Sector Analysis: Transportation

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Executive Summary

Investing in the transportation sector is a significant opportunity for investors. Inrate's ESG Impact Rating offers investors the opportunity to identify companies that understand best how to innovate and come up with products and services to reduce carbon emissions, while minimizing unfavorable trade-offs related to traditional fuel vehicles.

Main developments and trends

Transportation is a cornerstone of our economy and society. Currently, several major trends can be observed in the transportation sector: the traditional combustion engine is challenged by alternative drive systems, autonomous driving is becoming a reality and car sharing is gaining traction. Digital mobility services and new means of mobility such as e-bikes are shaping how people and goods move from A to B. It is only a matter of time until the transportation sector will be highly automatized, vehicles will be interconnected and able to communicate with each other.

Impact of the transportation sector

The economy might benefit from transportation, albeit at the expense of the environment and society. Transportation is a major contributor to climate change and responsible for more than half of all NO_x emissions worldwide. Transport activities have an impact on hydrological conditions, water quality and biodiversity. Not only are there health impacts due to environmental damage, but society is also affected by societal costs such as road accidents, in some cases poor working conditions, noise emissions and infrastructure capacity problems.

Moving towards sustainability

To accomplish the transition to a sustainable transportation system, we must shift our focus to three base pillars: decarbonization, internalization of external costs and the investment in infrastructure. It is imperative for society to transition to zero-emission vehicles, shift towards public transport, walking or cycling and reducing the need to travel. Also, the external costs of transportation need to be reduced, which can be done by implementing eco-taxes or emissions trading systems, for example. Last, but not least, substantial efforts in infrastructure are required.

Content

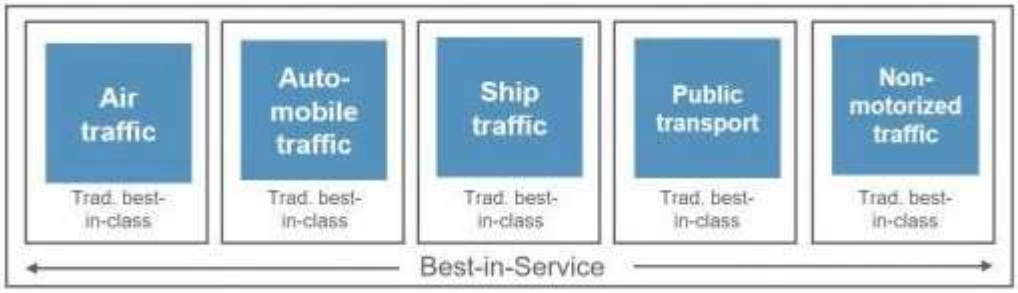
1. Relevance for Responsible Investors

The transportation sector is one of the key service sectors in the Inrate research universe, from a financial, economic and sustainability point of view. Understanding the sustainability impacts of transportation companies is crucial for investors in order to manage related risks and opportunities. Major challenges are the shift from combustion to alternative engines, transportation safety and the reduction of noise. Companies with better sustainability impacts than their sector peers are able to profit, others will run the risk of falling behind.

The transportation sector is the third largest sector of the Inrate research universe with a total of 290 out of 3'500 listings.[1] It is the sixth largest sector in the MSCI All Country World Index (MSCI ACWI) and represents 5.9% in terms of index weights.

The financial importance of the sector reflects the fact that transportation is a fundamental societal need and, as such, is indispensable in a highly globalized economy. However, the sector is a major contributor to climate change and NO_x emissions worldwide. In addition to the health impacts of environmental damages, society is further affected by road accidents and noise emissions, just to name a few major sustainability impacts (for further details see chapters 4 and 5).

Both for risk-oriented and ethical investors, knowing the sustainability impact of their investments is crucial. With its ESG Impact Rating[2], Inrate evaluates the overall impact of companies' activities on environment and society throughout entire product life cycles. Inrate's Best-in-Service approach groups companies by means of Inrate-defined service sectors. These sectors encompass companies from several industries that satisfy a specific basic social need. In the transportation sector vehicle manufacturing, aviation, shipping, public and non-motorized transportation companies all compete together (Inrate 2018a). By doing so, the approach identifies companies providing transportation with the best sustainability impacts and thus contributing to sustainability.



Source: Inrate 2018a

In order to reach the Sustainable Development Goals (SDGs) as defined by the United Nations (2015), the transportation sector must undergo drastic changes until 2030. These are fueled by changes in regulatory frameworks, technological progress affecting the costs of alternative powertrain technologies, public pressure, etc. Companies with more positive sustainability impacts than their sector peers have an advantage and are able to profit from this trend; they may be able to secure themselves a position in growth markets, avert the threat of rising costs, anticipate regulation at an early stage, or boost their appeal as an employer on the strength of their positive reputation. Companies with a negative impact, however, run the risk of losing out.

In the long run, the biggest challenge will be to develop the alternative to the internal combustion engine further to reduce carbon emitted by transportation. The success of car manufacturers will depend on their ability to adjust their business models to this changing environment. It will be pivotal how much resources companies devote to innovation and forward-looking product development to come up with new and more efficient products (Inrate 2017). Sustainable investments should support alternative fuels while at the same time keeping in mind the amount and origin of the electricity used to power the vehicles. Tesla has undertaken the right step in this direction by extending its product range from racing cars with comparatively high energy consumption to more everyday models as well as by offering solar power systems and storage systems.

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[1] The Inrate research universe comprises more than 3'500 companies (as of November 2018), which are drawn from the SPI, the SBI, the MSCI World Index, the MSCI Emerging Markets Index and also includes a range of unlisted corporations.

[2] The ESG Impact Rating evaluates the positive and negative impact that corporations have on sustainability and, thus, focusses on environmental, social and governance (ESG) issues. The ESG Impact Rating encompasses a product assessment – i.e. the impact of the products and services offered by a company– and a CSR (Corporate Social Responsibility) assessment. For more details see Inrate 2018a.

New innovative business models like connected autonomously driving cars or car-sharing services have potential to enhance efficiency and reduce emissions. Since sharing solutions use resources more efficiently, they can contribute to a more sustainable society. Companies that understand best how to innovate and come up with products that contribute to reduce carbon emissions, while minimizing trade-offs to traditional fuel cars, will lead the way into the future of transportation.

More recently, companies in the automobile industry have been involved in controversial business activities, with detrimental effects on their reputation and stock performance. Particularly due to the disputes around NO_x emissions of cars, some car manufacturers lost part of their credibility in the market. In 2015, reports revealed that Volkswagen cars were equipped with sophisticated software, which discretely turned off emissions controls while driving. While undergoing emissions tests, the software turned the controls on again to pass the test. Worldwide 11 million vehicles from VW and the subsidiaries Audi and Porsche were equipped with this defeat device. VW had to recall a large number of cars and pay penalties in several countries, potentially amounting up to 35 billion USD (as of September 2018, see Bloomberg 2018a). In the aftermath of the VW scandal other car manufacturers were also found to have engaged in similar practices. In light of these controversial events, the performance of automobile manufacturers also depends on their ability to re-gain trust.

This example again stresses the value of Inrate's methodology as the "tool of choice" for full-fledged ESG Impact Rating, as it reveals major related opportunities and risks. Companies with relatively severe negative sustainability impacts must expect, sooner or later, to feel the negative repercussions of those impacts. If regulators for instance set higher emission standards, companies can react by meeting these standards or by failing to meet them. Failure to meet higher standards leads to legal risks for car manufacturers. For ethical investors, the ESG Impact Rating allows to deliberately direct financial flows to companies that contribute to a sustainable development or to engage with companies to influence management decisions in favor of sustainability, e.g. through membership in the Inrate Responsible Shareholder Group (RSG) (Inrate 2018a). Both strategies contribute, as research has shown, to a more sustainable economy (Kölbel et al. 2018).

2. The Transportation Sector

"Transport is fundamental to our economy and society."

European Commission (2011)

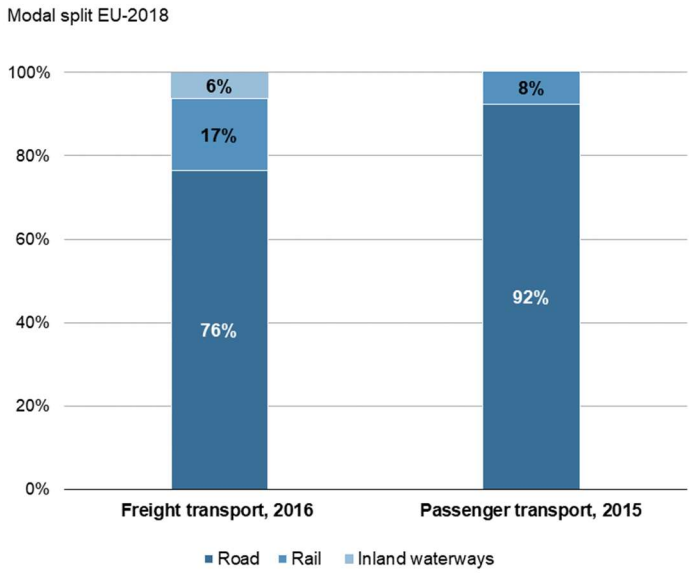
A functioning transportation system is important for the economy and society. Well-organized transportation and logistics chains are key on the international and local level alike. Especially in times of globalization, an efficient transport infrastructure is crucial for economic and social benefits – whether in developed or emerging countries (OECD 2018).

Looking on current and future developments, there are some major challenges ahead. The transport sector must adapt to new forms of mobility and regulations, to an increasing awareness for environmental sustainability as well as to digital and technological innovations. The European Commission's White Paper (2011), for instance, strongly emphasizes: *"European transport is at a cross roads. Old challenges remain, but new have come"* (European Commission 2011).

The way passengers or goods are transported is called "transport mode" and usually is distinguished between road, rail, air and water. Regarding the relative share of each transport mode (modal split), road clearly dominates inland freight as well as passenger transport in the European Union (EU) (Eurostat 2018a, Eurostat 2018b).

Inland transport modes – focusing on road, rail and waterways

Figure: Modal split of inland freight transport (in % of total ton-kilometers) and inland passenger kilometers (in % of total inland passenger-kilometers) in the EU-28



Sources: Eurostat 2018a, Eurostat 2018b; Graphic: Inrate; Note: In passenger transport, the transport mode 'road' comprises passenger cars, motor coaches, buses and trolley buses.

The major developments of the modes of transport in Europe

Road transport

For moving passengers and goods, roads are by far the main mode of transportation. With a share of more than four fifths, passenger cars clearly dominate the passenger transportation in Europe. The modal split in inland freight transport is similar: in 2016, about 75% of inland freight in EU countries is transported by road (Eurostat 2018a).

Rail transport

Despite its ecologic advantages, the share of railway compared to road is significantly smaller. In 2016, less than one fifth of inland freight transport in the EU was carried by trains. However, there are a few countries that are above average with respect to the share of railways – among them Latvia, Lithuania and Switzerland. In Switzerland public transport policies strive to move "as much transalpine freight traffic as possible" from road to rail. Therefore, more than one third of inland freight transport in 2016 was transported on railways (Eurostat 2018a, Swiss Federal Office of Transport 2016).

Air transport

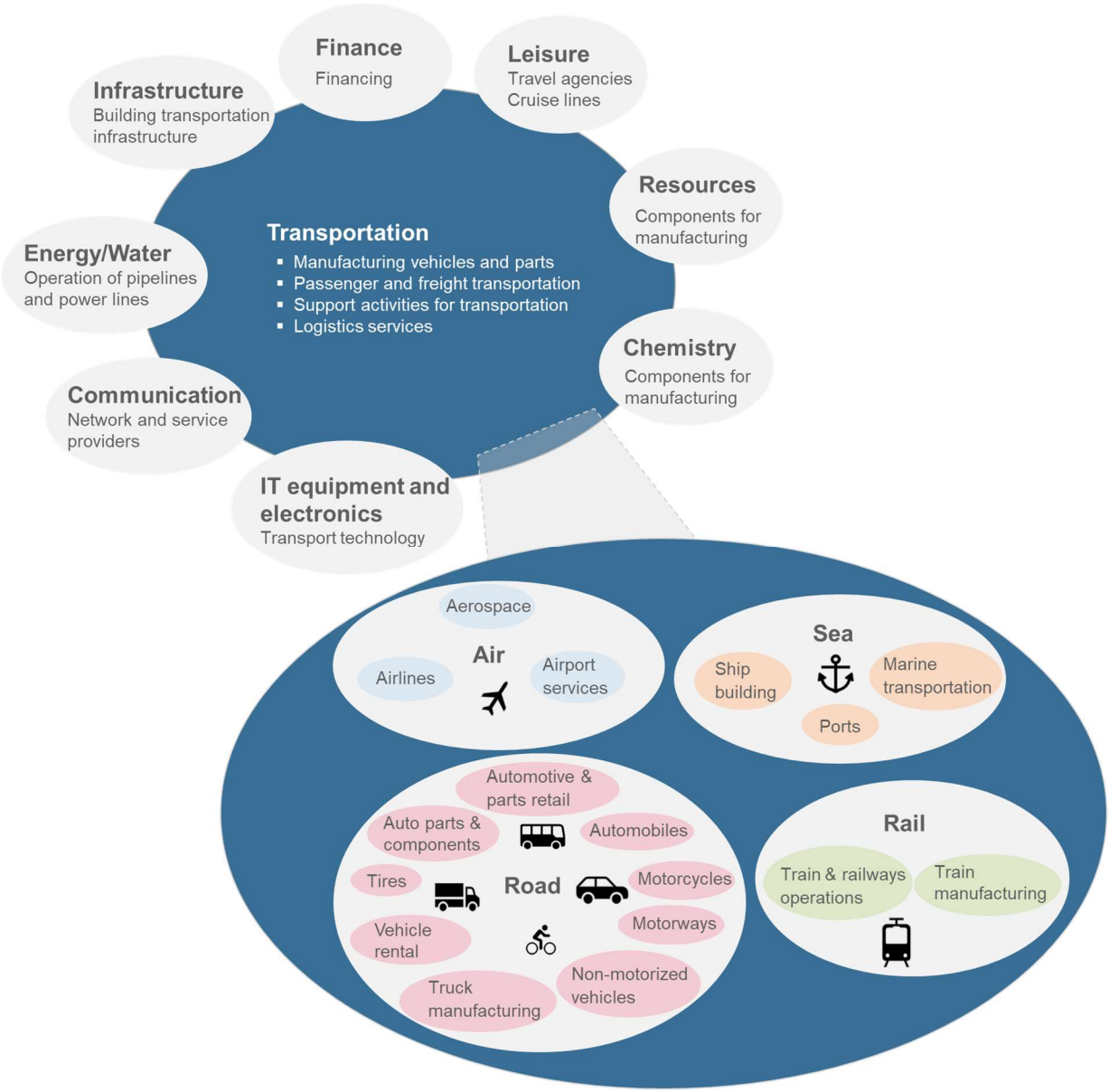
Globally, the continuously growing aviation industry transported a total of about 4.1 billion passengers in 2017. This is an increase of 7.3% compared to the previous year – and a new record. In the EU, about one billion passengers travelled by airplanes in 2017 (Eurostat 2018c, IATA 2018, Forbes 2018, Eurostat 2017a). Aviation experts assume that by 2036 there will be about 7.8 billion air passengers in 2036 – a doubling compared to today (IATA 2017). The share of air freight transport is comparatively low. Taking maritime, inland waterway, rail and road transport into account, in 2016 only 0.1% of freight transport (in ton-kilometers) in the EU was transported by air (Eurostat 2018a).

Water transport

The shipping industry is distinguished between transport on the sea and on inland waterways. In comparison to road and rail, 6 to 7% of freight transport in the EU flowed along inland waterways during the past years (Eurostat 2018a). However, the total maritime freight transport in the EU has been increasing since the second quarter of 2013 (Eurostat 2017b). In the first quarter of 2017, the 'gross weight of goods handled in main ports of the EU' was about 950 million tons (Eurostat 2017b, Eurostat 2018d). Worldwide 90% of all trade is carried by sea (International Chamber of Shipping 2018).

The main elements of Inrate's sector delimitation

Inrate evaluates the transportation sector on a global level. We take a close look at the entire value chain of air, rail, road and maritime transportation. Companies in the transportation sector manufacture and sell vehicles or parts, provide freight and passenger transportation, or supply support activities for transportation like operating ports and highways, as well as logistics services. Industries related to the transportation sector build transportation infrastructure, finance transportation related endeavors, provide travel arrangement services or operate pipelines.



Source: Inrate 2019

3. Main Developments and Trends

What might be shaping the development of the transportation sector in the coming decades? The main trends offer an exciting outlook on what will probably move the world in the future.

The transportation sector is under pressure. It plays a key role in mastering one of the major challenges of the 21st century: climate change. The public is aware of the environmental risks of the so-called "Dieselgate". More and more driving restrictions in cities are initiated while the transportation sector is simultaneously developing rapidly. These developments are visible along the entire logistics chain where digital and technical innovations are occurring.

Alternative drive systems

Alternative fuels comprise a range of alternative drive systems, which are not based on internal combustion engines. A switch to electric, hydrogen, fuel cells, hybrid, natural gas or biofuel is the base for an energy transition in the transportation sector.

According to Climate Action Tracker (CAT), 100% of new car sales in the EU need to be emissions-free by 2035 in order to reach the 1.5°C Paris agreement compatible scenario (Climate Action Tracker 2018). With 1.8% in 2018, the market share of electric cars in the EU still was very low in proportion to new registrations of fossil fuel cars (European Environment Agency 2018e). However, the Bloomberg New Energy Outlook 2018 estimates that the proportion will rise to 55% globally by 2040 (Bloomberg 2018a).

The shift to more vehicles powered by alternative fuels is accelerated by regulatory frameworks in certain countries. Notably, Chinese regulators have set a 2019 deadline for global car makers to meet new quotas: they request that electric cars and plug-in hybrids must account for at least 8% of an automaker's sales. Electric car sales in China are responsible for more than 40% of the electric cars sold in the world (IEA 2017). In 2016 Norway set another example to reduce internal combustion engine (ICE) vehicle sales: the country strives for 100% EV sales by 2025. Particularly in cities, electric mobility can shift pollution levels outside densely populated areas. For example, in Berlin's "green zones" drivers of cars with higher emission have to pay fines (McKinsey & Company 2017a).

Autonomous driving

With the ongoing progress of digital and technological advancement, the automatization of road transport only is matter of time. As Buzzwords like "self-driving cars", "autonomous driving" or "driverless cars" made headlines, they ignited public debates on the future development of the transportation sector.

Self-driving vehicles already exist today: in closed traffic systems, for example at the airports of Frankfurt or Zurich, automatic train operations between terminals are daily business. Autonomous metro lines are standard in an increasing number of European cities such as Barcelona, Copenhagen and Lausanne. And in France the railway company SNCF strives for driverless trains on long distance routes by 2023 (Allianz pro Schiene 2016, The Guardian 2018a). A study by Roland Berger (2016) expects the technological development towards fully automated trucks to take place step-by-step: while today drivers are either fully engaged or slightly profit from driver assistance systems, the authors assume first a "conditional automation" and finally "full automation" – a stage in which the driver has no responsibility during driving (Roland Berger 2016). In another study regarding the transport system in Germany Roland Berger anticipates, that autonomous vehicles will be of great relevance by 2030 and might even be mass produced by then (Roland Berger 2017, Roland Berger 2018). Also, a recent example shows the potential of autonomous vehicles for public transport in the near future (SRF 2018): the so-called "smart shuttles", which ran in Sion in Switzerland on a test basis from 2016 to 2017. Yet it remains unclear how fast consumers will accept and adapt to autonomous driving, because it is a fundamental change of their driving experience. And still many ethical, legal and safety aspects remain and must be solved (Inrate 2018b). In a report by the German ethics commission on automated driving the so-called "dilemma

situations" (see chapter 5 Impacts on Society) are described as moments in which the computer system of the car has to "decide" for the situation with no trade-off (BMVI 2017).

Digital transformation

Autonomous driving requires a digital transformation or disruption. Vehicles need to become interconnected with each other. When cars will be able to communicate vehicle-to-vehicle as well as vehicle-to-infrastructure, it bears huge efficiency gains in terms of improved traffic flows. By directing traffic in a smarter way, traffic jams can be reduced, and parking spaces can be found without searching. When cars are part of a broader mobility network, the industry only has to face its biggest challenge yet: cyber security. Digital design and manufacturing have the potential to increase productivity significantly by lowering development costs and decreasing time to market (Inrate 2018b).

New business models

Another disruptive trend in the automotive industry is new business models. In recent years, consumer preferences shifted from car ownership towards car sharing or digital mobility services. This increased the demand for car sharing services and transportation networks like Uber, Sharoo or Lyft (McKinsey& Company 2016a). Due to that, most vehicles will be moving constantly, and the space of parked cars will be freed up. However, more car sharing does not necessarily imply less traffic or car sales. This is due to the fact that when car sharing becomes more popular, car usage and therefore wear and tear might increase. Furthermore, consumers can choose from a broad variety of vehicle types, which might raise the demand of the customers e.g. for a rather utilitarian car to commute to work while enjoying a luxury sports car on a weekend drive (PWC 2015). Most automobile manufacturers do no longer solely rely on manufacturing vehicles and offer a set of digital mobility services too. According to experts, this development might lead to an expansion of existing revenue pools due to a broader diversification of offered services towards more on-demand mobility and data-driven services like software upgrades (McKinsey & Company 2016b, Inrate 2018b).

New means of mobility

New means of transport are increasingly shaping the mobility sector. Electric bicycles, also known as e-bikes, e-scooters and partly self-balancing personal transporters ("Segway"), are becoming a part of urban mobility. According to Eurostat, the "number of imports and exports of electric bicycles to and from the EU has risen sharply" in recent years (Eurostat 2017c). A study of IFH Köln shows, that e-bikes made about 50% of the total turnover in the bicycle market in 2017. The authors expect that the share of e-bikes will increase by about five percentage points within the next five years (IFH Köln 2018). In summer 2018 an announcement by Uber supported that trend: the transportation network company now intends to focus on e-bikes and scooters instead of cars for inner-city journeys, as they are more efficient especially in rush hour times (Business Insider 2018). New developments not only take place on the ground, but also in the air: drones increasingly find their way into daily life. Already today, these so-called "unaccompanied aerial systems" are used in military operations, on farms, by insurances, in leisure activities (e.g. holidays) or for commercial video recordings. For the upcoming years, innovative developments and new fields of application are expected, amongst them are delivery services or the use as air taxis. There are however, still various legal questions and challenges that need to be solved (TA-SWISS 2018, McKinsey 2017b).

4. Impacts on the Environment

The relationship between transport and the environment is paradoxical in nature. The socio-economic benefits of transport come with high external environmental costs, creating many challenges for humanity.

"Transport drives economic activity and is fundamental to human welfare, but the sector is also a major source of greenhouse gas emissions and other forms of pollution, with significant impacts on the environment and human health."

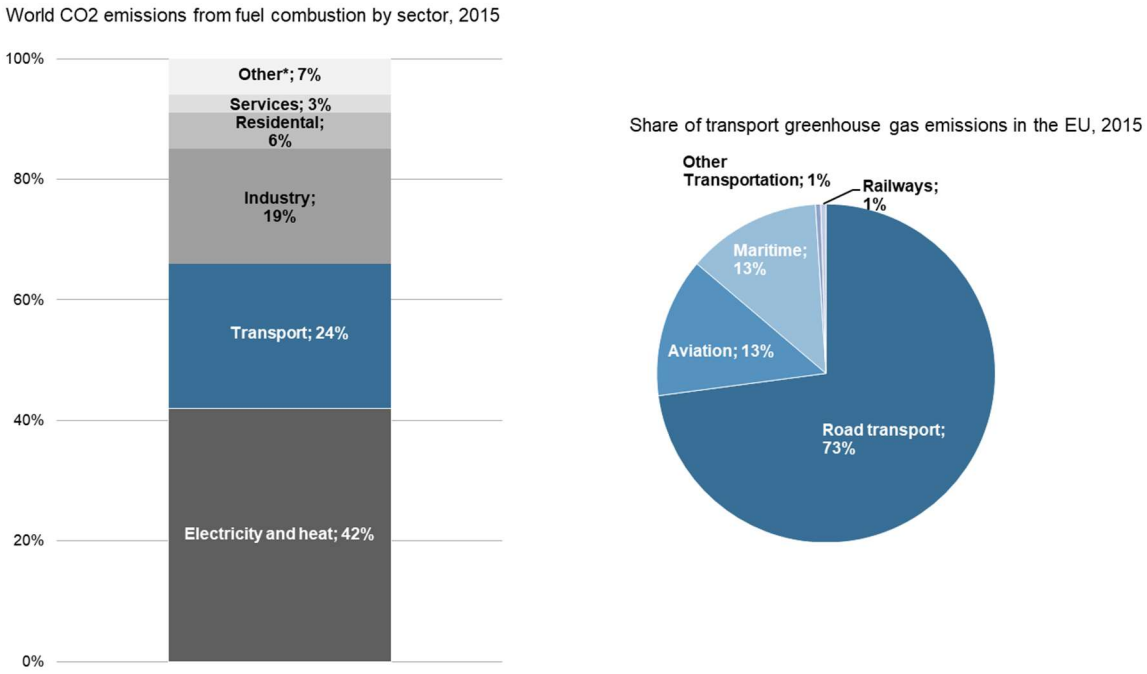
UNEP (2018)

Climate change

The transportation sector is one of the main causes of climate change with 95% of the world's transport energy still coming from fossil fuels (UNEP 2018). In 2015 approximately 25% of all global CO_2 emissions from fuel combustion were caused by aviation, road and other transport modes. Only the generation of heat and electricity were accountable for more emissions (International Energy Agency 2017).

Transport, heat and electricity made two thirds of all CO_2 emissions

Figure: World CO_2 emissions from fuel combustion by sector (2015) and share of transport greenhouse gas emissions in the EU, 2015



*Other includes agriculture/forestry, fishing, energy industries other than electricity and heat generation, and other emissions not specified elsewhere.

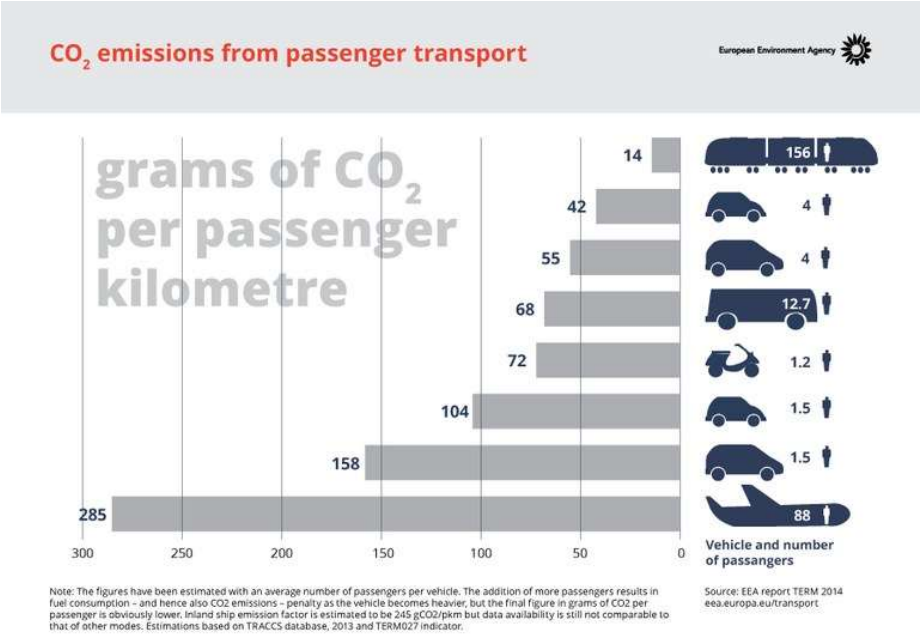
Sources: International Energy Agency 2017; European Environment Agency 2018a; Graphic: Inrate.

From all greenhouse gas emitted by transport in the EU in 2015, road transport was responsible for the highest share, namely about 73%. Rail transport only accounted for a small amount of 0.5% (European Environment Agency 2018a).

Looking at carbon emissions per passenger kilometer, we get a different picture. Air transportation clearly causes the highest CO_2 emissions per passenger kilometer (285 grams), followed by heavy and light passenger cars. The more passengers occupy a vehicle, the

heavier it becomes and thus consumes more fuel – but still, the final consumption per passenger is lower (European Environment Agency 2018b).

Carbon dioxide emissions from passenger transport



Source: European Environment Agency 2018b

In total, greenhouse gas emissions from transport strongly increased during the past decades. In 2015, emissions were about one quarter above the levels in 1990 (European Environment Agency 2018a). Aviation is one of the fastest growing sources of greenhouse gas emissions, with emissions having doubled in the last 20 years. This makes the sector responsible for an estimated 5% of anthropogenic global warming (Transport & Environment 2018).

In addition to contributing to climate change, transportation is also affected by it. Rising sea levels have an effect on infrastructure and more extreme weather situations lead to harsher operating conditions.

Air pollution

Transport is responsible for more than half of all NO_x emissions worldwide and contributes significantly (around 10 % or more) to the total emissions of other air pollutants. Road transport, in particular, continues to make a significant contribution to emissions of all main air pollutants (with the exception of SO_x). The majority of emissions from road transport are exhaust emissions from fuel combustion. The non-exhaust releases of road transport are non-methane volatile organic compounds (NMVOCs) from fuel evaporation as well as primary particulate matter (PM) from tire- and brake-wear and road abrasion (European Environment Agency 2018c).

Between 1990 and 2015 the transport sector significantly reduced emissions of certain air pollutants including carbon monoxide (CO), NMVOCs, sulfur oxides (SO_x) and nitrogen oxides (NO_x). All transport modes have reduced their emissions since 1990 – except international aviation and shipping whose CO, NO_x and SO_x emissions have increased (European Environment Agency 2018c). Studies indicate that ships cause about 2-4% of CO_2 emissions, 10-15% of NO_x and 4-9% of SO_2 from the global anthropogenic emissions of these air pollutants (OECD 2010). In Europe, air pollution from international shipping accounts for approximately 50’000 premature deaths per year (Transport & Environment 2018).

Water

Transport activities have an impact on hydrological conditions and water quality. Water bodies are contaminated by fuel, chemical and other hazardous substances discarded from aircrafts, cars, trucks and trains or from port and airport terminal operations.

Within the transportation sector, marine transport emissions have the strongest impact on water quality (The Geography of Transport Systems 2018). Today, sea shipping mainly burns heavy fuel oil. The alternative would be marine diesel oil, which is almost twice as expensive, or low-sulfur heavy fuel oil. The illegal disposal of oil residues is a major burden on the environment. About 1% (around 2.8 million tons worldwide) of heavy oil remains as oil sludge after separation and filtering. The sludge is collected in tanks on ships and should be disposed in ports. However, due to cost reasons, this is not always the case (Transport & Environment 2018).

Biodiversity and habitats

Transportation also significantly affects biodiversity. For example, the development of land-based transportation has led to deforestation. Many animal species are becoming endangered because of changes to or loss of their natural habitats due to the fragmentation of their living environment by transportation infrastructures (The Geography of Transport Systems 2018). Railway tracks and roads provide corridors which enable non-native invasive species to spread quickly. Ships carry organisms like small fish, plankton or germs across oceans in their ballast water. Thus, many foreign species – some of them invasive – have settled in places where they are not originally at home. These invasive species can assert themselves unhindered by local competitors, predators or parasites and – in the worst case – reproduce unrestrictedly (Transport & Environment 2018).

5. Impacts on Society

Transportation fulfils the societal need of moving passengers and freight from A to B. But this also generates many negative effects. Society faces numerous challenges including accidents, air pollution, issues due to infrastructure expansion and noise emissions.

Safety in transport

Safety is crucial for all modes of transportation. Here the focus lies on road transport, because it has the highest usage and accident risk per passenger kilometers of all modes of transportation. Nevertheless, motorcycle drivers face the highest risks. Rail, bus and air are relatively safe ways to travel (Leighton Walter Kille 2014). Road safety has been addressed by two Sustainable Development Goals (SDGs). The first is target 3.6: “By 2020, halve the number of global deaths and injuries from road traffic accidents”. The second is target 11.2: “By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons”.

Road accidents are a major societal issue. According to the World Health Organisation (WHO), road accidents cause the death of about 1.3 million people per year. Annually about 20 to 50 million people suffer non-fatal injuries. The WHO states that road accidents are “a major cause of death among all age groups and the leading cause of death among those aged 15-29 years” (WHO 2017). It is estimated that road accidents cause an economic loss of around 3% of GDP per annum globally (WHO 2015).

Driverless mobility has the potential to substantially increase passenger safety by avoiding human error. McKinsey estimates that human error is the cause for 90% of the accidents. Thus, driverless mobility could reduce accident rates accordingly (McKinsey 2015). In contrast, new challenges related to technical issues and cyber security arise.

Ethical questions about road safety remain unanswered. A famous thought experiment in this regard is called “the ethical dilemma of driverless cars”. Who should a driverless car save if an accident can’t be avoided? Should the car save the driver at all cost or minimize total harm (TED-Ed 2015)? And who should make this decision?

Safety is also an important issue for rail and air transportation, where accidents affect many people. In 2018, aviation statistics registered 15 fatal commercial (passenger and cargo) aviation accidents internationally with a total of 556 fatalities (Aviation Safety Network 2019). In 2016, 964 fatalities resulting from railway accidents were registered in the EU-28. Only a small fraction concerns railway passengers (44 fatalities); 600 fatalities were unauthorized persons on railway premises (Eurostat 2018f).

Working conditions in the transport sector

The transportation sector employed around 7.9% of the total workforce in the EU in 2015 and around 3.2% in the US in 2016 (Eurostat 2018e, Bureau of Labor Statistics 2017). Transport is mentioned in the ILO World Employment Social Outlook as one of the sectors with a high proportion of vulnerable employment (ILO 2018). In the road transportation segment, long working hours, occupational risks and misclassifications as independent contractors are some of the main issues.

Long working hours are a major issue for road transportation – especially for long haulage. In the road haulage sector, drivers are working in a seated position over long periods of time and carry several occupational risks, such as being involved in road accidents and exposed to harmful substances. International long haulage workers are often required to work on weekends and in shifts, which can have negative impacts on their work-life balance (ILO 2018).

Complex subcontracting chains makes the enforcement of laws concerning labor conditions for transportation workers difficult – especially in an international context. Conductors, who should be employed by transportation companies, are sometimes falsely classified as

contractors. The workers are employed via letterbox companies or required to work as self-employed workers. This misclassification of employees as independent contractors puts road transport workers outside the scope of employment protection laws (European Parliament 2015).

Workers in the transportation sector face a challenging environment. Because the transportation sector is getting more liberalized in several European countries, it becomes more competitive internationally and challenges former monopoly services. For example, after the French government announced in 2018 that the rail network would get liberalized (The Guardian 2018d) widespread strikes occurred, because workers feared a worsening of their working conditions. Digitalization substantially affects the transportation sector, too. With the rising need for digital skills, workers face changing job requirements. New business models, like Uber, are big competitors for the present workforce as well. Last, but not least, autonomous driving technology will make more and more jobs in the transportation sector obsolete.

Noise emissions

Increased transportation volumes led to more noise in the recent years. Noise emissions are an issue for all modes of transportation due to their negative impact on health. According to the WHO noise can cause impaired communication, disturbed sleep, difficulties with performance, annoyance, increased aggression, heart disease, hypertension and hearing impairment (WHO 2000).

Aviation constitutes a major source of noise from transport modes. Although aircrafts now are 75% less noisy than 30 years ago, and most airports try to reduce sound levels, the air transportation volume rose significantly over the past 30 years (European Commission 2018b). This noise particularly impacts those people living in the vicinity of airports.

Noise caused by road transport mainly affects people living in high traffic zones or next to highways. At low speed, electric drive vehicles emit less noise than cars with a combustion engine. This raised hopes among many people that these vehicles would contribute to the reduction of traffic noise levels. However, at low speed it is difficult to hear approaching electric vehicles. This is new safety risk – especially for visually impaired people. In the US and the EU, regulators have made it compulsory for hybrid and electric vehicles to make sounds at low speed (Reuters 2018, Regulation (EU) No 540/2014). Switzerland has adopted this EU regulation in November 2018 (NZZ 2018). Noise emissions are also a topic concerning rail transportation, because they increase with the speed of the train and depending on wheel and rail roughness levels (Global Reporting Initiative 2013).

Infrastructure capacity problems

According to an OECD outlook (2012), air passenger traffic could double within the coming 15 years; air freight could triple in the coming 20 years and port handling of maritime containers worldwide could quadruple by 2030. The OECD estimates that a good part of the current infrastructure is not equipped to handle a 50% increase in goods and passenger flows (OECD 2012). In order to avoid more traffic jams, transportation interruptions and delays, huge investments are needed. Additionally, some of the existing infrastructure requires renovation.

The need of new or better infrastructure presents a challenge. Major infrastructure projects need planning well in advance and require 10 to 20 years to be realized (OECD 2012). Recent discussions about the state of the transportation infrastructure in Europe have been triggered by the collapse of the Morandi Bridge in Italy in the summer of 2018, causing the death of 43 people.

6. Inrate Vision of a Sustainable Transportation Sector

"In contrary to industries such as housing, energy and industrial production, mobility as a sector does not have a clear 'problem owner' who should reduce mobility emissions. Neither the government, nor vehicle industries, nor the consumer is primarily responsible. Creating sustainable mobility needs a multi-actor approach, including all stakeholders."

International Scientific Conference on Mobility and Transport 2014.

To meet the needs of present and future generations, mobility should ideally be available, affordable and efficient for everyone. The future of the transportation sector especially will be shaped by the scarcity of fossil fuels, new technologies like the lithium-ion battery and the increasing societal acceptance of sharing.

Decarbonization

Global warming is progressing and if humanity wants to mitigate climate change, greenhouse gas emissions must be radically reduced. The global economy must be rapidly transformed in a way that it emits much less carbon than it does now. The following approaches are needed to achieve the so called "decarbonization" process in the transportation sector:

- Improve: Moving towards zero-emission vehicles. The transition towards low- and zero-emission vehicles needs to accelerate. There is already a wide range of zero-emission vehicles available: human-powered bikes, battery electric vehicles and fuel cell or hydrogen-powered vehicles. Apart from the human-powered bike, these vehicles only produce zero emissions, if powered by renewable energy. The shift to more alternative fuel powered vehicles is accelerated by regulations in China, India and Norway (see chapter 3 The Transportation Sector).
- Shift: Technology alone cannot deliver the required changes in a short time frame. Therefore, a strong modal shift towards public transport, walking and cycling is needed. This will be achieved only with policy and behavioral changes as well as infrastructure investments. Modal shift will also generate a number of additional benefits regarding employment, congestion, health, accidents and energy supply (International Association of Public Transport 2011).
- Avoid: Integrated land-use planning and transport demand management may reduce the trip distance length and the need to travel (also see following segment). Smart concepts like mobility pricing (which exists in many different variations) might help to reduce congestion and incentivize travelers to make less trips or to use less carbon intensive transportation options. In Sweden, night train bookings went up in 2018, while fewer domestic flights were operated. The Swedish word "flygskam" (ashamed of one's air travel) has become a buzz word. However, this might not only be due to flight avoidance, but also because of a new tax (see remarks on "Internalization" below). Video conferences help companies to save business travel costs and carbon emissions.

Internalization

Transport generates high external costs and as a result, too many trips are made, and freight is transported over large distances. Internalization is a policy instrument to correct market failure and the inefficient allocation of resources following from it. Possible examples of internalization mechanisms are eco-taxes or emissions trading systems. They increase the private costs for those involved in transport but reduce the overall costs (e.g. climate change). This is because higher private costs lower the demand or act as incentive for technical progress that will have a long-term effect. Internalization is also expected to lead to efficiency improvements. Additionally, the transfer of external costs from government to transport users should lower non-transport taxes.

- The European Environment Agency estimates that the total EU external transport costs are split in 83% from road traffic, 13% from aviation, 3% from rail and 1% from inland shipping. Three quarters of external transportation costs in the EU are caused in Germany, Italy, the United Kingdom and Spain (European Environment Agency 2018d).

- A toll on trucks, buses and cars depending on the number of kilometers driven would make it possible to charge the public more fairly for infrastructure and environmental costs incurred by road traffic. This has a positive ecological and traffic control effect in contrast to the time-dependent vignette: as a "flat rate" it tends to encourage frequent driving.
- The internalization of external costs in the aviation industry could be achieved by several methods like fuel charges, landing charges, seat/ticket charges and charges based on emission levels. In April 2018, Sweden's government introduced an airline passenger tax (6 EUR on domestic and up to 39 EUR on long haul routes) to combat climate change by reducing the demand for air travel. The government expects the tax to result in 2% less greenhouse gas emissions by reducing airline traffic by 450'000 to 600'000 passengers annually (Blue Swan Daily 2018).

Infrastructure

The transition to a more sustainable transport infrastructure will entail substantial efforts from key stakeholders. Governments will need to encourage infrastructure development. Companies will have to focus on the sustainability impact of their products and services along entire value chains.

- Cities and local authorities will play a crucial role in promoting sustainable transport infrastructure. They are already implementing incentives for low-emission alternative energies and vehicles, encouraging active travel (cycling and walking), public transport, sharing and pooling schemes to reduce congestion and pollution (European Commission 2018a). Equally important are increasing commercial speed and reliability for public modes of transport, e.g. priority at traffic lights and reserved corridors/lanes. When a commercial bus drives 5km/h faster on a busy line, it uses up to 20% less energy and attracts more passengers (International Association of Public Transport 2011).
- A change to zero-emission-vehicles also requires the necessary investments in charging infrastructure. An inadequate charging infrastructure without battery charging or hydrogen filling stations is seen as a major obstacle to the development of electric mobility. The car manufacturers VW, Daimler, Ford Motor Company and BMW founded the joint venture Ionity in 2017 to build stations with a particularly high output of up to 350 kilowatts on highways and motorways. This enables customers to fully charge the batteries of their electric vehicles in around half an hour. Ionity plans to reach 400 charging stations along major European highways until 2020 (Ionity 2018).
- In order to reduce noise disturbance of transport, a concerted effort of the key actors is required. Car manufacturers need to work on reducing the noise emitted by the vehicles. In terms of vehicle design, possible measures are low noise car tires. Governments need to ensure that the infrastructure is adapted accordingly and that traffic flows in an efficient way. New low-noise road surfaces, noise barriers and soundproofing of buildings are being implemented as means of infrastructure. Furthermore, traffic management can reduce noise emissions. Suggested measures aim at restricting traffic during the night, controlling the speed, directing the traffic to non-populated areas, building tunnels and roundabouts, promoting the use of public transportation, cycling and walking (Jacyna, M. 2017). In order to reduce noise emissions of air transportation, less noisy aircrafts need to be developed and built, land-use needs to be planned and managed efficiently[3], noise abatement operational procedures need to be put in place and operating restrictions need to be agreed upon (ICAO 2018).

[3] Land-use planning and management is an effective means to ensure that the activities nearby airports are compatible with aviation. Its main goal is to minimize the population affected by aircraft noise by introducing land-use zoning around airports (ICAO 2018).

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