MOBILITY & LOGISTICS

IMPACT VISION



SHIFT

December 2024

FOREWORD

SHIFT Invest's mission is to fight climate change, biodiversity loss and natural resource depletion. SHIFT invests in four high burden sectors: Mobility & Logistics, Food & Agriculture, Energy Transition, and Green Industries. In this document, we share our impact vision for Mobility & Logistics. People and goods will be always on the move. At SHIFT Invest, we support startups that create positive environmental impact in all mobility and logistics systems necessary to uphold societies and economies, against the (environmental) challenges we face.

The purpose of this document is **to outline key drivers of negative impact along the system on the one hand, and solutions** that have been shown to have the **greatest magnitude and importance**, collated from key academic institutions, interest groups, and (non)governmental organisations[1] on the other hand. Exact numbers vary between sources (e.g. the GHG emissions associated with mobility & logistics) depending on the methodology and scope used by the source. The goal is not to provide the most accurate assessment of various impact and mitigation potentials, but to demonstrate the relative importance and magnitude of each.

This strategy is by no means exhaustive as the problems posed to nature by the Mobility & Logistics sector are complex, interconnected, and also dependent on action taken in the public sector and international arena.

SUSTAINABLE MOBILITY

GREEN INDUSTRIES

ENERGY TRANSITION

SMART FOOD & AGRICULTURE



1. For example, the Intergovernmental Panel on Climate Change (IPCC), Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), European Environmental Agency (EEA).

EXECUTIVE SUMMARY

SUSTAINABLE MOBILITY & LOGISTICS

The impact challenge in Mobility & Logistics

- Transport emissions have grown faster than most sectors and account for ~16% of global GHG emissions.
- Transport could even account for up to ~21% when accounting for the footprint of manufacturing, operations and infrastructure.
- Aside from climate change, transport poses a broader environmental burden.
- The problem is worsening, as a further increase in volume of travel and trade is expected.
- Changing is difficult, given the high level of interdependencies within the value chain and the legacy of current systems.
- Challenges are huge and vary per transport sector (e.g. air, road, rail, water).
- The EU proposed policy to meet climate targets - however this is generally considered to be insufficient.



SHIFT's investment considerations for impact

- The transition to a new, efficient, low-carbon mobility and logistics system is essential to mitigate climate change, biodiversity loss and natural resource depletion.
- Therefore, SHIFT invests in technologies and solutions stimulating the modal shift towards less carbon-intensive transport modes, efficient use of assets, clean transport and livable communities.
- SHIFT follows the ASIF[1] framework for categorization of solutions that drive the transition towards zero-emissions. ASIF provides the following drivers: modal choice, activity, fuel carbon intensity and energy intensity. The various angles to drive impact are roughly all evenly effective to ultimately reduce GHG emissions.
- Natural resource depletion, biodiversity and non-carbon emissions are not included in the ASIF framework but are equally relevant.
- Innovations can also be enablers of mitigating climate change, biodiversity loss and natural resource depletion, instead of direct contributors. For example: nudging behavior or enabling infrastructural systems.

1. Used as the main framework by the IPCC, the United Nations body for assessing the science related to climate change, to outline the types of impact drivers. ASIF stands for Activity, modal Structure, modal energy Intensity, carbon content Fuels.

SHIFT IMPACT VISION FOR MOBILITY & LOGISTICS

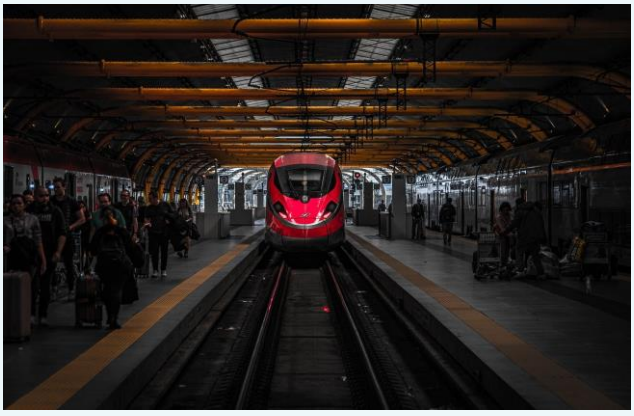
SHIFT's mission is to mitigate climate change, biodiversity loss and resource depletion in mobility and logistics, by investing in:

Modal shift
Solutions that contribute to the shift towards less carbon-intensive modes of transport

Clean transport
Technologies that reduce the emissions of transport operations, and thereby their impact on the environment

Efficient use of assets
Efficient use of assets is crucial for a low-carbon mobility and logistics system, given the limits of infrastructure and environmental footprint

Livable communities
Solutions that care for sustainable cities and communities by tackling pollution (air, waste, noise, etc.), reducing congestion and by improving biodiversity





…to avoid and reduce adverse impacts, and improve positive ones and restore the balance between nature and society

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01. SETTING THE STAGE



SHIFT

WHY INVESTING IN MOBILITY & LOGISTICS MATTERS

MOBILITY IS AN IMPORTANT SECTOR THAT PROVIDES

Mobility & logistics play a crucial role in shaping and supporting the global economy and society

From ancient trade routes to modern supply chains, the ability to move people and goods has been a cornerstone of human progress. Transport networks have connected cultures, facilitated commerce, and driven technological innovation throughout history. Today, in our highly interconnected world, the importance of mobility and logistics has only grown. These systems underpin global trade, enable the flow of ideas and information, and contribute significantly to economic growth and social development.

Pressures will grow

On a business-as-usual trajectory, the mobility sector is expected to triple in both passenger and freight travel demand by 2050[1]. This makes it increasingly challenging for the sector to deliver these fundamental services within our planetary boundaries. For instance, between 1990 and 2022, emissions from the transport sector grew by 1.7% p.a., while achieving net zero by 2050 requires these to fall by 3% p.a. by 2030.

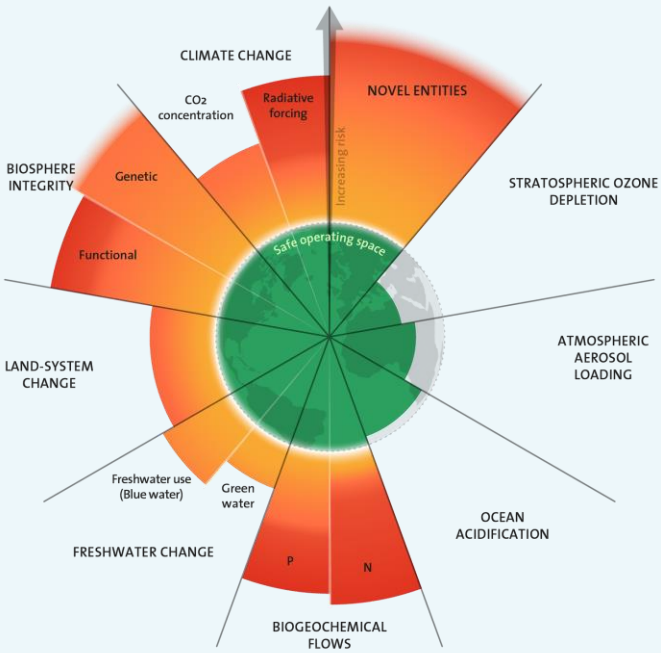
Transport is a substantial contributor to global GHG emissions and impacts other planetary boundaries

Transport and its infrastructure requires land, energy, water, and other raw (and novel) materials[1]. Aside from GHG emissions, transport contributes to aerosol and other forms of pollution, facilitates invasive species and fragments habitats, putting pressure on ecosystems.

There are diverse and promising mitigation solutions available

This ranges from solutions enabling the modal shift to less carbon-intensive modes of transport, to solutions providing efficient use of (existing) assets or new clean transport technologies.

The planetary boundaries framework[2]



1. Gupta et al. (2024); 2. Azote for Stockholm Resilience Centre, Stockholm University, based on Richardson et al. 2023, Steffen et al. 2015, and Rockström et al. 2009

POLICY LANDSCAPE – OVERVIEW AND CRITIQUE

THE EU PROPOSED POLICY TO MEET CLIMATE TARGETS BUT IS INSUFFICIENT, ACCORDING TO CRITICS



POLICY OUTLINE

EU set the goal of **being the first climate-neutral continent** by 2050. This requires **a 90% reduction in transport-related greenhouse gas emissions** by 2050 and an intermediate target of 55% GHG emissions reduction by 2030.

Important policy initiatives for sustainable mobility:

Reduced dependence on fossil fuels

- By 2030: 30 million zero emission cars and 80,000 zero emission trucks on the road
  - 55% reduction from cars, 50% reduction from vans by 2030
  - Zero GHG emissions from new cars by 2035
- Collective travel under 500km carbon neutral by 2030
- Supporting deployment of alternative fuels infrastructure and boosting production and uptake of sustainable transport fuels
- Zero emission large aircraft commercially ready by 2035

Making alternative choices available & attractive

- Large and mid-size cities have sustainable urban mobility plans by 2030
- Promoting multimodal transport
- Traffic on high-speed rail double by 2030, rail freight traffic to double by 2050
- Transport via inland waterways and short shipping to increase by 25% by 2030
- Implementation of CSRD, requiring businesses to disclose detailed information about their environmental impact (e.g. scope 3 emissions)

Pricing to reflect environmental impact *Internalization of external (environmental) costs of transport by 2050 (users to bear the cost rather than society as a whole)*

- Road transport to be covered by emissions trading from 2026
- Proposal to extend carbon pricing to maritime sector and targets for major ports to serve vessels with onshore power
- Aviation
  - The EU Emissions Trading System (EU ETS) will see carbon pricing for aviation rise sharply. Until 2026, the system remains focused on intra-EU flights, with a potential expansion to all EU departing flights in 2027[1]
  - Free ETS allowances will be reduced by 25% in 2024, 50% in 2025, and fully eliminated by 2026
  - To promote the use of Sustainable Aviation Fuels (SAFs), 20M allowances will be allocated between 2024 and 2030 to cover the price difference between sustainable fuels and kerosene
  - Monitoring of non-CO_2 emissions (e.g. contrails) starts in 2025, with potential inclusion in the ETS by 2028.

POLICY CRITIQUE

Scientists and other experts believe more is required:

EU's policies generally perceived as insufficient to meet 2°C warming scenario[2]:

- Goals regarding energy efficiency and renewable energy seen as insufficient
- Goals do not meet the fair share obligation (i.e. if all countries were to follow the EU's approach, we would reach up to 3°C)
- Especially in aviation and shipping sector, progress is critically insufficient since national governments are taking insufficient action to reduce emissions from international movements, action is focused on offsetting rather than real reductions, and non-CO_2 impacts are not addressed

For some indicators, global historical progress has stagnated, and a step-change is required to get on track:

- Carbon intensity of global steel and cement production (embedded emissions)
- Share of trips by private vehicles (worsening)
- Deforestation due to transport infra (worsening), while growth in annual tree cover should go 3x faster
- Increased share of low-emission fuel should go 12x faster

1. Depending on the effectiveness of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA); 2. Sources: Climate Action Tracker, 2021, CAT, State of Climate Action

BARRIERS TO CHANGE

CHANGE IS DIFFICULT, GIVEN THE HIGH LEVEL OF INTERDEPENDENCIES AND LEGACY OF CURRENT SYSTEMS

Changing is difficult given the nature of the existing transport sector

Transformations go beyond the sector alone, leading to (international) system-interdependencies with industries like energy and construction

The long lifetime of transport infrastructure (& high sunk costs)

The convenience of oil as a transport fuel, given high energy density, ease of transport, and low costs

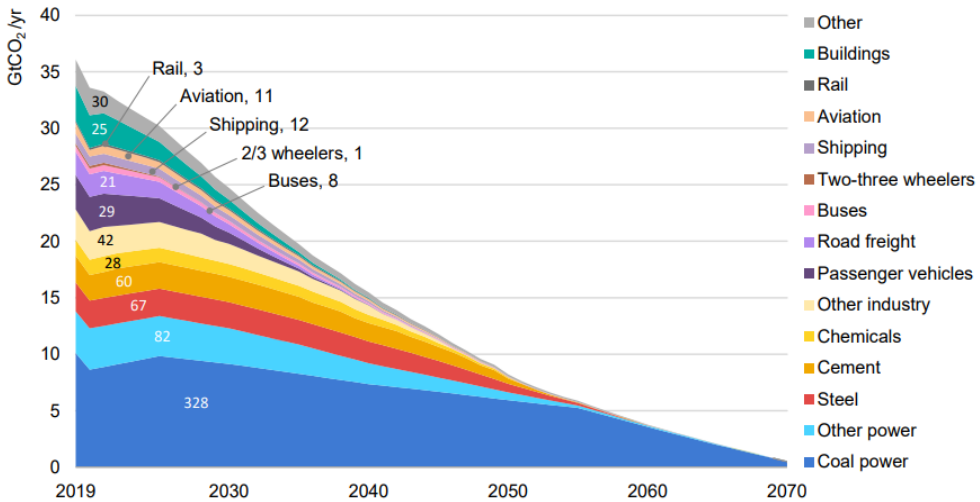
The high investment costs associated with low-emissions transport systems.

Existing transportation systems impose a huge burden: transport infrastructure from 2019 already accounts for ~21% of the carbon budget

- The estimated sum of 'committed' emissions from existing transport systems until 2070, is 82.5 Gt CO_2 due to polluting character of the system combined with lifetime (see figure)
- To put this in perspective, our current remaining carbon budget (scenario 1.5°C limit) is 316 Gt CO_2 - the world currently emits c. 40Gt CO_2 p.a..

CARBON FOOTPRINT LEGACY OF CURRENT SYSTEM

Estimated CO_2-emissions from existing energy and transport infrastructure *in the scenario that no additional CO_2-emitting devices (e.g. infra, plants, vehicles) are built, but all the existing infra/devices fulfill their asset lifetimes and emit CO_2 through their fuel usage, required maintenance, and decommissioning.*



Sources: carbon budget: MCC (2022); IPCC, (2014); Davis et al. (2010); IEA (2020)

MOBILITY & LOGISTICS AND SHIFT'S MISSION

INVESTING IN SOLUTIONS BASED ON THREE CHALLENGES AS PART OF SHIFT'S MISSION



CLIMATE CHANGE

In the last 25 years, transport GHG emissions and related air pollution grew with an annual rate of 1.7%[1]. This makes transport one of three sectors to stand out as the fastest growing sources of emissions since 1990[2]. Currently, the transport sector accounts for ~16% of global GHG emissions[1], mostly from its energy-related CO_2 emissions[3].

Emission and energy intensity of transport modes are generally decreasing, but this impact is offset by increased demand travel and trade. In addition, transport has the highest reliance on fossil fuels of any sector, and a limited uptake of alternative fuels due to limitations in energy intensity[4].



BIODIVERSITY LOSS

Transport and trade accounts for ~10% of the average biodiversity footprint in Europe[5], where species population growth is declining by 24%[6].

Transport contributes to four of the five impact drivers that affect biodiversity loss – ranked in order of severity: habitat loss & degradation, climate change, pollution and, invasive species & disease.



NATURAL RESOURCE DEPLETION

Transport and the required infrastructure has the highest material footprint after nutrition, but there is a critical lack of data and visibility on resource stocks and flows in the sector (especially end-of-life waste management, which is a major challenge for e.g. batteries).

Almost half of the most at-risk critical *non-renewable* materials are used in e-mobility, a growing concern given necessary electrification for low-carbon transition.

Sustainable transport fuels (biodiesel and bio-ethanol[7] have a substantially larger water footprint than fossil fuels, and the EU is expected to continue being the world's largest bio-diesel producing region in 2029[8].

1. IEA; 2. Together with industrial processes and electricity & heating (WRI, 2020); 3. IPCC, 2022; 4. IEA, 2022; 5. IPBES, 2020; 6. WWF, 2020; 7. Note: refers to first-generation biofuels, Gerbens-Leens & Hoekstra, 2011, 8. OECD, 2020

02. MOBILITY & LOGISTICS AND CLIMATE CHANGE



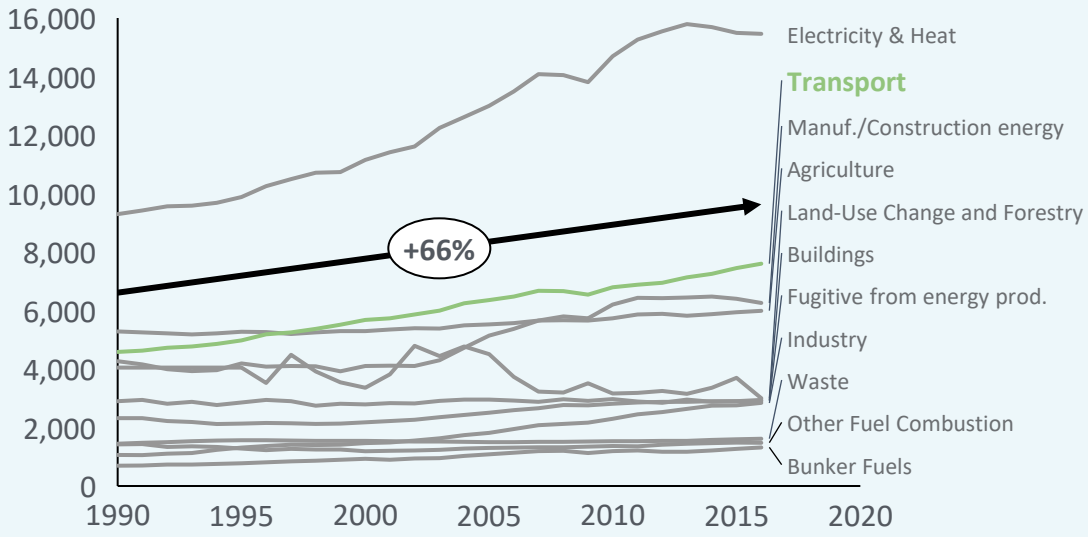
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GHG EMISSIONS IN MOBILITY & LOGISTICS

EMISSIONS OF MOBILITY & LOGISTICS GREW FASTER THAN MOST OTHER SECTORS AND ACCOUNTS FOR ~16% OF GLOBAL GHG EMISSIONS

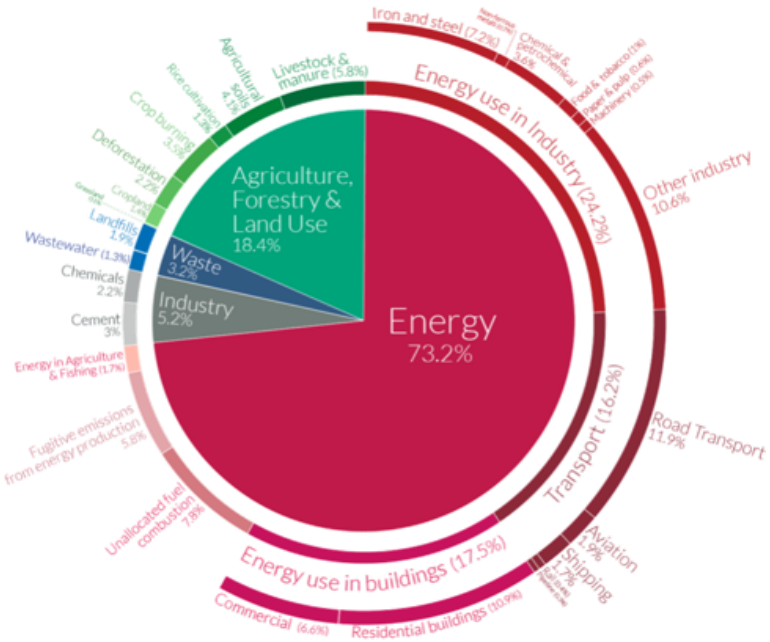
MOBILITY AND LOGISTICS EMISSIONS GREW FASTER THAN MOST OTHER SECTORS IN THE LAST 25 YEARS…

Annual global GHG emissions by sector, in million tonnes of CO_2-equivalents[1]



…AND ACCOUNTS FOR ~16.2% OF GLOBAL GHG EMISSIONS

Global GHG emissions by sector[2]

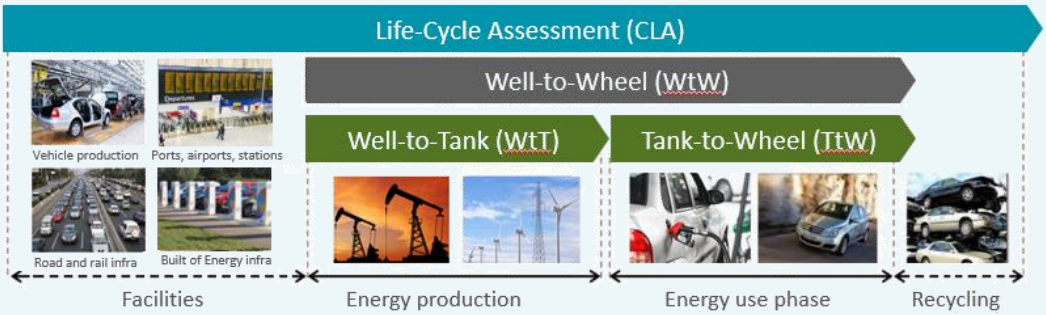


1. CO2e is a measure that accounts for multiple GHGs, including most importantly carbon dioxide, methane, nitrous oxide, and F-gasses; 2. The World Resources Institute (OurWorldinData.org). 16% in 2016 is most probably outdated and should be higher now. In 2018, WRI estimated that transport accounted for 17% of global GHG emissions. In the same year, RIVM estimated that for the Netherlands transport accounted for 20% of GHG emissions

GHG EMISSIONS IN MOBILITY & LOGISTICS

IT IS IMPORTANT TO CONSIDER EMBEDDED GHG EMISSIONS OF CONSTRUCTION, MAINTENANCE AND DISPOSAL OF TRANSPORT INFRASTRUCTURE

LIFE-CYCLE ASSESSMENT INCLUDES BROADER TOPICS THAN FUEL EMISSIONS ALONE

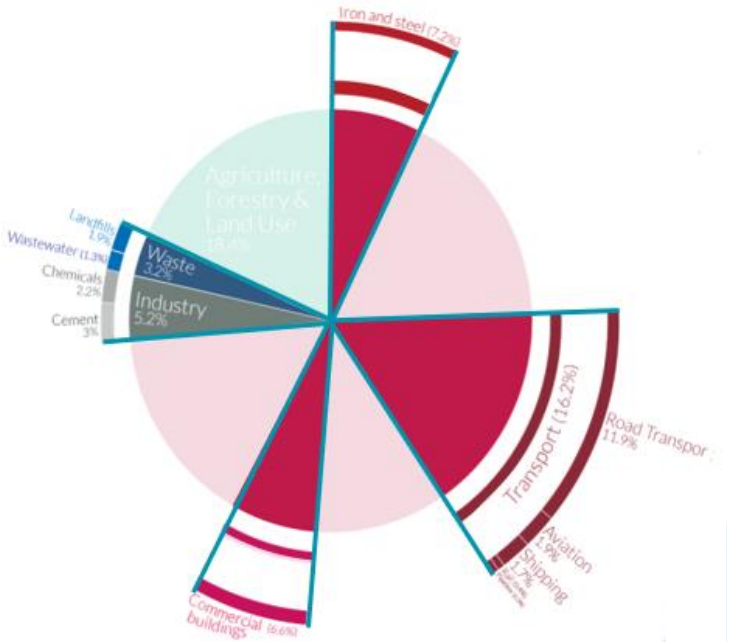


Aside from emissions in the energy use phase, it is important to consider **Life-Cycle Impact** of the transport sector. This includes construction, maintenance, and eventual disposal of transport vehicles and infrastructure:

- On average, **65-80% of life-cycle emissions come from fuel** (varies per transport mode)
- The other **20-35% emissions come from required material and infra** – this baseline is expected to increase given the required changes in infra / fleet electrification (e.g. batteries have a high material footprint)

INCLUDING EMISSIONS OF CONSTRUCTION, MAINTENANCE AND DISPOSAL OF TRANSPORT VEHICLES AND INFRASTRUCTURE, TRANSPORT WILL ACCOUNT FOR AN EVEN GREATER PROPORTION OF GLOBAL GHG EMISSIONS[1]

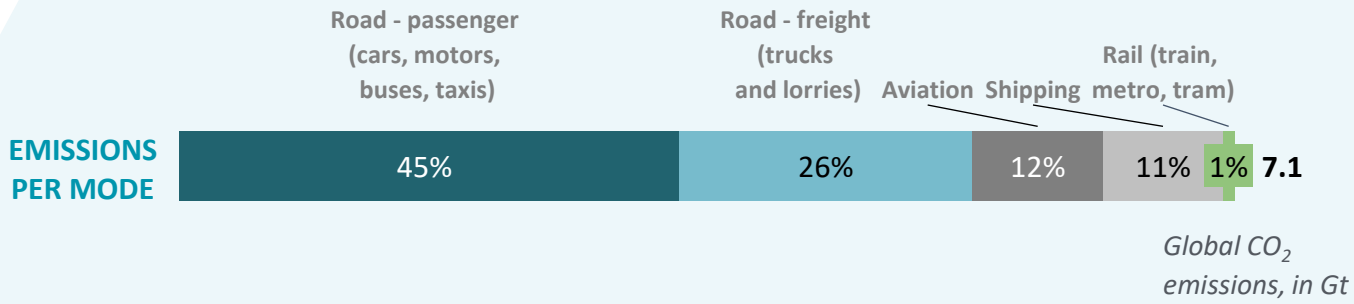
Global GHG emissions by sector[2]



1. Exact data on contribution of transport in the other sectors is not known. However, other sources (Circle Economy, 2020) find that the material footprint for mobility is 16% of the total final resource demand; 2. The World Resources Institute (OurWorldinData.org).

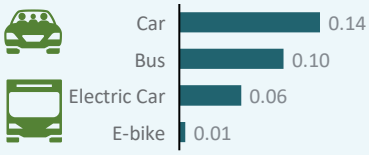
GHG EMISSIONS PER MODE OF TRANSPORT

CHALLENGES TO ACHIEVE DECARBONIZATION ARE BIG AND VARY PER TRANSPORT MODE



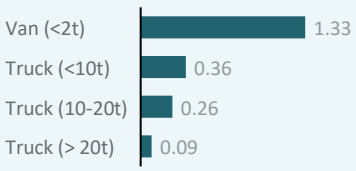
EMISSIONS BY PASSENGER

Average Dutch well-to-wheel emissions factors in kg CO_2e / passenger-km[1]



EMISSIONS BY FREIGHT

Average Dutch well-to-wheel emissions factors in kg CO_2e / tonne-km[1]

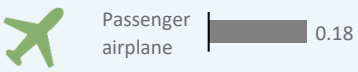


OTHER STATS PER MODE

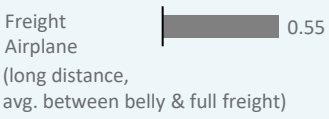
ROAD TRANSPORT

- 10% of the global population accounts for 80% of total transport-kms
- Need for material/infra increases, since electrification demands infrastructure and batteries

AIR TRANSPORT



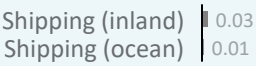
81% of aviation-km is passenger



19% of aviation-km is freight

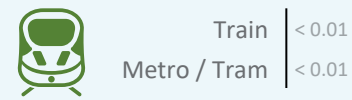
- 1% of the world population responsible for > 50% emissions in pas. aviation
- Flights: 33% short-haul, 33% medium-haul, 33% long-haul
- Aside from CO_2, planes produce contrail cirrus (estimated to *double* GWP)

TRANSPORT BY WATER



- Aside from CO_2, significant polluter of PM (10%), sulphur dioxide (20% in NL) and nitrogen oxide (30%)
- Split incentives as a result of the highly fragmented nature of the value chains makes change difficult

RAIL TRANSPORT





- Freight cargo often stuck in ports (Amazon effect)
- Major maintenance works preventing efficient use of the network.

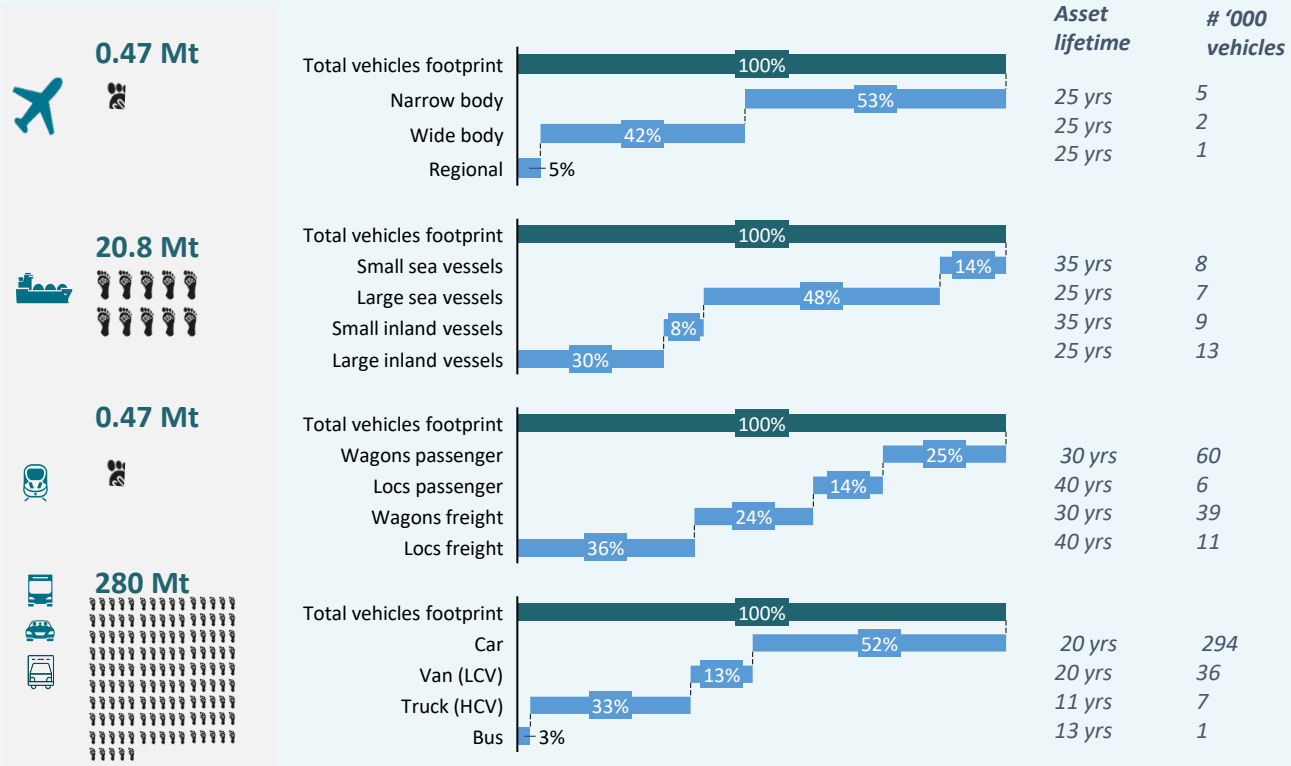
Sources: OurWorldinData.org – IEA and ICCT, 2018, [CO_2emissiefactoren](#) *(2021/22)*
1. Coefficient per passenger / tonne means total emissions of the mode depend on volume/occupancy transported (potential and realised). Well-to-wheel accounts for emissions associated with fuel type and composition but not scope 3 factors like vehicle manufacturing. ; GWP = global warming potential

CARBON EMBEDDED IN CURRENT SYSTEM

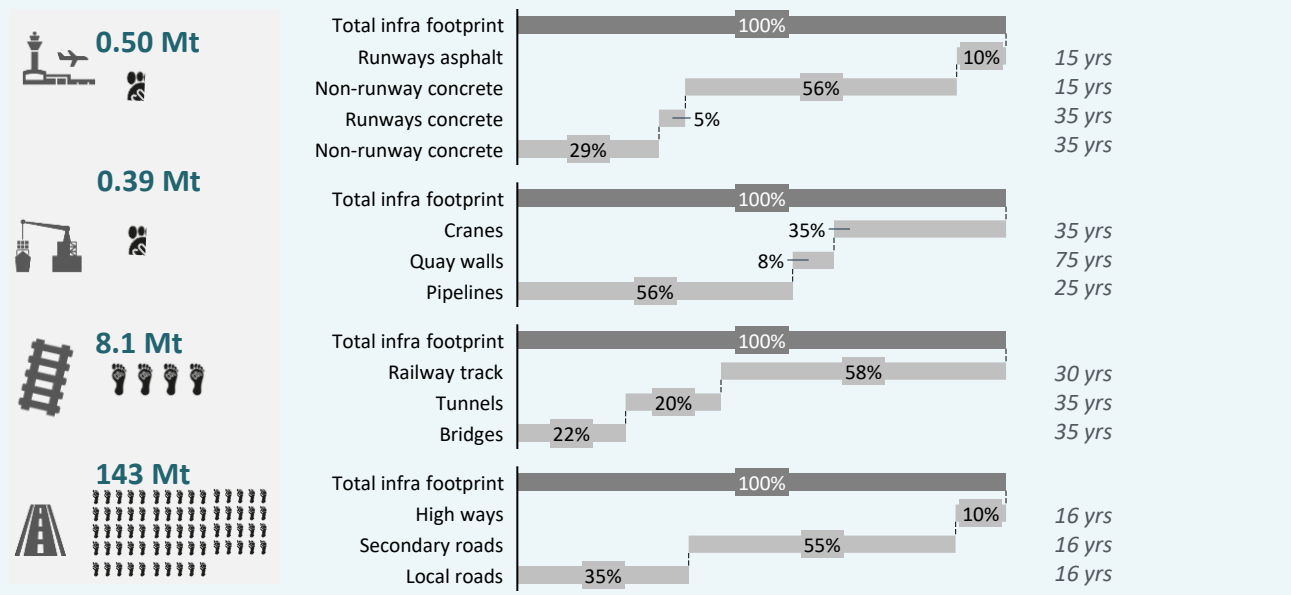
EMBEDDED CARBON IN OUR EXISTING TRANSPORT SYSTEM POSES A LARGE BURDEN

SHIFT made a model to estimate the resources and carbon embedded in the existing transportation vehicle and infra system aside from the tailpipe emissions of fuel. The results are estimates, indicating roughly where most impact can be made. The road sector has the most embedded carbon, followed by maritime (vehicles) and rail (infra). Significant impact can be made by promoting vehicle longevity and transitioning to lighter, more sustainable materials.

EMBEDDED CARBON IN EUROPE'S VEHICLES, NORMALIZED FOR ASSET LIFETIME[1)] (MILLION TONNES CO_2E PER YEAR)



EMBEDDED CARBON IN EUROPE'S INFRA, NORMALIZED FOR ASSET LIFETIME[1] (MILLION TONNES CO_2E PER YEAR)



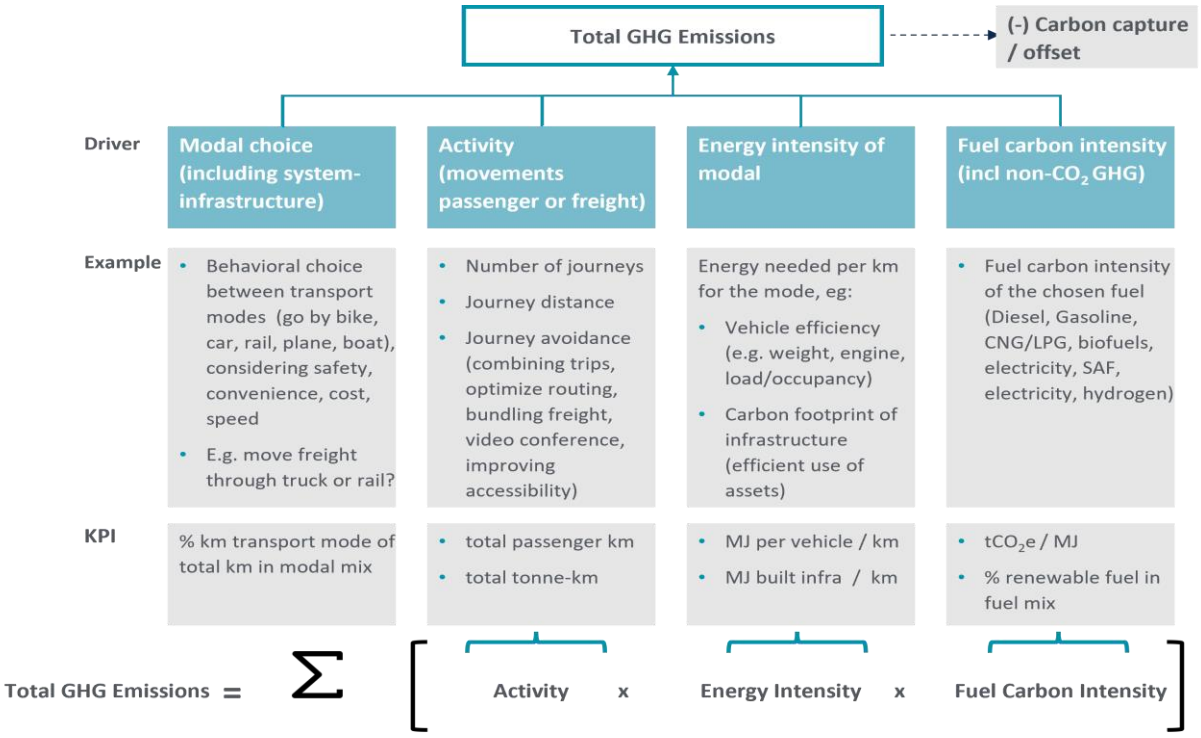
1. SHIFT estimation model, based on multiple scientific and public sources (e.g. OECD, IEA) and industry reports. The results are indicative and based on firm, high-level assumptions

ASIF FRAMEWORK FOR MOBILITY & LOGISTICS

SHIFT USES THE ASIF FRAMEWORK TO CATEGORIZE IMPACT DRIVERS IN THE TRANSITION TOWARDS ZERO-EMISSIONS

- SHIFT uses the **ASIF framework**[1] to categorize the total impact of the transport sector on GHG emissions into four impact drivers: modal choice, activity (number of movements), energy intensity of mode and fuel carbon intensity
- Per choice of mode, the emissions are a product of the other three drivers – the total GHG emissions is a summation for each mode option. Hence to reduce emissions, an impactful solution must have a mitigating impact on one or more drivers
- There are physical units of measurement (KPIs) associated with each of these types of emissions drivers that can be used to assess the impact of, and weigh possible trade-offs between, different measures in a comparable manner.
- Directions for solutions can be divided into three categories:
    - **Technological** – directly decreasing energy and/or fuel carbon intensity of a mode
    - **Infrastructural** – supporting and enabling the functioning of a low-carbon system
    - **Behavioral** – nudging behavior of individuals and businesses, regarding demand and use of modes

The ASIF framework is used as the main framework by the IPCC, the United Nations body for assessing the science related to climate change, to outline the types of impact drivers. ASIF stands for **A**ctivity, modal **S**tructure, modal energy **I**ntensity, carbon content **F**uels



1. Used as the main framework by the IPCC, the United Nations body for assessing the science related to climate change, to outline the types of impact drivers. ASIF stands for Activity, modal Structure, modal energy Intensity, carbon content Fuels.

03. MOBILITY & LOGISTICS AND BIODIVERSITY LOSS



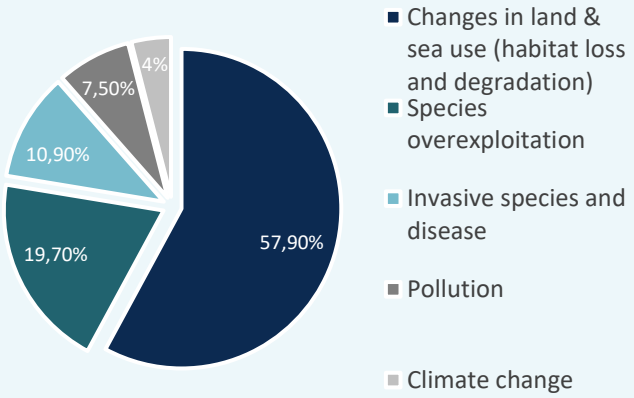
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BIODIVERSITY IN MOBILITY & LOGISTICS

SPECIES POPULATIONS HAVE BEEN EXPONENTIALLY DECLINING…

- Last 50 years, species populations have been exponentially declining, leading to abrupt and irreversible changes to global biodiversity.
- **Transport and trade** account for about **10%** of the average biodiversity footprint in Europe, where species population growth is declining by 24%.
- Several **impact drivers**[1] affect biodiversity loss. Habitat loss and degradation identified as most important cause.

The proportion of threats faced by species populations, 2020



…TRANSPORT CONTRIBUTES TO FOUR THREATS OF BIODIVERSITY LOSS

Habitat loss and degradation

Transport infrastructure is a main cause of **land fragmentation**, leading to small protected areas and **a lack of connectivity between habitats**. Populations become vulnerable **by limiting the genetic pool**.

Climate Change

Transport is an important **driver of climate change** through GHGs. Climate change impacts biodiversity by e.g., causing species to **shift territories or disrupting the signals** that trigger seasonal events.

Pollution

Road and sea transport have historically been a significant driver of air pollution, like particulate matter (*see next page*). Transport also causes **noise, light and toxic emissions,** affecting biodiversity (e.g. underwater noises lead to behavioural changes of species).

Invasive species and disease

The rise of seaborne and airborne transport has significantly increased the presence of **invasive species.** For example, global shipping brings ballast water with novel **bacteria, microbes, and various other species** to other ecosystems

SHIFT VIEW

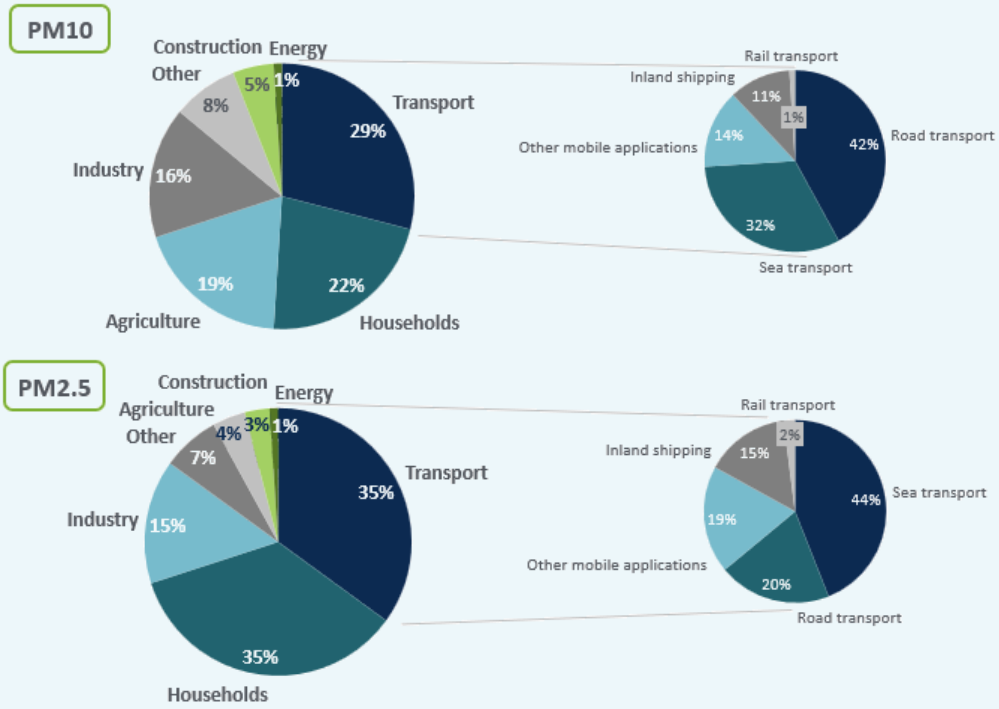
- Nature loss and climate change are intrinsically interlinked[2] – a failure in one sphere will cascade into the other, and attaining net zero will require mitigatory measures for both levers[3].
- Biodiversity threats are often addressed indirectly when investing in solutions that have climate change impact (e.g. solutions with lower energy intensity, could also prevent habitat loss)

1. in the Europe & Central Asia IPBES region - WWF, 2020 2. CISL (2019), for example, biosphere integrity is affected by increasing ocean acidification (a direct result of climate change), and declining biodiversity in the ocean impedes its ability to sequester carbon. See also Cook-Patton et al. (2021); 3. Bain (2023)

BIODIVERSITY & PARTICULATE MATTER

PARTICULATE MATTER MAINLY IMPACTS BIODIVERSITY

Emissions from transport constitute GHGs, but also conventional air pollutants and particulates. Transport is responsible for ~1/3 of total PM^{10} & $PM^{2.5}$ emissions in NL with road transport and sea transport being the largest contributors:



Research on particulate matter generally focusses on its impact on human health, but studies are starting to understand its environmental impacts:

CLIMATE CHANGE

- PM can have both cooling and warming effects.
- Black carbon has 460 – 1,500x warming impact than CO_2 per unit of mass, resulting in 0.1 °C increase.
- Net effect on surface air temperature is negative due to cooling PM components like nitrates and sulfates.

BIODIVERSITY LOSS

Plants

- Reduced photosynthesis
- Damage to leaf tissues
- Reduced stomatal function

Animals

- Respiratory issues, skin irritation, endocrine function, vulnerability to disease
- Contaminated food sources

NATURAL RESOURCE DEPLETION

- PM alters nutrient cycling, soil pH balance, and may reduce radiation interception and precipitation.
- Air quality degradation
- Water contamination

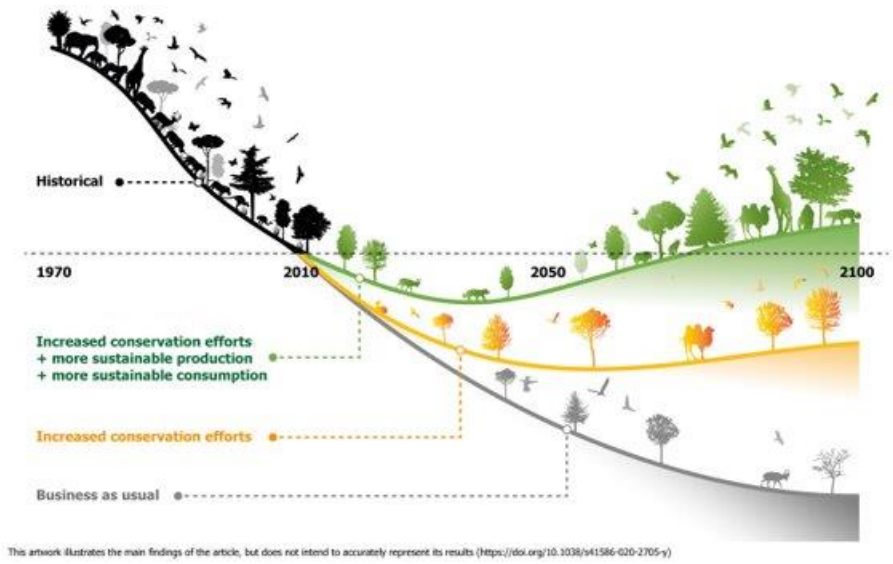
Sources: CBS; IPBES

TOP SOLUTIONS FOR BIODIVERSITY LOSS MITIGATION

CONSERVATION AND TRANSPORT SYSTEM CHANGE ARE NEEDED FOR BIODIVERSITY

CONSERVATION AND TRANSPORT SYSTEM CHANGE

Bending the curve of biodiversity loss requires an ambitious, integrated strategy combining conservation action and changes to transport systems, alongside wider sustainability efforts including on climate change[1].



This artwork illustrates the main findings of the article, but does not intend to accurately represent its results (https://doi.org/10.1038/s41586-020-2705-y)

KEY ACTIONS NEEDED TO BEND THE CURVE OF BIODIVERSITY LOSS

Many mitigation pathways for the climate impact of mobility and transport are likely to have positive co-benefits for biodiversity, such as decreased air and noise pollution. In the literature on the transport sector and biodiversity loss, a few specific mitigation measures are highlighted as being important, also to limit potential trade-offs to nature of the low-carbon mobility transition[2,3]:

- Compact cities with public (shared) transport systems
- Phase out of fossil-fueled transport and repurpose existing assets & infrastructure
- Limited and critical application of biofuels and hydrogen (due to associated land- and water-demand)
- Sustainable lithium and other metals and rare earth production & recycling, sustainable battery technologies

Aside from these, mitigation will constitute a diverse mix of actions that **avoid** or **reduce** drivers of biodiversity loss in the transport sector, as well as actions that **restore** and **regenerate** biodiversity, or solutions that enable us to transform the system[4]. Examples include the following:

Avoid	Unnecessary movements, route optimization, zero emissions transport, biofouling prevention
Reduce	Infrared street lighting, firefighting equipment, noise dampening shipping technologies
Restore	Ecological corridors in transport infra
Regenerate	Mangroves around transport infra
Transform	Sensor technologies

1. Image from PBL (2020); 2. Gupta et al. (2024); 3. IPBES (2019); 4. Science Based Targets Network (2024)

04. M&L AND NATURAL RESOURCE DEPLETION



SHIFT

NATURAL RESOURCE DEPLETION

TRANSPORT PUTS PRESSURE ON THE WORLD'S RESOURCES

Current linear practices in mobility, such as a high dependence on individual vehicle ownership and fossil fuels have led to many adverse impacts, including the depletion of (finite) resources[3]. The amount of materials used in the mobility system has increased over time, with vehicles growing in amounts and being used less intensively and efficiently[4]. For example, European cars are parked 92% of the time and when in use only 1.5 of 5 seats are occupied. After the built environment, mobility systems are the leading drivers of rising material use and its impacts[1]:

Non-metallic minerals

Sand, gravel, limestone, gypsum and clay account for most of the use of non-metallic minerals globally. The worlds transportation system relies heavily on these materials, mainly for infrastructure development, and the automotive sector also uses glass and ceramics. The production of these non-metallic minerals costs a substantial amount of energy due to the heat-intensive processes required to manufacture them[5]. The use of these materials is still largely linear- technical and economic constraints hinder the uptake of more circular practices.

Fossil fuels

The transport sector relies on fossil fuels like petroleum and natural gas as important energy sources, and vehicles contain fossil derivatives like plastics. Approximately 95% of the world's transport energy still comes from fossil fuels[6]. It is unlikely and highly undesirable that a point of physical scarcity will be reached due to their strong impact on GHG emissions, for example. As such, it is important to reduce our reliance on fossil-based transport. However, research also highlights[1] that biogenic raw materials are not always better than fossil alternatives: the former can sometimes have higher energy requirements as well as complex consequences for carbon stored in biomass around the globe, as well as for biodiversity loss. A case-by-case assessment is necessary.

Metals

Metals like iron, aluminum and copper are important to mobility infrastructure and the vehicle fleet. The electrification of mobility will further add to global metal demand and will require the build-up of metal recycling capacity. Critical metals lithium, cobalt and natural graphite are required for energy storage solutions and platinum for fuel cells. Rare earth metals like neodymium, terbium, and dysprosium are also increasingly used for electric motors or antimony for lead-acid batteries in micro-mobility vehicles and electric wires. Recycling is difficult as they are incorporated as small components in complex items or as part of complex materials.



28.6 BILLION TONNES
TOTAL MATERIAL DEMAND

1. Global Resources Outlook (2024); 2. Ritchie & Roser (2019); 3. Ellen MacArthur Foundation (2021); 4. CE Center (2020); 5. EIA (2019); 6. UN (2021)

MITIGANTS TO NATURAL RESOURCE DEPLETION

COMBINING PRINCIPLES OF THE CIRCULAR ECONOMY WITH TRANSPORT

The decoupling of natural resource use and environmental impacts from economic activity and human wellbeing is an essential element in the transition to a sustainable future[1].

In general, we need to transition to a mobility system that requires resources to move people and goods. For instance, a modal shift towards public transport or bicycles will lower the demand for materials per persons-transported. Reducing the need for mobility and enabling mobility through shared services can reduce related material stock requirements by 50% by 2060 compared to current trends[1]. According to the Ellen MacArthur Foundation[2], the circular mobility system should be accessible, affordable and effective. It should have a multi-modal structure, including public transport and on-demand transport for the last-mile. Transportation is electric, shared and automated. And vehicles and infrastructure are designed for durability, efficiency, easy maintenance, and remanufacturing.

EXAMPLES OF CIRCULAR ECONOMY STRATEGIES IN THE MOBILITY SYSTEM

1. Circular Design Solutions

Integrate circular principles in the design of mobility assets and infrastructure to eliminate waste, greenhouse gas emissions, and pollution.

- **Design for longevity**: ensure vehicles and infrastructure are durable, easily repairable, and capable of being upgraded.
- **Modular and/or lightweight design:** create less resource intensive (lightweight) vehicles with interchangeable parts to enable easy maintenance and remanufacturing.
- **Shared-use facilitation:** design infrastructure that is suitable for shared mobility services.
- **Zero-emissions assets and infrastructure:** build transport systems that align with net-zero emission, biodiversity and resource goals.
- **Bio-based alternatives**: replace fossil resources with renewable (biogenic) ones where feasible (e.g. textiles in vehicle interiors, battery materials).

2. Utilisation and Life Extension Solutions

Maximise the operational lifespan and usage of vehicles while reducing resource intensity.

- **Sharing services:** ride-/vehicle-sharing platforms and leasing/subscription ownership models to optimise vehicle use and reduce resource and spatial-demand.
- **Freight optimisation:** consolidated deliveries and sustainable last-mile solutions.

3. Value Recovery Solutions

Recovering and valorising materials and components at the end of their lifecycle.

- **Recovery, reuse and recycling:** solutions to effectively recover and reuse valuable materials like batteries, tyres, metals, and plastics

4. Digital and Circular Support Solutions

Leveraging technology and other (information) systems to enable the circular mobility system

- **ICT platforms:** facilitating a modal shift, and/or more efficient and intensive use of assets
- **Asset health detection:** facilitating predictive maintenance
- **Supply chain traceability:** facilitating material recovery and valorisation

1. Global Resources Outlook (2024); 2. Ellen MacArthur Foundation (2021)

CONTACT US

QUESTIONS, COMMENTS OR WANT TO CONNECT?



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I want to talk about this report and/or impact (methodologies) in Mobility & Logistics

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I'm a startup with an innovative solution to a problem highlighted in this report.
Fill out our form on the website to get funded: https://shiftinvest.com/getfunded
& contact Quint at quint.van.honk@shiftinvest.com

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