TransportNet INSIGHTS on
'**Green transition, reactions from European transport scientists**'

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Academia involved in TransportNET, a network of seven leading university groups involved in transport research and high-level education, from several European countries, supports the European Commission's 'Fit for 55' package of proposals to reduce greenhouse gas emissions by 55% by 2030. Since the launch of the Fit for 55 package, the European Union has further strengthened its policy framework with dedicated Port and Maritime Industrial Strategies, recognising that climate ambition must be matched with industrial resilience, technological sovereignty and global competitiveness.

While the academic insight fully supports the ambition and spirit of the *Fit for 55* package and beyond, it also points out the gaps and challenges in various transport subsectors, such as air, maritime, inland navigation, road and urban transport. As transport scientists, they respond to the latest European Commission publications in the context of the package of proposals under the title 'Fit for 55' released on EU climate, energy, land use, transport and tax policies. Eleven legislative initiatives impact directly/indirectly the transport sector, while four are transport specific. With these very ambitious initiatives, the European Commission (EC) aims at reducing net greenhouse gas emissions by at least 55% by 2030 compared to 2019. The academics focus in this contribution on what is missing in the policy documents per sub-domain of transport and went a step further by indicating which further research is needed.

The overall aim of this document is not limited to emissions reduction. It also seeks to preserve industrial competitiveness, strengthen supply chain resilience, and improve the quality of decision-making, which remains a major challenge in Europe. Moreover, stakeholders face significant market uncertainty, so policy needs to reduce this uncertainty for both passengers and freight transport. Achieving EU emission targets requires not only the deployment of new technologies and alternative fuels, but also the re-engineering of transport networks and nodes, the more effective use of existing infrastructure, and a long-term perspective that addresses land-use and (re)location implications.

According to their expertise, the TransportNET academics formulated their opinion below starting, covering both freight and passenger transport, from air and maritime transport to last-mile distribution.



Air transport and airports

Sharing a common global vision for the improvement of the world, accompanied by a framework that operationalizes this vision, is a crucial step for the long-term sustainability of the planet and its people. Movements of freight and people directly result from how societies operate. Fuelled by several megatrends, such as information connectivity, global markets, and new manufacturing processes, passenger and freight transport demand has risen over the last decades. The current global turmoil caused by the COVID-19 pandemic and its variants is just another strong evidence on the resilience of air transport. Indeed, most forecasts have envisaged a recovery period from 4 to 5 years, meaning a slow uptake of demand for air transport. It can be said that a global growth trend for air transport was interrupted by COVID but rather quickly recovered. Different market segments may have other behaviours, such as central Europe will be subject to railways focus policy that will tend to contract air transport in favour of railways, but long-distance travel, as well as peripheral regions, will remain captive of air transport. The same for business travel as opposed to tourism travel.
Unsurprisingly, transport is responsible for a large share of the world's greenhouse gas emissions and is a major contributor to climate change, within which air transport has major impacts. In recent years, emissions from transport have risen, in contrast to most other economic sectors, such as power production and industry. By way of example, transport emissions now account for more than one-quarter of the EU's total greenhouse gas emissions. A major challenge is that the bulk of the energy still comes from oil, which makes any reversal of this trend difficult to achieve. As a result, most greenhouse gas emissions come from cars, vans, trucks and buses; the remainder comes mainly from shipping and aviation. A main challenge is to decarbonize air transport, meaning strictly all players that contribute directly or indirectly to the air transport chain of production.
Biofuels, hydrogen are at the top priority, electrification is also a top priority for land vehicles within the airports. Waste and residue-based biofuels will do a large part of the decarbonization, but several other alternatives are at stake. Ground handling is of particular importance and easier to start with decarbonization, as technological solutions are already available in the market. However, a play of incentives and penalties is required to accelerate the process since airport managers lack effective authority to enforce other agents with relevant roles within the airport areas. Early 2023, the European Commission financed three main projects, each of 25 million EUR, for a duration of 3 years, with more than 30 demonstrations, dedicated to test solutions for the decarbonization of air transport. Airports are an important node in the network, and a significant part of emissions comes from this infrastructure, but it should also be noted that these nodes are also part of a mobility chain, that must be accessible, smooth, interoperable. The fact that each mode is reporting to different authorities is often hindering the results of some actions due to lack of articulation in the definition and implementation of measures

Legislation supporting Fit for 55 is expected to be fully in place by 2024. However, businesses (airlines, airports, ground handlers, freight forwarders, air navigation providers, etc.) must start to reform their processes even before the legislation comes into force.

One key question remains unsolved – will airport capacity increase in the coming years? If so, will we continue to prefer mega airports or will the trend twist to intensify regional airports? The stakeholders interests are colliding here. For airlines investing in hub operation the mega airport is a clear

advantage, but for low cost operation it is the opposite. There is no solution fitting all interests, so it is indispensable that each country reflects upon its air transport policy and defines a strategy.

It is hardly believable that Europe will develop more greenfield airports, Poland and Portugal are the only cases, the coming years will observe a serious pressure to move people from air travel to train travel, for reasons of sustainability. However, overseas travel and intercontinental will remain and demand will continue to grow, so air transport will have to solve their infrastructure capacity with brownfield solutions, maybe leading to the management of airport systems well connected with land infrastructures. This will maybe contain the environmental criticism against air transport. Technology will help, the future will bring electricity and hydrogen to the scene, both for airplane and airports. One evidence is uncontestable: people still want to fly!



Maritime freight transport and ports

With about 71% of all European overseas trade handled by deep-sea ships, and 19% of intra-European trade (2020) via shortsea shipping, it becomes apparent that maritime transport and seaports have an important economic role to society. (Eurostat, 2024) At the same time, that waterborne transport accounts for almost 4% of the EU's GHG emissions, including not only CO_2, but also NO_x and SO_2. Transport in general is also the economic sector having made least advances in emission reduction over the past decades. The need for immediate action towards industry-wide adoption of zero-emission technologies is emphasized by the tremendous increase in emissions from maritime operations, since the 1990s. The European Green Deal's objective of attaining zero-emission mobility is an uphill task for the maritime transport sector primarily due to the lack of fully market-ready zero-emission technology, the longer than average development and deployment lifecycles for vessels and the very high degree of international competition. While EU policy instruments can most directly affect intra-EU waterborne transport, which operates under different regulatory and market conditions, their influence on deep-sea shipping remains largely indirect. Nevertheless, it is clear that the European Commission has the ambition to make the European waterborne transport (deep-sea shipping, shortsea shipping and inland navigation) and port sector more sustainable. The focus is on the extension of the European emission trading system (EU ETS) to shipping and the deployment of a standard for more climate-friendly marine fuels, combined with more sustainable ship recycling practices. Policy impacts differ across transport modes and market segments, highlighting the importance of horizontal accompanying measures to avoid disproportionate effects.

Ports are increasingly expected to act as industrial coordinators between shipping, energy systems, hinterland logistics, and land use, while lacking matching governance competences or revenue tools. This structural imbalance between rising policy expectations and limited formal powers sits at the core of the emerging EU Port Industrial Policy debate and raises fundamental questions about the alignment between regulatory ambition, implementation capacity, and economic responsibility.
As for the **EU ETS**, the European Commission's plan has extended the system to include shipping as of 2023. The focus will primarily be on large ships (those over 5,000 gross tonnage), which account for 90% of shipping's CO_2 emissions. Starting in 2024, for the first time, ships entering Europe will be required to pay for their emissions through the EU ETS. Under this scheme, all intra-EU traffic and 50%

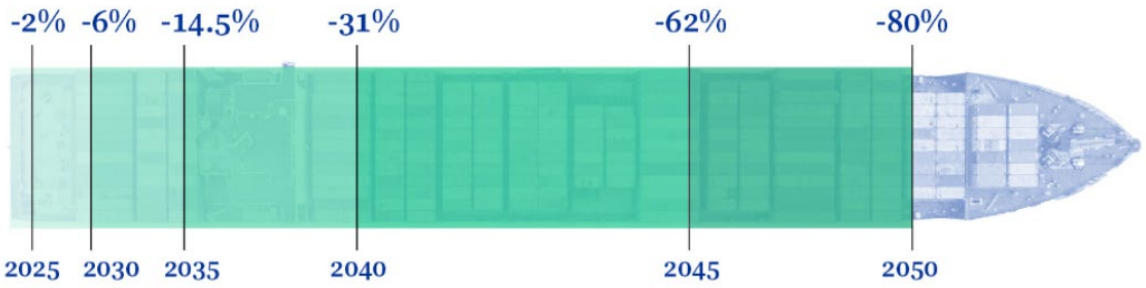
of extra-EU voyages will fall within its scope.[1] From 2026 onwards, methane (CH_4) and nitrous oxide (N_2O) will also be included. Shipping companies are required to report 40% of their emissions in 2025, 70% in 2026, and fully (100%) comply with the ETS obligation from 2027 onwards Climate Action.

However, there are two notable concerns with this ETS implementation. First, shortsea shipping, already at a disadvantage compared to road transport due to export-like procedures, faces further distortion if exposed to diverging or regional ETS regimes. Given the inherently international nature of maritime transport, fragmented regional regulation is particularly problematic and therefore strongly discouraged, as it may undermine competitiveness and modal balance without delivering proportionate climate benefits. Second, the application of the 5,000-gross-ton threshold appears largely arbitrary, capturing part of the shortsea fleet while excluding other comparable vessels, thereby creating unequal treatment within the sector. These issues underline the need for a more cautious and coordinated approach to market-based measures for shipping, ensuring consistency with International Maritime Organization (IMO) frameworks and avoiding unilateral regional solutions that cannot be effectively applied to global maritime activities.

Additionally, regarding ETS charges, they will be levied at the source (bunkering). To prevent tax evasion and the complete shift of bunkering activities outside Europe (to regions like the southern Mediterranean, Turkey, or even the UK), careful consideration is necessary. Such a shift not only reduces bunkering revenues for Europe but may also lead to vessel calls favoring neighboring regions, as vessels rarely bunker without loading or unloading cargo

With respect to stimulating the use of **alternative fuels**, the FuelEU initiative is relevant and entered in force as of January 2025. Its scope mirrors that of the EU Emissions Trading System (ETS). FuelEU introduces a fuel standard that limits the greenhouse gas intensity of energy used onboard ships, starting with a modest reduction of 2% in 2025 and gradually increasing to up to 80% by 2050, according to the proposed trajectory (Figure 1). However, the availability and large-scale deployment of alternative fuels (such as advanced biofuels, methanol, ammonia, synthetic fuels, and options involving carbon capture) are closely intertwined with the development of supply infrastructure, global energy markets, and geopolitical conditions. Given the inherently intercontinental nature of shipping services and the strong interdependencies within global fuel and commodity markets, fuel choices are ultimately shaped not only by regulation but also by market dynamics, supply security, and price volatility. An issue here is that the European shipping sector is already rather advanced in comparison with the rest of the world in terms of readiness to emission reductions, and therefore pleads for a more speedy reduction, so as to avoid the competitive distortion with ships from outside Europe, as is the case today.

Figure 1: Expected evolution of emission reduction



[1] Https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets_en

Source: Council of the European Union, 2023

Furthermore, FuelEU obliges to connect to onshore power supply for electrical power needs while moored at the quayside or use zero-emission technologies at berth. FuelEU pretends being technology-neutral, but its tying to the Alternative Fuels Infrastructure Regulation makes it impose cold ironing (OPS) to container and passenger ships. This forces ships into a technology lock-in with imposed electricity-compatible propulsion, whereas for many applications and trades, electricity may not be the best solution. This illustrates a broader challenge frequently observed in international and regional regulatory frameworks, including EU policy-making, where ambitious objectives and fixed thresholds are sometimes defined on the basis of optimistic assumptions about technological readiness, infrastructure rollout, and system adaptability. While setting ambitious targets can provide valuable impetus for change, the complexity of socio-technical systems such as maritime transport is often underestimated, leading to the need for reconsideration or adjustment at later stages of implementation. Forcing seaports to provide such infrastructure will also lead to making the impose its mandatory use, again creating an uneven playing field with other, maybe more suitable technologies and energy types. Moreover, under the current national taxation regimes, electricity is often taxed higher than other fuel types, which would then steer ships into the direction of using a far more expensive energy type.

On a global level, the following regulations apply:

- **GHG Fuel Intensity (GFI)**
  At MEPC 83 (7–11 April 2025), the IMO approved the draft Net-Zero Framework, which includes the GFI regulation. GFI is the IMO metric for measuring the greenhouse gas intensity of fuels used on board ships, expressed in grams of CO_2-equivalent per megajoule (gCO_2eq/MJ). It follows a well-to-wake approach, covering CO_2 and other GHGs and accounting for the full fuel lifecycle as defined in IMO guidance. GFI forms the basis of the IMO Net-Zero compliance framework, which sets phased targets and two compliance levels (Base and Direct). Adoption is scheduled for October 2025, with entry into force in 2027 (IMO, 2025a; IMO, 2025b)..
- **EEDI / EEXI (design vs. existing ship efficiency)**
  Since 1 January 2023, ships must calculate their attained EEXI and begin CII reporting. The Energy Efficiency Design Index (EEDI) applies to new-build ships as a design-phase metric introduced earlier by IMO. For existing ships, the Energy Efficiency Existing Ship Index (EEXI) serves as a technical compliance check, limiting installed propulsion power and baseline CO_2 intensity. In short: EEDI → new ships (design standard); EEXI → existing ships (retrospective compliance) (MEPC, 2021; IMO, 2025c)
- **CII (Carbon Intensity Indicator)**
  Adopted in 2021 and effective since 2023, the CII measures a ship's actual annual carbon intensity (gCO_2 per transport work) and assigns an A–E rating (A = best; E = worst). The first ratings, based on 2023 data, were issued in 2024. Ships must calculate, document, and verify their annual CII against a reference line and improvement trajectory. Ratings are recorded and linked to operational measures and SEEMP. Unlike EEDI/EEXI, CII focuses on operational performance rather than design alone (IMO, 2025d; IMO, 2025e).
- **SEEMP (Ship Energy Efficiency Management Plan)**
  SEEMP is the mandatory management framework under MARPOL Annex VI for planning, monitoring, and improving ship energy efficiency and carbon intensity. SEEMP now consists of multiple parts:
  - Part I: Ship energy-efficiency plan and measures
  - Part II: Data collection plan / DCS
  - Part III: Technical and operational elements for meeting short-term carbon targets

The SEEMP serves as the place to document actions to improve CII, comply with EEXI/EEDI requirements, and demonstrate how fuel choices and operational changes will meet GFI / Net-Zero obligations (MEPC, 2022; IMO, 2025f).

From the above, it is clear that regulatory frameworks (EU and IMO) are proliferating rapidly. Regulatory overlap, effectiveness, (potential impact on) economic competitiveness and administrative burden could be of concern, especially for small/medium-sized companies. A point of attention could be on impact assessment (data, transparency,…) rather than on more regulation; hence a shift to evaluating and optimizing existing regulation.

REGULATION	CRITICAL POINT
GHG Fuel intensity	The regulation assumes uniform global enforcement capacity and fuel availability, but data on real-world compliance costs and regional disparities (e.g. impact on Mediterranean, Baltic,…) remain limited. Costs impacts remain poorly understood
EEDI/EEXI	Little empirical evidence yet on whether technical standards alone deliver the intended CO_2 reductions, or whether they lead to unintended cost or fleet renewal effects
CII	IMO will re-assess. Next to this, it is advisable that it is examined whether the rating system incentivizes meaningful emissions reductions or only compliance behavior.
SEEMP	This regulation creates significant documentation requirements, but little research has quantified administrative costs or assessed whether reporting leads to real operational improvements.

One thing must be retained, sustainable maritime transport must be integrated in supply chains, otherwise any investment will be minimised in its results and impacts. This integration challenge is particularly evident in the case of ferry services, which function not only a commercial transport activity but also as public transport services that connectivity, regular frequencies, and territorial continuity. Ferry operations are often subject to strong seasonality and viability constraints, especially in off-peak periods, which are commonly addressed through public service obligation (PSO) contracts.

In this context, investments in new vessels and the alignment with sustainability objectives are frequently determined by the terms and duration of public service contracts. As ferry services, particularly those connecting islands and peripheral regions, constitute a social good and a prerequisite for social cohesion, economic activity, and inhabitants' welfare, public authorities have a critical role to play in supporting the associated investment needs. Public co-investment and risk-sharing mechanisms can therefore be essential to enable fleet renewal and the uptake of cleaner technologies, ensuring that decarbonisation objectives do not undermine service continuity, affordability, or regional accessibility.



Maritime passenger transport

In accordance with the Cruise Market Watch 2021, the **cruise industry** has registered an increase from 2020 statistics. However, it is still struggling to recover from the Covid-19 market crash (-53% of revenues in respect to 2019) with capacity constraints still applied in many markets (and ranging from 50% to 90% depending on different regional rules) and impacting company's strategies for the near future. Despite this, many cruise companies have used the market crash to reorganize themselves, selling old vessels and investing in more energy-efficient ships, often adapted to promote the use of new energy solutions (e.g. LNG, onshore power supply) to reduce their environmental impact. The possibility of leveraging new green investments as part of their marketing strategies and community engagement firmly pushed companies to assess alternative bunkering options with LNG solutions considered the most reliable one in respect to other alternative energy solutions. Because of this, starting from 2015, many companies have invested in such technology (with Carnival Cruise being the front-runner in such environmental mitigation strategy, followed by all the relevant competitors). Despite the investments and the advancements in ship technology, it is worth mentioning that some key issues in aligning the cruise industry to the Green Deal and UNSDG targets are still under scrutiny, such as the impact of passenger flows on local environment (e.g. small islands), heritage sites, and the external costs caused to access port facilities.
While the cruise industry can use the new investments needed to align ship emissions with long-term targets, the **ferry market** is currently behind due to a different business model. First attempts to test hydrogen, fuel cells, and full electric ships have seen ferries as ideal testbeds (e.g. Norway Ro-Ro / Ro-Pax ferries) thanks to the ship size and close loops of many services that simplify the testing of alternative technologies. Despite this, the ferry market is characterized by an over-proportional emission level regarding the number of ships deployed (with nearly half of the European ferry emissions stemming from the Mediterranean). Many sources (e.g. CMCC foundation, 2020) highlight how ferries represent just 3% of all vessels but accounted for 10% of CO_2 emissions from all ships in 2018 (e.g. EU-MRV, 2019). This ongoing performance is mainly connected to the fact that many ferry companies leverage on a reduced fleet renewal rate to maximize their rate of return, with ships that often exceed 25 years old and with a need to be able to easily sell ships in secondary markets when market conditions allow for it. While some companies represent best practices in investing in alternative fuels, most of the fleet is represented by old "standardized" ships with companies that have a reduced propensity in investing in novel technology due to both cost and rigidity issues.

Although the European Commission has set a clear pathway to achieve a 55% emission reduction by 2030 through Fit for 55, the international approach is progressing more slowly. The IMO's Marine Environment Protection Committee (MEPC/ES.2) recently decided to postpone the adoption of new requirements on greenhouse gas (GHG) fuel intensity and the associated pricing and reward mechanism, with discussions continuing into October 2026. This delay affects the implementation of the IMO Net-Zero Framework, which was approved at MEPC 83 in April 2025 as a new Chapter 5 of MARPOL Annex VI. The framework introduces two key elements: a global fuel standard and a global GHG emissions pricing mechanism. This creates tension: European shipping companies must invest quickly to comply with EU regulations (ETS, FuelEU), while global competitors gain more time. The risk? Competitive distortions and carbon leakage. Policymakers must anticipate this asymmetry through international diplomacy or compensatory measures. For cargo shipping, the main hurdles include high retrofitting costs, infrastructure lock-in, and risk of carbon leakage due to uneven carbon

pricing. Passenger segments, such as cruise and ferry, struggle with ageing fleets and limited alternative fuel infrastructure. Coordinated policy, accelerated R&D, and harmonized international standards are essential to prevent competitive distortions and ensure a level playing field.



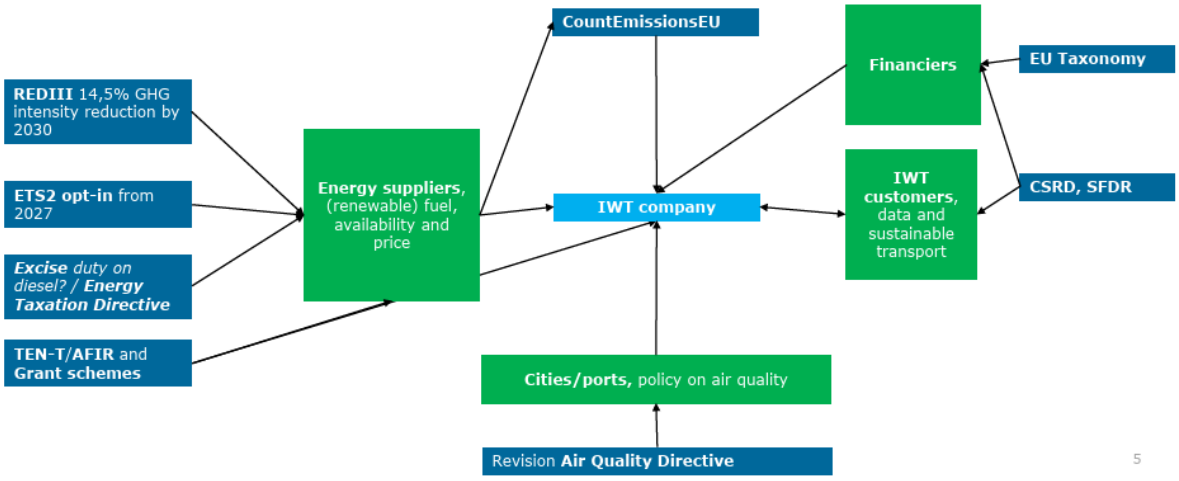
Inland navigation/shortsea shipping

The inland shipping sector faces a transition challenge that is comparable to, but distinct from, that of deep-sea shipping.. Vessels are generally used for a long time, 30 years or more is not uncommon, and a part of the fleet is even over 100 years old. From a sustainability perspective, this is a blessing when considering the impact of delving for new materials and aligns with the wish of the EU to move to a more circular economy, where assets are reused rather than replaced. However, it is also an issue when the world is changing fast, and innovations are required, as new systems are not easily integrated within the old ships and switching to new sources of energy to achieve near net-zero emissions is difficult.

Furthermore, the average shipowner owns between 1-2 ships (CCNR Report, 2022); the majority of companies consist of one ship. For such companies, it is difficult to innovate, as the owner performs all roles within the company, including that of the innovation department. With no direct economic benefits, the innovation part tends to be neglected. As a result, owners struggle to keep up with the new legislation.

Finally, there is a specific difference between inland and deep-sea shipping direct competition with other modalities. This competition is also present in shortsea shipping, though, from a certain weight and range, shipping demonstrates clear benefits. The extra transshipments required to reach the final destination already put pressure on the system for inland shipping. An ETS system, or any other impact on fuel prices that is not reflected on the trucking and train side, will result in a reverse model shift. Cargo will move from inland ships to trucks, increasing congestion and emissions, as this is a less fuel-efficient mode of transport.

To counter this, inland shipping requires support to reach the fit for 55 goals, as outlined in NAIADES III, and especially clear action perspectives already for the ship owners today. What can be done to reduce impact, starting with operational measures and later on also clear perspectives for energy solutions suited for all or at least a wide range of ships. The fact that all aspects of the energy transition are interwoven creates an issue too complex to leave to single ship owners. Coordinated policy, guidance, and a stable long-term vision are essential, taking into account practical limitations, such as the constraints of the current electricity network. Without this structured support, both compliance and competitiveness risks may increase, particularly for smaller operators in the inland shipping sector.



Source: Ministry of Infrastructure and Water Management, 2024

Inland waterway transport also competes directly with road and rail for freight flows, particularly in the hinterland and short-distance segments. Additional transshipment steps already place cost pressure on the system, and any policy measure—such as carbon pricing—that increases fuel costs for inland shipping but is not equivalently reflected in competing modes risks inducing a reverse modal shift. Such a development would lead to higher overall emissions and greater road congestion, given the higher energy efficiency of inland navigation relative to trucking.

The evolving EU regulatory framework introduces both opportunities and risks. While the expansion of the EU ETS to road fuels (ETS2) may improve inland navigation's cost competitiveness relative to trucking, future inclusion of inland shipping fuels in carbon pricing schemes without harmonized compensatory mechanisms could undermine this advantage. . Moreover, the absence of a broadly harmonized policy approach across Member States creates additional uncertainty and may emerge cost differential between national jurisdictions. Parallel obligations under the Renewable Energy Directive (RED III), including greenhouse gas intensity reduction targets and requirements for advanced biofuels and renewable fuels of non-biological origin, will further increase adaptation pressures. For small operators, the higher cost and limited availability of certified fuels and bunkering infrastructure may pose significant barriers.

To ensure that inland waterway transport contributes effectively to decarbonization while maintaining competitiveness, a co-ordinated and long-term policy approach is required. Initiatives such as NAIADES III provide a foundation, but targeted financial support, technical guidance, and clear transition pathways for different vessel categories are essential. This includes both short-term operational efficiency measures and medium- to long-term strategies for fleet renewal and alternative fuel deployment. Given the interdependence of vessel design, energy supply infrastructure, and regulatory developments, the transition cannot be left to individual shipowners; it necessitates integrated planning, policy harmonization, and investment frameworks that reflect the practical constraints of the sector.



Rail and intermodality

Rail transport is regarded as one of the solutions to meet the objectives of the European Green Deal by making Europe's transport system cleaner and greener, particularly by facilitating modal shifts from road and air to rail. This implies the need to make rail transport more attractive, among others by significant transport infrastructure enhancements. The proposed revised TEN-T regulation published by the European Commission in December 2021[2] stipulates the core TEN-T network to be completed by 2030, in compliance with existing TEN-T standards, such as electrification of the rail network and the possibility to run trains of 740 meters length. By 2040, the extended core network has to be completed in compliance with the new standards such as the 160 km/h minimum design speed for passenger rail, and the deployment of ERTMS on the entire TEN-T network. By 2050, the entire TEN-T network is expected to be completed according to TEN-T standards, including the sections of the comprehensive network. In order to facilitate among others seamless inter-city door-to-door transport chains, 424 major cities along the TEN-T are required to develop Sustainable Urban Mobility Plans (SUMPs). Furthermore, the revised TEN-T regulation stipulates to enhance handling capacity at freight terminals, to increase the number of transhipment points, and to reduce train waiting times at borders.
The proposal for a revised TEN-T regulation, which has been adopted by the European Parliament in April 2024, is accompanied by an Action Plan on long-distance and cross-border rail transport to support the EU's target of doubling high-speed rail transport by 2030 and of tripling it by 2050. Among others, the Action Plan aims to[3]: support user-friendly multimodal ticketing systems; facilitate quicker and more frequent cross-border rail services; and to achieve track access pricing that will ease rail operators' access to infrastructure, thus increasing competition among operators and allowing for more competitive rail ticket prices for passengers.

In January 2023, the European Commission published the financial support of ten cross-border rail services for passengers, helping "railway operators and authorities to break down remaining barriers in practice"[4].

In addition to conventional rail freight, rail–road combined transport (R-R) plays an important role in advancing modal shift objectives, particularly for long-distance freight where flexibility at origin and destination remains essential. Recent EU initiatives, including the evolving framework for combined transport and the work of representative bodies such as the UIRR, recognise the need to strengthen this market segment. However, one persistent disadvantage of R-R combined transport lies in its limited accessibility, both in physical and commercial terms. From a physical perspective, insufficient terminal density and a lack of well-connected interface hubs continue to constrain uptake, underlining the importance of multiplying intermodal terminals and integrating them more effectively into the

[2] European Commission (2021): Proposal for a regulation on Union guidelines for the development of the trans-European transport network, amending Regulation (EU) 2021/1153 and Regulation (EU) No 913/2010 and repealing Regulation (EU) 1315/2013, COM(2021) 812

[3] European Commission (2021), New transport proposals target greater efficiency and more sustainable travel, https://transport.ec.europa.eu/news/efficient-and-green-mobility-2021-12-14_en

[4] European Commission (2023), Connecting Europe by train: 10 EU pilot services to boost cross-border rail, https://transport.ec.europa.eu/news/connecting-europe-train-10-eu-pilot-services-boost-cross-border-rail-2023-01-31_en

TEN-T network. From a commercial perspective, combined transport often faces structural barriers to market entry and expansion, particularly in comparison with road-only solutions. Creating favourable conditions for the development and extension of this market segment requires targeted policy support, building on lessons learned from earlier initiatives such as the Marco Polo programme, while avoiding market fragmentation. Such measures can help de-risk new services, stimulate innovation, and improve the competitiveness and accessibility of combined transport solutions.

While large-scale investments in rail infrastructure are needed to achieve a higher competitiveness of rail transport in Europe, it is likewise important that negative climate and environmental effects of construction works have to be minimized, e.g. by avoiding the destruction of important greenhouse gas sinks such as moors and forests, and by using as far as possible climate and environment-friendly construction materials. Finally, the environmental footprint of rail transport operations is critically dependent on the environmental footprint of energy production.

Parallel to waterborne transport and ports, also here decarbonization speed is constrained not only by regulation but by industrial roll-out capacity.



Passenger road transport, incl. urban mobility

Transport produces around a quarter of Europe's greenhouse gas emissions (GHG), with road transport having a share of over 70% (Xu et al., 2020). In the EU-28, the passenger car accounted for 83,3 % of inland passenger transport in 2013 (Eurostat, 2015, Statistical books, Energy, transport and environment indicators, p.109). The majority of this road traffic is done by fossil energy which is responsible for a substantial part of the CO_2 or other pollutant emissions. Moreover, urban travel is responsible for 40% of all greenhouse gas emissions from passenger transport (ITF, Transport Outlook, 2021).
European countries have already done some effort to reduce emissions coming from road passenger travel, particularly in establishing stronger restrictive EURO norms for car vehicle emission and helping develop a modal alternative to cars. However, "over the five years from 2015 to 2019, there was strong growth in the number of registered passenger cars in the several Member States" (Eurostat, Passenger cars number, 2021). Then, road traffic emission reduction is facing car demand increase.
By 2030, the EC would get at least: "30 million zero-emissions cars and 80 000 zero-emission lorries in operation" and "90% reduction gas emissions in transport by 2050" (EC, Sustainable and smart mobility strategy, 9 Dec 2020). Last, "the EU transport system and infrastructure will be made fit to support new sustainable mobility services that can reduce congestion and pollution, especially in urban areas".
This effort can be reached in reducing Europe's dependence on fossil fuels with a standard transport policy mix based on pricing (through the deployment of sustainable alternative transport fuels and in continuing the internalization of external costs of transport) and quantitative instruments (car emission norms and car traffic constraints in urban areas).
As this standard economic approach has demonstrated efficiency, now the idea is to point out two uncertainties linked to this policy. The first uncertainty should concern the sustainable alternative

transport fuels production and pricing. Each innovative production process is risky-dependent which creates uncertainty and, beyond the current international energy price fluctuation, it is also quite complex to estimate when the price of these alternative transport fuels will converge to the equilibrium price. The second uncertainty should concern the behaviour of car users. As for public transport suppliers who need to invest and finance new public transport with alternative fuels, car users' behavioural change takes time and money. In 2019, the highest share of alternative fuels in new registrations was only around 14% (Eurostat, New passenger cars with alternative fuel engine, 2017-2019). Hence, car users' behaviour change is dependent on speeding change.

Urban areas are forced to a change process, and that is driven by the change of behaviour of citizens who have the last word in the decision of how they move, given the conditions facing them. Most policies are focused on markets, technology, environment, etc. However, the main driver of change is the citizen, and not much is being invested to change behaviour and to provide more deep awareness on the need to change. This is a clear gap in EU and national policies.



Hinterland logistics, urban warehousing and last-mile delivery

The theoretical concept – the process of Logistics

The term “Logistics” refers to a continuous process of optimization of the coordination of flows of goods (raw materials, semi-finished and finished products), information and capital with objectives a) minimizing the total cost of production and distribution of products on a company and business network scale b) maximizing the quality of the service offered to the end consumer and, increasingly nowadays, c) minimizing the "external" (social) costs of transportation and related activities. This process also includes the activities of returning physical flows of means, loading units and materials (reverse logistics).

Logistics activities are composed of the sequence and alternation of two main categories of physical functions:

a) the “physical” transport of goods and

b) the functions related to the treatment of goods at warehouses, terminals or similar facilities during the intermediate stages (consolidation of cargo, sorting, packaging, loading/unloading, organization of shipments, etc.).

Over the years, the scope of these activities has expanded significantly. Initially considered as a set of “physical” activities at the scale of a warehouse, complementary to physical transportation (until the 1970s), it gradually incorporated a set of "intangible" functions. It evolved into a "tool" for organizing, managing and coordinating flows, seeking the optimal form of spatial and temporal operation of transportation networks. Logistics is now a tool for adapting production sequences to the pace of demand and, therefore, a key tool for managing the entire production process through the flows’ management at the scale of industrial networks.

Logistics in the EU policy

The European Commission states that the fast growth of freight transport – driven to a large extent by economic decisions – contributes to growth and employment but also causes congestion, accidents, noise, pollution, increased reliance on imported fossil fuels, and energy loss. Infrastructure resources are limited and any disruption in the supply chain (i.e. energy) has necessarily a negative impact on the EU economy. Without adequate measures, the situation will continue worsening and increasingly undermine Europe's competitiveness and the environment that we all live in. To overcome such problems, Europe's transport system needs to be optimised by means of advanced logistics solutions (COM[2006]) 336 final, "Freight Transport Logistics in Europe – the key to sustainable mobility").

Transport is an integral element of the logistics supply chain. The Commission's approach focuses on logistics in freight transport and covers all modes of transport. The approach contains a vast variety of areas, such as pure modal logistics and multimodal logistics, and emphasises the need for optimum complementarity of modes in an efficient and seamless European transport system that can provide the best possible services to transport users.

Developing freight transport logistics is primarily a business-related activity and a task for industry. Nevertheless, the authorities have a clear role to play in creating the appropriate framework conditions and keeping logistics on the political agenda. This framework approach concentrates on improving the preconditions that Europe can offer for logistics innovation and leaves the internal running of company logistics to the companies themselves.

Therefore, Logistics is a tool for greening transport activities by "re-engineering" goods' flow patterns and the shape of distribution networks. Next to modal optimizations, such as appropriate consolidation of goods and increase of vehicles' occupancy rates, the promotion of Intermodal transport might perfectly result from logistics optimization solutions.

Further work on freight transport logistics should lead to the introduction of a logistics perspective into transport policy. Logistics considerations should be an underlying factor in decision-making.

An important aspect of logistics in Europe relates to the lack of Statistical data. There is a need to develop a reliable picture of the situation and its evolution over time, based on suitable methodologies and indicators.

Possible areas of action also include:

- Identification of bottlenecks and their solutions
- Logistics training
- Service performance, setting measurement systems for recognition of quality such as Benchmarking and Labelling excellence
- Promotion and simplification of multimodal chains and Loading standards

Spatial organization of Logistics

With the exception of key intermodal infrastructures (terminal facilities at ports, railway stations and airports), the vast majority of cargo management storage facilities are private in nature. These are dispersed in space, often in an anarchic manner, causing negative impacts on the immediate and wider environment.

The alternative spatial form of location of Logistics activities is the development of Freight Villages. The concept of Freight Village (FV) is related to the spatial concentration of transport/logistics companies and the supply of "common" services. Expected benefits for users mainly relate to the reduction of transport cost due to economies of scale and economies coming from sharing of heavy investments in infrastructure and "common" equipment, as well as from the synergies developed within a FV. Similarly, expected benefits for Public Authorities relate to rationalized land use planning, effects on physical circulation and traffic fluidity, as well as effects on the regional economy and reduction of transport externalities.

Nodal logistics infrastructure and facilities, such as Freight Villages, Freight Centers, Logistics platforms, Dry Ports etc., should be considered in the physical land-use planning process and the elaboration of Local, Regional and National Spatial Master Plans.

City logistics – last mile

City logistics or "last mile" refers to logistics in urban areas. This practically corresponds to the final link of the supply chain; as 80% of the population live in cities, a great percentage of goods find their final destinations for delivery in urban areas. For two decades now, City logistics tends to become a discrete research field. This results from the specificities and particular conditions of urban environment, where logistics operations take place: dense construction, many categories of land uses, high population density, high vehicle traffic often using narrow road networks, many types of traffic using the same infrastructure, many restrictive traffic regulations etc. These conditions make logistics operations more complicated and harder.

At the same time, there are not "horizontal" uniform rules for administrating logistics in the cities. Local authorities make their rules and restrictions depending on the characteristics of each city.

Experience, field surveys and relevant literature show a big variety of good practices and successful local policies for city logistics in Europe. Traffic restrictions are combined with innovative solutions of utilization of various modes and other infrastructure (e.g. tramway lanes, bicycles, barges in case a river cross the city, electric autonomous vehicles and robots, Urban Consolidation Centers etc).

Generally, it is possible to distinguish three different categories of city logistics policies, that can be combined:

- Traffic management
- Development and integration of logistics infrastructure in the city logistics networks
- Alternative fuel technologies

In the longer term, more radical changes in the spatial planning / land use organization, affecting origins and destinations of good, might further contribute to improve traffic patterns and decoupling traffic from

These logistics principles also have strong territorial and urban dimensions, particularly where freight flows intersect with cities and last-mile distribution

Beyond passenger mobility, land-use and urban transport policies play a critical role in shaping the sustainability of freight transport, particularly in relation to hinterland logistics, urban warehousing, and last-mile delivery operations. The requirement for TEN-T cities to develop Sustainable Urban Mobility Plans (SUMPs) offers an opportunity to better integrate freight transport considerations

into urban planning, including the location of logistics and distribution facilities, access to terminals, and the organisation of last-mile delivery.

Effective implementation requires going beyond a narrow modal-shift perspective and recognising that intermodality is about optimising traffic flows across modes, supported by appropriate technologies, terminals, and hub structures. Coordinated land-use planning can stimulate the development of freight villages, rail–road transhipment terminals, and multimodal logistics hubs, enabling smoother interfaces between long-distance rail and waterborne transport and urban distribution networks.

In parallel, urban and regional policies can further promote short sea shipping, making better use of the large number of small and medium-sized ports. With relatively limited infrastructure interventions, these ports can support regular services by small and medium-sized vessels between European coastal ports, thereby relieving pressure on road infrastructure and strengthening sustainable hinterland connections. Without such integrated land-use, infrastructure, and logistics planning, improvements in long-distance transport risk being partially offset by inefficiencies at the urban and last-mile level.

In sum, Table 1 gives an overview of some possible ways to address the gaps and challenges per transport sub-sector.

Table 1: Overview of challenges and solutions per transport sub-sector

Transport sub-sector	Air transport and airports	Maritime freight transport and ports	Maritime passenger transport (cruise and ferry)	Inland navigation/shortsea shipping	Rail transport and intermodality	Passenger road transport, incl. urban mobility	Inland logistics
Challenges	High greenhouse gas emissions and resilience to climate change	High greenhouse gas emissions and other pollutants Adoption of autonomous vehicles with improved level of consumption and use of electrical or LNG power	Different situations and market conditions	Difficulties in innovating and competing with other modes Adoption of autonomous vehicles	Significant infrastructure enhancements and multimodal integration Electrification, expansion of HS network	Congestion, pollution, and social exclusion Change citizen behaviour, invest in "intelligent Citizen"	Unexplored potential of Logistics to contribute for decoupling traffic from growth and greening transport
Solutions	Biofuels, hydrogen, electrification, and brownfield infrastructure development Investment in ground services in air side, with electrification of vehicle or NG, in addition enhacement of intermodality will reduce the car traffic in airports, together with a increase of parking price at the airport (i.e. opposite to what is currently happening	Extending the emission trading system (ETS) to shipping and introducing a fuel standard for more climate-friendly marine fuels	LNG, hydrogen, fuel cells, and electric ships	Operational measures and energy transition Lack of incentives for urban areas with channels	Completing the TEN-T network, supporting long-distance and cross-border rail services, and introducing user-friendly ticketing systems	Promoting active and public transport, low-emission zones, and mobility as a service (MaaS)	Development of appropriate statistical data and models, Optimised combination of transport modes based on optimised locations.
Barriers	Airport concessionaires have robust contracts that are difficult to overcome + Authorities are often captured by lack of knowledge on real costs and operational requirements + Contrats often have no monitoring from authority side. All these barriers together lead to significative deviations of costs and time for execution	Competitive distortion, tax evasion, and lack of market-ready technology Power of freight forwarders and armours dominate the market.	Cost, competition, and technology readiness	More policy and guidance from the EU Need to include railways in the commuting mobility chain	More attention to the environmental impact of rail infrastructure construction and operation	Find financing and adapted pricing, complexity of behaviour change	Lack of data and information about Logistics, Logistics not sufficiently included in Transport Policy and Spatial Master Plans

FUTURE RESEARCH

The transition towards the net zero emission transport sector already begun, but further efforts are essential, particularly in research to support the green transition. This cannot be overlooked in successful implementing the Sustainable and Smart Mobility Strategy and Fit for 55 actions. According to the latest Draghi report (2024), there is a pressing need for a long-term vision. As academia, we believe that there is a need for a long-term vision, a multidisciplinary approach and more research on innovation.

To develop such vision, table 2 draws the attention to what is needed with respect to recommended methodology and priority research topics per transport field. The insights gathered from this table are invaluable for policymakers and researchers alike; offering clear direction for future studies and policy development. This ensures that the transportation industry continues to evolve and meet the demands of a changing world. Additionally, a successful implementation plan, limited over time, needs to be developed

Table 2: Future research methodology and research topics

TRANSPORT FIELD	**METHODOLOGY/DATA COLLECTION/ ANALYSES**	**RESEARCH TOPICS**	
		cargo	Pax
Air transport and airports	- How to evaluate change? Much investment is now done in demos, but evaluation methodologies are still locked in CBA and LCCA which is not adequate to the evaluation of isolated demos. If we want to give room to innovation, we must also allow it in the evaluation methodologies. This is crucial for policy and for investment decisions - Innovative (sustainable) metrics	- Optimal solution in cargo transport - Efficient and interconnected multimodal transport system - To make the transport system as a whole sustainable - To make transport system resilient against future crises - Transport interconnected digitalization - To avoid competition between	- Explore choice of transfer/ barriers of air-rail intermodality - EV/hydrogen (fire) risk assessment in indoor car parks - To investigate the passenger perception and satisfaction of inland cruise ships - To harmonize policy for urban distribution
Maritime transport			
- Freight transport	- Modelling of energy transition in the maritime ecosystem		

	- Cost/benefit analysis - Case study - AI based forecasting models	transport modes with respect to fuel (e.g. cooking oil) - To study impact of ETS on modal shift - To study which measures can make the transport ecosystem more sustainably by incentivizing or penalizing (e.g. use of electronic B/L, cmr,….) - To examine digital twins and predictive maintenance	
- Passenger transport	- Multi-criteria assessments - AI based forecasting models - Network assessments		
Inland navigation	- Survey		
Rail and intermodality	- Simulation and decision-support for rail safety		
Passenger road transport, incl. urban mobility	- Survey and modelling with a better attention to alternative modes - Behavioural modelling		
Hinterland logistics and last mile	-Surveys for the location of transport companies, forwarders, 3rd Party Logistics Providers -Modelling optimised site selection for Logistics Centers -Elaboration of performance evaluation in logistics - Development of data collection methodologies regarding logistics performance - Modelling optimisation of intermodal chains		

From the above, it is clear that there seems to be a 'maturity synchronisation issue', meaning with respect to technology (adoption), market push, regulation, user behaviour, (vehicle/vessel) owner financing, etc. are not at the same level. Instead of transport silo-approach policies, the vision of the EU should be transporting solution oriented. It is clear by now that such a silo-approach (e.g. ETS) is bound to cause distortions with a negative impact both on efficiency of transport and its greening. Furthermore, key issues for sustainable future transport are related to data, regulatory and policy challenges.

- Adequate/relevant **data** is the biggest challenge. A solution could be: setting up an integrated data platform. Long-term monitoring provides better insights (e.g. seasonal influences, impact of climate change, etc.) and can stimulate qualitative (service) and quantitative (financial) performance (e.g. increase efficiency, improve asset utilisation, stimulate innovation, prepare better-suited labour, etc.). All in all, nextgen technology could help collecting data, monitoring real-time activities, and forecasting behaviours to optimise adaptation/reaction strategy.

- Regarding **regulatory and policy challenges**, it will be essential to avoid frictions between EU level and national policy schemes.

Ultimately, serial or parallel monodisciplinary approaches show more and more limitations, hence, in concrete terms for the transport sector, this means that transport solutions, based on integrated cost models, must be sought. Academic research needs to evolve towards a multidisciplinary approach (e.g. economic - legal, economic - IT,…) in both research and practice. This also poses challenges for research and education. In the last column, research topics are proposed. In a first stage, research can be done on interconnecting transport modes, as well as logistics. In the following stage, research should focus on the interconnection cargo and passenger. Targeting a fundamental transformation, this evolution in research is needed to meet the ambitions of EU, hence evolving to a sustainable, smart and resilient transport system.

The blog provides policy makers with the necessary, science-supported steps (i.e. when, who and under what conditions) to be taken by 2030/2050. Next, a successful implementation plan needs to be developed.

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