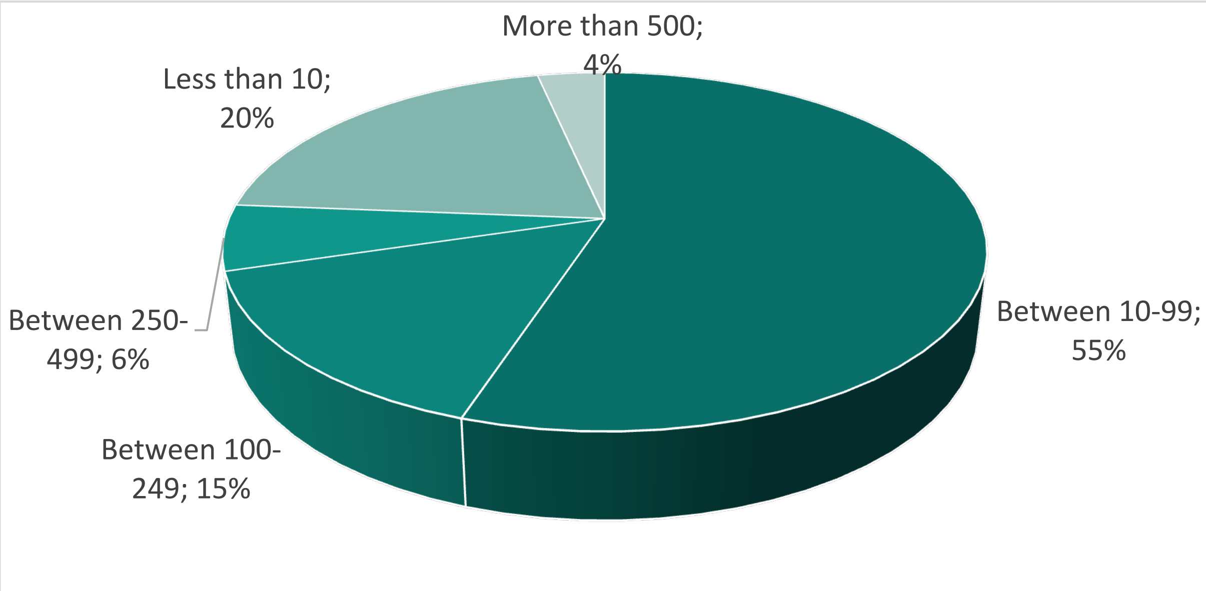
www.crunchbase.com

Appendix B: Methodological notes

EMI Survey 2024 – Sample of mobility companies

The EMI Survey 2024 included a total of 625 companies from the mobility industrial ecosystem, with the following sample distribution according to company size:

Figure 55: Survey sample distribution according to company size – mobility



Source: EMI enterprise survey 2024

Crunchbase and Net Zero Insights

Codes used include: Automotive, Autonomous Vehicles, Car Sharing, Electric Vehicle, Recreational Vehicles, Ride Sharing, Public Transportation, Taxi Service, Transportation, Charging Infrastructure, Water transportation, Marine Transportation, Electric vehicle (EV) Autonomous vehicle, Shared mobility, Mobility, Hyperloop, Micromobility

LinkedIn data analysis

Figure 56: Concordance between NACE and LinkedIn

NACE		**LinkedIn categories used**
C27	Manufacture of electrical equipment	Transportation Equipment Manufacturing Motor Vehicle Manufacturing Truck Transportation
C29	Manufacture of motor vehicles, trailers and semi-trailers	
C30	Manufacture of other transport equipment	
G45	Wholesale and retail trade and repair of motor vehicles and motorcycles	
H49	Land transport and transport via pipelines	
H50	Water transport	
H52	Warehousing and support activities for transportation	

Source: Technopolis Group based on LinkedIn

Green skills – keywords used: Cleantech, Sustainability, Sustainable Development, Sustainable Business, Energy Efficiency, Clean Energy Technologies, Renewable Energy, Wind Energy, Biomass, Biomass Conversion, Solar Energy, Solar Power, Urban Forestry, Forest Ecology, Sustainable Communities, Organic Farming, Organic Gardening, Urban

Agriculture, Organic Food, Waste Management, Waste Reduction, Recycling, Water Treatment, Water Resource Management, Water Purification, Green Marketing, Green Printing, Environmental Biotechnology, Environmental Science, Environmental Engineering, Environmental Management Systems, Environmental Protection, Wastewater Treatment, Ecology, Circular Economy, Zero Waste, Waste to Energy, Plastics Recycling, E-Waste, Carbon Reduction Strategies, Carbon Footprinting, Carbon Neutral, Energy Retrofits, Biodiversity, Biodiversity Conservation, Nature Conservation, Advanced Materials, Nanomaterials, Biomaterials, Reuse, Separation Process, Sorting, Equipment Repair, Natural Resource Management, Sustainability Reporting, Green Development, Sustainable Cities, Energy Conservation, Energy Management, Environmental Awareness, Environmental Impact Assessment, Environmental Compliance, Leadership in Energy and Environmental Design (LEED), Environmental Policy, Green Technology, Sustainable Design, Sustainable Architecture, Environmental Consulting, Maintenance and Repair, Solar PV, Solar Cells, Wind Turbines, Wind Turbine Design, Carbon Capture, Low Carbon Technologies, Low Carbon, Renewable Fuels, Renewable Energy Systems, Renewable Resources, Integrated Water Resources Management, Natural Resources, Biodiesel, Bioplastics, Waste Treatment, Waste Water Treatment Plants, Electric Vehicles, Hybrid Electric Vehicles, Multi-modal Transportation, Energy Efficiency Consulting, Recycled Water, Adaptive Reuse, Ecodesign, Life Cycle Assessment, Energy Optimisation, Alternative Fuels, Green Building, Green Infrastructure, Green Purchasing, Biodegradable Products, ISO 14001, EMAS, Environmental Standards

Digital skills – keywords used: data analytics, online platforms, digital payment, online ticketing, Cybersecurity, Intrusion Detection, Malware Detection, Cloud Security, Cybercrime Investigation, Cyber Threat Intelligence (CTI), Cryptography, DLP, Malware Analysis, IDP; Vulnerability Assessment, Certified Information Security Manager (CISM), Computer Forensics, Cloud Infrastructure, Cloud Services, Google Cloud Platform (GCP), SAP Cloud Platform, SAP HANA, Everything as a Service (XaaS), Software as a Service (SaaS), Platform as a Service (PAAS), Infrastructure as a Service (IaaS), Private Clouds, Hybrid Cloud, Cloud Computing, Edge Computing, High Performance Computing (HPC), Serverless Computing, Robotics, Robot, Robotic Surgery, Human-robot Interaction, Drones, Connected Devices, Internet of Things (IoT), Robotic Process Automation (RPA), Wireless Sensor Networks, Embedded Systems, Cyber-Physical Systems, Smart Cities, Artificial Intelligence (AI), Biometrics, Cognitive Computing, Computer Vision, Deep Learning, Machine Learning, Natural Language Processing (NLP), Natural Language Understanding, Natural Language Generation, Reinforcement Learning, Speech Recognition, Supervised Learning, Unsupervised Learning, Big Data Analytics, Hadoop, Real-time Data, Yarn, Teradata Data Warehouse, Blockchain, Ethereum, Bitcoin, Cryptocurrency, Crypto, Distributed Ledger Technology (DLT), Hyperledger, Augmented Reality (AR), Virtual Reality (VR), Mixed Reality, Computer-Generated Imagery (CGI), Connectivity, M2M, 5G, SD-WAN, Home Automation, Flexible Manufacturing Systems (FMS), Smart Manufacturing, Smart Materials, Quantum Computing, Smart Devices, Intelligent Systems, Big Data, Computer-Aided Design (CAD), Computer Science, MATLAB, C (Programming Language), Python (Programming Language), Digital Strategy, Digital Printing, Digital Marketing, Online Journalism, Revit, Building Information Modeling (BIM), JavaCard, R (Programming Language), Digital Imaging, Digital Media, C++, Collaborative Robotics, Industrial Robotics, Medical Robotics, Mobile Robotics, AutoCAD, Automation, Autodesk 3ds Max, Lumion, Data Analysis, Data Mining, 5G Core, Integrated Security Systems, Cloud Applications, Cloud Computing IaaS, Cryptocurrency Mining, CryptoAPI, Automated Machine Learning (AutoML), Machine Learning Algorithms, Virtual Reality Development, Virtual Data Rooms, Intelligence Systems, Robot Programming, Predictive Analytics, Data Lakes, Blockchain Analysis, Digital Publishing, Enterprise Software, Software Development, SAS (Software), SAP Products, SAP ERP, Online Payment, Online Payment Solutions; Online Travel, Online Marketing, Online Business Management, Online Advertising, Online Gaming, Web Services, Mobile Applications, Mobile Marketing, Java Database Connectivity (JDBC), Data Warehousing, Statistical Data Analysis, Data Modeling, Databases; Electronic Data Capture (EDC), Data Centres, Oracle Database, SAP Solution Architecture Data Entry, Data Management, Data Mapping, Web Applications, GIS

Applications, Oracle Applications, Visual Basic for Applications (VBA), Computer Hardware, Computer Maintenance, Computer Network Operations, Computer Networking, Computer Graphics, Online Communications, Social Media Marketing, Digital Direct Marketing, Digital Illustration, Digital Video, Digital Photography, Xero, GPS Applications, GPS Devices, GPS Tracking, GPS Navigation, Microsoft Power Apps, Social Networking Apps, Google Apps Script, Social Media, E-Commerce, Data Intelligence, Online Platforms, Mobile Payments

To perform a representativeness analysis of LinkedIn, the available industry-specific dataset has been compared to Eurostat figures regarding the active population. Nevertheless, there are several limitations in conducting a robust representativeness analysis since the two datasets have different origins, classification systems and hence there are mismatches in the definition of some categories[166]. There are 149 industries available on the LinkedIn platform and categories are allocated according to the individual choice of the user or the affiliation to a company registered on LinkedIn as a company profile.

Regarding the country profiles, there is an important heterogeneity in the national use of LinkedIn among EU Member States. The largest users are Netherlands, Denmark, and Ireland where LinkedIn is the most popular, with more than 75% of the active population registered. In other EU countries, the number of LinkedIn users is marginal such as in Hungary, Slovakia, Bulgaria, and Poland that display the lowest use of LinkedIn, with less than 20% of the population registered on the platform.

Keeping the above in mind, overall, it can be estimated that approximately 38% of mobility, transport and automotive industry professionals have a profile on LinkedIn.

Environmental certificates

ISO annual surveys report the number of companies/organisations with environmental certificates. Environmental certificates were the ISO 14000, which was updated requiring more stringent standards and practices in the year 2015. The new standard was then named ISO 14000/2015. Holders of the ISO 14000, starting from the year 2015, had to be re-certified to gain the new ISO14000/2015 certificate. New sustainability and environmental practices had to be put in place; with organisational change and financial requirements implied. Accreditation bodies had also to adopt new verification procedures, with their corresponding time lag. This may explain the drop in number of certified companies/organisations from 2015 to 2017.

Exiobase

Exiobase is a time series of environmentally extended multi-regional input-output (EE MRIO) tables. Its coverage is by country and industry from 1995 to 2021 and has EU and extra rest of the world coverage. Source: Stadler, Konstantin, Wood, Richard, Bulavskaya, Tatyana, Södersten, Carl-Johan, Simas, Moana, Schmidt, Sarah, Usubiaga, Arkaitz, Acosta-Fernández, José, Kuenen, Jeroen, Bruckner, Martin, Giljum, Stefan, Lutter, Stephan, Merciai, Stefano, Schmidt, Jannick H, Theurl, Michaela C, Plutzar, Christoph, Kastner, Thomas, Eisenmenger, Nina, Erb, Karl-Heinz, … Tukker, Arnold. (2021). EXIOBASE 3 (3.8.2) [Data set]. Zenodo. https://doi.org/10.5281/zenodo.5589597

[166] See more in detail ATI Methodological report: https://ati.ec.europa.eu/reports/eu-reports/advanced-technologies-industry-methodological-report

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