SUSTAINABLE FREIGHT TRANSPORTATION WITHIN THE EU –
A COMPARISON OF THE DEVELOPMENT AND REALIZATION BETWEEN THE EU, AUSTRIA AND GERMANY

Master’s Thesis
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General Management

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Affidavit declaration

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1 Introduction

This master thesis deals with the topic “Sustainable freight transportation within the EU – A comparison of the development and realization between the EU, Austria and Germany”.

Due to the globalizing world, freight transportation is increasing and this causes environmental degradation. For this reason, besides an economic view of transportation, there must be a social and environmental consideration of this theme. Thus, it is paramount to develop objectives for more sustainable freight transportation. The intensity of freight transportation is rising mainly because of increasing long-distance freight transportation, smaller consignments and shorter product lifecycles. This leads to the pollution of air, water and noise. Additionally, the climate is changing, land is dissected and biodiversity gets lost.

Therefore, the introduction starts with a problem statement which depicts the various difficulties arising from freight transportation. Afterwards, the research questions are elaborated. This thesis aims to find out why freight transportation is increasing, how the European Union is reacting, how different regulations are realized in the member countries Austria and Germany and what differences and similarities exist between those countries. Moreover, there is a description of the used method and procedure. Lastly, the structure and the content of the thesis are discussed briefly.

1.1 Problem statement

Particularly regarding the globalizing world and the harmful development of the environment like climate change, increasing ecological stresses and resource scarcity, it is of utmost importance to take actions to protect our surroundings and all human beings from the pollution and destruction of our everyday life. It is crucial to think and act sustainable to guarantee our children a future worth living in. For this reason, it is essential not just to focus on one field alone like in this case transportation but to combine it with an ecological and social dimension. Therefore, it is especially interesting to interlink the topics sustainability and transportation. As everyone is affected by the impacts of transportation like air, water and noise pollution, climate change, problems with sustainable land utilization as well as biodiversity losses, it is necessary to commonly act and react to the increasing transportation intensity in Europe.

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1 cf. Elkington 1997, pp. 70 ff
2 cf. Umweltbundesamt 2009, pp. 58 ff
3 cf. OECD 2010, pp. 198 ff
4 cf. OECD 2010, pp. 198 ff
For that reason, this master thesis reveals how the European Union is dealing with those problems and how sustainable transportation and related guidelines as well as measures are implemented in the EU and its member states. Especially a composition with the focus on the European level as well as the comparison of the implementation strategies derived from European guidelines and measures in the transit countries Austria and Germany have not been elaborated before in this way. Therefore, it is particularly interesting to compare the findings about the different implementation strategies regarding sustainable freight transportation in Europe with references to Austria and Germany.

1.2 Objectives

Due to the above mentioned problems the focus of this chapter lies on the definition of objectives which are further analyzed within this paper.

Initially, there is an emphasis on the increasing volume of freight transportation including the development and causes as well as the impacts on the environment. Therefore, the first research question is:

- What are causes and problems regarding the increasing volume of freight transportation?

Moreover, it is interesting which laws, guidelines and measures exist throughout the European Union and how the realization in the member states looks like. Therefore, it is important to know which different European standards there are and what actions are taken, especially in the transit countries Austria and Germany. Finally, a comparison of the results shows several similarities and differences concerning the implementation of the European guidelines and measures between the two countries. Thus, the following three research questions developed:

- How does the EU react to the increasing volume of freight transportation in terms of guidelines and measures?

- How are European guidelines and measures realized in the member states Austria and Germany?

- What are the main differences between Austrian, German and European implementation strategies?
1.3 Method and procedure

In order to answer the mentioned research questions, this master thesis is very applicative for being a scientific theoretical literature work. Therefore, there has been a broad literature research before starting with the literature study itself.

First of all, it is important to find out the status quo like existing literature, results and outcomes of various researchers and authors. This study does not only take traditional literature like books and articles into account but also focuses strongly on legislative texts. Along with a complementary internet research additionally scientific articles from the JKU databanks like Springer Link, Ebsco Host, Wiley Online Library, WISO and also Google Scholar are used.

Moreover, particularly this theme requires to find out information about the development of sustainable transportation, the impacts of traffic and how different laws, guidelines and measures are realized in different member countries of the European Union. For this reason, this master thesis is a theoretical reflection and discussion of existing literature. However, a known state of affairs is collected, summarized and depicted in a new and comparative way.

1.4 Structure and content

After the explanation of the method and the procedure, now there is a short overview of the structure of this paper and additionally a brief description of the following chapters is provided.

In this work the development of transportation issues within the European Union are depicted. Particularly, the focus is on freight transportation in Europe. Moreover, special attention lies on the interlinkage of sustainability and freight transportation.

Therefore, the second chapter is about the increasing transportation intensity in Europe. Reasons for this are inter alia transports over longer distances, “just-in-time” production and smaller consignments. As a result, the rising volume of freight transportation already damages the environment and therefore all human beings.\(^5\) In addition, this chapter describes the causes and what forces this megatrend. Furthermore, the shares of different transportation modes are discussed in more detail regarding their advantages and disadvantages. Additionally, future trends of goods transportation are highlighted.

\(^5\) cf. Umweltbundesamt 2009, pp. 58 f
In the third section, there is a focus on the impacts of freight transportation on the environment. Supplementary, it reveals how the transportation of goods negatively influences climate, air, water, land, flora and fauna as well as human beings.

The fourth chapter is about environmental policy as well as transport policy as an essential issue of sustainable development in the EU. Moreover, there is an analysis of precautionary measures done by the EU to intervene and protect the society as well as the environment during the last decades. Therefore, the term “sustainable freight transportation” needs to be defined beforehand. Additionally, the objectives of sustainable freight transportation regarding air pollution control, noise mitigation, climate protection, water pollution control as well as sustainable land utilization and biodiversity protection are depicted. Furthermore, guidelines and standards within the EU are analyzed in more detail. Therefore, there is an historical overview of the development of environmental policies. For this reason, the seven Environmental Action Programs (EAPs) starting in 1973 and lasting until 2020 are outlined. Additionally, other environmental policies like the European Strategy for Sustainable Development, the Europe 2020 Strategy, the Kyoto Protocol and the Paris Agreement are described. Then, the evolution of a common transport policy is circumstantiated. Tracing back to the Treaty of Rome in 1957, a common transport policy became more and more important. For this purpose, inter alia, the trans-European networks contributed a lot to the development of standardized guidelines. Additionally, the new White Paper of 2001 as well as the Mid-term Review of this paper in 2006, the Green Paper of 2009, the Transport White Paper of 2011 and the New Infrastructure Policy of 2014 conduced to this development.

After revealing the history of the environmental policy followed by the evolution of a common transport policy and demonstrating several guidelines and regulations towards sustainable transportation, chapter five highlights the national implementation strategies of these standards in the transit countries Austria and Germany. Therefore, the realization and the development of several guidelines and measures regarding the sustainable transport policy in those European member states are analyzed. Afterwards, a comparative survey on the findings namely the differences of the development and the realization of sustainable freight transportation between Austria, Germany and the EU is demonstrated. Lastly, in the sixth chapter there is a summary and conclusion of the results of this paper.
2 Increasing transportation intensity as a frame condition

In the following section, the history and reasons which lead to an increase in the transportation intensity in the European Union are discussed. Therefore, it is interesting to look at the advantages and disadvantages of the different transportation modes like road, rail, water, sea, air, pipelines and intermodal transportation as well as to examine the development of the modal split of freight transportation. Furthermore, an outlook is given on the future trends of transportation.

2.1 Development, causes and shares of different transportation modes

As mentioned above, this subchapter firstly explains the development of freight transportation within the European Union followed by the description of several causes which lead to this development. Lastly, the shares of different transportation modes are illustrated more precisely.

2.1.1 Development of freight transportation

Between 1980 and 2002 total freight transportation in the EU-15 increased from 1.9 trillion ton-kilometer (tkm) to 3 trillion tkm. This was a rise of 58 % or a yearly augmentation of 2.3 %. This trend further maintained or even became more intense between 1990 and 1999 where the average yearly increase of freight transportation amounted 2.6 %. Especially road transportation became the strongest transport carrier.6

From 2000 to 2007 there had still been an increase of inland freight transportation7. However, in 2008 and 2009 a decline as a consequence of the economic crisis could be detected. The highest drops between the years 2005 and 2009 were recorded in Ireland with a minus of 35 %, Cyprus decreased by 31 % and Denmark fell by 27 %. Nevertheless, the Eastern European countries even increased in this time. Especially Poland with a rise of 38 % and Bulgaria with a climb of 30 % are noteworthy.8 Figure 1 below shows the transport growth of goods, passengers and GDP between 1995 and 2013. Until 2007 an overall increase of the three indicators could be determined. Whereas GDP and goods transportation had higher annual growth rates of 1.6 % and 1.1 %, passenger transport only grew by 1.0 % per anno in the years between 1995 and 2013. Due to the high mentioned drop of goods transportation and the slight decrease of GDP during the financial crisis, the average annual growth rate between 2000 and

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6 cf. Rothengatter 2002, pp. 1 f
7 Note: Total transport of rail, road and inland waterways (European Union 2011, p. 106)
8 cf. European Union 2011, pp. 106 f
2013 was only 0.5 % for freight transportation and 1.2 % for GDP. Passenger transport grew steadily until 2007 and then remained nearly at the same level.9 Nevertheless, in the years between 2011 and 2012 a downward trend could be detected. The annual growth rate of the EU-28 GDP amounted - 0.4 %, passenger transport accounted for - 1.4 % and freight transport showed a - 2.1 % decline.10 However, between 2012 and 2013 the growth rates were again positive. Whereas goods and passenger transportation grew by 0.1 % and 1.1 %, GDP remained at the same level.11

**Figure 1: Transport Growth EU-28**12

Source: European Union 2015a, p. 21

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9 cf. European Union 2015a, p. 21  
10 cf. European Union 2014a, p. 21  
11 cf. European Union 2015a, p. 21  
12 Note: Road, rail, inland waterways, oil pipelines, intra-EU air, intra-EU sea (European Union 2015a, p. 21)
At this point it has to be mentioned, that the comparability of different numbers and statistics is sometimes quite difficult as there are different or lacking definitions of what is meant by e.g. total freight transportation. Often the term is used for total intra-EU freight activities whereas in some cases also extra-EU freight is included as the transportation starts within the European Union. Additionally, different transportation modes are taken for the statistics. Thus, the comparability of statistics is difficult. For this reason, additional information is given in the footnotes when possible.

2.1.2 Causes for increasing freight transportation intensity

After the depiction of the development of the increasing transport intensity, this subchapter is dealing with the causes which lead to this trend.

According to the figure above, there has been a significant overall increase of transportation within the EU from 2,846 to 3,481 billion ton-kilometers which is a rise of 22.3 %.\(^{13}\) Due to the effects of the globalizing world, worldwide trade is rising. More and more goods are transported and additionally they are replaced faster because of shorter product lifecycles.\(^ {14} \) Technical and scientific innovations are reasons for this development. As a result, the economy is growing and boosting production as well as sales and income.\(^ {15} \)

Therefore, it can be said that the high increase of the freight transport intensity is mostly attributable to the changes in the European economy and production system. During the former decades, there was a shift from an inventory holding to a production-synchronous “just-in-time” based economy.\(^ {16} \) Due to “just-in-time” delivery even smaller consignments are conducted. Although this saves warehousing space for the company, the frequency of transportation therefore increases. As a consequence, the volume of freight is not effectively used.\(^ {17} \)

Moreover, the rising trend of mail-order trade is enhancing traffic growth too, which might be a result of the shrinking transportation costs. For this reason, road traffic became more and more the preferred transportation mode.\(^ {18} \)

Furthermore, freight is carried over longer distances because of the enlargement of sales markets, the increasing trade interlinkages and liberalization. Additionally, frequently more

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\(^{13}\) cf. European Union 2015a, p. 36
\(^{14}\) cf. Umweltbundesamt 2009, p. 58
\(^{15}\) cf. OECD 2003, p. 17
\(^{16}\) cf. KOM(2001) 370 endgültig, p. 9
\(^{17}\) cf. Umweltbundesamt 2009, p. 61
\(^{18}\) cf. Umweltbundesamt 2009, pp. 59 ff
goods are produced in a country than can be sold domestically. This also leads to an increasing transportation volume due to trade surpluses.\textsuperscript{19} However, the importation of goods also results in increasing transportation intensity. Due to the fact that Europe cannot produce all goods or services that are important for the economic welfare and are in great demand by the population it is necessary to import goods from other countries. Examples for this might be seasonal products like vegetables which are expected by the customers to be available in supermarkets for the whole year.\textsuperscript{20}

Beyond that, the outsourcing of different production stages in order to minimize production costs also leads to more import respectively transport intensity.\textsuperscript{21} For example Audi established production buildings in China. For this reason, the overall transport volume increases. Therefore, the trend to outsource production stages to East European countries can contribute to a reduction of transport intensity. Companies like Daimler, Ford, VW, and Mercedes followed this tendency to go east and relocated production stages into countries like Hungary, Slovenia and Romania.\textsuperscript{22} It is seen as a very good alternative for European countries in contrast to offshore destinations regarding costs, quality, language, cultural affinities and distance. Additionally, the salaries of the employees in this branch are relatively low in comparison to the West.\textsuperscript{23} Although nearer outsourcing locations have already shorter distances than offshore destinations, the transportation intensity is still increasing due to the trend of moving production facilities abroad instead of producing nationally.\textsuperscript{24}

Moreover, the arrangement of central warehouses is further enhancing the volume of traffic as the distances to the end consumers and also between companies are as a result surging.\textsuperscript{25} In addition, globalization also leads to innovations like containerizing or navigation satellite systems in the fields of transport and communication. These developments diminish obstacles regarding time and distance and therefore also enhance further transportation.\textsuperscript{26}

\textsuperscript{19} cf. Umweltbundesamt 2009, pp. 58 f
\textsuperscript{20} cf. The Levin Institute 2015, n.p.
\textsuperscript{21} cf. Umweltbundesamt 2009, p. 59
\textsuperscript{23} cf. Fiscutean 2015, n.p.
\textsuperscript{24} cf. Umweltbundesamt 2009, p. 59
\textsuperscript{25} cf. Umweltbundesamt 2009, p. 59
\textsuperscript{26} cf. European Commission 2009, p. 15
2.1.3 Advantages and disadvantages of different transportation modes

As the section above highlights several causes which lead to an increase of the freight transportation volume, the following part reveals the advantages and disadvantages of the different transportation modes in order to illustrate their affinities and shows which of them are more environmentally friendly. Additionally, the combination of different modes is explained in more detail. Furthermore, at the end of chapter three there is an overview illustrating the main transportation modes regarding their environmental impacts.

However, it should be mentioned that the literature and statistics mostly refer to inland modes of freight transportation namely road, rail and inland waterways. Nevertheless, also air, pipelines and particularly maritime transportation account for a considerable amount of the transportation volume in Europe.\textsuperscript{27} Although they might not be included in all used statistics, it is still important to know the benefits and hindrances of these transportation modes.

2.1.3.1 Road transport

The advantages of road transportation through trucks are among other things the availability of a dense road network, possible small consignments, flexibility due to the independence of timetables, cheap transportation costs and easy cross-border traffic.\textsuperscript{28} Moreover, door-to-door delivery and a high average speed are possible. Therefore, transportation on the road has the capability for short periods of delivery. Additionally, individual services for customers can be made through special vehicles. The security of the transported goods is also given due to the personal responsibility of the driver. Furthermore, via specific disposition measures, the achievement of high utilization rates is possible. Because of the limited necessity of transshipment, direct customer service and therefore a high demand orientation can be reached.\textsuperscript{29}

Nevertheless, this mode of transportation is relatively vulnerable to the risk of congestion and to accidents. Additionally, it does not have a great bulk capacity and is very dependent on driving conditions like the weather and the situation on the roads. Moreover, there is an adverse ratio of load capacity and the net weight of the vehicle. Other disadvantages of road transportation are political restrictions like for example driving bans.\textsuperscript{30} Also regarding environmental effects, transportation on the road has several disadvantages.

\textsuperscript{27} cf. Eurostat 2014a, n.p. \\
\textsuperscript{28} cf. Umweltbundesamt 2009, pp. 69 f \\
\textsuperscript{29} cf. Kummer 2006, pp. 69 f \\
\textsuperscript{30} cf. Kummer 2006, pp. 69 f
For example, the road is the most polluting land transportation mode regarding noise, exhaust and CO₂ emissions. Therefore, a shift towards rail transportation or the combination with environmental friendlier modes would be very favorable.³¹  

2.1.3.2 Rail transport  

The mentioned disadvantages of the road however, are the most important benefits for railroad transportation as it is not prone to congestion and particularly appropriate for high bulk handling.³² Additionally, this mode is very safe and reliable, has low unit costs and is suitable for automation.³³ Furthermore, the railroad can be seen as the most sustainable land transport mode as it reveals the smallest CO₂ and exhaust emissions (NOₓ and PM)³⁴. The low emission values are partly due to the fact that for example in Germany 25 % to 33 % of the used energy is originating from nuclear power³⁵. Nevertheless, although without using nuclear power, the rail would still emit the fewest emissions compared to the other transportation modes.³⁶

However, disadvantages of rail transportation are the unfavorable noise pollution of trains, limited investments into the network, the arising problem that small consignments are not economically profitable due to a high percentage of fixed costs, little flexibility because of timetables, difficulties with cross-border transportation and the matter of fact that delivery is not possible to the last mile.³⁷ For this reason, time and cost consuming transshipments as well as pre- and onward carriages are necessary. Although the independence of visibility conditions is very beneficial, the resulting loss of capacity, due to the fact that the rails cannot be used so closely, also reflects a disadvantage at the same time.³⁸

³¹ cf. Umweltbundesamt 2009, p. 65  
³² cf. Umweltbundesamt 2009, p. 70  
³³ cf. Kummer 2006, p. 72  
³⁴ Note: Further information about different types of emissions can be find in chapter 3.1 Air pollution  
³⁵ Note: Here the question arises if the reduction of emissions through the usage of nuclear power can be regarded as sustainable.  
³⁶ cf. Umweltbundesamt 2009, p. 65  
³⁷ cf. Umweltbundesamt 2009, p. 70  
³⁸ cf. Kummer 2006, pp. 72 f
2.1.3.3 Inland waterway transport

An inland waterway can be a canal, lake or river which is not characterized as sea and appropriate for navigation. Nevertheless, the frontiers are firths not wider than 3 kilometers at low tide and 5 kilometers at high water level.\(^{39}\)

The transportation mode per inland waterway vessels is especially qualified for the transport of bulk goods and containers as well as large consignments. Additionally, the costs of movement are very low. Although inland vessels are very secure and have only little breakdown susceptibility, the network density is very small. Moreover, the vessels have low speed and therefore are timely inflexible. Another disadvantage is that transportation is only possible from terminal-to-terminal. Furthermore, loading and unloading times are very long and the vessels depend on seasonal weather conditions. This mode of transportation is also characterized by high competition with the railroad.\(^{40}\)

Regarding air pollutants, the inland waterway vessels fare better than lorries but clearly worse than the rail. The negative data is mostly attributable to the high average age of the vessels with about 40 years and the ship engines with 25 years. For this reason, the after-treatment of exhaust gases is also missing or lagging behind. Whereas the CO\(_2\) emissions per ton-kilometer are considerably lower than in the case of lorries, they are still higher than for rails. Additionally, noise pollution of the inland waterway vessels is particularly small in contrast to rail and road transport vehicles.\(^{41}\) Moreover, negative effects resulting from climate change will in turn influence all different transportation modes. Inland waterway transportation will for instance be affected a lot by floods and droughts.\(^{42}\)

Nevertheless, inland waterway transportation is assumed to have great future potential regarding the movement towards more sustainable transport. Through several initiatives this mode will be strengthened in order to be able to compete with other modes. Moreover 21 member countries of the EU-28 already have inland waterways and 13 of them are related. Additionally, the promotion of intermodality will further enhance its integration into European co-modal networks in future.\(^{43}\)

\(^{40}\) cf. Kummer 2006, p. 95  
\(^{41}\) cf. Umweltbundesamt 2009, p. 65  
\(^{42}\) cf. European Commission 2009, p. 14  
2.1.3.4 Maritime transport

Maritime transport of goods includes intercontinental cross-ocean deep sea shipping and short sea shipping.\(^{44}\) Due to the reference to the European Union, in the context of this paper, only the latter will be thematized. According to the European Commission, short sea shipping is defined as:

"(...) the movement of cargo and passengers by sea between ports situated in geographical Europe or between those ports and ports situated in non-European countries having a coastline on the enclosed seas bordering Europe."\(^{45,46}\)

However, it should be considered that in the literature it is often not clear which kind of mode is actually meant by inland waterway, sea or maritime transportation as they are often used synonymously without a clear definition. Therefore, for example the general term waterborne transportation has been used when no clear differentiation could be found.

The advantages and disadvantages of maritime respectively sea transport are similar to those of inland waterway transport. It is possible to carry a high amount of bulk goods, the costs of movement are relatively low and there is a decreasing trend in costs with an increasing ship size. Therefore, positive economies of scale can be reached. Due to the containerization trend of the last years, it has been feasible to solve problems regarding the packaging of goods in the sector of general cargo as well as congestion and handling difficulties on the vessel. Therefore, this mode allows a high degree of automation.\(^{47}\)

Additionally, there are several disadvantages resulting from the terminal-to-terminal transportation like additional pre- and onward carriage, hard direct customer relations as well as time- and cost consuming transshipments. Nevertheless, these problems still apply more to the railroad as to maritime traffic due to the fact that this mode of transportation is not in direct

\(^{45}\) COM(1999) 317 final, p. 2
\(^{46}\) Eurostat 2014b, n.p.: Note: Including ports in:
- EU-27 countries (actually only the maritime member states: Belgium, Bulgaria, Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Malta, the Netherlands, Poland, Portugal, Romania, Slovenia, Spain, Sweden and the United Kingdom)
- EEA countries (Iceland and Norway)
- Candidate countries (Montenegro and Turkey)
- The Baltic Sea area (Russia)
- The Mediterranean Sea area (Albania, Algeria, Bosnia–Herzegovina, Egypt, Israel, Lebanon, Libya, Morocco, Occupied Palestinian territory, Syria, and Tunisia)
- The Black Sea area (Georgia, Moldova, Russia and Ukraine)
\(^{47}\) cf. Kummer 2006, pp. 89 f
competition with other modes. Furthermore, the high percentage of fixed costs and the low speed of the vessels are problematic due to the long duration and therefore resulting capital commitments. Additionally, great packaging efforts of goods are needed to reduce the frequency of losses emerging from moisture. Also the necessity of common detour traffic is disadvantageously.\textsuperscript{48}

Furthermore, the environmental effects of maritime transport can be very harmful. For example, marine pollution through fuel oil treatment, ship accidents, air pollution due to the sulfurous fuels, the usage of anti-fouling paints which are toxic and the deterioration of ecosystems through ballast water are impacts resulting from the transportation of goods on the sea.\textsuperscript{49} Nevertheless, maritime transport will also be troubled with the effects of climate change. The sea level will increase due to global warming and therefore affecting the exposure of offshore infrastructure.\textsuperscript{50}

In contrast to other ways of haulage, maritime transport can serve as a relatively cheap and sustainable transportation mode in future. However, there needs to be a reduction of exhaust emissions. Nonetheless, a ship with a 4,000 deadweight tonnage can substitute 100 to 200 truck journeys. This can lead to a reduced congestion and less air pollution. For a successful shift towards short sea shipping, efficiency and the integration into the supply chain needs to be enhanced. If several improvements and investments for this mode of transportation will be done, maritime transport will constitute a sustainable alternative in European freight transportation.\textsuperscript{51}

\subsection{2.1.3.5 Air transport}

Air transportation is specifically characterized by great transportation security. Although the accident frequency is very small, the amount of loss would be very high. Another advantage is the high transport speed from one terminal to another and the opportunity to combine freight and passenger transportation.\textsuperscript{52}

Nevertheless, there are also disadvantages like the limited transport capacity. For example, the maximal cargo load of a Boeing 747-400F is about 123 tons.\textsuperscript{53} In comparison, in Europe there

\begin{flushright}
\textsuperscript{48} cf. Kummer 2006, pp. 89 ff \\
\textsuperscript{49} cf. Umweltbundesamt 2009, pp. 40 ff \\
\textsuperscript{50} cf. European Commission 2009, p. 14 \\
\textsuperscript{51} cf. Randelhoff 2014, n.p. \\
\textsuperscript{52} cf. Kummer 2006, pp. 78 f \\
\textsuperscript{53} cf. Kummer 2006, pp. 78 f
\end{flushright}
are freight trains which can transport a cargo load of up to 1,500 to 2,000 tones. Moreover, an elaborated ground infrastructure like a security system is necessary and therefore delimits the network-forming capability of air transportation. Additionally, the costs of transportation insurance as well as prior and subsequent handling are very high. Furthermore, an integration into intermodal freight transportation chains is needed as the delivery to the last mile is not possible.

What is more, the environmental impacts of this transportation mode are very high. Airplanes generate enormous noise pollution which especially harms the health of people near airports. In addition, air transportation is the only mode which emits its exhaust gases directly into the upper troposphere where they unfold far higher climate effects than at ground level. Moreover, aviation emits much more CO₂ then all other modes of transportation.

2.1.3.6 Pipeline transport

In this context, pipeline transport is only referring to long-distance pipelines for oil, natural gas and water. This means that pipelines for water, sewage and gas in residential areas are not included. An essential difference in contrast to other modes of transportation is the fact that the carriageway and the transport container coincide. Therefore, substantial advantages regarding unmatched transportation arise as back freights are not necessary. Moreover, pipeline transport is especially suitable for continuously accruing bulk cargos. The closest competitor to this transportation mode is shipping because also large amounts can be hauled with reasonable costs.

The following Figure 2 summarizes most of the above mentioned affinities of the different transportation modes railway, road, inland navigation and air transportation. All in all, it can be said that inland navigation is lagging behind regarding most of the depicted indicators except the mass volume performance where it has the best ranking. Air transportation is very fast, predictable, save and comfortable but concerning the mass volume performance and network capability it lies behind the other modes. Whereas indicators for rail transportation are mainly located in the middle, road transportation especially stands out for its comfort, transport frequency and particularly for its high networking capability.

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55 cf. Kummer 2006, pp. 78 f
56 cf. Umweltbundesamt 2009, pp. 35 ff
57 cf. VCÖ 2009, p. 18
58 cf. Kummer 2006, pp. 96 ff
2.1.3.7 Intermodal transport

Intermodal freight transport is the haulage of goods in the same transport unit but with multiple kinds of transportation modes. During the change of the transportation unit, the goods in transit need not be transshipped separately. Intermodal freight transport is called “combined transport”, when the main part of the route is carried on rails, inland waterways or sea and the pre- and onward carriage on the road is as short as possible.\textsuperscript{59}

Different kinds of combined transport are:\textsuperscript{60}

- **Rolling highway:**
  Embarkation of road vehicles on railway wagons

- **Roll-on/roll-off traffic:**
  Road or railway vehicles are loaded on ships

- **Swim-in/swim-out traffic:**
  Inland waterway vessels get incorporated from seagoing vessels and are transported over longer distances

- **Container traffic:**
  Standardized, easy-handling transport units for a more efficient transshipment

\textsuperscript{59} cf. Kummer 2006, p. 48
Combined transportation tries to unite the specific advantages of the different transportation modes. Due to the standardization of the transportation units it is possible to shift freight transportation towards more sustainable modes.\textsuperscript{61} Nevertheless, a shift of freight transport is only possible when the most important influential factors are considered namely transport costs, transport time and transport quality as well as the infrastructure offered by the specific mode.\textsuperscript{62} However, the benefits arising from intermodality are a faster and more efficient transshipment, more security, reduced damages and a better quality due to the consistent transport unit as well as a reduction of packaging costs.\textsuperscript{63} Moreover, transportation modes other than the road are less energy consuming.\textsuperscript{64} In contrast to continuous road freight transportation from door-to-door, combined transport can save 30\% energy and up to 90\% of polluting emissions. What is more, occurring congestion problems can be reduced and therefore road safety gets enhanced.\textsuperscript{65} For this reason, the stimulation of combined transportation, where the main part is carried on rail, sea or inland waterways, can improve the evolvement of a transport system which is more energy efficient, produces less external costs and additionally encourages sustainable development in this field.\textsuperscript{66} 

Disadvantages of combined transportation are partly long pre- and onward carriages with resulting unsustainable empty journeys. Moreover, the distances regarding road-rail or road-inland waterway transportation is sometimes longer than the same transport route solely on the road. Also the transshipment is still time and cost consuming due to emerging waiting periods.\textsuperscript{67} Therefore, several improvements need to be made. Additionally, there should be an enhancement of transportation modes which have expandable sustainable characteristics. For example, railroad transportation requires a reduction of noise emissions and inland waterway transportation should only be promoted on already existing waterways. If these and further changes will get implemented, combined transport can contribute to counteract environmental pollution and therefore enhance sustainable freight transportation in future.\textsuperscript{68}

\begin{footnotes}
\item 61 cf. Kummer 2006, pp. 49 f
\item 62 cf. Umweltbundesamt 2009, p. 69
\item 63 cf. Kummer 2006, pp. 49 f
\item 64 cf. Mathisen/Sandberg Hanssen 2014, pp. 611 f
\item 65 cf. Posset et al. 2014, p. 19
\item 66 cf. Mathisen/Sandberg Hanssen 2014, pp. 611 f
\item 67 cf. Kummer 2006, p. 50
\item 68 cf. Posset et al. 2014, pp. 12 ff
\end{footnotes}
2.1.4 Shares of different transportation modes

Thinking of all these mentioned advantages and disadvantages, it is interesting to examine the shares of the different transportation modes in more detail.

In the last ten years, it has been conspicuous that the road was more and more becoming the preferred mode of freight transportation in the European Union. Particularly in newer European member countries the rate was increasing. Between 2002 and 2012, the share of road transportation increased by 23 % in Estonia, by 19 % in Poland and Slovakia and by 12 % in Slovenia and Bulgaria. Nevertheless, there has already been a contrary development in eleven other European member countries. Those revealed more environmentally friendly numbers due to shifts from the road towards the rail and inland waterway transportation. Most noteworthy were Belgium and Austria with a decrease of road transportation of 19 % and 11 %. In four of the eleven countries the shift was towards inland waterway transportation. Belgium with a rise of 12.5 % and Romania with 14.3 % revealed the highest increment. The remaining seven member states had increases in rail transportation. The greatest shift was recorded in Austria with a surge of 11.5 %. Moreover, it should be mentioned that every member country of the European Union except of Latvia carried out more than 50 % of its freight transportation on the road. Only in Latvia 64 % of freight was transported on the rail. Some other countries also recorded high amounts in rail transportation like Estonia with 47 %, Austria and Sweden with 40 % and Lithuanian with 38 %. Moreover, the Netherlands, Belgium and Romania accounted for the highest shares of inland waterway transportation with 39 %, 24 % and 23 %. The modal split of inland freight transport of the different member countries is depicted in Figure 3.

\[69\] cf. European Union 2014b, pp. 132 f
Figure 3: Modal split of inland freight transport, 2011 (% of total inland freight tkm)

Source: European Union 2013, p. 111

Especially interesting for this thesis is the modal split of Austria and Germany. Austrian road transportation in 2011 accounted for 56 %, the railway had a share of 40 % and inland waterways made up 4 %. Germany revealed a proportion of 66 % of road transportation, 23 % of inland freight was transported via railway and 11 % of haulage was done on inland waterways.

On the European level, the amount of the railway only rose by 4.7 % between 1995 and 2013. However, the share of road transportation increased by 33.4 % with an annual growth rate of 1.6 %. The transportation on inland waterways climbed up by 25.1 % during this period. The proportion of pipelines decreased by about 2.7 %. Hence, in the year 2013, the road revealed the highest share of 71.9 % of the European modal split followed by the rail with 17 %, inland waterways with 6.4 % and pipelines with 4.7 %.

The overall European modal split of inland freight is depicted in Figure 4.

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70 Note: This indicator includes transport by road, rail and inland waterways. Rail and inland waterways transport are based on movements on national territory, regardless of the nationality of the vehicle or vessel. Road transport is based on all movements of vehicles registered in the reporting country and covers only the haulage of heavy goods vehicles (usually>3.5 tons load capacity). (European Union 2013, p. 111)

71 cf. European Union 2013, p. 110

72 Note: Measured in billion ton-kilometers

73 cf. European Union 2015a, pp. 36 f
As already mentioned above, most literature and statistics just focus on inland modes of transportation namely road, railway and inland waterways. Nevertheless, the comparison of the modal splits when air and especially sea are included reveals a very different picture as illustrated in the Figures 5 and 6.

**Figure 5: EU-28 Performance by mode – freight transport**

| Year | ROAD | RAIL | INLAND WATERWAYS | PIPERINES | SEA(*) | AIR(
<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>43.3</td>
<td>33.6</td>
<td>4.3</td>
<td>4.0</td>
<td>32.7</td>
<td>0.1</td>
</tr>
<tr>
<td>2000</td>
<td>46.5</td>
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<td>4.1</td>
<td>3.9</td>
<td>32.9</td>
<td>0.1</td>
</tr>
<tr>
<td>2001</td>
<td>47.2</td>
<td>31.8</td>
<td>4.0</td>
<td>4.1</td>
<td>32.9</td>
<td>0.1</td>
</tr>
<tr>
<td>2002</td>
<td>47.8</td>
<td>31.5</td>
<td>4.0</td>
<td>3.9</td>
<td>32.8</td>
<td>0.1</td>
</tr>
<tr>
<td>2003</td>
<td>48.6</td>
<td>31.7</td>
<td>3.7</td>
<td>3.9</td>
<td>33.1</td>
<td>0.1</td>
</tr>
<tr>
<td>2004</td>
<td>48.6</td>
<td>31.6</td>
<td>3.8</td>
<td>3.7</td>
<td>32.2</td>
<td>0.1</td>
</tr>
<tr>
<td>2005</td>
<td>48.7</td>
<td>31.3</td>
<td>3.8</td>
<td>3.7</td>
<td>32.5</td>
<td>0.1</td>
</tr>
<tr>
<td>2006</td>
<td>48.9</td>
<td>31.5</td>
<td>3.6</td>
<td>3.6</td>
<td>32.2</td>
<td>0.1</td>
</tr>
<tr>
<td>2007</td>
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<td>3.6</td>
<td>3.5</td>
<td>31.9</td>
<td>0.1</td>
</tr>
<tr>
<td>2008</td>
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<td>31.7</td>
<td>3.9</td>
<td>3.3</td>
<td>30.9</td>
<td>0.1</td>
</tr>
<tr>
<td>2009</td>
<td>50.3</td>
<td>31.8</td>
<td>3.9</td>
<td>3.6</td>
<td>31.4</td>
<td>0.1</td>
</tr>
<tr>
<td>2010</td>
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<td>4.4</td>
<td>3.4</td>
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<td>0.1</td>
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<tr>
<td>2011</td>
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<td>31.9</td>
<td>4.0</td>
<td>3.3</td>
<td>31.8</td>
<td>0.1</td>
</tr>
<tr>
<td>2012</td>
<td>48.6</td>
<td>31.7</td>
<td>4.3</td>
<td>3.3</td>
<td>32.0</td>
<td>0.1</td>
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<tr>
<td>2013</td>
<td>48.4</td>
<td>31.7</td>
<td>4.4</td>
<td>3.2</td>
<td>31.3</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Source: European Union 2015a, p. 36

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74 Note: Road: national and international haulage by vehicles registered in the EU-28. (European Union 2015a)
75 Note: In the 2015 edition, the time series for maritime transport performance has been revised, for the period from 2005 to 2013, by replacing previous estimates on port-to-port distances with more accurate measurements by Eurostat. The time series from 1995 to 2004 have been recalibrated by DG MOVE in line with the new Eurostat figures to avoid break in series. The revision of tkm figures mainly concerns the calculation of distance travelled and not the tonnages transported by sea.
Road: national and international haulage by vehicles registered in the EU-28. (European Union 2015a)
When domestic and intra-EU-28 air and sea transport is included, the European modal split is postponed considerably. In 2013, the modal split of the road accounted for 49.4 % followed by the sea with 31.3 %, rail with 11.7 %, inland waterways with 4.4 %, pipelines with 3.2 % and air with only 0.1 %.

Although maritime transports makes up a high share in the European modal split, which might be attributable to its mass capacity, it is hardly mentioned in public’s perception. For this reason, the great share of sea transport linked with the mentioned advantages of combined transportation reveals a high potential for more sustainable freight transportation.

Source: European Union 2015a, p. 35
2.2 Future trends of goods transportation

After the depiction of the development and causes of freight transportation as well as the representation of several affinities and the shares of the different transportation modes, this subchapter focuses on the future trends of goods transportation.

According to the European Environment Agency (EEA), freight transportation and especially road traffic are massively increasing in the EU.\textsuperscript{78} It is forecasted, that European goods transportation will rise by 50\% in the years between 2000 and 2020.\textsuperscript{79}

As depicted in Figure 7 below, it is estimated that the volume of road freight transportation will increase about 78\% in the years from 2000 to 2030 and therefore continues to be the mode of transportation with the most volume.\textsuperscript{80}

![Figure 7: Modal split of freight transport in EU-27, 1990-2030](image)

Source: EEA 2009, n.p.\textsuperscript{81}

Nevertheless, until 2050 there will probably be a downward trend in the annual growth rates especially of road transportation.\textsuperscript{82} According to a study from McKinnon & Piecyk, there will be a shift from road to other transportation modes of over 10\% until 2050.\textsuperscript{83}

\textsuperscript{78} cf. OECD 2010, p. 131
\textsuperscript{79} cf. COM(2006) 314 final, p. 7
\textsuperscript{80} cf. OECD 2010, p. 131
\textsuperscript{81} Note: Modal split covers public trucks, rail transport and inland navigation. It should be noted that inland navigation includes both waterborne inland transport activity and domestic sea shipping. However, international short sea shipping is not included in the above category. (EEA 2009, n.p.)
\textsuperscript{82} cf. Anders/Knaack/Rommerskirchen 2009, p. 34
\textsuperscript{83} cf. McKinnon/Piecey 2010, p. 8
Also a Swedish study forecasted a 10% shift towards rail and sea transport.\textsuperscript{84} However, it cannot be said how freight transportation will actually develop in future.\textsuperscript{85}

As it can be seen below in Figure 8, until 2050, there presumably will be a small shift towards transportation modes which are more ecologically friendly namely rail and inland waterway vessels. Even tough road transportation will still dominate.\textsuperscript{86}

**Figure 8: Development of modal split in long-distance freight transport**

![Figure 8](source-image)

Source: Schmiele et al. 2011, p.111

Notwithstanding, a general deterioration of road transportation is expected in all member countries.\textsuperscript{87} After 2020 there will probably be a remarkable rise in the share of rail transportation. Additionally, from 2035 on, the increasing share of inland waterway vessels will exceed the growth rate of the road.\textsuperscript{88} Furthermore, changes towards rail transportation are more likely in Eastern European countries especially in Estonia and Lithuania. In Western European member states road transportation is predicted to be higher than in Eastern ones. The proportion of inland waterways will probably not rise noteworthy.\textsuperscript{89}

All in all it can be said that until 2030 there will still be an increase of road transportation but from then on until 2050 there will be a decline and therefore a shift towards more sustainable transportation modes although the road will still be dominating.\textsuperscript{90}

\textsuperscript{84} cf. ERTRAC 2011, pp. 7 f
\textsuperscript{86} cf. Schmiele et al. 2011, p. 110
\textsuperscript{87} cf. Anders/Knaack/Rrommerskirchen 2009, pp. 42 ff
\textsuperscript{88} cf. Schmiele et al. 2011, p. 110
\textsuperscript{89} cf. Anders/Knaack/Rrommerskirchen 2009, pp. 42 ff
\textsuperscript{90} cf. Schmiele et al. 2011, pp. 109 ff
Taking reference to combined transportation, it should be stated that intermodal transportation will contribute significantly to sustainable freight transportation.\textsuperscript{91} Through the realization of several improvements and investments, combined transportation can be increased significantly and therefore delivers high potential regarding the reduction of road traffic. Additionally, the energy consumption and CO\textsubscript{2} emissions will decline. Furthermore, the combination of road and rail transportation is seen as being the most dynamic market for European freight haulage.\textsuperscript{92} Moreover, for example the “Motorways of the Sea”\textsuperscript{93} initiative of the European Commission should also enhance sustainability through shifting road haulage towards maritime transportation and therefore reducing negative environmental impacts.\textsuperscript{94} Nevertheless, there are several enhancements needed like intelligent transport technologies which make combined transportation more effective, less cost and time consuming and therefore more integrated as a solid mode of transport.\textsuperscript{95}

Nonetheless, shifting freight transportation towards sustainability will be quite difficult. Reasons for this are for example long time horizons for the development of sustainable driving systems, factors regarding different types of cargo, necessary changes in prices and missing innovations in the field of sustainable transportation modes in order to incite modal shifts.\textsuperscript{96}

\textsuperscript{91} cf. Anders/Knaack/Rommerskirchen 2009, p. 51
\textsuperscript{92} cf. Meyer-Rühle (2011), pp. 71 ff
\textsuperscript{93} See: OJ C 317, 2008, pp. 10 ff
\textsuperscript{94} cf. Anders/Knaack/Rommerskirchen 2009, p. 51
\textsuperscript{95} cf. Meyer-Rühle (2011), pp. 72 f
\textsuperscript{96} cf. Institute for Transport Studies 2010, p. 15
3 Review of the environmental impacts of freight transportation in the EU

Whereas the second chapter reveals the reasons for the increasing transportation intensity in Europe, the third part highlights the various impacts freight transportation can have on the environment. Besides the well-known pollution through greenhouse gas emissions there are also other harmful substances and impacts which are contaminating and derogating our surroundings. In this chapter, the effects resulting from freight transportation are highlighted in more detail including air, water and noise pollution as well as space and biodiversity effects and climate change.\footnote{cf. OECD 2010, pp. 198 ff} However, most sources only refer to general transportation. As it is difficult to find information separately for freight transport it should be noted that unless otherwise stated, in the next subchapters the single term transportation refers to passenger and freight transport.

3.1 Air pollution

Transportation respectively the combustion of fossil fuels contributes tremendously to the pollution of air. Additionally, also non-exhaust emissions are produced through the evaporation of fuel and the abrasion of tires and brake linings in form of particulate matter.\footnote{cf. Thomas 2015a, p. 17} As a consequence, this contamination influences the water, earth, crops, buildings and living environment but additionally, it is harmful to our lives as well as to the wildlife. Substances which pollute our surrounding most are: Particulate matter ($\text{PM}_{2.5}$, $\text{PM}_{10}$), Nitrogen oxides ($\text{NO}_x$), Ozone ($\text{O}_3$), Sulphur oxide ($\text{SO}_2$) and Volatile organic compounds (VOC).\footnote{cf. OECD 2010, pp. 199 f}

Particulate matter $\text{PM}_{2.5}$ is a partial quantity of $\text{PM}_{10}$. The attached number describes the size of the particles. They arise from transport and especially from diesel vehicles and dust turbulences on the streets. Furthermore, also domestic fuels resulting from old coal fired ovens and the construction industry are emitting particulate matter. Those particles are able to enter the pulmonary alveoli. As the particles are so small, they linger for days or even weeks in the atmosphere. Additionally, due to the high atmospheric transport distance of about 1,000 kilometers, particulate matter is of great international relevance.\footnote{cf. Umweltbundesamt 2015a, n.p.} Illnesses are the result of the suction of particulate matter.\footnote{cf. OECD 2010, pp. 199 f} Related health effects are among other things cardiovascular
diseases which can lead to a reduction of the life expectancy.\textsuperscript{102} Especially people which are vulnerable to breathing difficulties are exposed to a higher risk of such maladies.\textsuperscript{103}

Nitrogen oxides (NO\x26times;\x26circ;) emerge as a byproduct during the burning of combustibles and fuels. The main originator is transport. For humans especially NO\textsubscript{2} is harmful as it interferes with the pulmonary function. Additionally, nitrogen oxides are jointly responsible for the acidification and eutrophication of soils and water bodies. Especially in the summer, the combination with hydrocarbons leads to the formation of tropospheric ozone.\textsuperscript{104}

On the ground, ozone emerges not directly but out of the combination of other pollutants. Therefore, tropospheric ozone is increasing where the precursor substances emerge most often namely in industrial agglomerations and tropical regions with a high combustion of biomass.\textsuperscript{105}

On a global scale, also methane and carbon monoxide (CO) are conducive for the ozone formation. Due to higher ozone concentrations, humans can suffer from lung injuries and related diseases. Plant species sustain damages on their leaf organs, which might result in crop and growth losses. Although tropospheric ozone is one of the substantial greenhouse gases (GHGs), it is not regulated in the Kyoto Protocol\textsuperscript{106} which is further explained in chapter 4.3.1.\textsuperscript{107}

Sulphur oxide (SO\textsubscript{2}) arises especially from the combustion of coal and fuel oil. The main sources of emissions are firing systems in the energy sector, industry and small consumption. Highly concentrated, sulphur oxide is harmful to humans but also to flora and fauna. Oxidation products lead to acid rain which jeopardizes ecosystems like forests and lakes as well as damages buildings and materials. Particulate sulphates also contribute to the exposure of particulate matter.\textsuperscript{108}

Volatile organic compounds (VOC) without methane (NMVOC) are released through the evaporation of solvents (lacquers, colors and pasts) and fuel as well as incomplete combustion processes. This group of substances is particularly important due to their contribution to the formation of ozone.\textsuperscript{109}

\textsuperscript{102} cf. Umweltbundesamt 2015a, n.p.
\textsuperscript{103} cf. OECD 2010, pp. 199 f
\textsuperscript{104} cf. Umweltbundesamt 2015b, n.p.
\textsuperscript{105} cf. Paeger 2015, n.p.
\textsuperscript{106} See: OJ L 130, 2002, pp. 1 ff
\textsuperscript{107} cf. Umweltbundesamt 2015c, n.p.
\textsuperscript{109} cf. Umweltbundesamt 2015e, n.p.
In compliance with the World Health Organization, there are about 865,000 people which die due to air pollution worldwide every year, whereof about 10 % are citizens from the European Union. Nevertheless, it should be mentioned that differently to the impacts of CO₂ on the climate, the consequences of air pollution depend on the location. If air pollution is emitted in a region with more inhabitants it is more harmful than in a distant region.¹¹⁰

In the EU-28 road transportation emissions into the air have even revealed a downward trend mainly due to emission standards. Nevertheless, road transport is still the main polluter regarding NOₓ and particulate matter. Although road transportation has caused less exhaust emissions in the last years, the contaminants emerging from the abrasion of brakes and tires are increasing. Additionally, flora and fauna are still damaged and the quality of air continues to be inferior.¹¹¹

Contrary to the above mentioned air pollutants, CO₂ has no direct impact on humans’ health but rather is relevant in terms of greenhouse gases.¹¹² Therefore, this problem is further discussed in the chapter 3.5 Climate change.

### 3.2 Noise pollution

Increasing noise caused by transportation gets more and more important as the well-being of people and wildlife is deteriorating. Although often left behind, the environmental health problems caused by noise pollution should not be underrated. Generally, it can be said that in Europe, road traffic causes most of the environmental noise. However, this includes passenger and freight transportation.¹¹³ Additionally, also rail and air transportation are generating noise. Notwithstanding, the constant noise pollution originating from the road is usually experienced as more disturbing.¹¹⁴ Therefore it should be mentioned that also the context in which noise occurs is relevant. Whereas the sound level in the workplace is acceptable during the day, at night it would exceed the personal appropriate level. Moreover, if the source of noise is visible, it is perceived as more annoying than when it is hidden. Furthermore, noise is more accepted when it is temporarily like rail transport, in contrast to the more silent but continuous noise caused by transportation on the road.¹¹⁵ Nevertheless, more than 125 million people are exposed

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¹¹⁰ cf. OECD 2010, pp. 199 ff
¹¹¹ cf. EEA 2015b, pp. 33 ff
¹¹² cf. Rat von Sachverständigen für Umweltfragen 2005, p. 27
¹¹³ cf. EEA 2014a, p. 5
¹¹⁴ cf. Thaler 1999, p. 38
¹¹⁵ cf. OECD 1997, p. 9
to high road noise levels of over 55 decibels\textsuperscript{116} from which 37 million people actually have to endure more than 65 dB(A). Moreover, additional 8 million people are exposed to rail and 3 million people to air transportation noise levels above 55 dB(A).\textsuperscript{117}

Beside the resulting disturbance of millions of people, noise is also generating serious health problems like hearing losses. Additionally, blood pressure can increase and cognitive abilities especially of children are affected. The annoyance emerging from environmental noise leads to 43,000 hospitalizations in the EU per year. Moreover, it is assumed that due to noise impacts there are about 245,000 people per year which are suffering from cardiovascular diseases. Thereof, 20 % die because of a heart attack.\textsuperscript{118} Furthermore, the death of 10,000 unborn children is linked to environmental noise. Lastly, over 8 million people have permanent insomnia as a consequence of noise. Additionally, also the habitats of animals and other calm places need to be recognized and further protected.\textsuperscript{119}

For these reasons, the European Union is trying to reduce noise pollution until 2020 to the specifications of the World Health Organization. Nevertheless, this is quite difficult as the assessment of noise is not consistent between the European member countries and therefore the comparability is aggravated.\textsuperscript{120}

### 3.3 Impacts on space and biodiversity

Increasing transportation and the land usage due to transportation on the road, rail and water have a great impact on the quality of ecosystems and biodiversity. However, nobody considers resulting barriers which inhibit the dissemination of flora and fauna between different living spaces.\textsuperscript{121} Therefore, habitats of plants and animal species often get destroyed.\textsuperscript{122} Additionally, car accidents with wild animals are quite common and lead to injuries and death. Furthermore, also adjacent areas are polluted by the increasing hazardous waste like oil contamination, road salt as well as noise and air pollution.\textsuperscript{123}

\textsuperscript{116}Note: 55 dB(A) is the average EU ceiling
\textsuperscript{117} cf. EEA 2014a, pp. 19 ff
\textsuperscript{118} cf. OECD 2010, p. 200
\textsuperscript{119} cf. EEA 2014a, p. 5
\textsuperscript{120} cf. EEA 2014a, p. 5
\textsuperscript{121} cf. EEA 2015b, p. 42
\textsuperscript{122} cf. Umweltbundesamt 2009, pp. 48 ff
\textsuperscript{123} cf. EEA 2015b, p. 42
Especially more and more land is used for building new streets and therefore enhancing even more transportation. Almost 2.5 ha/km of land are needed for building a highway with four lanes. Nevertheless, approximately 8 ha/km of land are used because also space for noise barriers, traffic hubs, intersections and motorway restaurants is needed. What is more, due to the fact that territories of 50 to 80 meters on each side of the street are influenced zones of contamination and noise as well as compensation interspaces, the actual area affected can amount up to 20 ha/km. As a consequence, regions sometimes get isolated. This landscape fragmentation is leading to a high biodiversity loss. Moreover, the extinction of many animal species is destroying natural food chains. Also waters and rivers are changed and as a result ecosystems are destructed. In addition, emissions are harming the whole environment, the ground, air and wildlife. The construction of infrastructure also changes lighting and wind conditions as well as natural water drains which can lead to water damages in the surroundings. Furthermore, ground water can get polluted. Therefore, land usage and biodiversity should be more considered when building new infrastructure. Consequently, the reduction of land usage would contribute to more sustainable freight transportation.

### 3.4 Water pollution

As water is one of the most important natural resources, it is paramount to not further pollute and destroy its existence. Nevertheless, the interventions of humans into the body of water often destruct it in a way that totally changes its natural character for example through shipping, straightening, narrowing and rip rap revetment on the banks. As a consequence, through such “substantially changed” waters the biosphere of many animal species gets lost. Although freight transportation does not cause so much pollution into waters than into the air, it still influences the condition of water directly and indirectly.

An example of how freight transport directly affects the quality of water is shipping. The unloading of ballast water of ships can lead to a severe contamination. Moreover, through inland waterway transportation toxic substances like fuels and lubricants can dramatically pollute waters. Changing light and oxygen conditions through the rotation of the ship’s propeller can also harm the habitat of many species and subsequently lead to biodiversity

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124 cf. Umweltbundesamt 2009, pp. 48 ff  
125 cf. Thaler 1999, pp. 38 f  
126 cf. Umweltbundesamt 2009, pp. 48 ff  
127 cf. Meinel/Lehmann 2016, pp. 77 ff  
128 cf. Umweltbundesamt 2009, p. 51  
129 cf. OECD 1997, pp. 9 f
losses. However, the connection between tons per kilometers of freight and the rise of contamination is lower regarding water pollution than in the context of air pollution.

Additionally, water conditions can also be indirectly affected by land transportation. For instance, ground and surface waters can get polluted through substances which drain off the road due to accidents and continuous exhaust emissions. Furthermore, surface waters are in danger due to the imperviousness of spaces through streets and parking places. As a result, it is not possible for rain to get into the ground water. Therefore, the risk of floods increases and surface waters can get even more polluted.

All in all, it can be said that harming substances resulting from freight transportation are contaminating the ground and surface waters and therefore are jeopardizing the well-being of humans and the wildlife.

### 3.5 Climate change

The increasing appearance of weather anomalies and extreme weather events are traced back to the ongoing climate change according to the majority of today’s scientists. Before the age of industrialization, the impacts of anthropogenic interventions were regionally limited. However, since then, due to human interactions also global changes in the mass balance of the atmosphere have been observed. The key drivers for this have been anthropogenic emissions of greenhouse gases.

However, beside CO$_2$ also carbon monoxide (CO), hydrocarbons like methane, nitrous oxide (NO$_2$) and ozone have impact on the climate as they also reveal greenhouse gas potential. For the purpose of comparability, the greenhouse gas potential of the different substances is often converted into that of CO$_2$. These are described as CO$_2$-equivalents (CO$_2$-e).

Since 1750 greenhouse gases have steadily increased. Until 2005 the worldwide concentration of CO$_2$ rose by 35 %, methane by 148 % and NO$_2$ by 18 % compared with pre-industrial times. However, there have been multiple reasons for this namely the increasing combustion of fossil
fuels like coal, petroleum and natural gas, as well as the expansion of industrial production, the changes in land usage and the rise of livestock farming.\textsuperscript{137}

Greenhouse gases influence the energy balance of the atmosphere.\textsuperscript{138} They let short-wave high-energy radiation pass through relatively unhindered which is coming from the sun to the earth. In doing so, they absorb long-wave radiation from the warmed up surface of the earth. Hereby, the molecules of those gases get transferred into a so-called energetically excited condition in order to come back to the original ground state under emission of infrared radiation after a short period. The emission of thermal radiation takes place in every direction and therefore a substantial proportion goes back to the surface of the earth. In order that the additional supplied energy can still be emitted, the earth has to adopt a higher temperature accordingly. This process is called greenhouse effect.\textsuperscript{139} In conformity with the Intergovernmental Panel on Climate Change (IPCC), the average temperature of the worldwide ground surface will therefore heat up between 1.1°C and 6.4°C until 2100 compared with the year 2000. Moreover, the medium sea level is estimated to go up between 18 and 59 centimeters in the same time, which would have dramatic effects on ecosystems and the whole environment.\textsuperscript{140}

In terms of climate, it is apparent that the various impacts of transportation cannot be regarded separately as they are interlinked. The effects of the changing climate like global warming, starvation, diseases and natural disasters like floods, earthquakes, drought, tornados and tsunamis are major problems at the present. It is validated that the increase of greenhouse gas emissions and especially CO\textsubscript{2} can be seen as the main substance contributing to global warming. For this reason, it is important to mention that greenhouse gas and predominately CO\textsubscript{2} is emitted a lot through the burning of fossil fuels respectively transportation. However, the effects of global warming like severe weather, ecological disasters and maladies are estimated to increase differently in distinct regions.\textsuperscript{141}

Figure 9 shows, that according to the Intergovernmental Panel for Climate Change (IPCC), only the energy sector emits with about 30 \% more greenhouse gas emissions than the transport sector.\textsuperscript{142}

\textsuperscript{138} cf. Umweltbundesamt 2015f, n.p.
\textsuperscript{139} cf. Umweltbundesamt 2014, n.p.
\textsuperscript{140} cf. OECD 2010, p. 199
\textsuperscript{141} cf. OECD 2010, p. 199
\textsuperscript{142} cf. EEA 2014b, n.p.
However, nearly 20% of the whole European greenhouse gas emissions are attributable to transportation (passenger and freight).\textsuperscript{144} Whereas the total amount of anthropogenic GHG (and GHG equivalents) in the EU-28 diminished by 17% between 1990 and 2012, the transport sector revealed a rise of 22% of those gases.\textsuperscript{145} Therefore, it can be deduced that also freight transportation accounts for a large amount of the worldwide emission of greenhouse gases. In the European Union, trucks made up 6.5% of the whole CO\textsubscript{2} emissions in 2007. Due to the subscription of the Kyoto Protocol in 1997 nearly all other sectors revealed a decrease of CO\textsubscript{2} emissions. However, the emittances of freight transportation still increased about 50% between 1990 and 2003. Reasons for that may be on the one hand the increased ton-kilometers and on the other hand the shift to more environmentally unfriendly transportation modes. As mentioned above, the European freight transportation on the road (measured in billion ton-kilometers) increased by 33.4% in the years between 1995 and 2013 whereas the volume of air cargo rose by 27%. Moreover, inland waterway vessel transportation grew 25.1% and the rail gained 4.7%.\textsuperscript{146}

As depicted in Figure 10, from 2000 onwards, greenhouse gas emissions did grow slower than before. In the years between 2007 and 2012 there had already been a decline in the whole transport sector of 9.7%. This decrease can be traced back to the economic crisis and connected reductions in economic activities.\textsuperscript{147} However, the total emissions of the transport sector still have been slightly increasing in the following years.\textsuperscript{148}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure9.png}
\caption{Emissions share per main sectors in 2012\textsuperscript{143}}
\end{figure}

\begin{flushleft}
\textsuperscript{143} Note: Sectoral GHG emission by IPCC sector  \\
\textsuperscript{144} cf. European Union 2015b, p. 246  \\
\textsuperscript{145} cf. Thomas 2015a, p. 13  \\
\textsuperscript{146} cf. VCÖ 2009, p. 18  \\
\textsuperscript{147} cf. European Union 2015b, p. 246  \\
\textsuperscript{148} cf. EEA 2015b, pp. 27 f
\end{flushleft}
Thus, it can be said that in the near-term, several industrial countries will manage to diminish CO₂ and as a consequence meet the targets of the Kyoto Protocol without radical interventions into the transportation sector. However, in distant future, tremendous decreases of 40 to 80 % (in comparison with 1990) of CO₂ will be required to reduce global warming. Regarding the predicted increasing transport intensity of the following years, it is not possible to achieve those mentioned long term Kyoto goals without considerable contributions of the transport sector.¹⁴⁹

What is more, the various modes of transportation emit different amounts of greenhouse gases, nitrous oxides and particulate matter per ton-kilometer. Reasons for that are distinct types of drive and motor fuels as well as the capacity of the particular transportation mode.¹⁵⁰

Figure 11 shows the specific CO₂ emissions per ton-kilometers and per mode of freight transport in Europe between the years of 1995 and 2011.

However, it should be emphasized that for an adequate comparison of transport modes, upstream emissions from the generation of energy sources like electricity, kerosene, petrol and diesel actually need to be included (well-to-wheel).¹⁵¹

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¹⁴⁹ cf. OECD 2010, p. 213
¹⁵⁰ cf. Richter 2012, p. 14
¹⁵¹ cf. Richter 2012, p. 14
The shift from road and air to a more environmentally friendly transportation mode could significantly change the modal split and therefore enhance climate effects. Measures like energy taxes, road pricing, as well as space and transportation planning are necessary to reduce the growth of freight transportation and therefore positively contribute to the future climate.

Finally, Table 1 summarizes the different environmental impacts transportation has on humans, vegetation, the global climate and materials. Additionally, Table 2 gives an overview of environmental impacts by the mode of transportation.

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152 Note: The graph shows the development of specific CO₂ emissions, defined as emissions of CO₂ per transport unit (ton-km), by freight transport mode (road, rail, maritime, inland shipping) over the period 1995 to 2011. Data coverage: EEA-32 excluding Iceland and Liechtenstein. (EEA 2015c, n.p.)

153 cf. VCÖ 2009, p. 18
# Table 1: Summary of environmental impacts

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Source</th>
<th>Impact on:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Humans</td>
</tr>
<tr>
<td>Carbon monoxide (CO)</td>
<td>Incomplete combustion</td>
<td>Inadequate oxygen supply; heart, circulatory, nervous system</td>
</tr>
<tr>
<td>Hydrocarbons like methane</td>
<td>Incomplete combustion, carburetion, evaporation</td>
<td>Some are carcinogenic; ozone precursor</td>
</tr>
<tr>
<td>Nitrogen oxides (NOx)</td>
<td>Oxidation of N₂ and N-compounds in fuels</td>
<td>Respiratory irritation and other problems</td>
</tr>
<tr>
<td>Particulates, Soot (diesel)</td>
<td>Incomplete combustion, road dust</td>
<td>Respiratory damage, various toxic content; carcinogenic</td>
</tr>
<tr>
<td>Ozone (formed by interaction of other pollutants)</td>
<td>Photo-chemical oxidation with NOx and HC</td>
<td>Respiratory irritation, ageing of lungs</td>
</tr>
<tr>
<td>SO₂</td>
<td>Combustion of coal and fuel oil</td>
<td></td>
</tr>
<tr>
<td>Noise</td>
<td>Constant noise (street), temporarily (rail), starting and landing noise (planes)</td>
<td>Hearing loss, blood pressure, impacting cognitive abilities, cardiovascular diseases, unborn children die, permanent insomnia</td>
</tr>
</tbody>
</table>

---
<table>
<thead>
<tr>
<th>Impacts on space and biodiversity</th>
<th>2.5 -20 ha/km for streets, 1.2 ha/km for rails, IWW the fewest</th>
<th>Ground water can get polluted</th>
<th>Isolated regions, biodiversity losses, destruction of habitats &amp; natural food chains, changed waters, lighting &amp; wind conditions, car accidents, hazardous waste (oil contamination, road salt)</th>
<th>Land use changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water pollution</td>
<td>Imperviousness of spaces (streets, parking), exhaust emissions, substances remaining from accidents, shipping, straightening, narrowing &amp; rip rap revetment, ballast water, toxic substances (fuels, lubricants)</td>
<td>Groundwater pollution</td>
<td>Biodiversity loss, influences the condition of water, changing light and oxygen conditions through the rotation of the ship’s propeller, emissions get into ground and surface waters</td>
<td></td>
</tr>
<tr>
<td>Climate change &amp; Carbon Dioxide (CO₂)</td>
<td>Combustion, increasing combustion of fossil fuels (coal, petroleum, natural gas), the changes in land use</td>
<td>Weather anomalies, global warming, starvation, diseases and natural disasters like floods, earthquakes, drought, tornados and tsunamis</td>
<td>Major GHG, extreme weather anomalies, global warming, starvation, diseases, natural disasters (floods, earthquakes, drought &amp; tornados); sea level rise</td>
<td></td>
</tr>
</tbody>
</table>

Source: Adapted from Thaler 1999, p. 35
Table 2: Overview of environmental impacts by transport mode

<table>
<thead>
<tr>
<th></th>
<th>Road</th>
<th>Rail</th>
<th>IWW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise pollution(^{154})</td>
<td>Highest</td>
<td>Middle</td>
<td>Lowest</td>
</tr>
<tr>
<td>Space &amp; biodiversity impacts(^{155})</td>
<td>Highest</td>
<td>Middle</td>
<td>Lowest</td>
</tr>
<tr>
<td>Water pollution(^{156})</td>
<td>Middle</td>
<td>Lowest</td>
<td>Highest</td>
</tr>
<tr>
<td>Climate change (GHG)(^{157})</td>
<td>Highest</td>
<td>Lowest</td>
<td>Middle</td>
</tr>
<tr>
<td>CO(_2) &amp; CO(_2)-e(^{158})</td>
<td>Highest</td>
<td>Lowest</td>
<td>Middle</td>
</tr>
<tr>
<td>CO</td>
<td>Highest</td>
<td>Lowest</td>
<td>Middle</td>
</tr>
<tr>
<td>NO(_x)</td>
<td>Highest</td>
<td>Lowest</td>
<td>Middle</td>
</tr>
<tr>
<td>NMVOC</td>
<td>Highest</td>
<td>Lowest</td>
<td>Middle</td>
</tr>
<tr>
<td>Particulate matter</td>
<td>Highest</td>
<td>Lowest</td>
<td>Middle</td>
</tr>
</tbody>
</table>

Source: Based on Lawson 2007, OECD 1997, EEA 2015b, EEA 2015g

Accordingly, the rail is the transportation mode which has the lowest impacts on the environment followed by inland waterway transportation. Only regarding noise pollution as well as space and biodiversity impacts inland waterway transportation has less harmful effects than the rail. However, water pollution is particularly attributable to inland waterway transportation. Nevertheless, this overview clearly shows that road transportation contributes most to the environmental pollution.

\(^{154}\) See: Lawson 2007, p. 22  
\(^{155}\) See: Lawson 2007, p. 22  
\(^{156}\) See: OECD 1997, pp. 9 ff  
\(^{157}\) See: EEA 2015b, p. 28  
\(^{158}\) See: EEA 2015g, n.p.
4 Transport policy as an essential issue of sustainable development in the EU

After explaining the history and reasons for the increasing freight transportation intensity in the European Union and additionally depicting the trends of different transportation modes as well as revealing the impacts on the environment, it is necessary to define what the combination of sustainability and freight transportation actually means. Moreover, the objectives of sustainable freight transportation are described in this chapter before explaining several standards, guidelines and regulations concerning the environmental policy development and the evolution of a common transport policy in detail.

4.1 Definition of „sustainable freight transportation“

First of all, the term “freight transportation” refers to commercial carriage or transportation in return for payment. The definition includes rail, watercraft and motor vehicles which are heavier than 3.5 tons. Moreover, there is a differentiation between factory traffic which is only for the company’s own purpose and commercial transportation.\(^{159}\) There are different transportation modes treated in this thesis in particular road, rail and inland waterway transportation. Additionally air, maritime, pipeline and intermodal transport are thematized. Furthermore, there is a difference in the terms traffic, transportation and mobility. Whereas mobility describes the potential of agility, traffic is related to transportation and the means of transportation. Moreover, those two terms are interlinked as transport is the instrument that makes mobility possible.\(^{160}\)

In this regard, it has to be mentioned that during the research phase it became apparent that the distinction of various types of transport was very difficult. Especially concerning statistics, the terms and therefore a consistent database was intricate to define. For this reason, it should be pointed out, that domestic traffic, also called inland or internal traffic in a narrower sense means that the source and sink of traffic lies in one country. However, when there is a close integration of states like in the European Union or the NAFTA (North American Free Trade Agreement), transportation between these states can also be termed domestic, inland or internal traffic in a broader sense. Consequently, if the source and sink is located in one state but during the transport foreign territory is passed through, this kind of transportation is called cross-border


\(^{160}\) cf. Götz 2011, pp. 326 f
internal traffic and not international traffic. International traffic occurs, when the source and sink of the transport are located in different states.\footnote{161}

Nevertheless, it is still not transparent if some statistics base their figures only on inland transportation or if also the part of international transportation is included which occurs within European borders. Therefore, the comparability of different figures is sometimes not really possible.

Additionally, it is important to explain the term “sustainability” in more detail beforehand to find out what “sustainable freight transportation” basically stands for.

The term sustainability goes back to a book about forestry called “Sylvicultura Oeconomica“ from 1713 where Hanns Carl von Carlowitz firstly mentioned the principle of sustainability as a method of how to use a forest in the long run.\footnote{162} However, the concept of sustainability further developed due to increasing environmental issues. Therefore, the U.N. Conference on Human Environment in Stockholm in 1972 highlighted the need for environmental protection, economic development and social responsibility.\footnote{163} For this reason, the World Commission on Environment and Development (WCED) also known as the Brundtland Commission, defined the term “Sustainable development” in its report “Our common Future” (1987) as:

“\textit{Development that meets the needs of the present without compromising the ability of future generations to meet their own needs}.\footnote{164}”

The adapted definition which is particularly important for organizations, was made by the International Institute for Sustainable Development (IISD) in 1992:

“\textit{For business enterprises, sustainable development means adopting business strategies and activities that meet the needs of the enterprise and its stakeholders today while protecting, sustaining and enhancing the human and natural resources that will be needed in the future}.\footnote{165}”

\footnote{161} cf. Kummer 2006, pp. 54f
\footnote{162} cf. Spindler 2011, p. 3
\footnote{163} cf. Blackburn 2009, pp. 2 f
\footnote{164} World Commission on Environment and Development 1987, p. 41
\footnote{165} IISD et al. 1992, p. 1
Therefore, it can be generally said that the concept of sustainability emerged out of the growing importance of the interaction between economic and environmental issues as well as the social responsibility and the need of sustaining future generations.\textsuperscript{166} However, as there are several different definitions and terms used for sustainability, the Triple Bottom Line (TBL) by John Elkington, tries to connect them all.\textsuperscript{167}

The emphasis of the Triple Bottom Line lies on all three dimensions namely the economic, social and environmental responsibility. Thus, it is especially important for companies not just to focus on the economic dimension namely the financial performance, but also on the other two dimensions as the impact organizations have on the society and environment is crucial and should not be underestimated.\textsuperscript{168} The goal of the Triple Bottom Line is to consider all three dimensions equally as they are of the same weight. Additionally, the interests of all parties involved should be balanced.\textsuperscript{169} Hence, a company which is acting sustainable does not just face economic challenges but also social and environmental ones as well as the problems arising from the overlaps of the three dimensions.\textsuperscript{170}

The following figure shows the three dimensions of sustainability and those overlaps.

\textbf{Figure 12: The Triple Bottom Line}

![Figure 12: The Triple Bottom Line](image)

Source: Based on Hauff/Kleine 2009, p. 117

\textsuperscript{166} cf. Hopwood/Mellor/O’Brien 2005, p. 39  
\textsuperscript{167} cf. Blackburn 2009, p. 5  
\textsuperscript{168} cf. Savitz/Weber 2014, pp. 5 f  
\textsuperscript{170} cf. Blackburn 2009, p. 5
Additionally, it should be mentioned that there are numerous factors which can be measured in respect of the Triple Bottom Line. Mostly, traditional financial instruments are used which are adding a social and environmental perspective like sustainability accounting or sustainability reporting. Especially reporting is crucial, as it gives a company and also the stakeholders the possibility to compare their efforts and to find out if set targets have been reached. Here the usage of indicators like sustainable footprints is particularly beneficial for organizations. Thus, positive results will contribute to the profit of an organization.\textsuperscript{171}

Sustainability is based on the principle that you just get what you measure because this is the field where you pay most attention to. This means, that organizations only will be additionally socially and environmentally responsible if they also measure their social and environmental impact.\textsuperscript{172}

After this detailed explanation of the two terms transportation and sustainability, the meaning of sustainable freight transportation emerges out of the combination of those two terms. Therefore, the definition of “environmentally sustainable transportation” is:

\textit{“An environmentally sustainable transport system is one where transportation does not endanger public health or ecosystems and meets needs for access consistent with (a) use of renewable resources below their rates of regeneration, and (b) use of non-renewable resources below the rates of development of renewable substitutes”}\textsuperscript{173}

\textsuperscript{171} cf. Elkington 1997, pp. 92 ff
\textsuperscript{172} cf. Kaplan/Norton 1996, p. 21
\textsuperscript{173} BMLFUW 2000, p. 17
4.2 Objectives for sustainable freight transportation

In this subchapter, the focus lies on the objectives for making freight transportation more sustainable in future. Regarding the different impacts already mentioned before, several targets of the European Union are explained in more detail. Afterwards, there is an analysis of the environmental policy development as well as the progress towards a common transport policy.

Objectives for sustainable freight transportation respectively the European environmental policy are very complex and therefore over 300 legal acts exist. Those involve decisions, regulations, directives and recommendations. Moreover, the legal provisions include for example products like emission controls for cars, actions for the preservation of nature and the diversity of species as well as quality protection for water, air and land. Most legal acts are directives. However, if there is no implementation into national law needed, decisions and regulations are defined.174

The following subchapters are fielded according to the mentioned environmental impacts of freight transportation. However, the different transportation modes often have impacts on several fields. Therefore, also a categorization conforming to the objectives from transport modes would have been possible. Nevertheless, in order to proceed consistently, the used division fits best for providing a good overview. Additionally, it should be mentioned, that only the most important regulations of the different impact fields are stated although more detailed provisions regarding the different transport modes may exist.

4.2.1 Air pollution control

Contrary to the developments of GHG trends, in 2013 a decrease of the shares of road transport in total emissions of the main air pollutants in the EU-28 was recorded compared with 1990. The reasons for this were stricter technical standards and the economic crisis. Most reductions are attributable to road transportation whereas air and water transportation emissions especially of NOx, particulate matter and SOx are still increasing.175 Table 3 shows the shares of transport emissions in 1990 and 2013.

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174 cf. Ueapme 2005, p. 18
175 cf. Thomas 2015a, p. 17
Table 3: Share of transport in total emissions of the main air pollutants in the EU-28, in 1990 and 2013 (exhaust and non-exhaust emissions)\(^\text{176}\)

<table>
<thead>
<tr>
<th></th>
<th>CO</th>
<th>NMVOC</th>
<th>NO(_x)</th>
<th>PM(_{10})</th>
<th>PM(_{2.5})</th>
<th>SO(_x)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>54 %</td>
<td>35 %</td>
<td>50 %</td>
<td>19 %</td>
<td>25 %</td>
<td>7 %</td>
</tr>
<tr>
<td>2013</td>
<td>25 %</td>
<td>15 %</td>
<td>57 %</td>
<td>20 %</td>
<td>24 %</td>
<td>27 %</td>
</tr>
</tbody>
</table>

Source: Thomas 2015a, p. 17

Nevertheless, road transportation continues to contribute significantly to the overall air pollution. Moreover, diesel-driven vehicles have even more negative impacts as petrol-driven ones, as the former emit more particulate matter and NO\(_x\).\(^\text{177}\)

In compliance with the World Health Organization, also particulate emissions which are especially harmful should be limited through maximum amounts. Moreover, the WHO recommends that the predecessors of particulate emissions which are already regulated through the National Emission Ceilings Directive (NECD)\(^\text{178}\) mentioned below should be further decreased in future. Particularly PM\(_{2.5}\) emissions are extremely dangerous and risky as they are constantly very harmful for humans’ health. For this reason, a reduction in particulate emissions is crucial.\(^\text{179}\)

Therefore, the European Union operates on several different levels in order to improve air quality standards.\(^\text{180}\) Numerous instruments have been developed which should regulate emissions of air pollutants and immission loads respectively air quality. As a consequence, national emission ceilings, sectoral emission limits and regulations for imissions have been implemented.\(^\text{181}\)

Regulations regarding immission loads were determined in the directive on “Ambient air quality and cleaner air for Europe” 2008/50/EC\(^\text{182}\). It aimed to define and specify air quality goals to prevent, avert and reduce harmful impacts on humans and the whole environment.\(^\text{183,184}\)

\(^{176}\) Note: International air and waterborne transport are included (Thomas 2015a, p. 17)

\(^{177}\) cf. Thomas 2015a, p. 17

\(^{178}\) See: OJ L 309, 2001, pp. 22 ff

\(^{179}\) cf. Umweltbundesamt 2009, p. 47

\(^{180}\) cf. EEA 2015d, n.p.

\(^{181}\) cf. Umweltbundesamt 2013, p. 35

\(^{182}\) See: OJ L 152, 2008, pp. 1 ff

\(^{183}\) cf. ABl. L 152, 2008, p. 4

\(^{184}\) Note: Specific data about the allowed concentration of pollutants can be retaliated in the Annex of the Directive 2008/50/EG.
The National Emission Ceilings Directive from the European Parliament and Council is an EU directive which defined a mandatory maximum emission quantity for each member state. It aimed that the different atmospheric pollutants sulfur dioxide (SO$_2$), nitrogen oxide (NO$_x$), ammonia (NH$_3$) and non-methane volatile organic compound (NMVOC) must not be exceeded after 2010. Additionally, the reduction of ozone levels, acidification and eutrophication was intended.

In conformity with the 6th Environmental Action Program, (described subsequently) the directive has demanded that the exposure of humans and the environment due to air pollutants was to be reduced in a way that there will not be any significant effects on health and ecosystems in future. Additionally, it has been required that limits of the WHO should be in compliance and therefore compulsory for all member states.

A revised version of the National Emission Ceilings Directive for the whole EU-27 in 2009 charged national programs and plans for emission levels until and after 2010. Member states have been additionally required to report their emissions yearly. For the EU-15 this meant a maximum quantity of 3,850 kilotons (kt) SO$_2$, 6,519 kt NO$_x$, 6,510 kt NMVOC and 3,110 kt NH$_3$.

In 2013 the directive was amended by the “Clean Air Policy Package” with “A Clean Air Programme for Europe” (CAFE) which included new and stricter goals for the quality of the air until 2030. Additionally, a proposal for a renewed National Emission Ceiling Directives was comprised. The measures of this new strategy were based on the “Thematic Strategy on air pollution” of 2005 and should contribute to the achievement of the long-term goals of the 6th and 7th Environmental Action Program, which are described in the following chapter.

Several reductions of pollutants have already been achieved as depicted in Figure 13. However, to reach the objective of the 6th Environmental Action Program and consequently not affecting humans’ health and ecosystems, numerous improvements will be necessary in the future.

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185 cf. Umweltbundesamt 2009, p. 47
186 cf. ABl. L 309, 2001, p. 23
187 cf. ABl. L 309, 2001, p. 22
189 cf. ABl. L 309, 2001, p. 29
190 See: COM(2013) 918 final
193 See: COM(2005) 446 final
194 cf. COM(2013) 918 final, p. 2
Therefore, the long-term goals of the “Thematic Strategy on air pollution” for 2020 (compared with 2000) are:  

- 47% reduction in loss of life expectancy as a result of exposure to particulate matter;
- 10% reduction in acute mortalities from exposure to ozone;
- reduction in excess acid deposition of 74% and 39% in forest areas and surface freshwater areas respectively;
- 43% reduction in areas or ecosystems exposed to eutrophication.

In order to achieve these goals it is necessary that the emissions of \( \text{SO}_2 \) will diminish by 82%, VOCs by 51%, PM\(_{2.5}\) by 59%, \( \text{NO}_x \) by 60% and NH\(_3\) by 27%.  

**Figure 13: EU-25 land-based emissions of NECD pollutants**

![Graph showing emissions of SO\(_2\), NO\(_x\), VOCs, and NH\(_3\) from 1980 to 2020.]

Source: COM(2005) 446 final, p. 4

Nevertheless, the consideration of air pollution control regarding freight transportation is especially interesting in this context as the contribution of transport emissions to air pollution is extremely high. Therefore, there are different European emission standards arranged for new light- and heavy-duty vehicles. Emission standards for heavy-duty vehicles are numbered with roman numerals (Euro-Norms I-VI) and are based on the Directive 05/55/EC which highlighted measures against emissions. The CAFE-program also included new Euro-Norm standards. Euro-Norm VI was the first norm which was directly applicable due to the fact that it is a regulation. In general, emission standards determine limits for specific pollutants of new cars in Europe. However, for certain vehicle types CO\(_2\) emission limits are regulated for the average of the whole fleet and not for individual vehicles.

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195 COM(2005) 446 final, pp. 3 ff
196 cf. COM(2005) 446 final, p. 5
197 See: OJ 275, 2005, pp. 1 ff
Table 4 gives an overview of the development of the Euro-Norms for heavy-duty diesel engines.

### Table 4: EU emission standards for heavy-duty diesel engines

<table>
<thead>
<tr>
<th>Stage</th>
<th>Date</th>
<th>Test</th>
<th>CO (g/kWh)</th>
<th>HC (g/kWh)</th>
<th>NOx (g/kWh)</th>
<th>PM (g/kWh)</th>
<th>PN (g/kWh)</th>
<th>Smoke</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euro I</td>
<td>1992, ≤ 85 kW</td>
<td>ECE R49</td>
<td>4.5</td>
<td>1.1</td>
<td>8.0</td>
<td>0.612</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1992, &gt; 85 kW</td>
<td></td>
<td>4.5</td>
<td>1.1</td>
<td>8.0</td>
<td>0.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Euro II</td>
<td>1996.10</td>
<td></td>
<td>4.0</td>
<td>1.1</td>
<td>7.0</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1998.10</td>
<td></td>
<td>4.0</td>
<td>1.1</td>
<td>7.0</td>
<td>0.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Euro III</td>
<td>1999.10 EEV only</td>
<td>ESC &amp; ELR</td>
<td>1.5</td>
<td>0.25</td>
<td>2.0</td>
<td>0.02</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2000.10</td>
<td></td>
<td>2.1</td>
<td>0.66</td>
<td>5.0</td>
<td>0.10</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>Euro IV</td>
<td>2005.10</td>
<td></td>
<td>1.5</td>
<td>0.46</td>
<td>3.5</td>
<td>0.02</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Euro V</td>
<td>2008.10</td>
<td></td>
<td>1.5</td>
<td>0.46</td>
<td>2.0</td>
<td>0.02</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Euro VI</td>
<td>2013.01</td>
<td>WHSC</td>
<td>1.5</td>
<td>0.13</td>
<td>0.40</td>
<td>0.01</td>
<td>8.0×10^{11}</td>
<td></td>
</tr>
</tbody>
</table>

Source: DieselNet 2016, n.p.\(^{201}\)

All in all it can be said that despite several improvements regarding air pollution control in recent years, there are still numerous improvements required to actually stop the negative influence on humans’ health and ecosystems.\(^{202}\)

#### 4.2.2 Noise mitigation

Although the problem of noise pollution is very complex, it is possible to determine concrete target values for noise mitigation. The WHO recommends limit values for environmental noise between 32 and 42 dB(A) during the night in order to prevent health risks.\(^{203}\) Moreover, the noise limit in the daytime is about 50 dB(A).\(^{204}\) Nevertheless, national noise thresholds are very different in the European member states and often exceed WHO recommendations.\(^{205}\)

As the noise level during the night is mostly traced back to freight transportation, the stated noise levels are considered to be directly applicable for freight transportation. Whereas during the day, the levels of noise mitigation should be stricter for freight transportation, as the overall noise exposure also includes passenger traffic.\(^{206}\)

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\(^{201}\) Note: Table 4 lists emission standards applicable to diesel (compression ignition, CI) engines only, with steady-state emission testing requirements. (DieselNet 2016, n.p.)

\(^{202}\) cf. COM(2005) 446 final, pp. 3 ff

\(^{203}\) cf. Clausen et al. 2012, p. 25

\(^{204}\) cf. EEA 2010, p. 23

\(^{205}\) cf. Clausen et al. 2012, p. 25

\(^{206}\) cf. Umweltbundesamt 2009, p. 48
Furthermore, the European Union tried to reduce transport noise through several attempts. On the one hand, the mitigation of noise can be attributed to the source like noise emission standards of vehicles or on the other hand the minimization of noise for example thought noise barriers can be focused. However, regulations of the European Union have been mainly targeted at noise pollution control from the source.²⁰⁷

A great step towards noise mitigation was firstly made through the mentioning of noise reduction in the 5th Environmental Action Program in 1993. Thereafter, the European Commission introduced a “Green Paper on Future Noise Policy”²⁰⁸ in 1996. This paper highlighted the importance and the tremendous health effects of environmental noise. Also the 6th Environmental Action Program has emphasized the significance of humans’ health and in this context proposed the adaption of an environmental noise directive.²⁰⁹

The aim of the European Noise Directive 2002/49/EC “relating to the assessment and management of environmental noise”²¹⁰ was the development of a common concept in order to avoid, inhibit and reduce negative impacts from noise pollution. To achieve this, incremental measures have been necessary like the introduction of noise maps – a coherent assessment of environmental noise of the member states. Additionally, public transparency about gained information of environmental noise and its impacts should have been given. According to the results of the noise maps member states had to create action plans for noise mitigation if necessary. Those had to include a long-term strategy to prevent health risks due to noise pollution. In addition, action plans and noise maps have to be renewed every five years (beginning in 2018).²¹¹

In 2004 still 14 member countries including Austria and Germany, had not implemented the directive into their national law. However, in 2007 it was realized in all member states. In the first round of noise mapping and action planning (2008) only big agglomerations and infrastructure with high traffic loads were affected whereas the second round (2013) also included smaller conurbations. However, the range of thresholds differed a lot between the different member states. Only Estonia, Luxembourg, Portugal and Slovenia considered introducing limits aligned with health care.²¹²

²⁰⁷ cf. EEA 2015b, p. 41
²⁰⁸ See: COM(96) 540 final
²⁰⁹ cf. EEA 2014a, pp. 6 f
²¹¹ cf. ABl. L 189, 2002, pp. 13 ff
²¹² cf. Clausen et al. 2012, pp. 25 ff
A preliminary evaluation of the European Noise Directive in 2015 showed that the introduction of noise maps and action plans and the gained information out of them are enhancing the achievement of the second objective of “providing a basis for developing Community measures to reduce noise emitted by the major sources, in particular road and rail vehicles and infrastructure, aircraft (…)”. However, it is still a long way to achieve a “common approach”. Therefore, at the moment, the Noise Directive does not cover its maximum potential.

As it seems very interesting, the next paragraphs should reveal how various noise measures have been realized concerning the different transport modes.

Regarding road traffic, anti-noise measures at source, taken by the member states are often perceived as most cost-effective. Whereas 31.5 million people benefit when expenses of 6 billion Euros are made for vehicle emission reductions, only 0.2 million people can profit from the same investment into noise protection walls. In 2014 the “Regulation (EU) No 540/2014 of the European Parliament and of the Council on the sound level of motor vehicles and of replacement silencing systems” was adopted. However, the goals regarding the noise emission limits through road transport are estimated to not having an effect before 2027.

Apart from noise emission limits for road vehicles, since 2000 there have also been regulations in effect for trains. Nevertheless, only vehicles which are crossing the borders of at least one member country are included. Also regarding rail transportation, measures concerning the source of noise are most cost-effective. Especially rail freight traffic is causing noise during the night. Therefore, a retrofitting with composite brake blocks can mitigate disturbances of this kind of about 10 dB(A). The costs would amount between 5 and 10 billion Euros and would lead to 100 million fewer people exposed to noise. Whereas measures like a rail barrier would cost a lot more (about 80 billion Euros) not even twice as much people (only 180 million) would benefit from this measure. Consequently, in 2015 there was a new regulation of the European

214 cf. European Commission 2015e, p. 21
215 cf. EEA 2015b, p. 41
216 See: ABl. L 158, 2014, pp. 131 ff
217 cf. EEA 2014a, p. 53
218 cf. EEA 2015b, p. 41
219 cf. ABl. L 70, 2015, p. 36
Union (2015/429)\textsuperscript{220} which focused on heartening the implementation of a faster retrofitting especially of freight wagons.\textsuperscript{221}

Moreover, the “Commission Regulation (EU) No 1304/2014 of 26 November 2014 on the technical specification for interoperability relating to the subsystem ‘rolling stock — noise’”\textsuperscript{222} targeted the mitigation of noise from existing trains. Thus, among other things also noise limits for freight trains were introduced.\textsuperscript{223}

There also have been several measures to reduce noise resulting from air transportation. For example, new technologies should diminish the noise of engines. However, also the management of flight paths through thin populated areas or the right selections of construction places of airports are paramount.\textsuperscript{224}

Therefore, the European Union introduced a “Single European Sky”\textsuperscript{225} legislation in 2004 and a second package “Single European Sky II”\textsuperscript{226} in 2009 which should enforce environmental performance goals for distributors of navigation services for aircraft.\textsuperscript{227} Additionally, with research projects like SEAR (Single European Sky Air Traffic Management Research) technological innovations should enhance the management of air transportation and therefore leading to noise mitigation.\textsuperscript{228}

Also according to the 7\textsuperscript{th} Environmental Action Program, lots of people have to bear noise levels above 55 dB(A) during the day and 50 dB(A) during the night. Therefore, the program aims to reduce noise considerably until 2020, to approximate WHO levels. However, to reach this several improvements in technology, various measures and a renewed noise policy will be needed.\textsuperscript{229}

\begin{itemize}
  \item \textsuperscript{220} See: ABl. L 70, 2015, pp. 36 ff
  \item \textsuperscript{221} cf. EEA 2015b, p. 41
  \item \textsuperscript{222} See: ABl. L 356, 2014, pp. 421 ff
  \item \textsuperscript{223} cf. EEA 2015b, p. 41
  \item \textsuperscript{224} cf. EEA 2015b, pp. 41 f
  \item \textsuperscript{225} See: OJ L 96, 2004, pp. 1 ff
  \item \textsuperscript{226} See: COM(2008) 389 final
  \item \textsuperscript{227} cf. EEA 2015b, pp. 41 f
  \item \textsuperscript{228} cf. European Commission 2015d, n.p.
  \item \textsuperscript{229} cf. EEA 2014a, p. 6
\end{itemize}
4.2.3 Sustainable land utilization and biodiversity protection

According to the biodiversity convention of the United Nations, biological variety means variability of all living organisms from all sources like land, sea and other ecosystems. Nevertheless, transportation and the related infrastructure is dramatically influencing and harming the living space of flora and fauna. Emissions into the air, water and ground as well as noise pollution and land fragmentation are destroying ecosystems and biodiversity. Therefore, overall future objectives are the preservation and restoration of biological diversity and natural habitats.\(^\text{230}\)

Furthermore, it is crucial to reduce derogation through contaminants, noise and light. New and existing transport routes have to be ecologically permeable and undissected ecosystems should be preserved. Additionally, the use of new land should be reduced to zero by 2050.\(^\text{231}\)

In 2001, the European Union agreed upon the target to reduce biodiversity loss inter alia through optimizing transportation systems and enhancing the management of land utilization by 2010, in the “Strategy for Sustainable Development”\(^\text{232}\).\(^\text{233}\) To reach this goal several political strategies on the national, EU and pan-European level were necessary. The communication from the Commission “Halting the loss of biodiversity by 2010 – and beyond”\(^\text{234}\) can be seen as the political framework to achieve this goal.\(^\text{235}\)

However, despite those measures, only 17 % of legally protected European habitats and species and 11 % of protected ecosystems were in a good condition in 2011. Moreover, about 30 % of the European region was marked by medium to heavy fragmentations of the land.\(^\text{236}\) More than 1,000 square kilometers of land are used yearly for transport infrastructure, housing or industry. Moreover, nearly half of this used land is permanently sealed. Also the irreversible pollution of soil is an important issue.\(^\text{237}\) In addition, in cities more infrastructure is built than in rural areas which makes up between 10 to 15 % of the total usage of land.\(^\text{238}\)

\(^\text{230}\) cf. Umweltbundesamt 2009, p. 27
\(^\text{231}\) cf. Umweltbundesamt 2009, p. 49
\(^\text{232}\) See: COM(2001) 264 final
\(^\text{233}\) cf. COM(2001) 264 final, pp. 5 ff
\(^\text{234}\) See: COM(2006) 216 final
\(^\text{236}\) cf. KOM(2011) 244 endgültig, pp. 1 ff
\(^\text{237}\) cf. COM(2011) 571 final, p. 15
\(^\text{238}\) cf. Portal 2002, p. 4
Therefore, in 2010, the European Heads of State and Government acknowledged that despite great achievements like the development of “Natura 2000”\textsuperscript{239} – the worldwide biggest network of protected regions – the set biodiversity objectives could not be reached. As a consequence, they advocated a long-term vision according to the communication from the European Commission “Options for an EU vision and target for biodiversity beyond 2010”\textsuperscript{240}.\textsuperscript{241}

**2020 headline target:**

*“Halting the loss of biodiversity and the degradation of ecosystem services in the EU by 2020, and restoring them in so far as feasible, while stepping up the EU contribution to averting global biodiversity loss.”*\textsuperscript{242}

**2050 vision:**

*“By 2050, European Union biodiversity and the ecosystem services it provides — its natural capital — are protected, valued and appropriately restored for biodiversity's intrinsic value and for their essential contribution to human wellbeing and economic prosperity, and so that catastrophic changes caused by the loss of biodiversity are avoided.”*\textsuperscript{243}

The steps mentioned above and the goals of the international Convention on Biological Diversity (2010) defined in the “Global Strategic Plan for biodiversity 2011-2020”\textsuperscript{244} built the basis for the European Biodiversity Strategy (2011) called “Our life insurance, our natural capital: an EU biodiversity strategy to 2020”\textsuperscript{245}. It targeted to protect biodiversity and services of ecosystems in order to detain the extinctions of species and land fragmentation by 2020.\textsuperscript{246}

The European Biodiversity Strategy highlighted six main objectives and additionally 20 measures to reach its headline target namely: “protecting and restoring biodiversity and associated ecosystem services (targets 1 and 2), enhancing the positive contribution of agriculture and forestry and reducing key pressures on EU biodiversity (targets 3, 4 and 5), and stepping up the EU’s contribution to global biodiversity (target 6).”\textsuperscript{247}

\textsuperscript{239} See: OJ L 206, 1992, pp. 7 ff
\textsuperscript{240} See: COM(2010) 4 final
\textsuperscript{241} cf. KOM(2011) 244 endgültig, pp. 1 ff
\textsuperscript{242} COM(2011) 244 final, p. 2
\textsuperscript{243} COM(2011) 244 final, p. 2
\textsuperscript{245} See: COM(2011) 244 final
\textsuperscript{246} cf. KOM(2011) 244 endgültig, pp. 1 ff
\textsuperscript{247} COM(2011) 244 final, p. 4 ff
In 2015, there was a mid-term review of the strategy\textsuperscript{248} which showed that although there had been several local improvements, no considerable development towards the stated overall objective could be detected.\textsuperscript{249} Therefore, to counteract significant impacts, small successes have to multiply and the actions of the EU have to be more purposeful.\textsuperscript{250}

The Biodiversity Strategy is also included in “Europe 2020 – A strategy for smart, sustainable and inclusive growth”\textsuperscript{251} as part of the Flagship Initiative: "Resource efficient Europe"\textsuperscript{252} \textsuperscript{253}. There, also the “Roadmap to a Resource Efficient Europe”\textsuperscript{254} (2011) is included which aims that:

“By 2020, EU policies take into account their direct and indirect impact on land use in the EU and globally, and the rate of land take is on track with an aim to achieve no net land take by 2050; soil erosion is reduced and the soil organic matter increased, with remedial work on contaminated sites well underway.”\textsuperscript{255}

Also the 7\textsuperscript{th} Environmental Action Program advertises the importance of the reduction of land usage.\textsuperscript{256} However, developments like the trans-European transport policy with several priority projects of infrastructure buildings are seen as obstacles for the achievement of the goals set by the Biodiversity Directive until 2020.\textsuperscript{257}

### 4.2.4 Water pollution control

Water is a crucial resource for all humans, ecosystems as well as flora and fauna. However, all over the world water is developing into a scarce resource. Therefore, it is essential to protect, preserve and manage surface and groundwater reserves.\textsuperscript{258} As already mentioned above, water can be polluted directly through shipping and indirectly through land transportation and resulting substances which are penetrating the soil and as a consequence harming the surface and the groundwater.\textsuperscript{259}

\textsuperscript{248} See: COM(2015) 478 final
\textsuperscript{249} cf. COM(2015) 478 final, p. 4
\textsuperscript{250} cf. EEA 2015b, p. 42
\textsuperscript{251} See: COM(2010) 2020 final
\textsuperscript{252} See: COM(2011) 21 final
\textsuperscript{253} cf. KOM(2011) 244 endgültig, pp. 1 ff
\textsuperscript{254} See: COM(2011) 571 final
\textsuperscript{255} COM(2011) 571 final, p. 15
\textsuperscript{256} cf. ABl. L 354, 2013, p. 173
\textsuperscript{257} cf. EEA 2015b, pp. 42 f
\textsuperscript{258} cf. Europäische Umweltagentur 2013, n.p.
\textsuperscript{259} cf. OECD 1997, pp. 9 f
In 2000, the first integrated approach to protect water ecosystems, water quality and quantity as well as water habitats was introduced. The Water Framework Directive (2000/60/EC) which has been mandatory for all European member countries, stated concrete targets for surface-, ground-, transitional- and coastal waters. It had to be converted into national law of the European member states. The most important environmental objectives of the directive have been that surface and ground waters need to achieve a “good ecological status”, all water bodies should be improved, deterioration must not occur, a pollution reduction of hazardous substances is necessary, counteracting continuous trends of increasing concentrations of pollutants in the groundwater and the fulfillment of legal regulations should be realized by 2015.

In 2012, a communication from the European Commission named “A Blueprint to Safeguard Europe's Water” was published. It concentrated on measures to enhance the realization of the Water Framework Directive and aimed to integrate water protection control into other policy strategies like transportation.

Besides those measures various other directives promoted the realization of a good ecological status of European waters. There have been several environmental standards for reducing the impacts of maritime transportation. In recent years, several measures have been adopted which should protect the maritime environment. Among them are for instance, the Directive 2000/59/EC about “port reception facilities for ship-generated waste and cargo residues” which highlighted the mandatory disposal of fuel and waste of European ports. The Regulation No 782/2003 focused “on the prohibition of organotin compounds on ships” like anti-fouling paints as they are incredibly harmful to aquatic organisms. Moreover, the Directive 2005/35/EC emphasized “ship-source pollution and the introduction of penalties for infringements”.

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261 See: OJ L 327, 2000, pp. 1 ff
262 Note: Achieving good status involves meeting certain standards for the ecology, chemistry, morphology and quantity of waters. In general terms, 'good status' means that water shows only a slight change from what would normally be expected under undisturbed conditions. (EEA 2012, p. 15)
263 cf. Umweltbundesamt 2009, p. 50
264 See: COM(2012) 673 final
266 See: OJ L 332, 2000, pp. 81 ff
267 See: OJ L 115, 2003, pp. 1 ff
268 See: OJ L 255, 2005, pp. 11 ff
Additionally, there had been several provisions amended by the Directive 2012/33/EU “as regards the sulphur content of marine fuels.”

Safety regulations and therefore reduced ship accidents have also contributed to a better water quality and to the preservation of ecosystems and animal habitats. The “Motorways of the Sea” priority project of the trans-European transport policy is on the one hand a sustainable alternative to the increasing road transportation but on the other hand the aquatic ecosystems might suffer more. Therefore, it is important to assess the assets and drawbacks of such projects accurately.

Nevertheless, great improvements are still necessary in future. From 21 European member states and 82,684 included water bodies, only 42% were in a good status in 2009, whereas in 2015 already 52% could be described as such. Thus, an increase of 10 percentage points was determined after all in this period of six years.

**4.2.5 Climate protection**

Climate protection is one of the most important topics of the European environmental policy. Also in other sectors than transportation the handling of climate change has gained high significance. The overall target of the European climate policy is to keep the temperature rise of global warming below 2°C compared with pre-industrial times.

Therefore, the EU has set several objectives in order to achieve a tremendous reduction of GHG emissions until 2050. The main goals regarding climate and energy were determined in the “2020 Climate and Energy Package” and in the “2030 Climate and Energy Framework.”

The 2020 Climate and Energy Package included several mandatory legislations in order to reach the set goals in 2020 which are also part of the Europe 2020 Strategy. The 2030 Climate and Energy Framework is based on the 2020 Climate and Energy Package and was introduced in 2014. The main objectives for 2020 and 2030 compared to 1990 are listed below.

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269 See: OJ L 327, 2012, pp. 1 ff
270 cf. Ratcliff 2015, pp. 3 f
273 cf. EEA 2012, p. 76
274 cf. Ohliger 2016, p. 1
275 See: COM(2007) 2 final
276 See: COM(2014) 15 final
• 20% reduction of GHG emissions, (40 % in 2030)
• 20% of renewable energies, (27 % in 2030)
• 20% enhancement in energy efficiency, (27 % in 2030)

Moreover, the package contained four legally binding measures concerning the Emissions Trading System, national emission reduction targets, national targets for renewable energy and energy efficiency.279

The Emissions Trading System (ETS)280 is an essential instrument to reduce GHG emissions and to attain Kyoto goals.281 However, the Kyoto Protocol itself did not set clear objectives for the decrease of GHG emissions from the transport sector. Nevertheless, there have already been various provisions and strategies of the EU aiming to diminish GHGs in this field. For example, the European Emissions Trading System has also included international air transportation since 2012 which contributed a lot to the reduction of GHG emissions.282

The transport sector itself is not part of the ETS. Therefore the European member states are obliged to diminish emissions from transportation through national laws.283 The national emission reduction targets have been included in the Effort Sharing Decision284 (ESD), which set goals for non-ETS sectors like transportation. The average goal is to achieve a 10 % reduction of GHG emissions in these areas until 2020.285

Renewable energy – national targets286, vary from 10 % to 49 % in the different member states. However, the overall impact should lead to the realization of the 20 % objective of the European Union and to gain 10 % regarding renewable energies in the transportation sector.287 Moreover, energy efficiency288 should be enhanced through a carbon capture and storage technology.289

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280 See: OJ L 140, 2009, pp. 63 ff
281 cf. Ohliger 2016, pp. 2 f
285 cf. Ohliger 2016, pp. 2 f
286 See: OJ L 140, 2009, pp. 16 ff
289 cf. Ohliger 2016, pp. 2 f
Furthermore, the long-term objectives of the 2030 Climate and Energy Framework comply with the desired goals of developing Europe into a low-carbon economy which was specified in the “2050 Low-carbon Roadmap”\textsuperscript{290}, the “Energy Roadmap”\textsuperscript{291} and the “Transport White Paper 2011”\textsuperscript{292,293}.

Generally, a White Paper of the Commission is a document with recommendations for community actions in a special field. Moreover, it can be linked to a Green Paper, which has been published before, to initiate a consultation process on the European level.\textsuperscript{294}

According to the Transport White Paper (2011) called ”Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system”\textsuperscript{295}, the European Union aimed to reduce transport GHG emissions\textsuperscript{296} by 20\% in the period between 2008 and 2030. Moreover, in the years from 1990 to 2050 a 60\% reduction in the transport sector is desired.\textsuperscript{297}

Figure 14 depicts the GHG emissions from transport within the EU-28 and highlights the targets and current trends. Additionally, by 2030, 30\% of road transportation over 300 kilometers should be shifted to other transport modes like rail or waterborne traffic. By 2050, this percentage should climb up to 50\%. An enhancement of supply chains and intermodal transportation should be achieved through energy efficient modes and the replacement of conventional fossil fuel driven cars through alternative concepts.\textsuperscript{298}
Figure 14: GHG emissions from transport within the EU-28: targets and current trends

Source: Thomas 2015a, p. 15

Another Regulation No 510/2011/EC\(^{300}\) determined that by 2017 new light commercial vehicles (< 3.5 t) have to reduce their CO\(_2\) emissions to a maximum ceiling of 175g per kilometer and by 2020 to a limit of 147g per kilometer.\(^{301}\)

However, on the European level, there are no regulations for heavy-duty vehicles although they are accountable for about 25% of CO\(_2\) road transport emissions. Therefore, the Commission recommended a “Strategy for reducing Heavy-Duty Vehicles' fuel consumption and CO\(_2\) emissions”\(^{302}\) in 2014.\(^ {303}\) Another Directive 2009/30/EC\(^ {304}\) targeted a 6% reduction of lifecycle GHG emissions of road transportation fuel between 2010 and 2020.\(^ {305}\)

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\(^{299}\) Note: All modes but international maritime transport (Thomas 2015a, p. 15)

\(^{300}\) See: OJ L 145, 2011, pp. 1 ff

\(^{301}\) cf. Thomas 2015a, p. 14

\(^{302}\) See: COM(2014) 285 final

\(^{303}\) cf. Thomas 2015a, p. 14

\(^{304}\) See: OJ L 140, 2009, pp. 88 ff

\(^{305}\) cf. Thomas 2015a, p. 14
The most recent development in climate protection took place in December 2015. The first mandatory global climate agreement has been accepted by 195 countries at the climate conference in Paris (COP21)\(^3\) and will become effective in 2020. The objective is to develop worldwide action plans in order to actually reduce the global warming to below the 2°C ceiling.\(^4\) Although the targets are formulated very generally and are not really sector specific, transportation is seen as a main contributor and entry point for accomplishing climate protection.\(^5\)

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\(^3\) See: United Nation FCCC/CP/2015/L.9/Rev.1  
\(^5\) cf. PPMC 2015, p. 4
4.3 Standards, guidelines and regulations concerning sustainable transportation

After analyzing the objectives of sustainable freight transportation, in this section, several standards, guidelines and regulations of sustainable freight transportation in the European Union are described in more detail. Therefore, the development of European guidelines towards sustainability and the increasing need for a common transport policy are illustrated. For this reason, at first, there is a historical overview of the evolution of environmental policies followed by the course of development towards a common transport policy. In this context, several milestones like the Environmental Action Programs (1973-2020), the European Strategy for Sustainable Development (EU SDS), the Europe 2020 Strategy, the Kyoto Protocol, the Paris Agreement as well as the first Transport White Paper (1992), the trans-European networks and their contribution to an easier movement of goods within the EU are analyzed. Additionally, the new White Paper (2001), the Mid-term Review of the White Paper (2006), the New Transport White Paper (2011) as well as current developments are explained more precisely.

4.3.1 Historical overview of the development of environmental policy

Generally, it can be stated that there have been several different steps regarding the development of a European environmental policy and additionally the integration of environmental issues into other policy areas like transportation. Environmental policy integration is tracing back to the 1st Environmental Action Program309 adopted in 1973, where the importance of environmental protection was firstly highlighted.310

Environmental Action Programs are an important instrument for the realization of the European Strategy for Sustainable Development.311 With Environmental Action Programs, the European Union defines a framework and sets priorities for the future environmental policies.312 Moreover, this strategic instrument gives environmental issues more importance. Without such a superior strategy, environmental policies could be seen as an ad hoc legislation and therefore not being regarded in other policy areas.313 Nevertheless, the Environmental Action Programs are formally not mandatory. For the realization of Environmental Action Programs there are two possibilities namely legislations and directives. Legislations like acts are directly applicable

309 See: OJ C 112, 1973, pp. 1 ff
310 cf. ABl. C 112, 1973, pp. 1 ff
312 cf. ABl. L 354, 2013, p. 171
throughout the EU. In contrast, directives need to be transformed into national law.\textsuperscript{314} Therefore, the liability for the realization of the programs depends on the directorate-general environment of the European Commission, other directorate-generals, special institutions like the European Economic and Social Committee and the Committee of the Regions, external interest groups like non-governmental organizations as well as small and medium-sized enterprises, which can therefore influence the development.\textsuperscript{315}

The goal of the European Economic Community was a harmonious development of the economic life. However, the economic expansion should also be reflected in the quality of life of the population. Therefore, the 1\textsuperscript{st} Environmental Action Program (1973-1976) was adopted. The Heads of State and Government highlighted the significance of an environmental policy during the summit of Paris in 1972. Moreover, they requested to work out an action plan with a clear schedule from the community institutions. Thus, goals for the European environmental policy were determined in the scope of the 1\textsuperscript{st} Environmental Action Program and for the next two years. This EAP could be seen as a framework and orientation for political decision-making processes in following policies. One of the main principles of the program was the precautionary principle which notes that it is better to prevent environmental burdens a priori instead of opposing the effects afterwards.\textsuperscript{316}

The 2\textsuperscript{nd} Environmental Action Program\textsuperscript{317} (1977-1981) focused on a broader area of environmental problems. It especially highlighted pollution control and enhanced a more detailed action program.\textsuperscript{318}

A holistic strategy regarding the environment was extended through the 3\textsuperscript{rd} Environmental Action Program\textsuperscript{319} (1982-1986). Additionally, a special focus lied on preventing pollution in advance. Moreover, preserving land usage and the conservation of natural resources, two factors especially relevant for transportation, got relevant.\textsuperscript{320} Additionally, the environmental policy integration into other policy fields was especially emphasized in the 3\textsuperscript{rd} EAP.\textsuperscript{321}

\textsuperscript{315} cf. Endl/Berger 2012, pp. 22 ff  
\textsuperscript{316} cf. ABl. C 112, 1973, pp. 1 ff  
\textsuperscript{317} See: ABl. C 139, 1977, pp. 1 ff  
\textsuperscript{318} cf. ICT Train 2015, n.p.  
\textsuperscript{319} See: ABl. C 46, 1982, pp. 1 ff  
\textsuperscript{320} cf. ICT Train 2015, n.p.  
\textsuperscript{321} cf. ABl. C 46, 1982, p. 2
This led to a legal status in The Single European Act\textsuperscript{322} in 1987. Therefore, environmental policy got incorporated in this revised version of the Treaty of Rome which represented a turning point for the evolution of environmental protection.\textsuperscript{323} However, it was reversed and further reinforced in the Treaty on the European Union in Maastricht\textsuperscript{324} in 1992. There it was stated, that the preservation of the environment and sustainable development needed to be integrated into Community policies.\textsuperscript{325}

In the 4\textsuperscript{th} Environmental Action Program\textsuperscript{326} from 1987 to 1992 the integration of environmental issues into other European policies was solidified.\textsuperscript{327} Especially four different ranges of activities were highlighted, namely the successful integration of national legislation in place, the reduction of environmental effects as well as the possibility of people to get and obtain information. From then on, sustainable development became a more and more regulatory provision regarding environmental policies in the European Union.\textsuperscript{328}

The 5\textsuperscript{th} Environmental Action Program\textsuperscript{329} (1993-2000) clearly stated the realignment of the former program. Moreover, it was the first program with a title which speaks for itself: “Towards Sustainability”. Additionally, it emphasized reaching long term goals as well as acting more globally.\textsuperscript{330} A report about the environmental condition in 1992 also revealed that despite the goals defined in former action programs the ecological status in fact deteriorated. Also the new contract about the European Union (1992) highlighted the importance and the promotion of a long-lasting environmentally appropriate growth. The program listed several environmental priorities: climate change, overacidification, air and noise pollution, exploitation of natural resources, biodiversity loss, water pollution, destruction of the urban environment and coastal regions as well as garbage. Moreover, there were several areas of focus like the manufacturing industry, transport, energy, tourism and agriculture.\textsuperscript{331}

For this reason, following the “Green Paper – on the impact of Transport on the Environment – A Community strategy for "sustainable mobility"”\textsuperscript{332} of 1992, the 5\textsuperscript{th} EAP highlighted several improvements which were necessary in the transport sector. These included for example

\textsuperscript{322} See: OJ L 169, 1987, pp. 1 ff
\textsuperscript{323} cf. Ueapme (2005), p. 7
\textsuperscript{324} See: OJ C 191, 1992, pp. 1 ff
\textsuperscript{325} cf. Endl/Berger 2012, pp. 21 ff
\textsuperscript{326} See: OJ C 328, 1987, pp. 1 ff
\textsuperscript{327} cf. ABl. C 328, 1987, pp. 6 ff
\textsuperscript{328} cf. ICT Train 2015, n.p.
\textsuperscript{329} See: OJ C 138, 1993, pp. 1 ff
\textsuperscript{330} cf. ICT Train 2015, n.p.
\textsuperscript{331} cf. ABl. C 138, 1993, pp. 11 ff
\textsuperscript{332} See: COM(92) 46 final
enhancements in the field of land usage, transport reductions, alternatives for road transportation, technical optimizations of vehicles and used fuels and a better coordination of infrastructure planning.\(^{333}\)


Moreover, the fifth action program was justified until 2000 and indicated that there should be an action control in 1995.\(^{338}\) The interim review stated that the program had required more quantifiable goals and monitoring mechanisms as well as focusable priorities which would have highlighted the need for action especially for the member states.\(^{339}\)

Furthermore, environmental policy integration and sustainable development were heightened as key objectives in the Amsterdam Treaty\(^{340}\)in 1997. Additionally, in 2001 the EU Strategy for Sustainable Development (EU SDS) was adopted. It can be seen as a great success regarding to environmental policy integration.\(^{341}\) The EU SDS extended the Lisbon Strategy\(^{342}\) (2000) by a special focus on sustainability.\(^{343}\) In addition, the SD-Strategy can be seen as the EU environmental policy with the highest level of targets regarding transportation.\(^{344}\) Sustainable transportation is actually one key challenge of the strategy.\(^{345}\) The overall goal in this area is:

\(^{333}\) cf. ABl. C 138, 1993, p. 35
\(^{334}\) See: OJ L 296, 1996, pp. 55 ff
\(^{335}\) See: OJ L 327, 2000, pp. 1 ff
\(^{336}\) See: OJ L 257, 1996, pp. 26 ff
\(^{337}\) cf. ICT Train 2015, n.p.
\(^{338}\) cf. ABl. C 138, 1993, p. 17
\(^{339}\) cf. Gouldson 1995, p. 27 f
\(^{340}\) See: OJ C 340, 1997, pp. 1 ff
\(^{341}\) cf. Endl/Berger 2012, pp. 21 f
\(^{342}\) See: http://eur-lex.europa.eu/legal-content/DE/TXT/?uri=uriserv%3Ac10241
\(^{343}\) cf. BMLFU 2016a, n.p.
\(^{344}\) cf. Petersen et al. 2009a, pp. 179 f
\(^{345}\) cf. BMLFU 2016a, n.p.
“To ensure that our transport systems meet society’s economic, social and environmental needs whilst minimising their undesirable impacts on the economy, society and the environment.”  

The operational objectives of the EU SDS regarding sustainable transport are:

- Decoupling economic growth and the demand for transport with the aim of reducing environmental impacts.
- Achieving sustainable levels of transport energy use and reducing transport greenhouse gas emissions.
- Reducing pollutant emissions from transport to levels that minimize effects on human health and/or the environment.
- Achieving a balanced shift towards environment friendly transport modes to bring about a sustainable transport and mobility system.
- Reducing transport noise both at source and through mitigation measures to ensure overall exposure levels minimize impacts on health.
- Modernizing the EU framework for public passenger transport services to encourage better efficiency and performance by 2010.
- In line with the EU strategy on CO₂ emissions from light duty vehicles, the average new car fleet should achieve CO₂ emissions of 140g/km (2008/09) and 120g/km (2012).
- Halving road transport deaths by 2010 compared to 2000.

Therefore it can be said that, the instruments of the SDS which focus on transportation inter alia aim to shift freight transportation from the road to more sustainable modes, enhance energy-efficiency, reduce harmful emissions and internalize external costs.

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346 European Council 2006, p. 10
347 European Council 2006, p. 10
349 Note: The European Road Safety Action Program 2011-2020 adapts this reduction target. The new goal is to halve the number of road deaths in Europe between 2011 and 2020. (Eurostat 2015)
350 cf. Petersen et al. 2009a, p. 183
In addition, the 6th Environmental Action Program\textsuperscript{351} (2002-2012) called: “Environment 2010: Our future, our Choice”, was the first program with a duration of 10 years. It exposed a framework for the policy making of environmental guidelines within the EU. Therefore, several actions were needed especially in the priority areas of environment and healthiness, nature and biodiversity, mineral deposits and garbage, as well as the changing climate.\textsuperscript{352}

Priority action areas regarding climate control in terms of transportation were the determination and realization of specific measures to reduce GHG emissions from air transportation, motor vehicles and maritime navigation as well as improving energy-efficient and less polluting modes of transport including an optimization of the logistic process. Moreover, the enhancement of alternative fuel usage and the internalization of external costs were focused. Concerning the protection of the environment, health and life quality, the reduction of transport noise was required through traffic avoidance actions, shifting transportation towards less noisy modes of transportation as well as through the improvement of transport technologies and more sustainable transportation planning.\textsuperscript{353}

Furthermore, this program promoted the inclusion of several preconditions regarding environmental preservation into all other policies of the Community. Additionally, it constituted the environmental part of the European Sustainable Development Strategy of the Community.\textsuperscript{354} Moreover, the “polluter pays“ principle as well as the precautionary principle were highlighted in this program.\textsuperscript{355}

In 2011 there was a final evaluation of the sixth action program. Thereafter, the program could be seen as beneficial as it provided a superior environmental framework. Most actions have already been implemented or were shortly before completion. Notwithstanding, the assessment of the goals turned out differently. Whereas climate protection targets were fulfilled, biodiversity goals were not met.\textsuperscript{356}

Due to the codecision procedure, the legal provisions got more legitimacy. Nevertheless, the involvement of the member states into the action program did not meant that they actually felt

\textsuperscript{351} See: OJ 242, 2002, pp. 1 ff
\textsuperscript{352} cf. ABl. L 242, 2002, p. 3
\textsuperscript{353} cf. ABl. L 242, 2002, pp. 7 ff
\textsuperscript{354} cf. ICT Train 2015, n.p.
\textsuperscript{355} cf. ABl. L 242, 2002, p. 1
\textsuperscript{356} cf. KOM (2011) 531 endgültig, pp. 3 f
obliged. Environmental policy implemented within the action program now got an integrated part of “Europe 2020 – A strategy for smart, sustainable and inclusive growth”.\textsuperscript{357}

Furthermore, the targets of the Lisbon Strategy, which had not been achieved until 2010, have also been followed up in the Europe 2020 Strategy.\textsuperscript{358} The strategy for 2020 helped Europe during the economic crisis and can be seen as the cornerstone for the development of a sustainable future based on “smart, sustainable and inclusive growth”.\textsuperscript{359} Therein, sustainable transportation is handled through two flagship initiatives which are part of the sustainable growth priority of the strategy. The Flagship Initiative “Resource efficient Europe” includes the Biodiversity Strategy (2011) and the Roadmap to a Resource Efficient Europe (2011) to tackle sustainable land utilization and biodiversity impacts, as already mentioned above. The second Flagship Initiative “An industrial policy for the globalization era”\textsuperscript{360} focuses on a competitive industry including an improved and sustainable transportation infrastructure.\textsuperscript{361}

Furthermore, the well-known Kyoto Protocol was established on the third Conference of the Parties (COP3) of the United Nations Framework Convention on Climate Change (UNFCCC) in Kyoto in 1997.\textsuperscript{362} This agreement became effective in 2005 and is seen as the most detailed international convention that targets the reduction of worldwide GHGs.\textsuperscript{363} Moreover, until 2020, the agreement is the only legally mandatory instrument to achieve this goal. Furthermore, 192 countries including the EU ratified the protocol. However, several great contributors of GHG emissions like the USA, China and Canada are not part of the protocol.\textsuperscript{364} Therefore, the participants of the Kyoto agreement make up only 12 \% of worldwide emissions. In the first period from 2008 to 2012 a 5 \% reduction target of GHG emissions was set compared to 1990. In the second period from 2013 to 2020 new parties engaged themselves to reduce emissions by 18 \% compared with the same base year.\textsuperscript{365}

Moreover, in 2013 the 7\textsuperscript{th} Environmental Action Program\textsuperscript{366} was adopted which will run until 2020. During this period it will lead the European environmental policy.\textsuperscript{367}

Although several goals of the 6th Environmental Action Program have already been achieved, according to the final evolution there have been still some deficits. Therefore, a further action program was needed. The 7th Environmental Action Program is called: “Living well, within the limits of our planet.” However, to realize the goals, a high engagement of the European member countries and the responsible institutions is needed. Nevertheless, the 7th Action Program has more binding character and legitimization than the other programs, as it was adopted through an ordinary proceeding. This means that the European Commission, Council and Parliament were equally involved. Furthermore, it is important that the program is an action program and not a work program as this provides a higher political and strategic added value. Therefore, it is necessary that the program defines long term goals in order to set the basis for a strategic direction for future European environmental policies.

This action program is based on several existing documents which are also paramount for the development of sustainable transportation. It is built on the political initiatives according to the “Europe 2020 Strategy” including:

- the Union Climate and Energy Package which is important for sustainable transportation regarding the included Emissions Trading System;

- the Commission Communication on a Roadmap for moving to a low-carbon economy in 2050, which highlights the need for technological efficiency improvements of motor vehicles, the usage of alternative fuels and the optimization of transport networks in order to make the transport system more sustainable;

- the EU Biodiversity Strategy to 2020, is particularly meaningful for infrastructure planning;

- the Roadmap to a Resource Efficient Europe emphasizes the necessary enhancement of the efficient use of resources in the transport sector;

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368 See: OJ L 354, 2013, p. 171
369 cf. ABl. L 354, 2013, p. 171
370 cf. Deutscher Naturschutzzring 2012, p. 3
371 ABl. L 354, 2013, p. 172
372 See: COM(2007) 2 final
373 See: COM(2011) 112 final
374 See: COM(2011) 244 final
375 See: COM(2011) 571 final
• the Innovation Union Flagship Initiative\textsuperscript{376} includes the development of an Intelligent Transport System (ITS);

• and the European Union Strategy for Sustainable Development\textsuperscript{377} where the main goals regarding sustainable transportation are already listed above.

Furthermore, the program states several goals until 2020. More precisely, it emphasizes nine priorities which are listed and visualized below in Figure 15. However, the first three are the main thematic objectives (green), followed by four enabling framework objectives (black) and two additional horizontal objectives (blue).\textsuperscript{378}

(a) to protect, conserve and enhance the Union’s natural capital; (reduction of transport emissions)

(b) to turn the Union into a resource-efficient, green and competitive low-carbon economy; (the 2050 Energy Roadmap and the 2011 White Paper on transport should be underpinned)

(c) to safeguard the Union’s citizens from environment-related pressures and risks to health and well-being; (tackling air and noise pollution through goals set in the Roadmap to a Single European Transport Area)

(d) to maximize the benefits of Union environment legislation by improving implementation;

(e) to improve the knowledge and evidence base for Union environment policy;

(f) to secure investment for environment and climate policy and address environmental externalities;

(g) to improve environmental integration and policy coherence; (through the enhancement of transport networks)

(h) to enhance the sustainability of the Union’s cities; (sustainable public transport)

(i) to increase the Union’s effectiveness in addressing international environmental and climate-related challenges.

\textsuperscript{376} See: COM(2010) 546 final

\textsuperscript{377} See: COM(2001) 264 final

Figure 15: 7th EAP priority objectives

Source: European Commission 2015a

In compliance with the mentioned goals, the action program also includes a vision for 2050:

“In 2050, we live well, within the planet’s ecological limits. Our prosperity and healthy environment stem from an innovative, circular economy where nothing is wasted and where natural resources are managed sustainably, and biodiversity is protected, valued and restored in ways that enhance our society’s resilience. Our low-carbon growth has long been decoupled from resource use, setting the pace for a safe and sustainable global society.”

According to the assessment of the State of the Environment Report (SOER) 2015, disclosed by the European Environment Agency (EEA), it is said that the ecological impacts in Europe can be diminished in the short run. Additionally, it will be possible to decouple the development of some environmental fields from economic growth. Nevertheless, the forecast does not look quite as good in the long run. Whereas a comprehensive realization of existing European policies is essential, they are not sufficient to achieve the vision for 2050 formulated in the 7th Environmental Action Program.

The following Table 5 demonstrates the developments and failures of the three main priority areas, where transportation is mostly mentioned as a contributor.

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379 OJ. L 354, 2013, p. 176
380 cf. EEA 2015a, pp. 10 ff
Table 5: An indicative summary of environmental trends

<table>
<thead>
<tr>
<th>Protecting, conserving and enhancing natural capital</th>
<th>S-10 year trends</th>
<th>20+ years outlook</th>
<th>Progress to policy targets</th>
<th>Read more in Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrestrial and freshwater biodiversity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land use and soil functions</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Ecological status of freshwater bodies</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Water quality and nutrient loading</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air pollution and its ecosystem impacts</td>
<td></td>
<td>3.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marine and coastal biodiversity</td>
<td></td>
<td>3.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Climate change impacts on ecosystems</td>
<td></td>
<td>3.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Resource efficiency and the low-carbon economy      |                  |                  |                           |                     |
| Material resource efficiency and material use       | No target         |                  |                           |                     |
| Waste management                                    |                  |                  |                           |                     |
| Greenhouse gas emissions and climate change mitigation | 4.5             |                  |                           |                     |
| Energy consumption and fossil fuel use              |                  |                  |                           |                     |
| Transport demand and related environmental impacts  |                  |                  |                           |                     |
| Industrial pollution to air, soil and water         |                  |                  |                           |                     |
| Water use and water quantity stress                 |                  |                  |                           |                     |

| Safeguarding from environmental risks to health     |                  |                  |                           |                     |
| Water pollution and related environmental health risks |                  | 5.4              |                           |                     |
| Air pollution and related environmental health risks |                  | 5.5              |                           |                     |
| Noise pollution (especially in urban areas)         | N.A.             |                  |                           |                     |
| Urban systems and grey infrastructure               | No target         |                  |                           |                     |
| Climate change and related environmental health risks |                  | 5.8              |                           |                     |
| Chemicals and related environmental health risks    |                  | 5.9              |                           |                     |

Indicative assessment of trends and outlook

| Deteriorating trends dominate | Largely not on track to achieving key policy targets |
| Trends show mixed picture     | Partially on track to achieving key policy targets  |
| Improving trends dominate     | Largely on track to achieving key policy targets    |

Source: EEA 2015a, p. 11

With a focus on improving efficiency, for example water and air quality can be enhanced in the short run. Transport emission reductions can be reached with the introduction of quality standards for fuels and limits regarding air pollution and CO₂ from exhaust emissions. However, climate change and land usage will still be challenging. In the short run, resource efficiency is quite promising. Nevertheless, in 2020 there has to be a 20 % contribution of renewable energy consumption whereof 10 % need to be from the transport sector. Member countries of the EU already make progress towards reaching this goal. Anyhow, environmental impacts will not be solved with efficiency improvements alone, as those measures are often compensated for by rising transport demand. Additionally, the forecasted reduction of
greenhouse gas emissions will not be enough to reach the 2050 target of a decrease of 80-95 \%.
In the transport sector a decline of 60 \% of CO$_2$ is required by 2050 to achieve this goal (base year 1990). In this respect, technical innovations are seen as the most effective measures. Moreover, health risk will reach some enhancements like the improvement of the quality of drinking water. Despite the fact that air and noise pollution can be reduced in part, especially in urban areas they will still lead to health problems. Although the impacts from transport can be diminished to some extent and policy targets can be achieved partially in the short run, in the 20 years outlook, trends are declining and a faster implementation of measures would be necessary to keep down environmental impacts of transportation.$^{381}$

Nevertheless, this action program essentially helps to promote sustainable development because it tries to dissolve environmental problems and highlights the necessity of interlinking different policy areas with the environmental dimension.$^{382}$

All in all, it can be said that beside several achievements, there are still many challenges left in reaching the 2050 vision of the 7th Environmental Action Program.$^{383}$

As already mentioned above, latest developments regarding climate change mitigation took place in Paris in 2015. The Paris Agreement (COP21) is seen as a turning point in the history of climate protection as it constitutes the first mandatory global climate convention with 195 participating countries which will become effective in 2020. Its overall goal is to advance actions to reduce the global warming below the 2°C ceiling.$^{384}$ Although the targets are not set for specific sectors, transportation is seen as a key factor in fighting climate change.$^{385}$

Summarized, Table 6 should give an overview of the above mentioned European environmental policy development.

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$^{381}$ cf. EEA 2015a, pp. 10 ff
$^{382}$ cf. Endl/Berger 2012, pp. 43 f
$^{383}$ cf. EEA 2015a, p. 144
$^{385}$ cf. PPMC 2015, p. 4
Table 6: Overview of the historical development of environmental policy

<table>
<thead>
<tr>
<th>Year Range</th>
<th>Environmental Policy Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973-1976</td>
<td>1st Environmental Action Program</td>
</tr>
<tr>
<td>1977-1981</td>
<td>2nd Environmental Action Program</td>
</tr>
<tr>
<td>1982-1986</td>
<td>3rd Environmental Action Program</td>
</tr>
<tr>
<td>1987</td>
<td>Single European Act</td>
</tr>
<tr>
<td>1992</td>
<td>Maastricht Treaty</td>
</tr>
<tr>
<td>1993-2000</td>
<td>5th Environmental Action Program</td>
</tr>
<tr>
<td>1997</td>
<td>Amsterdam Treaty</td>
</tr>
<tr>
<td>1997</td>
<td>Kyoto Protocol</td>
</tr>
<tr>
<td>2000</td>
<td>Lisbon Strategy for growth and jobs</td>
</tr>
<tr>
<td>2001</td>
<td>EU Strategy for Sustainable Development</td>
</tr>
<tr>
<td>2002-2012</td>
<td>6th Environmental Action Program</td>
</tr>
<tr>
<td>2011</td>
<td>Europe 2020</td>
</tr>
<tr>
<td>2015</td>
<td>Paris Agreement (COP21)</td>
</tr>
<tr>
<td>2013-2020</td>
<td>7th Environmental Action Program</td>
</tr>
</tbody>
</table>

Source: Own research
4.3.2 Towards a common transport policy

After the historical overview of the environmental policy development, this chapter focusses on the evolution of a common transport policy in the light of sustainability.

First of all, a common transport policy within the whole European Union is crucial for the economy and its growth and therefore also for trade and employment. Without a dense network between all member states interoperability, which is essential for Europe’s economy and the creation of an internal market, cannot be guaranteed.\(^{386}\)

One of the first common policies of the European Economic Community was the transport policy tracing back to the Treaty of Rome in 1957. There already three of the “four freedoms”, namely free movement of goods, services and people, were incorporated, which are needed to achieve the overall goal of creating a single European transport market. However, due to disagreement of the member states a special regulation was used. Therefore, not the content of a common transport policy was determined in the treaty but only abstract formulations. Thereafter, a long process began, in which the different member states needed to agree on a common realization. Nearly 25 years passed by without any measures because the member states did not want to lose their power over national transport networks.\(^{387}\) Moreover, the member states had different preferences regarding their main transport modes. Whereas the bigger countries like Italy, Germany and France focused on rail transport, peripheral members like Great Britain, Greece and the Benelux countries concentrated more on shipping and road transportation. As the member states wanted to maintain their preferred transportation mode, a harmonization and liberalization towards a common transport policy was aggravated.\(^{388}\) Nevertheless, after this time the European Parliament decided to intervene and sued the Council of the European Union for not accomplishing a common policy. This led to some proceedings in the following years including the opening of national markets, reducing access barriers and adjusting different standards regarding administration and technology like taxes and prices. Moreover, in 1992 a White Paper published by the European Commission was created in order to advance the internal market and therefore develop a single European transportation area.\(^{389}\)

\(^{386}\) cf. European Commission 2014b, p. 3
\(^{387}\) cf. European Commission 2014b, pp. 3 ff
\(^{388}\) cf. Rauch 2007, pp. 22 ff
\(^{389}\) cf. European Commission 2014b, pp. 3 ff
This White Paper about “the future development of the common transport policy”\textsuperscript{390} summarized the previous results of a common transport policy. Moreover, it proposed several recommendations necessary for the full opening of the transportation market.\textsuperscript{391}

However, to enhance fluent transportation within the whole Union market liberalization was not sufficient. The infrastructure within the EU needed to be modernized, enlarged and rationalized to make internal transportation smoothly and available for different transportation modes. For the purpose of enhancing the completion of a single transport market the trans-European network policy was developed.\textsuperscript{392}

4.3.2.1 Trans-European networks

The trans-European networks have been a very important measure on the way to an integrated European transport system.\textsuperscript{393} Trans-European networks are high-level transport networks defined by the European Union in 1996 and later enhanced in 2004, 2010 and 2014. They are serving as an instrument for the unification of the European traffic systems. Therefore, in the long run there should be an amendment of cross-border connections, an elimination of deficiencies regarding national networks, a linkage of peripheral regions and an advancement of intermodal transportation in order to promote the interoperability in Europe.\textsuperscript{394}

For this reason, in 1990, the twelve member states of Europe decided to enhance the internal market by creating trans-European networks in three different areas namely energy, telecommunication and transportation, whereas the latter is especially important and supports this thesis.\textsuperscript{395} In 1992, the trans-European networks were incorporated in the Maastricht Treaty. The trans-European transport network (TEN-T) however, should intensify a transport policy which also focuses on the environment. This movement towards a common transport policy was further enhanced by the already mentioned White Paper of 1992.\textsuperscript{396}

The term “networks” in relation to transportation refers to all ways and hubs for rail, road, air and waterborne transportation. “Trans-European” means that all networks need to be constructed and enlarged so that they can be used smoothly within the whole European internal

\begin{itemize}
\item \textsuperscript{390} See: COM(92) 494 final
\item \textsuperscript{391} cf. Rauch 2007, pp. 22 f
\item \textsuperscript{392} cf. European Commission 2014b, p. 3
\item \textsuperscript{393} cf. Rauch 2007, pp. 22 f
\item \textsuperscript{394} cf. Posset et al. 2014, p.157
\item \textsuperscript{395} cf. European Commission 2014a, n.p.
\item \textsuperscript{396} cf. European Commission 2014b, pp. 4 f
\end{itemize}
market. Therefore, all national systems need to be compatible and interlinked to ease cross-border traffic. 397

The main goal of the trans-European network is the development of a single market and the advancement of economic and social coherence of the Community. 398 Therefore, the key instruments for the trans-European transport policy are common Union guidelines which set goals, priorities and measures as well as a European infrastructure fund which promotes the implementation of the network. 399

The TEN-T guidelines are based on two levels of planning. On the one hand, there is the comprehensive network layer which contains a basic framework for road, rail, inland waterways, maritime, air and intermodal transport infrastructure. On the other hand there are several priority projects of special European interest. 400

For this reason, in 1994 the Essen European Council defined 14 priority projects which were the basis for the funding of the transport infrastructure by the European Union. The adaption of the TEN into the Maastricht Treaty was not very successful until 1994. Only one fifth of the planed infrastructure was constructed. 401

Considering the congestion of several main axis and consequential environmental burden, it was essential, that the European Union executed the trans-European projects effectively. In this context, the list of the fourteen priority projects has been adopted, increased and adjusted in the following years. 402

The first common guidelines, the Decision No 1692/96/EC “Guidelines for the development of the trans-European transport network” 403 (TEN-T) were seen as a so called “Master Plan” for the construction and expansion of important European infrastructure. The Council Regulation (EC) No 2236/95 of 18 September 1995 “laid down general rules for the granting of Community financial aid in the field of trans-European networks” 404. Furthermore, the regulation acted as a reference framework for the infrastructure policy in the different member countries. 405

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397 cf. Rauch 2007, pp. 26 f
398 cf. Posset et al. 2014, p. 158
400 cf. European Commission 2009, p. 9
401 cf. KOM(2001) 370 endgültig, p. 8
402 cf. KOM(2001) 370 endgültig, p. 16
To guarantee interoperability and therefore the possibility to cross borders on these networks technical norms were harmonized. However, to change existing systems in terms of a unified European standard meant a lot of time and cost exposure. Therefore, in order to provide interoperability, the union previously focused on the development of new networks.\footnote{406 cf. Rauch 2007, pp. 26 f}

In the Treaty of Amsterdam in 1997 additional adjustments concerning environmental friendly transportation were incorporated. Moreover, the European Parliament now got the power to decide beside the Council on the most important issues regarding transport policy.\footnote{407 cf. European Commission 2014b, pp. 4 f}

Meanwhile, the trans-European transport networks included 30 priority projects of special European interest as depicted in Figure 16.\footnote{408 cf. Posset et al. 2014, p.158} The projects should have been started before 2010 and should be finished until 2020. Further amendments regarding the TEN-T policy had also been made in the course of the EU enlargement.\footnote{409 cf. European Commission 2014a, n.p.}
Figure 16: TEN-T priority projects

The construction and financing of the TEN-T networks normally rests on the different member states. Therefore, they are dependent on the national planning and financing possibilities. The European Union is co-financing the TEN-T networks within the limits of the EU budget line, EU structural funds like the European Regional Development Fund (ERDF), the cohesion fund as well as co-financing through loans from the European Investment Bank (EIB) and the European Investment Fund (EIF).\textsuperscript{410}

According to the European Commission, the costs for the realization of the TEN-T network will account for 600 billion Euro until 2020. This amount also includes the necessary means for the extension in the new European member states. This was determined through the Transport Infrastructure Needs Assessment (TINA).\textsuperscript{411}

\textsuperscript{410} cf. Posset et al. 2014, p. 158
\textsuperscript{411} cf. Posset et al. 2014, p. 158
However, those mentioned priority projects are adding value for Europe’s economy and also directly for the population. Furthermore, they are enhancing the sustainable development goals of the European Union. Most of the projects are in regard to railways. Some are rail and road projects and a few are concerning inland waterways. The “Motorways of the Sea” initiative also became a priority project as it highlights the reduction of environmental pollution especially through freight transportation. Also the “Galileo” project, which is the global navigation satellite system (GNSS) of the European Union, was implemented as a priority project.

Sensors can gather traffic situations like the speed, position and driving direction. Satellite systems are representing an advanced technology for telematics. Regarding transportation, especially tracking and navigation are significant topics. The European satellite navigation system offers high potential for all transport modes regarding more efficiency and security. For this reason, Galileo can particularly contribute to the enhancement of an integrated trans-European transport network.

However, the entire completion of the projects is essential for the creation of an internal market. Therefore, the New White Paper (2001) focused on a revision and amendment of the existing TEN-T guidelines.

### 4.3.2.2 New White Paper (2001)

With the White Paper of 2001 called: “European transport policy for 2010: time to decide” the EU developed a ten-year strategy which is seen as a milestone towards a more sustainable transport policy. The paper included topics like increasing environmental impacts of transport in terms of pollution, congestion and irregular increase of the different transportation modes. In this White Paper also health and environmental problems were highlighted, which were expected to rise especially because of increasing pollution. Moreover, a growth of the traffic density was forecasted particularly in road and air transportation.

For this reason, an action program was included into the White Paper which focused especially on balancing out the proportion of different transportation modes. Therefore, the enhancement of the quality of road traffic, the revitalization of rail transportation and the growth of air

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412 cf. OJ L 228, 1996, p. 6
414 cf. Rauch 2007, pp. 88 f
415 cf. COM(2001) 370 final, pp. 14 f
416 See: COM(2001) 370 final
417 cf. European Commission 2014b, p. 5
transportation should have been mastered appropriately. Furthermore, modernization measures for maritime and inland waterway transportation were seen as necessary.\textsuperscript{418}

Additionally, an overall strategy for the linkage of all transportation modes was needed. To promote this, a new program called „Marco Polo“ (2003-2006) for the improvement of intermodality and the enhancement of a shift from the road to other more sustainable transportation modes was planned. This program replaced the former PACT-program (Pilot Action for Combined Transport) which was introduced in 1992. The PACT-program led to many successful initiatives with 167 projects which were completed until 2000 although there had been only modest financial means available.\textsuperscript{419} Even after investments into a second program called Marco Polo II (2007-2013) the ambitious goals could not be reached. Although a shift towards more sustainable transport modes occurred the percentage rate was just half as big as planned.\textsuperscript{420}

Another focus of the White Paper was on the elimination of bottlenecks. Especially the adaption of the trans-European transport network (also in the enlarged EU) and the advancement of the mentioned priority projects were highlighted. Furthermore, the paper emphasized to align transport policy with the needs of users and to tackle the problems regarding transport globalization.\textsuperscript{421}

To accelerate the decision-making process and the screening of the achieved results, the White Paper included a mechanism for a revision. Accordingly, the European Commission had to submit a schedule with concrete goals. In 2005, a balance about the positioned measures was implemented. If necessary, appropriate modifications should have been undertaken.\textsuperscript{422}

4.3.2.3 Mid-term Review of the White Paper (2006)

According to several projections and studies, the Mid-term Review\textsuperscript{423} (2006) stated that the planned measures of the White Paper had not been enough to reach the set objectives. Especially in order to facilitate mobility as well as to curb the problem of environmental pollution and the increasing transport intensity, a broader view and more flexible instruments would have been necessary to be implemented into the transport policy. Additionally, globalization and the

\textsuperscript{418} cf. KOM(2001) 370 endgültig, pp. 124 ff
\textsuperscript{419} cf. KOM(2001) 370 endgültig, pp. 124 ff
\textsuperscript{420} cf. Europäischer Rechnungshof 2013, p. 14
\textsuperscript{421} cf. KOM(2001) 370 endgültig, pp. 124 ff
\textsuperscript{422} cf. OJ C 161, 2007, p. 90
\textsuperscript{423} See: KOM(2006) 314 endgültig
enlargement of the European Union were further reasons why consistent legal regulations in all member countries, flexible economic instruments as well as technological integration and a strengthened cooperation were needed. 424

Therefore, further instruments for the actual realization of the White paper included action programs for freight logistics 425, intelligent traffic systems for environmentally friendlier and efficient transport 426, a possible transformation of urban mobility 427, the enhancement of inland waterway transportation 428, more sustainable fuels to be used in road transportation as well as a strategy for maritime policy until 2018. 429

In order to make the European maritime transportation more competitive, the Commission adopted “Strategic goals and recommendations for the EU’s maritime transport policy until 2018” 430 in 2009. The objective of this paper has been the improvement of maritime transport regarding environmental issues in order to make it coequal and able to compete with other transport modes. This strategy has had a strategic perspective whereas also short term problems have been considered. 431 For example, qualitative shipping should be a main advantage in competition in 2018. Therefore, the improvement of sustainable performance through the total reduction of emissions and garbage, diminishing of greenhouse gas emissions and reaching a “good ecological status” of waters should be enhanced. 432

Transportation accounts for 30% of the overall energy use and 71% of the mineral oil use in the European Union, whereas 60% of the oil consumption is due to road transportation. Therefore, within the framework of the Mid-term Review, the Commission also submitted a strategic technology plan for energy in 2007 and a broader action program for environmentally friendlier motor vehicles in order to reduce the subordination on petroleum and to strengthen sustainable transportation. 433

426 See: COM(2008) 886 final
427 See: COM(2009) 490 final
428 See: COM(2006) 6 final
430 See: COM(2009) 8 final
432 cf. COM(2009) 8 final, pp. 5 f
Nevertheless, it has to be mentioned that in 2001 a strong economic growth was expected which ultimately did not occur.\footnote{cf. KOM(2006) 314 endgültig, p. 7} Moreover, through the European enlargement, the EU reached a continental dimension, new technological developments converted the transport sector more and more into a high-technology sector, the modal split had further developed and the price of oil rose. Due to these changes a reorientation of the White Paper’s objectives and of the transport policy goals in general have been necessary.\footnote{cf. ABl. C 161, 2007, p. 89}

However, since 2001 several significant legal regulations have been adopted like the enhancement of the social standards for road transport, the definition of 30 priority projects in terms of the trans-European networks, the development of the Single European Sky and the new directive regarding road charges. Moreover, the opening of rail freight transportation for stimulating competition through the Railway Packages\footnote{See: http://ec.europa.eu/transport/modes/rail/packages/index_en.htm} created a legal basis for the establishment of a common transport market in the railway sector.\footnote{cf. Jarzembowski 2007, p. 282}

One central part of the Mid-term Review was also the focus on and the advancement of co-modality through the “Marco Polo” program mentioned above.\footnote{cf. KOM(2006) 314 endgültig, p. 7} Co-modality means an efficient usage of the different transportation modes as well as the combination of them. Thereby, an optimal sustainable utilization of resources can be reached. Co-modality is perceived as safeguarding high mobility as well as eco-friendliness.\footnote{cf. ABl. C 161, 2007, p. 91} Moreover, with the development of systems such as Galileo – the global navigation satellite system – the European Union proved its own capacity for innovative programs.\footnote{cf. European Commission 2014b, p. 5}

All in all, it can be said, that after a progress check in 2006, it turned out that despite several achievements since the introduction of the White Paper in 2001, more measures would have been needed to counteract the harmful effects transport exerted on the environment. Therefore, the implementation of schedules for freight logistics, the enhancement of more sustainable modes of transportation and generally forcing “greener” transportation has been planned.\footnote{cf. KOM(2006) 314 endgültig, p. 7}
4.3.2.4  Keep freight moving (2007)

As a consequence, in “The EU’s freight transport agenda: Boosting the efficiency, integration and sustainability of freight transport in Europe”\(^{442}\) (2007), the European Commission suggested several measures to enhance logistic processes of freight transportation, to support the competitiveness in the rail freight sector, to promote investments for the renewal of European harbors, to improve the shift of other transport modes towards maritime freight transportation and to control the progress of the Motorways of the Sea initiative.\(^{443}\) Thus, the freight transport agenda included several policy initiatives:

- **Freight Logistics Action Plan**\(^{444}\)

As the Mid-term Review of the White Paper 2001 highlighted the importance of logistics, this action plan contained measures like:

- **e-Freight and Intelligent Transport Systems (ITS)**
  
  Information and communication technologies (ICT) including RFID (Radio-frequency identification) are a great tool to support co-modality through better organization and management as well as tracking and tracing.

- **Sustainable quality and efficiency**
  
  Bottlenecks should be identified and the improvement of performance is highlighted.

- **Simplification of transport chains**
  
  EU-wide administrative standards, the use of one single transport document as well as the unification of liability clauses should be implemented.

- **Vehicle dimensions and loading standards**
  
  For the transportation between member states severe regulations regarding the equipment, the drivers and transport paths have been required.

- **Urban freight transport logistics**
  
  Performance figures were needed to reveal efficiency and sustainability lacks of the consignment and to improve urban freight transport logistics.

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\(^{442}\) See: COM(2007) 606 final


\(^{444}\) See: COM(2007) 607 final
o  "Green" transport corridors for freight

In the course of the revision of the White Paper in 2006, the shift towards more environmentally friendly modes of transport respectively the combination of different modes and therefore the development of “green” transport corridors were highlighted. Also the strengthening of “green” corridors in the projects of TEN-T like Marco Polo should have been forwarded to reduce environmental impacts of transportation.445

- Communication on a freight-oriented rail network446

Here the focus lied on the improvement of rail freight which should have been an integrated part of TEN-T. Also the enhancement of time needed for the transit was paramount as it increases the reliability of the rail.447

- Communication on a European Ports Policy448

The European Ports Policy focused on the improvement of attractiveness of European ports in order to shift more transport towards this mode.449

- Commission staff working paper "Towards a European maritime transport space without barriers"450

This paper tried to improve maritime transport through the simplification of administration and therefore to make it more competitive.451

- Staff working paper on Motorways of the Sea452

The identification of the development of this initiative was desired. Additionally further recommendations should have been suggested for the future.453

All these policy initiatives should support each other mutually and therefore enhance the efficiency and sustainability of freight transport in the EU.454

446 See: COM(2007) 608 final
447 cf. COM(2007) 608 final, p. 3
448 See: COM(2007) 616 final
449 cf. COM(2007) 606 final, pp. 3 f
450 See: SEC(2007) 1351
451 cf. COM(2007) 606 final, p. 4
452 See: SEC(2007) 1367
453 cf. COM(2007) 606 final, p. 4
454 cf. COM(2007) 606 final, p. 4
4.3.2.5 Greening Transport (2008)

In order to make transportation even more “greener” and sustainable the European Commission established a “Greening Transport” package. This included three parts namely a strategy which highlighted the internalization of external costs, a plan which should assist member countries to introduce road charges and a recommendation how to diminish noise impacts from rail freight transportation. For example, the package included suggestions for a revised EU Eurovignette Directive which was supposed to make it possible for member states to use road charges not only for infrastructure but also for counteracting negative environmental impacts of transport. The new directive focused on the harmonization of traffic charges in all member states and differentiated between environmental issues. Therefore, the member countries have been able to control and regulate transportation by themselves.

Furthermore, “Greening Transport” has been essential for Europe’s transport policy as it tried to attribute environmental cost to the emitters which is still a very contentious problem. Moreover, it has provided the EU in reaching its climate and energy objectives. However, the measures of the package have probably been not enough to compensate rising emissions from transportation.

4.3.2.6 Green Paper (2009)

Therefore, a policy review of the trans-European transport networks was launched through adopting the Green Paper “TEN-T: A policy review towards a better integrated trans-European transport network at the service of the common transport policy” in 2009. Several experts from different fields summarized previous considerations in order to foster recommendations and legal provisions.

Past achievements of the TEN-T policy are for example the establishment of several connections of national rail and road networks, the interoperability of cross-border rail
transportation, the introduction of intelligent transport systems like Galileo, the enhancement of co-modality and the Motorways of the Sea project.\footnote{cf. COM(2009) 44 final, p. 3}

Through the enlargement of infrastructure and the creation of multimodal nodes, transport time and distance can be reduced as well as shifted towards more sustainable modes, which positively contributes to the environmental protection.\footnote{cf. Europäische Gemeinschaften 2005, pp. 27 ff} However, the acceleration of transport also leads to an increase in the transport intensity. Nevertheless, there will be considerable shifts towards rail and inland waterways. Additionally, the expansion of infrastructure itself has impacts on the environment. Although, the emission of CO$_2$ can be alleviated they cannot be reversed.\footnote{cf. European Communities 2001, p. 4}

Moreover, noise pollution is still an environmental bottleneck regarding TEN-T resulting from even increasing transportation. Furthermore, there are often controversies between the emergence of new infrastructure and landscape preservation of several territories.\footnote{cf. Petersen et al. 2009b, p. 24}

The objective of this Green Paper has been to adapt Community actions concerning the new challenges of the EU especially regarding climate change, the social and economic objectives of the Lisbon Strategy and interoperability. Therefore, the Commission recommended the strengthening of the network integration through the optimization of intermodal transportation, an improvement of intelligent transport systems and the promotion of technological innovations.\footnote{cf. Dankelfsen/Soave 2009, pp 26 f}

The results of this review process led to revised TEN-T guidelines\footnote{See: OJ L 204, 2010, pp. 1 ff} which were implemented in 2010. Additionally, in 2014 a new legislation of the trans-European transport policy was realized which is shortly explained below.\footnote{cf. European Commission 2014a, n.p.}
4.3.2.7 New Transport White Paper (2011)

As the White Paper of 2001 nearly faced the end of its action period, a new concept regarding the future of transport was necessary. Therefore, the “Communication from the Commission – A sustainable future for transport: Towards an integrated, technology-led and user friendly system”\(^\text{472}\) was launched. The paper included several studies and policy recommendations for the purpose of promoting discussions and ideas for the next White Paper in 2011.\(^\text{473}\)

As a consequence, in 2011, the Commission adapted a new Transport White Paper called “Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system”\(^\text{474}\) in order to enhance an internal market of transportation. Special focus lied on the development of integrated transport networks which should unify various transportation modes, the construction of multimodal hubs to overcome bottlenecks, the enhancement of the infrastructure of new member states of the EU and developing more sustainable solutions regarding transportation for the future.\(^\text{475}\) The paper contained 40 specific initiatives which should promote the competitiveness of the European transport system, eliminate obstacles and significantly diminish the dependence on external oil sources as well as reduce CO\(_2\) emissions of the transport sector by 60 % by 2050.\(^\text{476}\)

In order to reach these goals by 2050 and therefore cut GHG emissions, the White Paper stated ten goals for a “competitive and resource efficient transport system”:\(^\text{477}\)

1) No conventionally fueled cars in city traffic
2) 40 % usage of low-carbon sustainable fuels in aviation, a 40 % cut in CO\(_2\) emissions from maritime transport
3) 50 % shift from road freight transport towards rail and waterborne transportation
4) Completion of an EU high-speed rail infrastructure by 2030
5) Finishing the trans-European transport core network by 2030
6) Connection of multimodal nodes of the TEN-T network
7) Usage of intelligent transport systems like Galileo
8) Creation of an intermodal transport information, organization and payment system by 2020

\(^{472}\) See: COM(2009) 279 final
\(^{473}\) cf. COM(2009) 279 final, p. 1
\(^{474}\) See: COM(2011) 144 final
\(^{475}\) cf. European Commission 2014b, pp. 4 ff
\(^{477}\) cf. COM(2011) 144 final, pp. 10 ff
9) Almost no mortalities in road transportation and increasing security in all different modes of transport
10) Full implementation of the “user pays” and “polluter pays” principle and generating enough money for future transportation investments

In order to reach these objectives, the White Paper listed inter alia the following measures: 478

- A Single European Transport Area
  - A true internal market for rail services
  - Completion of the Single European Sky
  - Capacity and quality of airports
  - A maritime “Blue Belt” and market access to ports
  - A suitable framework for inland navigation
  - Multimodal transport of goods: e-Freight

- Promoting quality jobs and working conditions

- Secure Transport
  - Cargo security
  - Land transport security
  - ‘End-to-end’ security

- Acting on transport safety: saving thousands of lives

- Service quality and reliability

However, this strategy has also required technological innovations and solutions regarding increasing efficiency of vehicles, alternatives for the usage of energy and improving networks with intelligent transport systems. This might also contribute to a more sustainable behavior. Additionally, to completely unify the European infrastructure with an inclusion of multimodal nodes sufficient financial resources are needed. As mentioned above, the “polluter pays” – principle need to be expanded in order to gain more transport charges and therefore internalize external costs. 479 All in all it can be said, that the European transport system needs a revision in the form of the mentioned measures. As a result, the set objectives of reaching at least a 60 % reduction of GHGs and an increase of competitiveness and efficiency of the transport sector should be achieved. 480

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478 COM(2011) 144 final, pp. 18 ff
479 cf. COM(2011) 144 final, pp. 10 ff
480 cf. COM(2011) 144 final, p. 17
4.3.2.8 New transport infrastructure policy (2014)

As already mentioned above, the policy review launched through the Green Paper of 2009 resulted in a new legislation for the trans-European transport network policy in 2014. Therefore, the “Union guidelines for the development of the trans-European transport network”481 (amended the TEN-T guideline version of 2010) and the “Connecting Europe Facility”482, a funding instrument for the promotion of the realization of TEN-T projects between 2014 and 2020, were adopted by the EU.483

The special focus of the new infrastructure policy lies on the connection of North and South as well as East and West Europe. Therefore it aims to eliminate bottlenecks in order to guarantee frictionless transportation. This also implies to conclude remaining gaps of the transport network between all member countries of the European Union. Additionally, interoperability especially regarding rail transport and other technical impediments need to be enhanced in order to be able to endorse an efficient internal market. This new policy will reinforce the utilization of well-functioning transportation chains with the application of advanced technological innovations.484 The guidelines of 2014 have implemented a new bilayer structure which differs between a priority core network and a comprehensive network.485

As depicted in Figure 17, the core network consists of nine corridors486 which constitute the most important long-distant routes. Moreover, they should enhance co-modality and transnational transports within the EU. During the determination of those corridors it was tried to include the previous defined priority projects which were mainly targeting rail transport.487

Whereas not all objectives are fully accomplished at the moment, several achievements like the linkage of East and West Europe have been very successful.488 As a result, the core network corridors which now include all modes of transportation should contribute significantly to the completion of the core network until 2030.489

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482 See: OJ L 348, 2013, pp. 129 ff
485 cf. Council of the European Union 2013, p. 1
486 See: OJ L 348, 2013, pp. 151 ff
All in all, it can be said, that despite several great achievements and successes there have always been similar problems in the different development phases of transport policy. It was hardly possible for the EU to reach its ambitious goals. Therefore various amendments were necessary. However, it is not an easy task as successful measures also depend on trends and changes like the EU enlargement and globalization. Therefore policies need to be adjusted and objectives might not be suitable anymore. Although the EU tries to give its best, stricter and more binding legislations which should be implemented in the member states simultaneously, are needed to really change the system and to tackle environmental degradation and therefore enhance sustainability and especially sustainable freight transportation.

Finally, Table 7 should give an overview of the environmental policy development, the evolution of the common transport policy and several mentioned measures, directives and regulations in terms of time.
### Table 7: Policy overview

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<th>Common transport policy development</th>
<th>Measures, directives and regulations</th>
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<td>1997 Treaty of Amsterdam 1997</td>
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<td>1997 Kyoto Protocol</td>
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|      |                                                     | - Directive 2000/60/EC on establishing a framework for Community action in the field of waste policy  
|      |                                                     | - Water Framework Directive                                                      |
| 2001 | EU SDS                                             | New White Paper                                                                 |
|      | 2001                                               | - National Emission Ceilings Directive                                           
|      |                                                    | - Railway Packages                                                               |
|      |                                                    | - Revised NEC-directive                                                          
<p>|      |                                                    | - Galileo (2003)                                                                 |
|      |                                                    | - Marco Polo (2003-2006)                                                         |
|      |                                                    | - Regulation No 782/2003 on the prohibition of organotin compounds on ships       |
|      |                                                    | - Euro norms (2005)                                                              |
|      | 2007                                               | Keep freight moving                                                             |
|      |                                                    | - Thematic Strategy on air pollution (2005)                                      |
|      |                                                    | - Directive 2005/35/EC on ship-source pollution and the introduction of penalties for infringements |
|      |                                                    | - Marco Polo II (2007-2013)                                                      |
|      |                                                    | - Ambient air quality and cleaner air for Europe (2008)                          |
|      |                                                    | - Motorways of the Sea (2008)                                                    |
|      |                                                    | - A sustainable future for transport: Towards an integrated, technology-led and user friendly system |
|      |                                                    | - Effort Sharing Decision (2009)                                                 |
|      |                                                    | - Directive 2009/30/EC targets a 6 % reduction of life-cycle GHG emissions        |
|      |                                                    | - Renewable energy (2009)                                                        |
|      |                                                    | - Single European Sky II&quot; (2009)                                                 |
|      | 2008                                               | Greening Transport                                                              |
|      |                                                    | - Motorways of the Sea (2008)                                                    |
|      |                                                    | - A sustainable future for transport: Towards an integrated, technology-led and user friendly system |
|      |                                                    | - Effort Sharing Decision (2009)                                                 |
|      |                                                    | - Directive 2009/30/EC targets a 6 % reduction of life-cycle GHG emissions        |
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|      | 2009                                               | Green Paper                                                                     |
|      |                                                    | - Thematic Strategy on air pollution (2005)                                      |
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|      |                                                    | - Marco Polo II (2007-2013)                                                      |
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|      |                                                    | - A sustainable future for transport: Towards an integrated, technology-led and user friendly system |
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|      |                                                    | - Directive 2009/30/EC targets a 6 % reduction of life-cycle GHG emissions        |
|      |                                                    | - Renewable energy (2009)                                                        |
|      |                                                    | - Single European Sky II&quot; (2009)                                                 |
|      | 2009                                               | Maritime transport strategy until 2018                                            |</p>
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<td></td>
<td>- Commission Regulation (EU) No 1304/2014 on the technical specification for interoperability relating to the subsystem ‘rolling stock – noise’</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- European Union (2015/429) on heartening the implementation of a faster retrofitting especially of freight wagons</td>
</tr>
</tbody>
</table>

Source: Own research
5 The national implementation in Austria and Germany

After analyzing different European standards, guidelines and regulations towards a common and sustainable transport policy, the last section of this master thesis focuses on the realization of these regulations and measures in the transit countries Austria and Germany. The goal is to show the differences and similarities between Austria and Germany as well as to compare these two countries with the situation in the EU. Therefore, with reference to the previous chapter, a short overview of the TEN-T infrastructure in Germany and Austria is given. Afterwards, the different freight transport impact areas will again be examined with a special view on Austria and Germany. In regard to the national implementation strategies of the two member countries, objectives in the fields of air pollution control, noise mitigation, sustainable land utilization and biodiversity protection, water pollution control as well as climate protection are further analyzed. As a consequence, the main differences and similarities are determined.

5.1 TEN-T

The trans-European transport network is especially favorable for transit countries. Therefore, Austria and Germany can profit from the corridors as the multimodal core network will contribute significantly to the cohesion of the European Union. As a result, more competitiveness will lead to higher employment. Additionally, through the enhancement of the intermodality of rails, inland waterways and maritime transportation as well as through innovative technologies, transport will be shifted towards more sustainable modes. Moreover, the reduction of transport congestion will lead to reduced air pollution and GHG emissions.490

In Germany, six out of the nine European core network corridors run through the country: the North Sea-Baltic Corridor, the Orient/East-Med Corridor, the Scandinavian-Mediterranean Corridor, the Rhine-Alpine Corridor, the Atlantic Corridor and the Rhine-Danube Corridor.491

The main Austrian transport axis are the Danube (Rhine-Danube Corridor), the Brenner (Scandinavian-Mediterranean Corridor), the Baltic-Adriatic Corridor and also the Orient/East-Med Corridor.492 It had been achieved, that in the revision of the TEN-T guidelines the southern rail route including the Semmering Base Tunnel and the Koralm railway were incorporated as part of the Baltic-Adriatic Corridor. In the long run, the intention is an additional enhancement of the connection with west Balkan countries. For Austria this could mean an inclusion of the

490 cf. Europäische Kommission n.d., p. 1
491 cf. Europäische Kommission n.d., p. 1
Tauern axis and the Pyhrn axis into the core network. For transit countries like Austria a high quality infrastructure which is planned for its own corridors is also of great significance for neighboring countries to guarantee interoperability and an effective realization of the TEN-T goals.493

In addition, Austrian and German TEN-T infrastructure quality and the completion progress compared with the EU average are further explained. According to a World Economic Forum survey, Austria is on the second place regarding the quality of roads in the whole European Union with a score of 6.27. Germany is the sixth best country with 5.88 points whereas the EU average amounts 4.88. Also railroad infrastructure and air transportation were above the EU mean in Austria. Whereas Germany reached the fourth rank, Austria achieved the sixth place regarding rail quality. While Germany also attained the fourth place concerning air transportation, Austria was slightly above the EU average on place 15. Furthermore, the time needed for importing or exporting in Austria is lower (rank nine) than the average of all member states. However, Germany is even faster and therefore achieves place six in the EU ranking. Furthermore, all Austrian and German inland waterways are included in the trans-European transport network. While only 37 % of the high speed rail core networks have already been finalized in Austria, Germany already finished 58 %. Nevertheless, nearly the whole Austrian road core network has been completed (97 %) while Germany is below the EU average (74 %) with only 59 %. Lastly, the rail core network in Germany is almost done with 94 % whereas in Austria 72 % are achieved.494 All in all it can be said, that compared with the EU average both countries reveal quite good figures. However, Germany did even better than Austria in five of the eight mentioned rankings.

Nevertheless, there are also numerous negative effects and controversies regarding the TEN-T network. Besides emission reductions a shift towards more sustainable modes like rail and inland waterways always include an intervention into the regional environment (e.g. the expansion of transportation on the Danube). Therefore, environmental impact assessments are crucial in order to find out if projects can contribute to more sustainable freight transportation in Europe or not.495 Consequently, the different freight transport impacts as well as implementation strategies and measures in Austria and Germany are further analyzed in the next subchapters.

495 cf. Deutscher Naturschutzring 2004, pp. 7 f
5.2 Air pollution control

Air pollution control on the European level led to the introduction of several directives which needed to be implemented into national law.

According to the above mentioned National Emission Ceilings Directive (2001) from the European Union, each member country has individual emission ceilings for air pollutants. In Austria, the national realization of this directive took place through the “Austrian Air Emission Ceiling Act” (Emissionshöchstmengengesetz-Luft) and came into effect in 2003. Moreover, European immission loads were adopted through the directive on “Ambient air quality and cleaner air for Europe” (2008). After a revision of the “Austrian Air Quality Act” and the regulation regarding the protection of natural ecosystems and vegetation in 2010, immission limits and target values were implemented into national law. In Germany, air quality is primarily regulated by the “Act on the Prevention of Harmful Effects on the Environment Caused by Air Pollution, Noise, Vibration andSimilar Phenomena (Federal Immission Control Act – BImSchG – Bundes-Immissionsschutzgesetz)” The "Neununddreißigste Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes – Verordnung über Luftqualitätsstandards und Emissionshöchstmengen" of 2010, served the implementation of the “Ambient air quality and cleaner air for Europe” directive and NEC-directive into national German law.

As shown in Table 8, Austrian emission ceilings for 2010 amounted 39 kt SO₂, 103 kt NOₓ, 195 kt NMVOC and 66 kt NH₃. For Germany, this meant a maximum quantity of 520 kt SO₂, 1,051 kt NOₓ, 995 kt NMVOC and 550 kt NH₃.

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496 See: EG-L. BGBI. I Nr. 34/2003
497 cf. Umweltbundesamt 2013, p. 35
498 See: IG-L. BGBI. I Nr. 77/2010
499 See: VO, BGBl. II Nr. 298/2001
500 cf. Umweltbundesamt 2013, pp. 35 f
501 See: BImSchG last amandment BGBl. I S. 1474, 1487
502 See: 39. BImSchG last amandment BGBl. I S. 1474, 1489
503 cf. Deutsche Gesellschaft für internationale Zusammenarbeit 2015, p. 8
504 Note: Kiloton = kt
505 cf. ABl. L 309, 2001, p. 29
Table 8: National emission ceiling targets of SO$_2$, NO$_x$, NMVOC and NH$_3$ until 2010

<table>
<thead>
<tr>
<th>Country</th>
<th>SO$_2$ kt</th>
<th>NO$_x$ kt</th>
<th>NMVOC kt</th>
<th>NH$_3$ kt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>39</td>
<td>103</td>
<td>159</td>
<td>66</td>
</tr>
<tr>
<td>Belgium</td>
<td>99</td>
<td>176</td>
<td>139</td>
<td>74</td>
</tr>
<tr>
<td>Denmark</td>
<td>55</td>
<td>127</td>
<td>85</td>
<td>69</td>
</tr>
<tr>
<td>Finland</td>
<td>110</td>
<td>170</td>
<td>130</td>
<td>31</td>
</tr>
<tr>
<td>France</td>
<td>375</td>
<td>810</td>
<td>1050</td>
<td>780</td>
</tr>
<tr>
<td>Germany</td>
<td><strong>520</strong></td>
<td><strong>1051</strong></td>
<td><strong>995</strong></td>
<td><strong>550</strong></td>
</tr>
<tr>
<td>Greece</td>
<td>523</td>
<td>344</td>
<td>261</td>
<td>73</td>
</tr>
<tr>
<td>Ireland</td>
<td>42</td>
<td>65</td>
<td>55</td>
<td>116</td>
</tr>
<tr>
<td>Italy</td>
<td>475</td>
<td>990</td>
<td>1,159</td>
<td>419</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>4</td>
<td>11</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Netherlands</td>
<td>50</td>
<td>260</td>
<td>185</td>
<td>128</td>
</tr>
<tr>
<td>Portugal</td>
<td>160</td>
<td>250</td>
<td>180</td>
<td>90</td>
</tr>
<tr>
<td>Spain</td>
<td>746</td>
<td>847</td>
<td>662</td>
<td>353</td>
</tr>
<tr>
<td>Sweden</td>
<td>67</td>
<td>148</td>
<td>241</td>
<td>57</td>
</tr>
<tr>
<td>UK</td>
<td>585</td>
<td>1,167</td>
<td>1,200</td>
<td>297</td>
</tr>
<tr>
<td>EG 15</td>
<td><strong>3,850</strong></td>
<td><strong>6,519</strong></td>
<td><strong>6,510</strong></td>
<td><strong>3,110</strong></td>
</tr>
</tbody>
</table>

Source: ABl. L 309, 2001, p. 29

At the end of 2014, the latest of the annual NEC-directive status reports of The European Environment Agency was published. As depicted in Table 9, Austria only met the objectives for NMVOCs and SO$_2$ in all years. However, the targets for NO$_x$ and NH$_3$ had not been met until 2013.$^{506}$ Regarding the high NO$_x$ value, the transportation sector was a dominant factor for this result with a share of 48 %.$^{507}$ However, it should be mentioned that there has already been a decline of 24 % of NO$_x$ in the transport sector since 1990 due to progresses in the automotive technology especially regarding heavy goods vehicles and fleet renewals as well as the declining freight transport demand as a consequence of the economic crisis. Nevertheless, this is especially applicable to gasoline-powered vehicles, whereas the NO$_x$ value of diesel vehicles increased steadily.$^{508}$ The 54 % decline of NMVOCs (since 1990) was also attributable to transportation and especially to reductions in road transportation as a consequence of the installation of catalysts, stricter exhaust emission ceilings and increasing diesel vehicles.$^{509}$ Nevertheless, future scenarios anticipate a significant reduction of NO$_x$ emissions until 2030

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$^{506}$ cf. EEA 2015e, pp. 7 ff
$^{507}$ cf. Umweltbundesamt 2013, pp. 36 f
$^{508}$ cf. Umweltbundesamt 2013, p. 216
$^{509}$ cf. Umweltbundesamt 2013, pp. 36 f
due to further fleet modernizations, less specific emissions of motor vehicles because of new emission standards and an increase of electro mobility until 2020.\footnote{cf. Umweltbundesamt 2013, p. 47}

Table 9: EU-27 member state progress in meeting NECD emission ceilings

<table>
<thead>
<tr>
<th>Member State</th>
<th>NO\textsubscript{x}</th>
<th>NMVOCs</th>
<th>SO\textsubscript{2}</th>
<th>NH\textsubscript{3}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Belgium</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Cyprus</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Denmark</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Estonia</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Finland</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>France</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Germany</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Greece</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Hungary</td>
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<tr>
<td>Ireland</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Italy</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Latvia</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Lithuania</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Malta</td>
<td>✓</td>
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<td>✓</td>
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<tr>
<td>Netherlands</td>
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<td>Poland</td>
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<td>Romania</td>
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<td>Slovakia</td>
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<tr>
<td>Sweden</td>
<td>✓</td>
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<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

\begin{tabular}{|l|c|c|c|c|c|c|c|c|c|}
\hline
\hline
Austria      | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | x     | x     | ✓     | ✓     | ✓     | x     |
Belgium      | x     | x     | x     | x     | x     | x     | x     | x     | x     | x     | x     | x     |
Bulgaria     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
Cyprus       | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
Czech Republic | ✓         | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
Denmark      | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
Estonia      | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
Finland      | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
France       | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
Germany      | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
Greece       | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
Hungary      | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
Ireland      | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
Italy        | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
Latvia       | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
Lithuania    | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
Luxembourg   | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
Malta        | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
Netherlands  | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
Poland       | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
Portugal     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
Romania      | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
Slovakia     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
Slovenia     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
Spain        | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
Sweden       | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
United Kingdom | ✓        | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     | ✓     |
\hline
\end{tabular}

\textit{Notes:} 
\begin{itemize}
\item ✓ indicates that the emission ceiling has been attained.
\item x indicates the ceiling has not been attained.
\end{itemize}

Source: EEA 2015e, p. 7

In the NEC-directive status report, Germany was the only member country which exceeded three out of four ceilings namely NO\textsubscript{x}, NMVOCs and NH\textsubscript{3}. It only reached the desired amount for SO\textsubscript{2}. The poor development of NO\textsubscript{x} can be traced back to the fact that road transport is the main contributor to the surpassing NO\textsubscript{x} amount in the member countries.\footnote{cf. EEA 2015e, pp. 7 ff}
Freight transportation in Germany is responsible for a quarter of NO\textsubscript{x} emissions and an eighth of particulate matter. Due to strict exhaust emission standards for new cars in the so called Euro-Norms, it was possible to reduce NO\textsubscript{x} and particulate emissions in Germany by half between 1990 and 2015.\textsuperscript{512} Table 9 also shows the progress in achieving the emission ceilings of the NEC-directive from all other European member states.

Summarized, it can be said that regarding the NEC-directive, 12 out of 27 European member countries surpassed the emission ceilings of at least one listed harmful substance in 2010. In the year 2011, still 11 member states exceeded the regulated limits. In the following year, again 12 countries had higher amounts. In 2013, still 10 member states remained which did not stay under the emission ceilings. Worth mentioning is the fact, that in 2013 only Germany reached just one out of four emission ceilings namely SO\textsubscript{2}. However, also Austria, Denmark and Ireland only achieved two out of four.

Furthermore, in Austria, the daily average immission ceiling for PM\textsubscript{10} amounts to 50 \(\mu\text{g/m}^3\) and the yearly average is 40 \(\mu\text{g/m}^3\). Whereas in 2009, 30 transgressions were allowed, in 2010 this amount was reduced to 25. Moreover, in 2009 there had only been overruns of 8 \% of the measuring point while in 2011 this percentage rose to 56 \%.\textsuperscript{513} However, in 2014, 6 out of 125 measuring points recorded excesses (more than 25 daily averages were over 50 \(\mu\text{g/m}^3\)) namely in Linz, Leibnitzer Feld, Vienna and Graz. However, the yearly average was not transgressed. All in all, the year 2014 recorded the lowest figure of PM\textsubscript{10} load so far. Causes for this were mostly attributable to the warm weather.\textsuperscript{514}

Also in Germany the ceilings for PM\textsubscript{10} come to a daily average of 50 \(\mu\text{g/m}^3\) and a yearly mean of 40 \(\mu\text{g/m}^3\). However, Germany allows 35 days of transgression per year.\textsuperscript{515} In 2014, the pollution from PM\textsubscript{10} was lower than during the years from 2005 to 2013. About 10 \% of measuring points close to traffic exceeded the limit on more than 35 days in the year. According to WHO recommendations, the daily average should only be transcended on three days in the years as a maximum. This was achieved only by 12 \% of all measuring points in Germany. However, high inter-annual fluctuations are caused by varying weather conditions. Nevertheless, the yearly average legal limit was not surpassed throughout Germany. In the last years, there had been sporadic transgressions but not any more since 2012.

\textsuperscript{512} cf. Umweltbundesamt 2009, p. 47
\textsuperscript{513} cf. Umweltbundesamt 2013, pp. 43 ff
\textsuperscript{514} cf. Spangl/Nagl 2015, p. 7
\textsuperscript{515} cf. Dauert et al. 2015, pp. 6 f
Although the PM$_{10}$ yearly average value of 2014 was slightly above the previous year, from a long term perspective, 2014 was one of the least polluted years.$^{516}$

Nevertheless, in many cities there will still be a great overall burden of particulate emissions as one third of PM$_{10}$ emissions are resulting from the abrasion of tires and brake linings as well as from road wear. These PM$_{10}$ particulate emissions rise proportionally to the traffic growth and counteract the positive effects resulting from emission control. As a consequence, the resulting environmental objective regarding air pollution control focuses on the continual reduction of particulate emissions resulting from freight transportation. Therefore, the increase of abrasion emittances must not be higher than the reduction in particulate emissions resulting from the combustion process.$^{517}$

Furthermore, according to the “Austrian Air quality Act”, it was not allowed to exceed 20 $\mu$g/m$^3$ of PM$_{2.5}$ between 2013 and 2015. Among 2009 and 2011 the average amount represented 17.8 $\mu$g/m$^3$. Nevertheless, the goal for the years between 2018 and 2020 is a reduction of 15 \% in contrast to the years from 2009 to 2011.$^{518}$ In 2014, the average amount was only 13.4 $\mu$g/m$^3$.$^{519}$

In Germany, since 2010 a maximum amount of 25 $\mu$g/m$^3$ PM$_{2.5}$ was allowed. However, since 2015 it is not permitted to transcend the value of 20 $\mu$g/m$^3$.\footnote{cf. 39. BImSchV 2010, p. 7} This ceiling was not surpassed on any measuring point in 2013 and 2014. The German national goal for 2020 is also a reduction of 15 \% compared to 2010.$^{521}$

In comparison, it can be said, that both countries Austria and Germany did not meet all NEC-directive ceilings in 2013. Whereas Austria was able to comply with two out of four legal limits, Germany only achieved enough reductions for one harmful emission.$^{522}$ Regarding particulate matters, Austria and Germany are reaching quite good figures and did not surpass PM$_{2.5}$ emission limits in 2014. In the same year, also the PM$_{10}$ value was the lowest amount recorded so far in Austria.$^{523}$ While in 2013 Germany had slightly better amounts of PM$_{10}$, in the long term perspective 2014 revealed a very low average.$^{524}$

\footnotesize{
516 cf. Dauert et al. 2015, pp. 6 f \\
517 cf. Umweltbundesamt 2009, p. 48 \\
518 cf. Umweltbundesamt 2013, pp. 43 ff \\
519 cf. Spangl/Nagl 2015, p. 7 \\
520 cf. 39. BImSchV 2010, p. 7 \\
521 cf. Dauert et al. 2015, p. 8 \\
522 cf. EEA 2015e, p. 7 \\
523 cf. Spangl/Nagl 2015, p. 7 \\
524 cf. Dauert et al. 2015, pp. 6 f
}
Although the PM$_{2.5}$ values have decreased or not transgressed their ceilings in the past, it should be highlighted that already small amounts of particulate matter are very harmful to humans’ health. Therefore, significant reductions are still needed.\textsuperscript{525}

With regard to the whole EU, Figure 18 shows the development of air pollutants from 2010 to 2013. Referring to the aggregated member state emission ceilings (Annex I) for the given emissions, the EU was below this limit in all four years. Also the stricter emission limits (Annex II) were not surpassed in 2013. Only NO$_x$ emissions were higher in 2010 and 2011.\textsuperscript{526} Therefore, it can be derived that although Austria, Germany and several other member states were not able to meet all NEC-directive requirements the EU was able to comply with those limits in 2012 and 2013. Consequently other member states must have had emission values far below the allowed limits.

**Figure 18: EU-27 progress in meeting emission ceilings set out in NECD**

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure18.png}
\caption{EU-27 progress in meeting emission ceilings set out in NECD.}
\end{figure}

Source: EEA 2015e, p. 15\textsuperscript{527}

\textsuperscript{525} cf. Umweltbundesamt 2009, p. 47
\textsuperscript{526} cf. EEA 2015e, p. 15
\textsuperscript{527} Note: The emission ceilings shown are those set out for the EU in Annexes I and II to the NECD. The Annex I EU ceilings represent the aggregation of individual Member State ceilings defined in that annex. The Annex II EU ceilings are stricter than those of Annex I, and are designed with the aim of attaining, by 2010, for the EU as a whole, the interim environmental objectives set out in Article 5 of the NECD (i.e. a reduction of European ecosystem areas where the critical loads for acidification are exceeded, as well as of vegetation-related ground-level ozone exposure by 2010, compared with the 1990 situation). There is no separate ceiling for NH$_3$ defined in Annex II to the NECD. (EEA 2015e, p. 15)
5.3 Noise mitigation

The European Noise Directive which sets measures against environmental noise caused by transportation became effective in 2002. Two years later, Austria, Germany and 12 other member states still had not realized the directive.\textsuperscript{528}

At the federal level of Austria, the implementation of the directive took place through the “Bundes-Umgebungslärmsschutzgesetz”\textsuperscript{529} in 2005.\textsuperscript{530} This law also included the “Bundes-Umgebungslärmsschutzverordnung”\textsuperscript{531} for specific noise limits.\textsuperscript{532}

In Germany, the national realization of the EU directive was also carried out in 2005 by the “Gesetz zur Umsetzung der EG-Richtlinie über die Bewertung und Bekämpfung von Umgebungslärm”\textsuperscript{533} which was integrated as a sixth part into the “Act on the Prevention of Harmful Effects on the Environment Caused by Air Pollution, Noise, Vibration and Similar Phenomena (BImSchG – Bundes-Immissionsschutzgesetz)”\textsuperscript{534}

The Austrian and German national legislation acted in two steps as required by the EU directive. Firstly, noise maps of the most frequently used infrastructures were created until 2007 followed by the development of action plans until 2008.\textsuperscript{535} In a second round, scheduled for 2013, also smaller conurbations were included in noise maps and action plans.\textsuperscript{536}

As a consequence, the Austrian legislation introduced ceilings regarding the action plans and measures for noise reductions as depicted in the following Table 10.\textsuperscript{537}

<table>
<thead>
<tr>
<th></th>
<th>$L_{DEN}$</th>
<th>$L_{Night}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road transport</td>
<td>60 dB(A)</td>
<td>50 dB(A)</td>
</tr>
<tr>
<td>Air transport</td>
<td>65 dB(A)</td>
<td>55 dB(A)</td>
</tr>
<tr>
<td>Rail transport</td>
<td>70 dB(A)</td>
<td>60 dB(A)</td>
</tr>
<tr>
<td>Industry areas</td>
<td>55 dB(A)</td>
<td>50 dB(A)</td>
</tr>
</tbody>
</table>

Source: Based on Clausen et al. 2012, p. 28

\textsuperscript{528} cf. Clausen et al. 2012, pp. 25 ff
\textsuperscript{529} See: Bundes-LärmG, BGBl. I Nr. 60/2005
\textsuperscript{530} cf. Wiener Umwelt Anwaltschaft 2008, pp. 1 ff
\textsuperscript{531} See: Bundes-LärmV, BGBl. II Nr. 144/2006
\textsuperscript{532} cf. Wiener Umwelt Anwaltschaft 2008, p. 3
\textsuperscript{533} See: §47 BImSchG
\textsuperscript{534} cf. Richard 2015, p. 22
\textsuperscript{535} cf. Wiener Umwelt Anwaltschaft 2008, pp. 1 ff
\textsuperscript{536} cf. Clausen et al. 2012, pp. 25 ff
\textsuperscript{537} cf. Clausen et al. 2012, p. 28
In the frame of the first noise mapping in Austria (2007), the number of people exposed to $L_{DEN}$ noise levels above 55 dB(A) amounted two millions due to road transportation, 700,000 as a consequence of rail transport and 9,000 inhabitants were disturbed by air transportation noise. In the second phase even stricter requirements regarding the inclusion into noise maps were demanded.\textsuperscript{538}

Nevertheless, in 2012 still 144,000 people were exposed to a $L_{DEN}$ level over 60 dB(A) as a result of road transportation. During the night 227,000 people have been subjected to a noise level above 50 dB(A).\textsuperscript{539}

In comparison to the Austrian legislation, Table 11 shows German noise level limits for newly built and rebuilt transport infrastructures.\textsuperscript{540}

**Table 11: German noise ceilings for newly built and rebuilt transport infrastructures (2006)**

<table>
<thead>
<tr>
<th></th>
<th>$L_{DEN}$</th>
<th>$L_{Night}^{541}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Near hospitals, schools and sanatoriums</td>
<td>57 dB(A)</td>
<td>47 dB(A)</td>
</tr>
<tr>
<td>Purely residential areas and small settlements</td>
<td>59 dB(A)</td>
<td>49 dB(A)</td>
</tr>
<tr>
<td>Centrally located areas, places or mixed sectors</td>
<td>64 dB(A)</td>
<td>54 dB(A)</td>
</tr>
<tr>
<td>Industrial areas</td>
<td>69 dB(A)</td>
<td>59 dB(A)</td>
</tr>
</tbody>
</table>

Source: Based on Clausen et al. 2012, pp. 27 f

According to a German survey of 2,000 respondents, 54 % of the participants felt disturbed by road traffic noise, 34 % by railroad noise and 23 % by air traffic noise in 2014.\textsuperscript{542}

At the beginning of 2015, in Germany there were 6,095 reports for noise maps. This means that in more than half of all German communities there was at least one source of noise relevant for mapping. 91 % of the population lives in those communities. The most frequent source for noise

\textsuperscript{538} cf. BMLFUW 2015, p. 13
\textsuperscript{539} cf. Umweltbundesamt 2013, p. 134
\textsuperscript{540} cf. Clausen et al. 2012, pp. 27 f
\textsuperscript{541} Note: $L_{Night}$ = Night equivalent sound level
\textsuperscript{542} cf. Umweltbundesamt 2016a, n.p.
mapping was road transport. In the second round there were 64% more communities included in the noise maps. Most noteworthy was here the duplication of rail transport noise. However, according to a survey of the Federal Environment Agency, noise maps include only a mere fraction of people which actually feel disturbed. This is a clear indication that there needs to be an adoption of this system. In addition, action plans which were finished, in process or still under scrutiny covered one fifth of all communities in the noise maps. Concrete measures were reported by 12% of all included communities in 2015. Those especially focus on the reduction of road transportation noise. In order to prevent road noise, measures regarding traffic technology, improvements of buildings, transport regulations as well as road and city construction measures reveal a high local noise mitigation potential. The impacts of these measures are transport prevention, removal, reduction, deceleration, homogenization (striking noises are harmonized to get more monotonous) and constructional noise insulations. The most frequently used measures are infrastructure renewals and speed reductions. Moreover, high populated communities are more likely to realize measures than small ones. Therefore, besides the above mentioned necessary review of the noise mapping criteria also small communities need to be focused in the future.

All in all, it can be said, that Austria and Germany needed three years to implement the European Noise Directive into national law. Moreover, they defined the noise levels for different parameters. Austrian legislation launched ceilings concerning the planning of measures for noise of road, rail and air transportation as well as industrial areas. However, Germany adopted noise limits for newly built and rebuilt transport infrastructures. Nevertheless, still numerous people are exposed to high noise levels especially from the road. Although, Austria and Germany try to comply with the EU legal requirements the implementation of measures needs a lot of time. In regard to the environmental impacts and effects on humans’ health, more coordination on the European and national level is needed in order to make a better assessment and therefore to improve the effectiveness and realization of measures.
5.4 Sustainable land utilization and biodiversity protection

The global Convention on Biological Diversity in 1992 was the most comprehensive agreement regarding nature and biodiversity. As a consequence, the “Österreichische Strategie zur Erhaltung der biologischen Vielfalt”\(^{549}\) was ratified by Austria in 1995. It defined goals and measures regarding biodiversity and sustainable development.\(^{550}\) However, based on new goals from the European Biodiversity Strategy launched in 2011, Austria revised its strategy through the “Austrian Biodiversity Strategy 2020+”\(^{551}\) which was implemented in 2014. It focused on the significance of protecting Austrian biodiversity and nature, curbing the loss of species and ecosystems and minimizing the causes of threat. The strategy defined five areas of action: knowing and acknowledging biodiversity, sustainable use of biodiversity, reducing pressures on biodiversity, conserving and developing biodiversity as well as securing global biodiversity. Additionally, 12 targets and over 140 measures have been formulated to protect the Austrian variety of species.\(^{552}\) Transportation is included in the eleventh target which focuses on the integration of biodiversity into the fields of regional planning, transportation and mobility. Here concrete measures are among others the elevation of Austrian data regarding land utilization, the development of an action plan with mandatory target values and the identification of necessary wildlife crossings.\(^{553}\)

In Germany the “Nationale Strategie zur biologischen Vielfalt”\(^{554}\) was introduced in 2007. It was the first comprehensive strategy for the realization of the global Convention on Biological Diversity. Therein, 330 goals and 430 measures regarding all biodiversity relevant topics were included.\(^{555}\) They aimed amongst other things that transport impacts like emissions, light and noise should be reduced, new infrastructure has to be ecologically permeable, biotope networks will not be harmed through transport routes by 2020, fragmented land will get ecologically pervious and the amount of undissected land of 23 % will stay at the same level.\(^{556}\)

It can be said, that the most essential threats for biodiversity are the changing climate, the spread of invasive alien species, pesticides and the increasing sealing of the soil surface through

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\(^{549}\) See: BGBl. Nr. 213/1995

\(^{550}\) cf. Umweltbundesamt 2013, p. 117

\(^{551}\) See: Banko et al. 2014

\(^{552}\) cf. BMLFUW 2016b, n.p.

\(^{553}\) cf. Banko et al. 2014, p. 25

\(^{554}\) See: BMUB 2015c, pp. 1 ff

\(^{555}\) cf. BMUB 2014a, n.p.

\(^{556}\) cf. Umweltbundesamt 2009, p. 49
transport infrastructures and buildings. Consequently, this leads to the loss or fragmentation of important habitats and ecosystems.\textsuperscript{557}

In Austria, the number of different kinds of species is estimated to amount 45,000 of which 98.6\% are invertebrates. Actual Red Lists do exist for 19 animal groups as well as for old domestic animals. Also alpine species are especially threatened by the climate change. It is forecasted, that already in low global warming scenarios about 77\% of those areas will get lost.\textsuperscript{558}

Therefore, from 172 protected species in Austria, 11\% are in a favorable conservation status. Moreover, 16\% of the whole Austrian land area is strictly protected as Natura 2000 region, national park or natural reserve.\textsuperscript{559} Additionally, there are about 3,000 native species of ferns and flowering plants. Around 15 years ago, 40\% of these were endangered. However, actual Red Lists do not exist for these kind of plants. Nevertheless, Red Lists for specific animal species show that there are 37\% mammals, 36\% birds, 64\% reptiles as well as 60\% of amphibians and fish which are classified as categories of threat.\textsuperscript{560}

According to the German “National strategy for biodiversity”, Germany is the European member state with the most hazardous rates for flora and fauna. 72.5\% of all ecosystems, 26.8\% of ferns and flowering plants and 36\% of native animal species were threatened to the continued existence in 2007. Three percent of animal species had been already extinct. Especially acidifying substances, the destruction and fragmentation of habitats, river regulations and water constructions have been responsible for the biodiversity loss in Germany. Therefore, spatial development plays an important role concerning the preservation of biodiversity. This applies particularly to areas for nature conservation.\textsuperscript{561}

Regarding sustainable land utilization Germany wants to reduce its land consumption used for transportation and residential purposes from about 129 ha/day between 1997 and 2000 to 30 ha/day in 2020. Among the years of 2002 and 2005 the amount already decreased to 118 ha/day.\textsuperscript{562} In 2015, the daily usage of land used for transport and buildings amounted 70 ha/day. The 30 ha/day target was defined in the “National sustainability strategy of Germany”. The “National strategy for biodiversity” of 2007 concretized this goal in terms of

\textsuperscript{557} cf. Banko et al 2014, p. 6
\textsuperscript{558} cf. Umweltbundesamt 2013, pp. 120 ff
\textsuperscript{559} cf. Umweltbundesamt 2013, pp. 118 f
\textsuperscript{560} cf. Banko et al 2014, p. 6
\textsuperscript{561} cf. Umweltbundesamt 2009, p. 49
\textsuperscript{562} cf. Umweltbundesamt 2009, pp. 48 f
visions and action fields. The European Commission even focuses a land usage target of zero by 2020.\textsuperscript{563}

In Austria about 7.4 ha/day are converted from uninhabited land to traffic areas which is three times higher as the “National Austrian sustainable development strategy” requirement for 2015 which is 2.5 ha/day.\textsuperscript{564}

As already mentioned above, the utilization of land refers not only to the traffic construction itself, but also to the land area which is affected by the usage of traffic facilities and traffic flow. Therefore, the traffic area depicted in Figure 19, does not only include permanently sealed land but also space needed for transport installations.\textsuperscript{565}

\textbf{Figure 19: Shares of land usage in Germany and Austria in 2003}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure19.png}
\caption{Shares of land usage in Germany and Austria in 2003}
\end{figure}

\textsuperscript{563} cf. BMUB 2015a, n.p.
\textsuperscript{564} cf. VCÖ 2015,
In 2004, the proportion of the traffic area in Germany was 5% of the total national territory whereas in Austria 2.8% of land was used for infrastructure. This percentage is smaller than the land used for construction and settlement areas.566

Regarding the application of the above depicted field of transport, it is visible that the highest amount is attributable to public streets. In Austria 52% and in Germany 56% are used for this purpose whereas only 5% of Germans streets are motorways.567

Comparing the transport capacity of the road and the rail, Austrian rail transportation needs 4.5 times less land than the road, whereas in Germany the land usage with regard to the transported weight of goods is the same for streets and rails.568

Summarized it can be said, that Austria was faster with the realization of the global Convention for Biological Diversity as it introduced a first strategy in 1995, followed by its National Biodiversity Strategy 2020+ in 2014 which was already based on the European strategy.569 Although, Germany had plans for the introduction of a biodiversity strategy, it implemented its first comprehensive strategy in 2007.570 Regarding the high amount of goals and measures in this strategy, it can be assumed that Germany defined more concrete goals than Austria. Moreover, in terms of flora and fauna, Germany has the most hazardous rate of all European member countries.571 Additionally, in percentages Germany has a larger traffic area than Austria. Whereas Germany needs 56% of this area for streets and places, Austria uses 52% for the same purpose. However, in Austria more private streets are included in this category. Nearly the same percentage is used for rails and airfields in both countries.572 Nevertheless, although Austria and Germany have set several objectives regarding sustainable land utilization and biodiversity protection for the future, the actual realization of measures is paramount as many species and ecosystems are in danger and the increasing global warming will aggravate this situation.573

571 cf. Umweltbundesamt 2009, p. 49
573 cf. Umweltbundesamt 2013, pp. 15 f
5.5 Water pollution control

Based on the European Water Framework Directive (2000) and the Austrian “Wasserrechtsgesetz”\textsuperscript{574} (1959), the “Austrian national water management plan”\textsuperscript{575} (Nationaler Gewässerbewirtschaftungsplan – NGP 2009) was implemented in 2010 and set the basis for water protection control until 2015. Beforehand, there had to be an evaluation of national water bodies which was firstly done in 2005. After some revisions the actual assessment was published as a part of the NGP 2009. Thus, two thirds of Austrian rivers and 87\% of the significantly changed and artificial waters did not achieve a good ecological status.\textsuperscript{576}

The development of an action program was one of the main assignments of the NPG. In this context three different types were included. Firstly, there were conservation measures which should prevent the deterioration of the water status. Secondly, there were restructuring measures which should guarantee the incremental transformation into a good ecological status. Lastly, there were measures regarding the enhancement of water development which should harmonize differentiating water standards.\textsuperscript{577}

The time schedule for reaching a good ecological status was planned by the EU until 2015. If there are extensions of time, the environmental goals for waters have to be achieved in the following two cycles of management planning (from 2015 until 2021 and from 2021 until 2027).\textsuperscript{578} Moreover, the EU directive required that a regulatory review of waters has to be done at least in 2013.\textsuperscript{579} This analysis revealed that 41.5\% of Austrian flowing waters will still be at risk not to reach a good ecological status in 2021. Furthermore, 24.5\% will be potentially threatened and only 33.9\% won’t be jeopardized. Additionally, out of 37 natural Austrian lakes (>50ha), 30 will show no danger and seven will reveal potential threats in 2021. Regarding the 25 artificial or substantially changed lakes all are assumed to reach a good ecological status.\textsuperscript{580} At the moment, 39\% of flowing waters are in good condition whereas 61\% are not.\textsuperscript{581}

In consideration of this analysis, a “Second national water management plan”\textsuperscript{582} should have been introduced for the period from 2015-2021. The concept has already been developed with

\textsuperscript{574} See: BGBl. Nr. 215/1959 amended by BGBl. I Nr. 123/2006
\textsuperscript{575} See: BGBl. II Nr. 103/2010
\textsuperscript{576} cf. Umweltbundesamt 2013, pp. 21 ff
\textsuperscript{577} cf. BMLFUW 2016c, n.p.
\textsuperscript{578} cf. BMU 2013, p. 6
\textsuperscript{579} cf. BMLFUW 2014, p. 1
\textsuperscript{580} cf. BMLFUW 2014, pp. 77 ff
\textsuperscript{581} cf. Fenz/Ofenböck/Schenker 2015, p. 15
\textsuperscript{582} See: Fenz/Ofenböck/Schenker 2015
public participation and is now under verification.\textsuperscript{583} The pursued objective for the European member states is to achieve a good ecological status for all rivers, lakes and the groundwater at least by 2027.\textsuperscript{584} Therefore, it can be derived that there might be a positive development from actually 61 \% waters which are not in a good status to 41.5 \% in 2021. Nevertheless, this are still twice as much waters which need to be transformed in the third period until 2027 as it was possible to convert in the second one (between 2015 until 2021).

In Germany, the “Wasserhaushaltsgesetz”\textsuperscript{585} (WHG) of 1957 built the basis for national water rights. After several amendments and through a revision in 2009\textsuperscript{586}, it realized the European Water Framework Directive. Since that time, action programs and management plans have been created and implemented. Monitoring programs clearly showed, that in the last decade there have been several improvements regarding water conservation in Germany.\textsuperscript{587}

However, the first evaluation in 2004 showed that 80 \% of German waters did not meet the condition of having a good ecological status. Furthermore, 75 \% of federal waterways were completely changed. For this reason, there must not be a deterioration of the situation but protection, enhancement and rehabilitation of all water bodies. Moreover, a reduction and reversal of pollution through harmful substances in the ground water is essential.\textsuperscript{588}

Hence, Germany was not able to fulfil the objective of reaching a good ecological status of all water bodies in 2015. Therefore, there had been a deadline extension for 80 \% of surface waters and 32 \% of ground water bodies.\textsuperscript{589}

The European Commission used the results from the first water management plans of the member states from 2009 in order to develop the above mentioned “Blueprint to Safeguard Europe's Water” (2012). Afterwards, the recommendations of the Commission as well as the outcomes of the regulatory review of 2013 were integrated into the “Second national water management plan” of Germany in December 2015. Public participation was possible in all development phases.\textsuperscript{590}

\begin{flushright}
\textsuperscript{583} cf. BMLFUW 2014, p. 30  \\
\textsuperscript{584} cf. Fenz/Ofenböck/Schenker 2015, p. 6  \\
\textsuperscript{585} See: BGBl. I S. 1110  \\
\textsuperscript{586} See: BGBl. I S. 2585  \\
\textsuperscript{587} cf. BMU 2013, p. 6  \\
\textsuperscript{588} cf. Umweltbundesamt 2009, p. 50  \\
\textsuperscript{589} cf. BMU 2013, pp. 6 ff  \\
\textsuperscript{590} cf. MKULNV NRW 2015, pp. 1 ff
\end{flushright}
The revised action program included many measures in form of directives regarding drinking water, bird protection, the control of accident hazards through dangerous substances, environmental sustainability, plant protection, nitrate pollution, environmental pollution, water pollution and groundwater contamination.\textsuperscript{591}

In comparison, in Austria and Germany the water right is based on the “Wasserrechtsgesetz” of 1959 respectively on the “Wasserhaushaltsgesetz” of 1957.\textsuperscript{592} Both had very similar methods regarding the national implementation of the European Water Framework Directive as the required procedure has been determined in it. The two member countries implemented their national program in 2009 and followed the pretended cycles of review.\textsuperscript{593} However, in 2015 the EU goal of a conversion of all water bodies in order to reach a good ecological status was not met by 61\% Austrian flowing waters.\textsuperscript{594} Additionally, still 41.5\% will not reach a good ecological status in 2021. Furthermore 24.5\% will be potentially threatened.\textsuperscript{595} Also Germany was not able to meet this objective. As a consequence 80\% of surface waters and 32\% of ground water bodies needed a deadline extension.\textsuperscript{596} The management plans of all member countries showed that in the whole EU more than 50\% of surface waters are not in a good condition.\textsuperscript{597} The development phase of a second national water management plan was proceeded in the same way in Austria and Germany. In both member countries public participation was possible. Although the plan was scheduled to begin in 2015 like it actually did in Germany, in Austria it is still under verification.\textsuperscript{598} Nevertheless, for achieving a good ecological status for Austrian and German water bodies only a combination of various measures like for example green ships, green fuels and green ports, sustainable construction innovations for ships and shipping logistics will be successful.\textsuperscript{599} However, controversies regarding the expansion of water bodies and the compliance with the Water Framework Directive need to be proportional to the desired level of protection. Therefore, regarding the results of the Blueprint the European Council recommends that all member states have to put more effort into the full implementation of the relevant laws.\textsuperscript{600}

\begin{itemize}
\item \textsuperscript{591} cf. Flussgebietsgemeinschaft Elbe, 2014, pp. 20 ff
\item \textsuperscript{592} cf. Umweltbundesamt 2013, p. 21 & cf. BMU 2013, p. 6
\item \textsuperscript{593} cf. BMU 2013, p. 6
\item \textsuperscript{594} cf. Fenz/Ofenböck/Schenker 2015, p. 15
\item \textsuperscript{595} cf. BMLFUW 2014, p. 77
\item \textsuperscript{596} cf. BMU 2013, pp. 6 f
\item \textsuperscript{597} cf. Umweltbundesamt 2013, p. 27
\item \textsuperscript{598} cf. BMLFUW 2014, p. 30 & cf. MKULNV NRW 2015, pp. 1 ff
\item \textsuperscript{599} cf. Lexikon der Nachhaltigkeit 2015b, n.p. & cf. Umweltbundesamt 2013, pp. 28 ff
\item \textsuperscript{600} cf. Umweltbundesamt 2013, pp. 28 ff
\end{itemize}
5.6 Climate protection

Climate protection is one of the greatest challenges of the 21st century. Drastic reductions of greenhouse gas emissions are necessary to delimit the average global warming to no more than 2°C in order to prevent far-reaching irreversible consequences of climate change in the future.\(^{601}\)

In Austria the average yearly temperature rise amounted to 2°C from the 19th century until 2009. This increase was significantly higher than the world average of 0.76°C and is additionally attributable to the Alpine region and the transition area of different climatic influences.\(^{602}\) Also in Germany there had been an increase of about 0.9°C in the last century.\(^{603}\)

However, the climate system reacts very slowly to changes. The impacts of today can be traced back to GHG emissions from 200 years ago. Also if GHG emissions could be reduced significantly, serious climate impacts will affect the environment, society and economy in the next decades. Therefore, to withstand the consequences of climate change, besides measures against it also adaption strategies are necessary to reduce the vulnerability and to increase the resilience.\(^{604}\)

The Kyoto Protocol set internationally binding targets for the reduction of GHG emissions for industrial countries between 2008 and 2012. The whole EU wanted to reduce its emissions by 8% compared to 1990. According to the related EU-15 “burden sharing” Austria had a reduction goal of 13% which meant an average target value of 68.8 million tons of CO₂-equivalents.\(^{605}\) In Austria a Climate Strategy\(^{606}\) to reach the Kyoto goal was adopted in 2007.\(^{607}\) To achieve the national goals this strategy proposed a yearly target amount of 18.9 million tons of CO₂-e in the transport sector between 2008 and 2012. Afterwards a value of 20.45 million tons of CO₂-e is planned.\(^{608}\) The Austrian Energy Strategy\(^{609}\) (2010) which also

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\(^{601}\) cf. Umweltbundesamt 2013, p. 63  
\(^{602}\) cf. Umweltbundesamt 2013, p. 84  
\(^{603}\) cf. Schwarz/Hamerling/Bals 2007, p. 4  
\(^{604}\) cf. Umweltbundesamt 2013, p. 83  
\(^{605}\) cf. Umweltbundesamt 2013, pp. 63 f  
\(^{606}\) cf. Umweltbundesamt 2013, pp. 63 f  
\(^{607}\) cf. Umweltbundesamt 2013, pp. 63 f  
\(^{608}\) cf. Umweltbundesamt 2013, p. 210  
\(^{609}\) See: http://www.bmwf.w.gv.at/EnergieUndBergbau/Energieeffizienz/Documents/Eckpunkte%20Energiestrategie.pdf
serves the attainment of the Kyoto goal has aimed that a reduction of 5% of the energy usage in the transport sector is necessary by 2020 compared with 2005.\textsuperscript{610}

The Kyoto commitment period ended in 2012.\textsuperscript{611} The GHG emissions regulated in the EDS could not be reduced sufficiently through national measures in Austria. Nevertheless, Austria was able to reach its Kyoto goal in 2012 but only with the acquisition of emission allowances from abroad.\textsuperscript{612}

Moreover, a second cycle between 2013 and 2020 was defined during the eighth United National Framework Convention on Climate Change in Doha in 2012. There, another target was the above mentioned agreement on the new global climate treaty defined in Paris in 2015 and starting in 2020.\textsuperscript{613}

In accordance with the 2020 Climate and Energy Package (2007) of the EU a new reduction target of 20% was defined (compared to 1990) for the new period until 2020. Since 2013, there have not been general national targets as there has been a differentiation between emissions included in the ETS and emission regulated through the ESD.\textsuperscript{614} Therefore, the overall European emission trading companies have to reduce their GHGs by 21%. Emissions not included in the ETS like transport emissions are regulated through the Effort Sharing Decision as stated previously. Here national targets exist like depicted in Figure 20.

**Figure 20: Effort Sharing**

![Effort Sharing Diagram](image)


\textsuperscript{610} cf. Umweltbundesamt 2013, p. 209
\textsuperscript{611} cf. Umweltbundesamt 2013, p. 63
\textsuperscript{612} cf. Anderl et al. 2015, p. 63
\textsuperscript{613} cf. Umweltbundesamt 2013, p. 63
\textsuperscript{614} cf. Anderl et al. 2015, p. 5
Therefore, Austria has to decrease those emissions by 16 % until 2020 compared to 2005. Additionally, the usage of renewable energy sources has to increase to 34 %.\textsuperscript{615}

In Germany the national GHG emission goal is a reduction of 14 % by 2020 compared to 2005.\textsuperscript{616} Moreover, the renewable energy utilization should amount 18 % in the same year.\textsuperscript{617}

The effort sharing ceilings for Austria are also embedded in the Austrian Climate Protection Law\textsuperscript{618} which was introduced in 2011. It contained emission ceilings for all sectors not contained in the Emissions Trading System between 2008 and 2012. A new version\textsuperscript{619} set targets for the period between 2013 and 2020.\textsuperscript{620}

Between 1990 and 2013, the Austrian GHG emissions of the transport sector increased from 13.8 to 22.3 million tons of CO\textsubscript{2}-equivalents which is a rise of 61 %. Road transportation is the largest contributor whereas goods transportation was responsible for 10 million tons of CO\textsubscript{2}-equivalents. Passenger transport was accountable for 12 million tons CO\textsubscript{2}-e. Other emissions stemmed from planes, ships and trains. Besides the increasing transport intensity on Austrian streets the export of fuel to neighboring countries is also responsible for the rising amounts of GHG emissions.\textsuperscript{621}

Nevertheless, in 2013 the GHG emissions of the transport sector were 0.05 million tons below the sectoral goal of 22.3 million tons CO\textsubscript{2}-equivalents. Therefore, transportation was the field with the lowest difference to the climate goals compared to other areas.\textsuperscript{622} Whereas in 2011, transportation had even been the field with the highest deviations of the sectoral climate goal (+3.6 million tons).\textsuperscript{623} The target for the transport sector in 2020 is an average yearly maximum amount of 21.7 million tons CO\textsubscript{2}-equivalents.\textsuperscript{624}

In comparison with the year before, in 2013 the Austrian GHG emissions rose by 4.7 % due to increases regarding total sales of transport fuel (+4.4 %) and decreases of biofuels (-1.4 %). However, through the usage of biofuels 1.7 million tons of CO\textsubscript{2}-e could be saved. Since 2005, a downward trend of GHG emission in the transport sector has been detected (- 9.6 %) which

\textsuperscript{615} cf. Umweltbundesamt 2013, p. 64
\textsuperscript{616} cf. European Commission 2016f, n.p.
\textsuperscript{617} cf. OJ L 140, 2009, p. 46
\textsuperscript{618} See: KSG, BGBl. I Nr. 106/2011
\textsuperscript{619} See: BGBl. I Nr. 128/2015
\textsuperscript{620} cf. Umweltbundesamt 2013, p. 64
\textsuperscript{621} cf. Anderl et al. 2015, p. 23
\textsuperscript{622} cf. Anderl et al. 2015, p. 23
\textsuperscript{623} cf. Anderl et al. 2013, p. 29
\textsuperscript{624} cf. BGBl. I Nr. 128/2015, p. 2
is attributable to the usage of biofuels, more efficient vehicle fleets and several programs regarding GHG reductions in this sector.\textsuperscript{625} Nevertheless, for a sustainable reduction of emissions and the achievement of the Kyoto goals in 2020, additional measures and the acquisition of emission reduction units will be necessary in the Austrian transport sector.\textsuperscript{626}

Based on the German “Integrated Energy and Climate Program”\textsuperscript{627} (2007) also the National Energy Concept\textsuperscript{628} of 2010 defined fundamental climate protection goals for 2020. Greenhouse gas emissions have to decrease by 40\% compared to 1990.\textsuperscript{629} Until 2050 a GHG reduction of 80 to 95\% is targeted compared with the same base year.\textsuperscript{630}

Moreover, Germany significantly contributed to the EU commitment regarding the first Kyoto period with an obligation to reduce GHG emissions by 21\% until 2012 compared to 1990. However, it was even able to diminish its emissions by 25.8\% in 2012.\textsuperscript{631} National transportation emitted 160 million tons CO\textsubscript{2}-equivalents in 1990. This was a share of 13\% of total GHG emissions. Between 1990 and 1999 they peaked with 185 million tons of CO\textsubscript{2}-e. After a short decrease the emissions have again increased since 2010. In 2014, the level of 1990 has been slightly surpassed with 164 million tons of CO\textsubscript{2}-e. The share of transport related pollution of the whole GHG emissions increased from 13\% in 1990 to 18\% in 2014.\textsuperscript{632} Therefore, transportation is currently the third largest contributor to GHG emissions in Germany.\textsuperscript{633} However, it is estimated that GHG emissions from the transport sector will decrease to 144 million tons of CO\textsubscript{2}-e until 2020.

Nevertheless, with the existing measures it is estimated that in 2020 the overall GHG emission will only be 33\% below the level of 1990. Therefore, there is a gap of 7\% which has to be closed to reach the desired goal.\textsuperscript{634}

\textsuperscript{625} cf. Anderl et al. 2015, pp. 23 f
\textsuperscript{626} cf. Umweltbundesamt 2013, p. 72
\textsuperscript{628} See: https://www.bundesregierung.de/ContentArchiv/DE/Archiv17/_Anlagen/2012/02/energiekonzept-final.pdf;jsessionid=4D62EEE6BE9BE6242B770407ED622048.s6t2?__blob=publicationFile&v=5
\textsuperscript{629} cf. BMUB 2009, n.p.
\textsuperscript{630} cf. BMUB 2014b, n.p.
\textsuperscript{631} cf. Strogies/Gniffke 2016, pp. 128 f
\textsuperscript{632} cf. BMUB 2015b, pp. 18 ff
\textsuperscript{633} Note: Here GHG emissions from agricultural fuel consumption, international aviation and inland waterways are not included although continual growth is estimated.(cf. BMUB 2015b, pp. 18 ff)
\textsuperscript{634} cf. BMUB 2014b, n.p.
Consequently, a comprehensive action program “Climate protection 2020” was introduced in 2014. Therein, Germany ensured that it will reduce its whole GHG emission with additional measures to actually meet its reduction goal of 40% by 2020 and therefore close the projected gap.

However, also if the global temperature will not rise above the 2°C ceiling, there will be impacts of past environmental pollution. To counteract those impacts Germany introduced the “German Adaption Strategy” in 2008. It aimed to reduce negative climate effects and to promote the adaptability of natural, social and economic systems.

The transport sector is one of the main contributors to GHG emissions in Germany. However, this sector also reveals an essential reduction potential. Therefore, measures in the climate protection action program regarding transportation could lead to a decrease of 7 to 10 million tons of CO₂-equivalents. Measures are defined in the area of climate friendly freight and passenger transport, more widespread use of electrical drives of motor vehicles as well as climate protection regarding air transportation and international maritime transport. Concrete measures concerning freight transport are the advancement of the truck toll system and the conversion of truck tolls to energy efficiency classes, the market introduction of energy efficient vehicles, the improvement of rail and inland waterway transportation as well as the promotion of regional economic cycles. For example, the individual food consumption influences transport volumes and therefore the expenditure of energy and emissions. For instance the energy usage of imported apples is about 27% higher than the regional cultivation in Germany.

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636 cf. Strogies/Gniffke 2016, pp. 128 ff
637 See: Bundesregierung 2009, pp. 4 ff
638 cf. Bundesregierung 2008, pp. 4 ff
639 cf. Richter 2012, pp. 16 ff
In comparison, it can be said that in the last century Austria had the highest temperature increase of 2°C whereas the world average rose by 0.76°C, EU average amounted to 1.3°C and in Germany there was an increase of 0.9°C.\textsuperscript{640}

Until the end of the first period of the Kyoto Protocol in 2012, Austria was able to meet its obligations of a 13% reduction of GHGs but only with the acquisition of emission allowances.\textsuperscript{641} However, Germany did overreach its goal of 21% by 4.8 percentage points.\textsuperscript{642} The EU in general was also able to surpass the 8% goal with a reduction of GHG by 11.7%.\textsuperscript{643}

Moreover, it is estimated that the 20% GHG reduction goal of the European Union will also be exceeded in 2020. In 2013, there had already been a decrease of 19% whereas in 2014 already 23% could have been detected. Therefore, it is projected that the EU will diminish its GHG emissions by 24% until 2020.\textsuperscript{644} In Austria especially the emissions included in the EDS directive are estimated to reveal a gap of 2.2 million tons of CO\textsubscript{2}-equivalents with the existing measures. However, through the complete implementation of further measures, this gap can be significantly reduced.\textsuperscript{645} Also in Germany the goal of cutting 40% of GHG emissions is presumed to reveal a gap of 7 percentage points. However, with the introduced action program further measures will be implemented in order to reach the desired target in 2020.\textsuperscript{646}

Regarding the mentioned forecasts, Europe is doing quite well and also Germany will be able to reach its goals. Austria will struggle to meet its aims. Although the figures reveal quite good forecasts for 2020, continuous further measures are the key point in achieving future goals. Therefore, it is important that these measures will actually be realized to protect our environment, to counteract negative climate impacts as well as to reduce responsible emissions drastically. Especially due to the ambitious goals of 2030 and 2050 further measures are needed to achieve the mentioned targets and to keep global warming below 2°C.

Table 12 summarizes the main goals of the EU, Austria and Germany regarding climate protection.

\textsuperscript{641} cf. Anderl et al. 2015, p. 63 \\
\textsuperscript{642} cf. Strogies/Gniffke 2016, pp. 128 f \\
\textsuperscript{643} cf. European Commission 2016g, n.p. \\
\textsuperscript{644} cf. European Commission 2016h, n.p. \\
\textsuperscript{645} cf. Anderl et al. 2015, p. 7 \\
\textsuperscript{646} cf. BMUB 2014b, n.p.}
<table>
<thead>
<tr>
<th></th>
<th>EU</th>
<th>Austria</th>
<th>Germany</th>
<th>Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Global warming</strong> (Goal &lt;2°C)**</td>
<td>1.3°C</td>
<td>2°C</td>
<td>0.9°C</td>
<td>World average 0.76°C</td>
</tr>
<tr>
<td><strong>1. Kyoto period</strong> <strong>GHG reduction goals 2012</strong></td>
<td>8%</td>
<td>13%</td>
<td>21%</td>
<td>Base year: 1990</td>
</tr>
<tr>
<td><strong>Achievements in 2012</strong></td>
<td>11.7%</td>
<td>13%</td>
<td>25.8%</td>
<td></td>
</tr>
<tr>
<td><strong>2. Kyoto period 2020</strong></td>
<td>20%</td>
<td>40% (overall)</td>
<td>1990</td>
<td></td>
</tr>
<tr>
<td>- ETS</td>
<td>21%</td>
<td>21%</td>
<td>21%</td>
<td>2005</td>
</tr>
<tr>
<td>- ESD</td>
<td>10%</td>
<td>16%</td>
<td>14%</td>
<td></td>
</tr>
<tr>
<td>- Renewable energy</td>
<td>20%</td>
<td>34%</td>
<td>18%</td>
<td></td>
</tr>
<tr>
<td><strong>Estimations for 2020</strong></td>
<td>24%</td>
<td>&gt;16% (EDS)</td>
<td>33% (overall)</td>
<td>2005</td>
</tr>
<tr>
<td><strong>Transport GHGs goals 2030</strong></td>
<td>30%</td>
<td></td>
<td></td>
<td>2008</td>
</tr>
<tr>
<td><strong>Transport GHGs goals 2050</strong></td>
<td>60%</td>
<td></td>
<td></td>
<td>1990</td>
</tr>
<tr>
<td><strong>GHG goals 2030</strong></td>
<td>40%</td>
<td>43%</td>
<td>37.7% - 46.9%</td>
<td>2005</td>
</tr>
<tr>
<td>- ETS</td>
<td>30%</td>
<td>30%</td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td>- ESD</td>
<td>27%</td>
<td>27%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Renewable energy</td>
<td></td>
<td>37.7% - 46.9%</td>
<td>30%</td>
<td>2005</td>
</tr>
<tr>
<td>- Energy efficiency</td>
<td></td>
<td></td>
<td>649</td>
<td></td>
</tr>
<tr>
<td><strong>GHG goals 2050</strong></td>
<td>80-95%</td>
<td>80-95%</td>
<td>80-95%</td>
<td>1990</td>
</tr>
<tr>
<td><strong>Renewable energy goals 2050</strong></td>
<td>30%</td>
<td>42.7% - 66.6%</td>
<td>60%</td>
<td>1990</td>
</tr>
</tbody>
</table>

Source: Own research

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647 cf. BMWF 2015, pp. 7 + 82 ff
648 cf. Anderl et al. 2015, p. 56
649 cf. BMW 2014, p. 11
650 cf. Umweltbundesamt 2013, p. 63
651 cf. BMW 2014, p. 11
652 cf. Anderl et al. 2015, p. 56
653 cf. BMW 2014, p. 11
After the analysis of national strategies to counteract freight transportation impacts, an overview of European, Austrian and German and external freight transportation costs is additionally demonstrating the remaining burden of unsustainable freight transportation as depicted in the Figures 21, 22 and 23."654

Figure 21: Average external costs 2008 for EU-27*: freight transport (heavy freight transport; excluding congestion)

Source: Essen et al. 2011, p. 73

Figure 22: External costs of freight transport – Austria


Note: It should be mentioned that due to differentiating parameters of the illustrations an actual comparability is restricted.
Nevertheless, the three illustrations finally show that road freight transportation causes by far the most external costs in Austria, Germany and generally in the EU. Whereas in Austria and Germany rail transportation is on the second place, total EU external costs are higher for inland waterways due to a great share of air pollution costs. In Austria especially noise is responsible for the greatest part of inland waterway costs whereas in Germany this mode especially generates air pollution expenses.655

Notwithstanding, Austria and Germany (and also all other member states) reveal very high implementation rates of 97% and 98% of European directives in the field of transportation. However, especially Germany has several pending infringements in all modes of transport due to the consideration of the Commission that EU rules have not been realized correctly.656

Regarding the impacts and high external costs of freight transportation while nearly all EU transport directives have been implemented by the member states, it is obvious that much more needs to be done to transform freight transportation towards sustainability. Consequently, where the avoidance respectively a shift towards more sustainable freight transportation is not possible, it is crucial that harmful impacts need to decrease more strongly. Therefore, the further development of emission limits and the advancement of additional instruments and measures on a national as well as on European level are essential in order to make freight transportation more sustainable in future.657

657 cf. Umweltbundesamt 2009, p. 113
6 Summary and Conclusion

Currently, greenhouse gas emissions and congestion problems are seen as the main environmental and sustainable challenges regarding freight transportation in Europe. They already have great impacts on the environment and on humans’ health and its effects multiply with the increase in population, consumption and transportation.

It can be said that there are various causes for the increasing transport intensity resulting from globalization, liberalization, shorter product lifecycles, more production, longer-distance freight transportation, smaller consignments, “just-in-time” production, the rising trend of mail order trade, shrinking transportation costs, exports and imports, transport of seasonal goods, outsourcing, arrangements of central warehouses and innovations like containerizing or navigation satellite systems. Therefore, the significance of sustainability is steadily increasing. Especially because of the emerging problems and environmental impacts like air, noise and water pollution as well as climate change, fragmentation of land and biodiversity losses, European guidelines and measures for sustainable freight transportation gain more and more in importance.

Therefore, the European Union has constantly developed its environmental policy starting in 1973 with the introduction of the 1st Environmental Action Program as an instrument for achieving the goals of the European Strategy for Sustainable Development. Now already the 7th EAP has been adopted. Based on “Europe 2020 – A strategy for smart, sustainable and inclusive growth” the 7th EAP highlights several priority areas and should lead the future of the European environmental policy.

With a special focus on sustainable freight transportation, this paper particularly highlights the evolution of a common European transport policy. Tracing back to the Treaty of Rome, transport policy was one of the first common policies in the EU. One of the most important developments in order to handle the increases in transportation was the creation of the trans-European transport network. Nevertheless, positive achievements like reductions of bottlenecks, the interoperability of networks and the improvement of intermodality also lead to increasing negative effects on the environment. Although liberalization and the combination of modes respectively the shift of road transport towards more sustainable modes can reduce negative environmental effects, these might be offset by the simultaneous increase in freight transport. Therefore, an accurate assessment of costs and benefits needs to be done beforehand. Also the financial perspective is critical as large investments are necessary in order to be able
to exploit the maximum benefits out of a trans-European transport network. Nevertheless, sustainability is getting more and more important and accepted as a substantial need for the worldwide future development. Therefore, initiatives like Greening Transport, the Green Paper of 2009, the Maritime transport strategy until 2018, the new Transport White Paper and the new infrastructure policy of 2014 especially highlight the necessity for acting more sustainable. Particularly because freight transport plays a major role regarding environmental pollution this sector requires special focus and attention.

In Austria and Germany the implementation rate of European transport directives is very high. However, the actual realization of included measures needs to be better monitored and controlled in order to achieve the desired environmental objectives. It can be said that besides marginal differences regarding the realization processes and emission limits, Austria and Germany do not reveal very divergent implementation strategies. Moreover, Austria and Germany did both not achieve their national goals of the NEC-directive regarding emission ceilings of transportation. Additionally, despite several achievements concerning particulate emission reductions, those substances are very harmful for humans’ health and therefore need to be further diminished in both countries. Nevertheless, the comparability is often quite difficult as Austria and Germany sometimes use different parameters to specify for instance transport noise levels. Also in respect of sustainable land utilization and biodiversity protection both countries need to actively react to the negative effects of transportation. In reference to climate protection it can be said that Germany is doing better than Austria in achieving its set objectives. Whereas Germany was able to surmount its Kyoto goals in 2012, Austria had to acquire additional emission allowances. Moreover, concerning the TEN-T infrastructure implementation Germany also scored better than Austria in five out of eight rankings. However, both countries were principally superior compared with the EU average. Nevertheless, more specific measures included in the different Austrian and German regulations may vary more regarding their nature and realization. However, most of the mentioned directives concerning air pollution control, noise mitigation, sustainable land utilization, biodiversity protection, water pollution control and climate protection are regulated on EU level and therefore already include implementation plans for the member states. Notwithstanding, until the EU directives are transformed into national law, included national measures are developed and implemented as well as revised and optimized a lot of time passes by. Consequently, often deadline extensions are the result like for example in the field of Austrian and German water protection. Therefore, to reach the ambitious goals for 2030 and 2050 Germany and especially Austria need to actually introduce further effective measures.
Moreover, a sustainable development of freight transport will be even more difficult to reach than sustainable passenger transport. For example there is a long time period necessary for a technological change regarding vehicles, a shift towards more sustainable transportation modes, changes in prices and the development of new innovations for more sustainable modes of transport.

The current concept of sustainability in the European Union regarding freight transport pursues the right approach regarding the most important issues. It reveals several strengths including the focus on co-modality, the realization of transport charges and the usage of information and communication technologies. However, in other fields like sustainable freight systems in urban areas it is less developed. Nevertheless, there are many possibilities for the improvement of sustainable freight transportation like modal pricing, alternative fuels, promoting a modal shift towards sustainable modes, enhancing co-modality, the usage of information and communication systems as well as intelligent transport systems and innovative solutions regarding urban freight transport. As mentioned above, in order to exploit the maximum potential out of these possibilities, there needs to be a constant high level of investments into research and development.

However, it should be considered, that the enhancement of transportation efficiency might also increase its demand. Therefore, the prices should also reflect external environmental costs. Furthermore, a general change in behavior towards sustainability needs to be stimulated through pricing. In the long run, completely new and innovative transportation modes are conceivable although the costs for such a development might be not negligible. Moreover, the realization of alternative, sustainable models of economy or business like turning away from globalization might be possible but not probable.

All in all, it can be said that Europe is behind schedule regarding the achievement of set objectives towards sustainable freight transport. Although the defined goals are very aspiring, the cut in GHG emission reductions of 60 % in the transport sector by 2050 will not be achieved unless further and stricter initiatives will be realized. The comprehensive ongoing and planned research activities will lead to a significant improvement in many facets in terms of sustainability in freight transportation. However, it will take some time before improved technologies will be available for commercial usage.\textsuperscript{658}

\textsuperscript{658} cf. Institute for Transport Studies 2010, pp. 7 ff
7 List of References

Main references (monographs, anthologies, journals…)


Internet references


Legal references


Note: Same Official Journals are used in English (OJ) and German (ABl.). Therefore, the abbreviations differ.


