

CEE CLIMATE POLICY FRONTIER

Between Regional Best Practices and Paris
Agreement-compatibility in the transport
sector

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Table of abbreviations

B2DS Scenario	The Beyond 2°C Scenario
BAU Scenario	Business-As-Usual Scenario
ESR	Effort Sharing Regulation
IPCC	Intergovernmental Panel on Climate Change
PA Scenario	Paris Agreement Scenario
PKM	Passenger-kilometer
RBP Scenario	Regional Best Practice
SIAMESE	Simplified Integrated Assessment Model with Energy System Emulator
TKM	Tonne-kilometer
VKM	Vehicle-kilometer

1. Introduction

In 2018 the transport sector constituted 22% of the EU's emissions – an increase from 14% in 1990. It was the only major sector since 1990 which saw increasing emissions, and a significant increase at that of around 20%. This increase was largely, if not only, driven by the countries that joined the EU in 2004 and 2007. Since 1990, these countries have registered improvements in quality of life, but also increasing urban sprawl. Combined with privatization and often negligence of railway infrastructure and declining public transport this has resulted in greater reliance on individualized transportation, particularly travel by car.

This led to an increase in emissions from transport in all EU countries. The increase in the six countries investigated in this report - Bulgaria, Czechia, Hungary, Poland, Romania, and Slovakia - was especially high, ranging from 24% in Slovakia, to 32% in Romania, to as high as 84% in Czechia. In the case of Poland, emissions from the transport sector have more than doubled between 1990 and 2018 (European Environment Agency, 2020).

Even more worryingly, current policies would not do much to change this trend. According to projections submitted by the member states to the European Environment Agency (EEA), transport sector emissions in 2030 will decrease only in Czechia (against a 2005 baseline). In Bulgaria they are set to increase by 28%, whereas in Poland rapid growth is set to continue with emissions increasing by 85% (European Environment Agency, 2019, 2020).

Such growth not only runs contrary to the EU goal of emissions neutrality, but it may also have financial repercussions for the countries affected. Since the transport sector constitutes a significant share of the emissions covered by the Effort Sharing Regulation (ESR), achieving the binding emissions reduction goals imposed by the ESR would mean that either emissions would have to decrease significantly in other sectors covered by the ESR – namely buildings and agriculture – or these countries would have to purchase statistical transfers from countries overachieving their emissions reduction goals (European Parliament and the Council of the European Union, 2018).

To change this increasing trend, it is necessary to understand what determinants are driving it in the first place. The main purpose of this report is to improve this understanding by investigating 52 indicators influencing emissions from the passenger and freight transport. We also go one step further by developing a scenario in which the indicators with the best value from the selected countries are applied universally across these countries until 2030 and compare it with the Paris Agreement compatible levels.

As a result, we present three levels of emissions: the first one reflecting the continuation of past trends until 2030 (BAU Scenario), the second assuming a universal uptake of climate optimal trends (RBP Scenario), and the third one showing the compatibility with the Paris Agreement temperature limit.

The goal of this exercise is not to predict the future. Rather, sections 3.3 and 4.3 respectively describe why the future might be different than the past. By disaggregating the main indicators to changes in emissions and the impact of the regional best practices – understood as best trends from the selected countries – the exercise aims to illustrate which levers to pull to change the overall trend of increasing emissions towards Paris Agreement-compatible emissions reduction levels described in section 5.

2. Methodology

To find out whether the regional adoption of country Best Practices would be enough to meet the Paris Agreement temperature limit, we needed to find out what are the Paris Agreement-compatible emissions in the transport sector in each of the six countries analyzed. Furthermore, Regional Best Practice (RBP) scenarios had to be developed and compared with the Paris Agreement-compatible emissions levels.

The two subsections below explain how each of these sets of emissions pathways was developed.

2.1. Paris Agreement-compatible emissions in 2025 and 2030

In this report, the sectoral Paris Agreement-compatible emissions levels in 2025 and 2030 were scaled down from the Beyond 2°C scenario (B2DS) developed by the International Energy Agency (IEA, 2017). The scenario is a combination of forecasting known trends, and back casting from a specified long-term outcome. This outcome has been defined by the IEA as reducing emissions to net zero by 2060 and limiting average temperature increase to 1.75°C with 50% probability. This scenario can be considered Paris Agreement-compatible under the condition that if the pathway is extended beyond 2060 (the final year in B2DS), it will allow for net negative emissions in the energy sector at a level similar to that in other scenarios assessed by the IPCC. In this case, the B2DS scenario reaches peak warming of 1.6°C and warming drops below 1.5°C before 2100.

Therefore, it can be understood as a rather lax interpretation of the Paris Agreement temperature limit. At the same time, this is one of few scenarios available at the moment that provides the necessary sectoral granularity to derive the sectoral-based results relevant for this analysis.

The results of the emissions pathway have been scaled down using a tool developed by Climate Analytics called Simplified Integrated Assessment Model with Energy System Emulator (SIAMESE) (Sferra et al., 2019). The Model uses an optimization approach, incorporating UN population projections and GDP growth projections compatible with the relevant Shared Socioeconomic Pathway (SSP) to create least-cost fuel mix pathways that produce emission reductions necessary to achieve the goals of the Paris Agreement.

Based on historic energy consumption in the transport sector in the selected countries, this downscaling resulted in emissions levels for 2025 and 2030. These emissions levels are compared with emissions levels resulting from the application of the Regional Best Practices (RBPs)

2.1. Regional Best Practice (RBP) Scenario

The Regional Best Practices in this report are understood as the best trends identified in the selected region from the climate perspective, meaning the impact on greenhouse gas emissions. An exception is made for activity levels in trains and buses where it only leads to modest (for buses) or minimal (for trains) increase in emissions while allowing for higher levels of mobility. In those cases, the maximal activity level is applied.

To cover the whole of the transport sector, passenger and freight transport are divided into different modes of transport: eight modes of transport for passenger cars (e.g. railways, buses,

cars – see Table 1 for full list), and six modes of transport for freight transport (e.g. railways, heavy-duty, navigation – see Table 2 for full list).

Subsequently, three indicators are identified for each of the modes of transport: emissions intensity per vehicle (in gCO₂ per VKM travelled), load factor (number of passengers or tonnage per vehicle), and activity (kilometers travelled per vehicle). The default period analyzed is 2000-2015, for which data is available from JRC IDEES Project (EU Science Hub, 2019). However, whenever later data is available from EUROSTAT or the latest edition of the DG MOVE Statistical Pocketbook this period is extended up to 2019 (DG MOVE, 2020; Eurostat, 2020b).

Two scenarios are developed on the basis of these indicators: the BAU Scenario in which the country-specific past trends are extrapolated until 2030, and the RBP Scenario where the best practices from the selected countries are universally applied to all countries (see Figure 1).

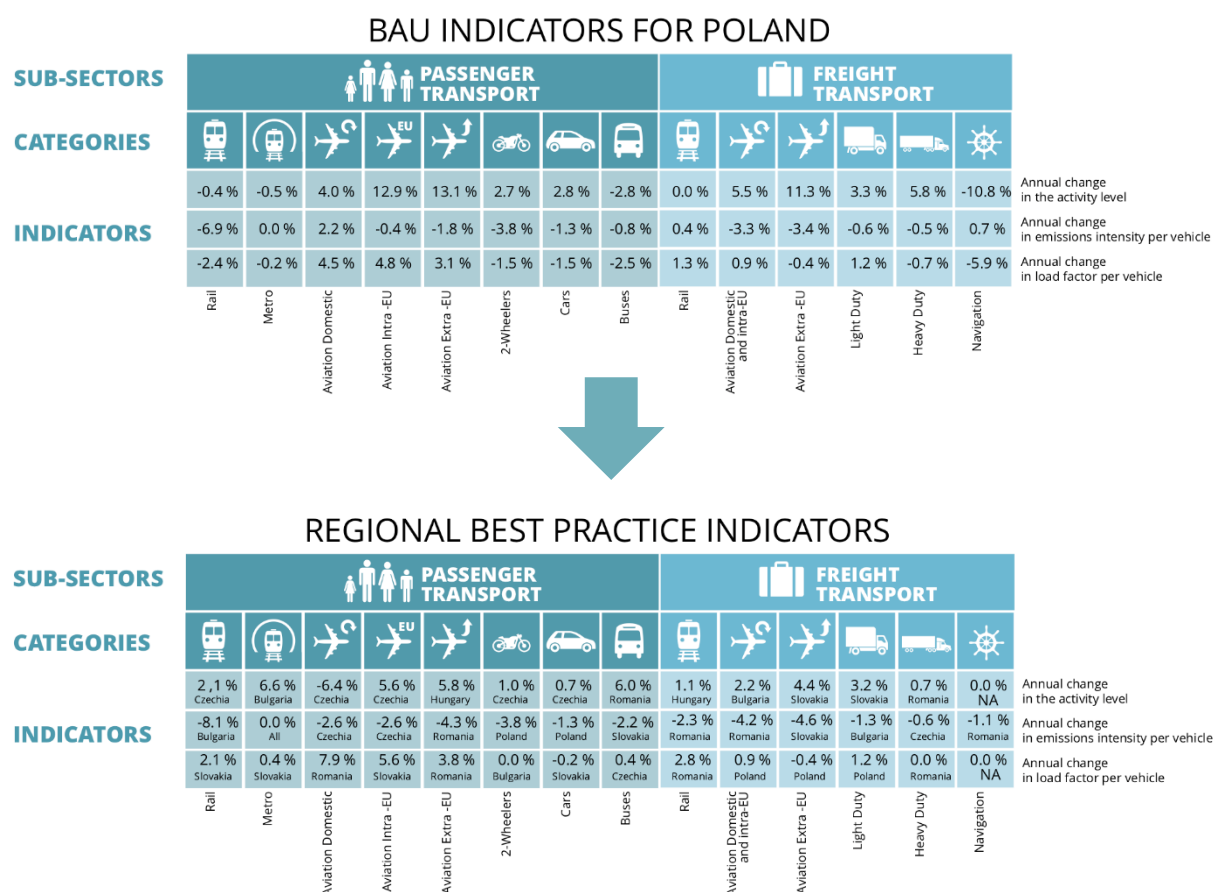


Figure 1: Replacing national indicators (above) by Regional Best Practice Indicators (RBP).

In terms of the activity levels, the RBP Scenario for passenger transport is defined as the largest decrease or the smallest increase in the average annual activity levels. To allow for an increase in mobility with the lowest possible carbon footprint, RBP for rail, metro and buses is considered as the highest increase in activity. For the load factor, the highest increase or the smallest decrease in the number of passengers per vehicles for all means of transport has been selected. However, the improvement of the load factor for aviation was reduced to result in a maximum of 150 people per plane for domestic flights (the maximum capacity of A320 used mostly for domestic flights) and 220 for intra-EU and extra-EU (the maximum

capacity of Airbus 321). The best improvement of emissions per VKM has been considered best practice, except for metro, where due to the 100% electrification rate no direct emissions were accounted for (see Table 1).

	Annual change in activity levels (t/capita)	Annual change in load factor (t/vehicle)	Annual change in emissions intensity (CO ₂ /VKM)
Rail	Fastest increase	Fastest increase	Fastest decrease
Metro	Fastest increase	Fastest increase	Fastest decrease
Aviation domestic	Slowest increase	Fastest increase (max. 150)	Fastest decrease
Aviation Intra-EU	Slowest increase	Fastest increase (max 220)	Fastest decrease
Aviation Extra-EU	Slowest increase	Fastest increase (max 220)	Fastest decrease
2-wheelers	Slowest increase	Fastest increase	Fastest decrease
Passenger Cars	Slowest increase	Fastest increase	Fastest decrease
Buses	Fastest increase	Fastest increase	Fastest decrease

Table 1. Definition of Regional Best Practices for passenger transport.

Similarly, for freight transport, RBP is identified as the slowest increase in the activity levels for all means of transport, except for rail. For emissions intensity, the fastest decrease in emissions per vehicle kilometer travelled was defined as RBP. An increase in the load factor was defined as best practice for all means of transport. Combining a decrease in emissions with an increase in load from different sources may be misleading: a decrease in freight transport may result in lower emissions, especially in aviation. However, better utilization of the available space would nonetheless result in lower emissions per unit of freight transported.

A slightly different approach was taken for navigation. Extrapolation of the RBP for activity (9.8% annually) and load factor (17.5% annually) would result in unrealistic assumptions, due to the limited potential and inflexibility determined by run of the river or the weather conditions (see Table 2). As a result, no change was assumed for these two values.

	Annual change in activity levels (t/capita)	Annual change in load factor (t/vehicle)	Annual change in emissions intensity (gCO ₂ /VKM)
Rail	Fastest increase	Fastest increase	Fastest decrease
Aviation domestic and intra-EU	Slowest increase	Fastest increase	Fastest decrease
Aviation extra-EU	Slowest increase	Fastest increase	Fastest decrease
Light duty	Slowest increase	Fastest increase	Fastest decrease
Heavy duty	Slowest increase	Fastest increase	Fastest decrease
Navigation	Kept unchanged	Kept unchanged	Fastest decrease

Table 2: Definition of Regional Best Practices for freight transport.

Emissions from the freight and passenger transport sector are summarized and compared with emission levels compatible with the Paris Agreement for the transport sector. These results are from the downscaling described above.

3. Passenger transport

In 2015, the combined emissions from passenger transport for the six selected countries amounted to almost 69 MtCO₂. This was 11% of total emissions for the selected countries. The highest was in Bulgaria at 16.6% and the smallest in Poland, where emissions from passenger transport corresponded to 7.9% of total CO₂ emissions. This excludes, however, indirect emissions from electricity used in the transport sector, which is currently important especially railways.

Passenger transport corresponds to around 62% of all transport emissions from the selected countries. However, there are some important differences between the respective countries: whereas in all countries emissions from passenger transport dominated, for Poland it was only a small majority of 51% of total transport emissions. In Slovakia, the share of emissions was equal to the average for all countries, whereas for Bulgaria and Romania it was much higher with 81% and 76%, respectively.

The number of kilometers travelled per capita between 2000 and 2015 increased in all selected countries. The fastest increase took place in Bulgaria and Romania where the number of travelled kilometers increased by 86 and 88%, respectively. The major difference between these two countries is that the increase in Bulgaria began from a higher base, which resulted in the second highest number of kilometers travelled among the selected countries.

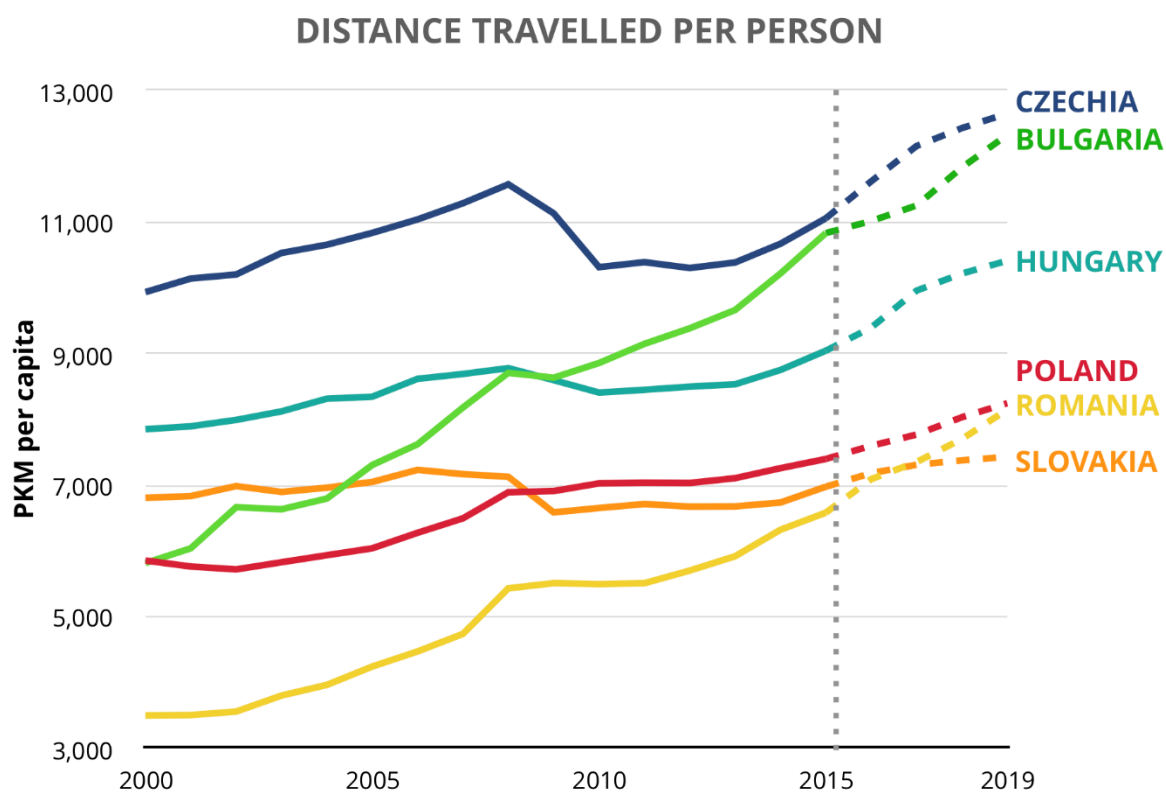


Figure 2: Total distance travelled per person in the selected countries. Data between 2016 and 2019 based on a mix of historic data and extrapolations.

Despite a similar level of increase in Romania, due to the lowest starting based, it was only post-2015 that the country exceeded Slovakia in terms of PKM per capita. As a result of these trends, there has been a regional convergence in terms of overall mobility: in 2000 an average Romanian travelled only 35% of the distance travelled by an average Czech. By 2015, this number increased to 63% (see Figure 2).

Trends until 2019 are based partly on already available data (aviation, railways), and partly on extrapolation from more recent years (metro and 2-wheelers until 2015, buses and cars until 2017 for some countries). They show a continuation of upward trends, with Bulgarians travelling the most, and Romanians ahead of Poland and Slovakia, mainly due to a significant increase in kilometers travelled by plane.

3.1. Assessing past trends

Between 2000 and 2015, a move from buses (-7.5%-points) and trains (-5.5%-points) to cars (+8.0%) and planes (+4.4%-points) could be observed (see Figure 3). Among the latter, the share of passenger kilometers travelled on intra-EU planes (including the UK) has almost tripled. As a result, in 2015 more kilometers were travelled by intra-EU and domestic planes than by trains. In *absolute* terms, the number of PKM travelled by metro increased by 16% but its *share* in total kilometers travelled per capita decreased slightly in the analyzed period.

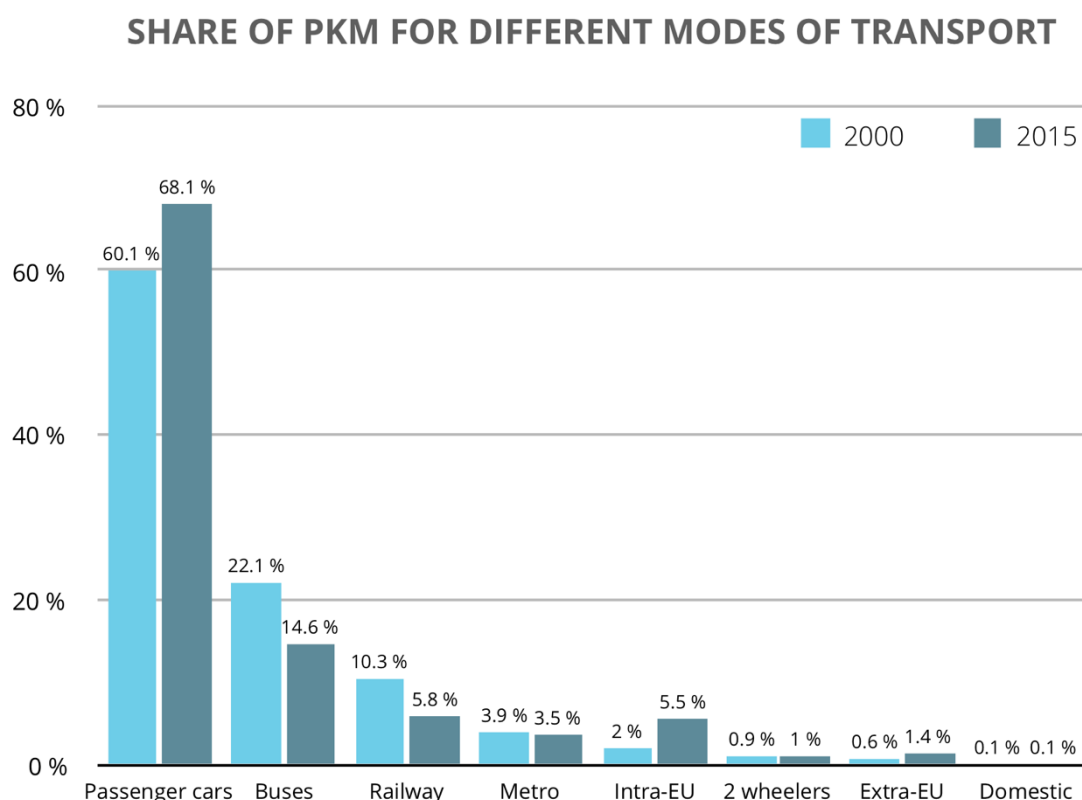


Figure 3: Share of total PKM travelled for different modes of transport – combined for the selected six countries.

The subsections below explain in more detail past trends for different modes of transport in terms of activity levels, load factor, and emissions per vehicle and passenger travelled.

3.1.1. Cars and 2-wheelers

In 2015, passenger cars in the selected countries were responsible for close to two thirds of kilometers travelled and over three quarters of transport emissions. Three main trends for this mode of transport can be singled out: decreasing discrepancy between the selected countries in terms of activity, modest decrease in emissions intensity, and more than modest decrease in the load factor.

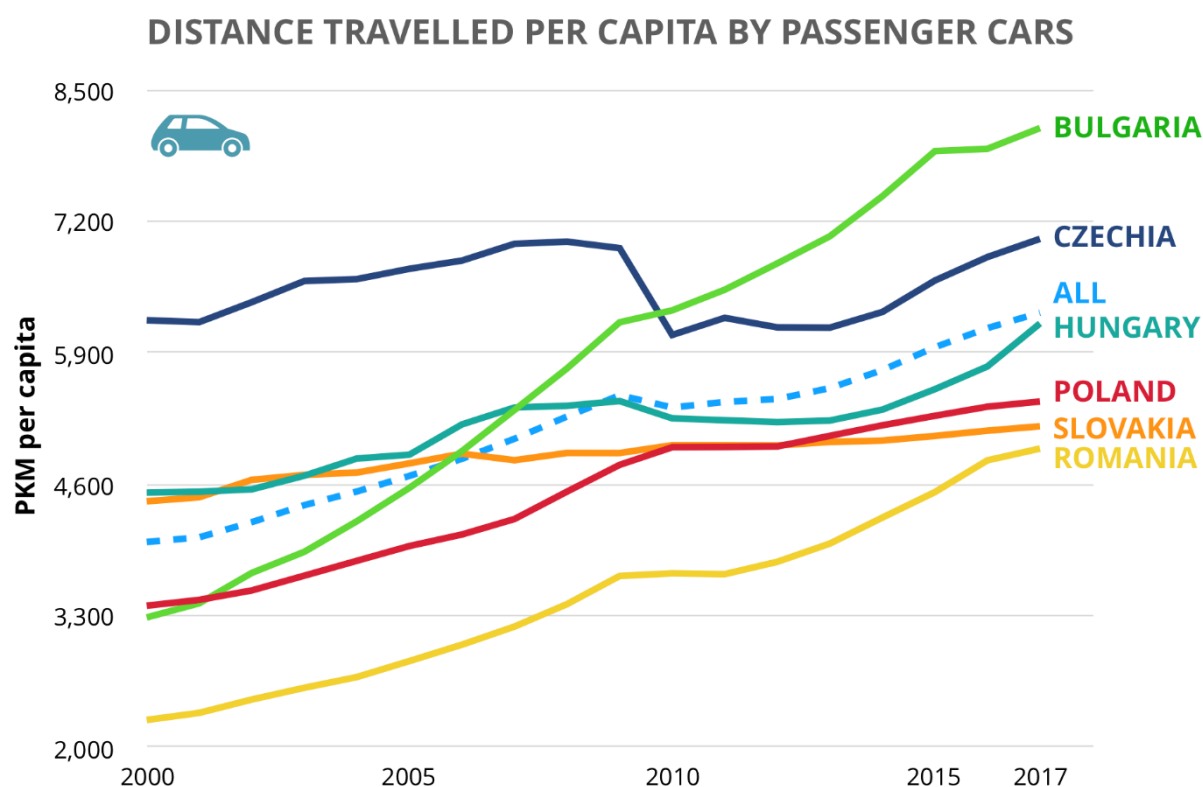


Figure 4: PKM per capita for passenger car.

In 2000, the average citizen of Romania – the country with the lowest PKM in the selection for that year – travelled less than 2,300 kilometers by car. By 2017 – the last year for which data for passenger cars are available – this number has more than doubled and reached 4,953 PKM (see Figure 4). As a result, the disparity between the countries with the highest number of PKM per capita and the lowest decreased: in 2000 the average Romanian travelled 49% of what the average citizen of Czechia – the country with the highest number of PKM per capita in 2000 – travelled by passenger car. By 2017 this indicator reached 70%.

In the same period, however, Bulgaria overtook Czechia. But the disparity between the country with the highest number of PKM per capita and the one with the lowest still lessened – in 2017 an average Romanian travelled 61% of the distance by passenger car in comparison to an average Bulgarian. On average, the mileage in Romania and Bulgaria increased by 4.7% and 5.5% annually between 2000 and 2017. Also, Poland and Hungary registered an increase in the levels of activity by passenger cars, but at a much smaller rate – by 2.8% and 1.9% annually, respectively. In Czechia and Slovakia, the average increase was below 1%.

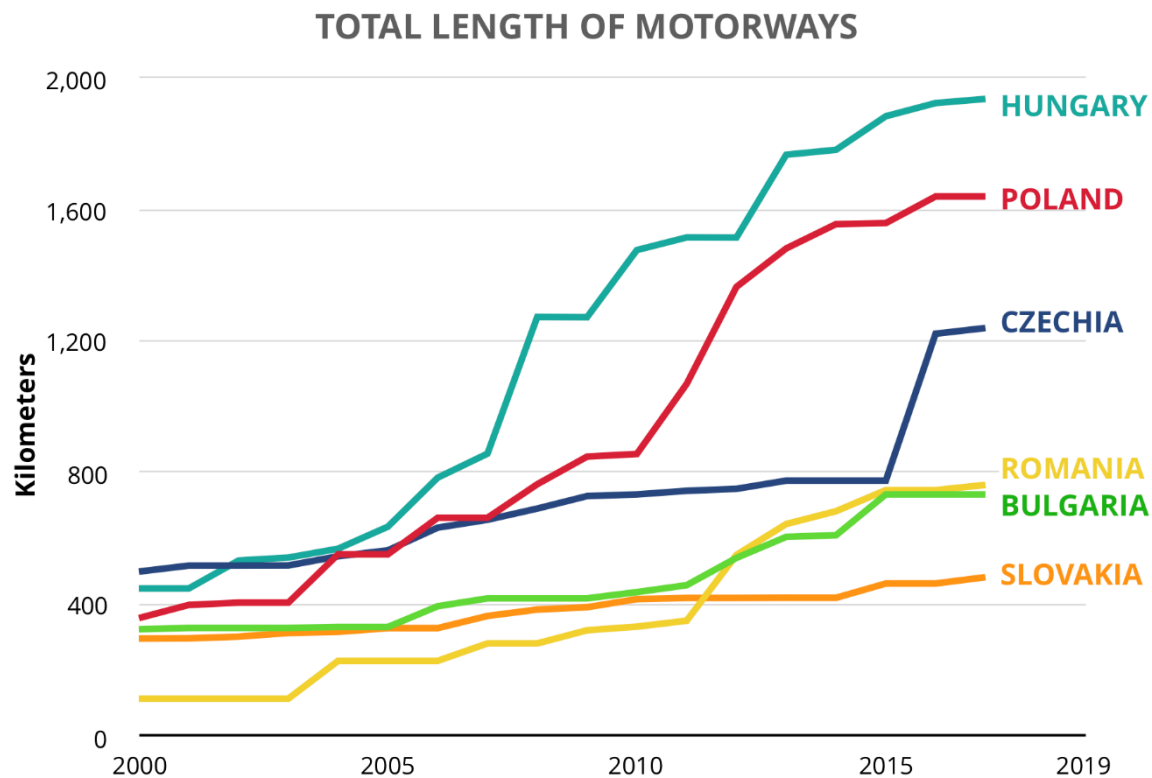


Figure 5: Total length of motorways in kilometers per country

This increase in activity could be traced back to four main causes. Firstly, after joining the European Union, the selected countries gained access to EU structural funds which allowed them to invest heavily in new infrastructure. The outcome is clearly visible in the number of kilometers of motorways, which increased fourfold for Hungary, Poland, and Slovakia. The increase for Slovakia was steady, but delayed for Romania and Bulgaria (see Figure 5).

Secondly, increasing income per capita has had a number of effects. Car ownership increased dramatically in all six countries – from between 139 (Romania) and 336 per 1000 citizens (Czechia) in 2000 to between 261 (Romania) and 546 per 1000 citizens (Poland) in 2015 (see Figure 6). The growth continued for the following two years, except in Romania for which data is not available and in Bulgaria where a 10% decrease in car ownership between 2015 and 2017 could be observed. As a result of this growth, car ownership in Poland in 2017 was the fourth highest in the EU and much higher than even in the United States (UNECE, 2018).

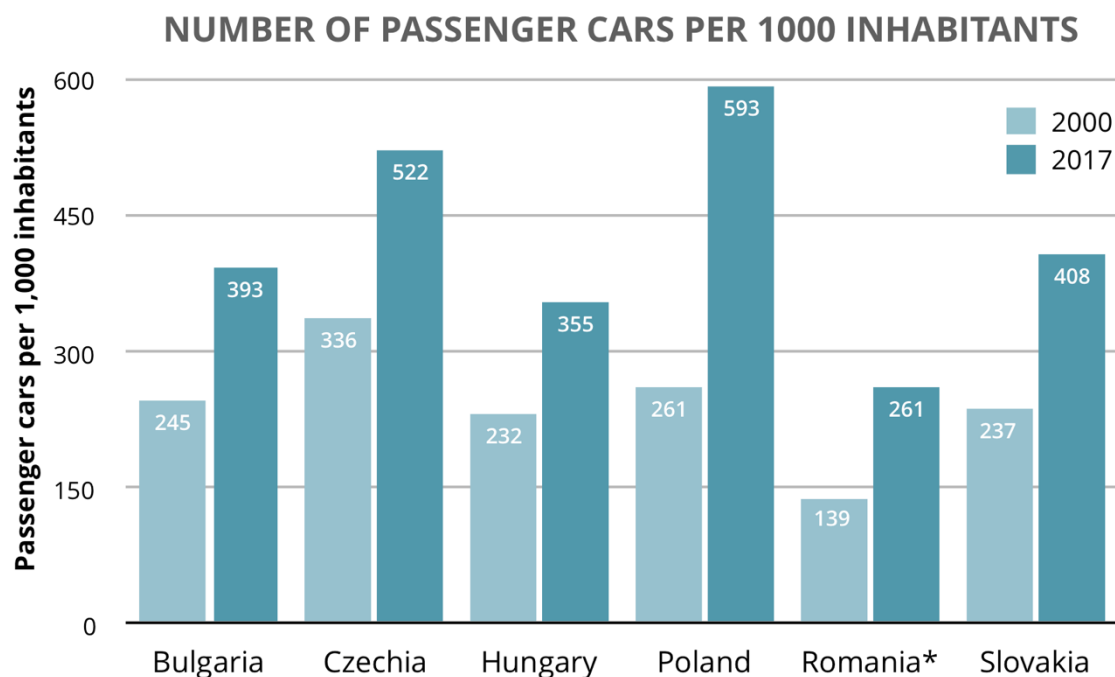


Figure 6: Car ownership per 1000 citizens. *For Romania, due to lacking availability, data for 2015 instead of 2017 (Eurostat, 2020f)

Increasing level of income has also resulted in a trend of moving from the cities to the suburbs, especially in Czechia, Hungary and Poland. It was especially clear in the latter, where there was a clear move from rural areas (decrease by 5.5%-points) and cities (-7%-points) to towns and suburbs. With the economic and social life often still focused in the neighboring city, this increased the amount of commuting, resulting in not only higher emissions but also worsening air pollution and traffic jams. The increase in individual transport has decreased demand from public transport, resulting in cancelled connections and increased fares, but this kind of reaction also exacerbates the original increase in individual transport (Pucher & Buehler, 2018).

The third major trend observed in most of the assessed countries was an improvement of emissions intensity of the passenger cars, mainly occurring in Poland and Romania. As a result, in 2015 the vehicles on the road emitted respectively 18% and 16% less gCO₂ per kilometer travelled than in 2000. With 144 gCO₂/km, Poland boasts the least polluting cars. Emissions intensity of vehicles in Slovakia increased by almost 50% in the same period.

Finally, cars got emptier in all of the selected countries. In 2000, there were between 1.9 and 2.6 passengers travelling in a single car. By 2015, this indicator decreased to between 1.5 and 1.9. The emptiest cars drive in Poland, whereas the fullest – with 2 passengers – are in Romania. When combined with only modest improvement in emissions per vehicle, the decreasing load factor resulted in an increase in emissions per person-kilometer travelled across all countries.

Motorcycles played only a limited role, both in terms of the share of emissions (around 0.92%) and person-kilometers (0.94%) travelled. The increase in activity for this mode of transport between 2000 and 2015 was higher than average for all modes of transport – 56% versus 24% increase – which could indicate a correlation with increasing income as many of the motorcycles are used for recreational purposes. The highest level of activity could be noticed in Czechia at around 171 kilometers travelled per person, and the lowest in neighboring

Slovakia at around 22 PKM per capita. In all countries, a modest decrease in emissions intensity was recorded.

3.1.2. Buses and motor coaches

At over 22% of the share in combined PKM travelled in the selected countries in 2000, buses were the second major contributor to mobility. By 2015, their role decreased both in terms of *absolute* PKM travelled (-15%) as well as *share* of all PKM travelled: in 2015 less than 15% of all PKM were travelled by bus, motor coach, or a trolleybus.

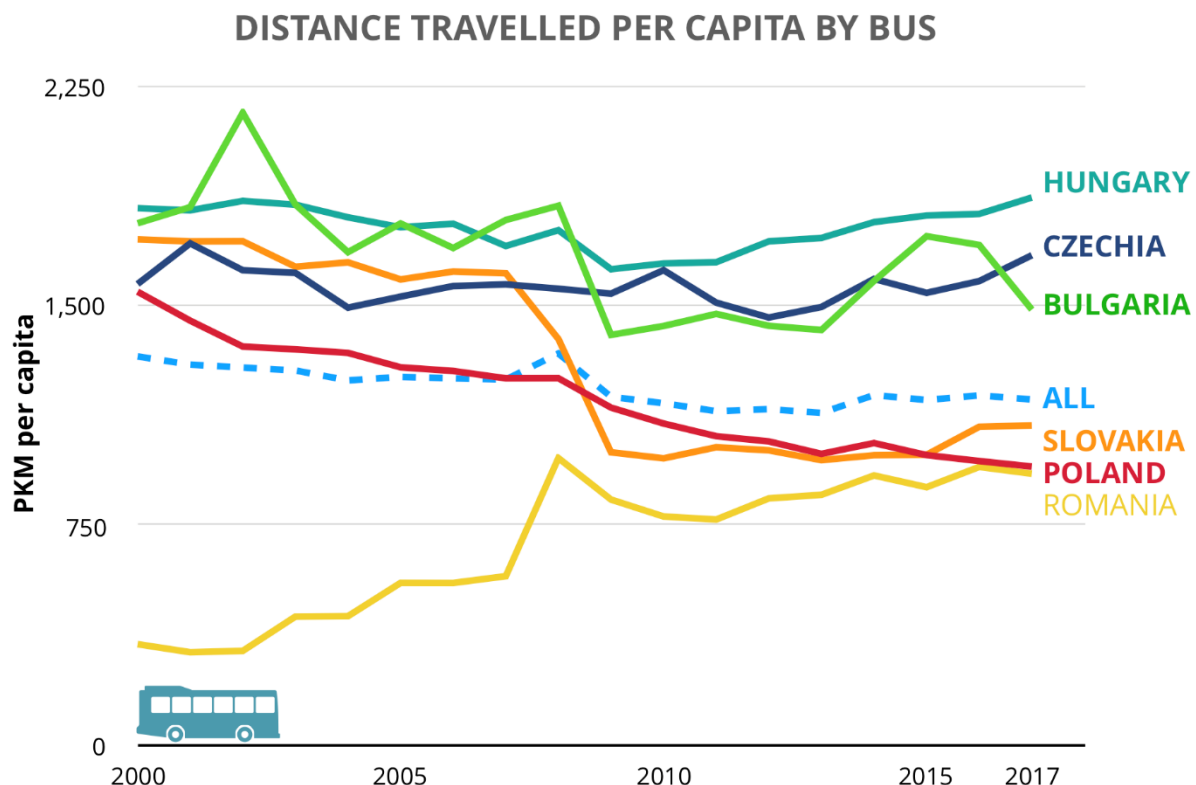


Figure 7: PKM per capita for buses and coaches.

This decrease would have been much larger had there not been a more than 2-fold increase in the number of PKM travelled by bus in Romania between 2004 and 2008. While some of this growth was followed by steady decline in the following years, it started to recover in 2012 and exceed the 2008 peak in 2018 (see Figure 7). It is possible this was related to the country's joining of the European Union in 2007 and abolishment of requirement to have a work permit in December 2013. This resulted in a significant increase in seasonal, work-related travels by plane or bus between Western European countries and the new EU member states. However, it is not clear why this growth did not affect neighboring Bulgaria. An explanation could be that this increase in travels in Bulgaria was conducted using passenger cars (see section 3.1.1.).

More recent data show a recovery in the number of kilometers travelled by buses and coaches per capita for Czechia (+8% between 2015 and 2017), and Hungary (+3% in the same period), and the continuation of growth for Romania (+5%). Also, the decreasing trend for Bulgaria continued with 14% fewer PKM per capita in 2017 than in 2015. The average distance travelled per trip between 2015 and 2018 – over 17 kilometers for Romanians and less than 5 kilometers for Poles – indicate the dominance of urban transport in the latter and international transport for the former.

A significant disparity can be observed in the number of passengers travelling per bus – from 9 passengers travelling per bus in Romania to almost 31 in Hungary. This difference can be explained by the higher share of international, occasional transport for Romania, where smaller buses can be more flexibly utilized, than for Hungary. Except for Czechia, the buses became emptier in all selected countries, which may also result from their decreasing size. The fastest decreases occurred in Slovakia (-3.6% annually), Poland (-2.5% annually), and Bulgaria (-2.1% annually).

Emissions per vehicle kilometre (VKM) from buses and coaches decreased in all countries on average faster than for passenger cars. The only exception was Hungary, where emissions intensity in 2015 remained at the same level as in 2000 and was the highest of all analysed countries. However, due to high load factor, per capita emissions were among the lowest – with 62gCO₂/km on par with Czechia. An improvement in emissions intensity in Poland (by 0.83% annually) was not enough to compensate for emptier buses (by 2.5% annually), thus resulting in 41% higher emissions per capita. It must be noted, however, that the accelerating electrification of Poland's bus fleet took place mostly after 2015, thus is not reflected in this data. Emissions intensity per capita was also very high for Romania, but, contrary to Poland, was 6% lower than in 2000.

3.1.3. Aviation

In the period between 2000 and 2015, emissions from aviation increased the fastest of all sectors of transport – by between 66% in Poland and 110% in Romania. The only outlier was Hungary, where emissions from aviation decreased by a quarter. However, this does not reflect a number of new connections and increased activity post 2015 from Budapest to Dubai, Barcelona, or London Luton.

In 2015, the last year that emissions numbers for all means of transport are available, aviation was responsible for 7% of transport emissions in all selected countries combined – ranging from 10% in Poland, between 6-7% in Bulgaria and Romania, to around 3% in Slovakia. In the latter case, however, the low share of emissions from aviation can be explained by the availability of nearby airports in other countries, especially in Vienna. Thus, neither the emissions, nor the PKM were accounted for in Slovakia.

The share of emissions from domestic aviation is much higher than the share of PKM travelled by plane, which results from the much higher emissions intensity of domestic flights. A similar trend is noticed for extra-EU aviation, but on a much smaller scale. The biggest share of PKM travelled were on intra-EU flights – corresponding with slightly smaller shares of emissions (see Figure 8).

EMISSIONS VERSUS DISTANCE IN AVIATION

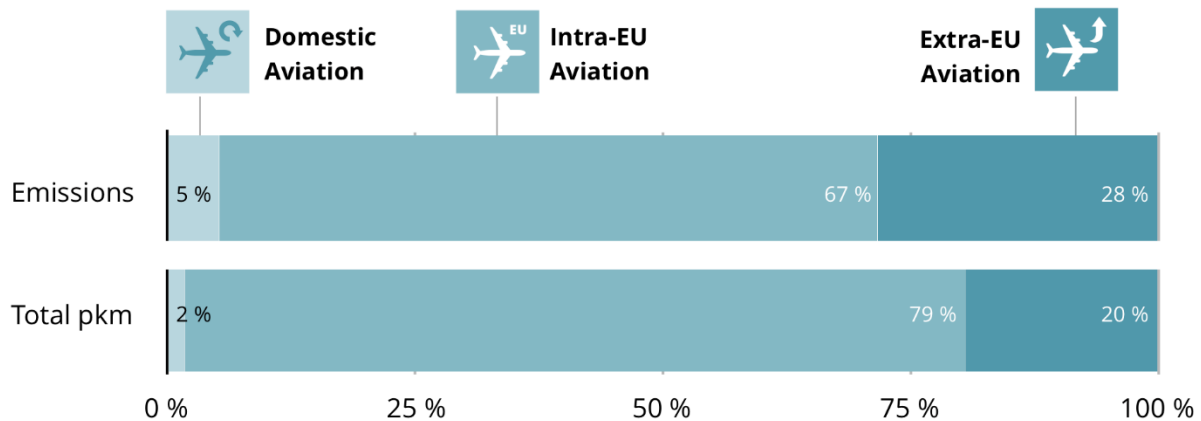


Figure 8: Share of PKM and emissions from domestic, intra-, and extra-EU aviation in total aviation in 2015 for all selected countries combined.

Contrary to the passenger cars and buses, activity numbers for aviation are available for a much more recent period.¹ The data shows an increase in PKM travelled between 2000 and 2019 for all types of aviation and all selected countries by 460%. Due to a decrease in the population in the selected countries by 5% in the same period of time, the increase in PKM per capita is even higher – by 488% (see Figure 9).

The increase took place in two waves: between 2005 and 2008, and again after 2014. While the first wave can be explained by membership in the European and employment migration, the second could have been related to increasing levels of income and a resulting leisure travel. As a result of both waves of increase combined, the number of kilometers travelled per person by plane increased from between 83 and 498 kilometers per person in 2000 (for Romania and Czechia, respectively) to between 284 and 1,543 for Slovakia and Czechia correspondingly in 2019.

This significant and accelerating increase in the activity levels for aviation, combined with a decrease in the utilization of trains (see section 3.1.4), resulted in more PKM travelled in all selected countries combined by air than by rail in 2008 and after 2011 (Figure 9). The discrepancy continued to grow, especially after 2015, when an increase in overall train utilization (22% between 2015 and 2019) was much slower than an increase in plane utilization (66% in the same period).

¹ At the time of writing activity levels up to Q2 2019 (Poland, Romania, and Hungary), and Q3 2019 (Bulgaria, Czechia, and Slovakia) were available. To account for the remaining quarters, we multiplied the activity levels from the respective quarters in 2019 by the rate of change for the quarters for which data is available between 2018 and 2019.

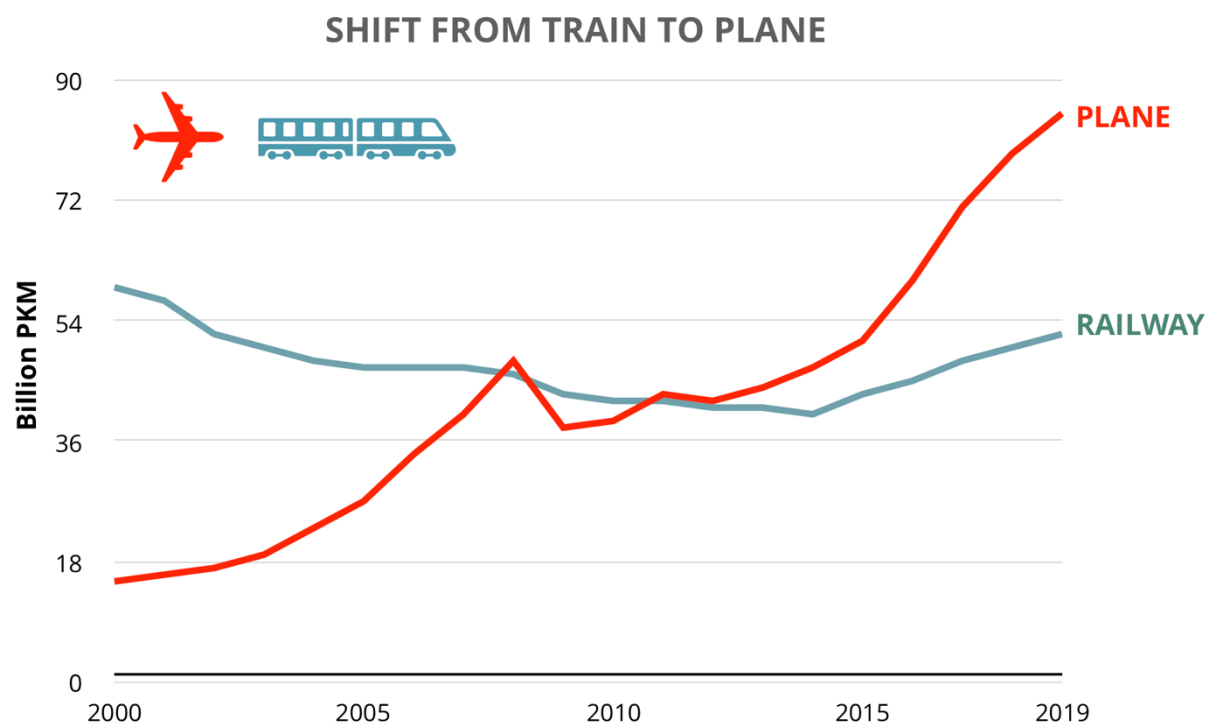


Figure 9: Combined number of PKM travelled by plane and train in all selected countries.

The subsequent subsections present a closer look at the factors driving emissions in domestic, intra-EU, and extra-EU aviation.

Domestic aviation

Out of the six countries analysed, the number of kilometres travelled by plane domestically increased in Poland, Bulgaria, and Romania, and decreased in Czechia. Especially strong was the increase for Romania: from 2.5 PKM per person to 23.6 PKM per person in 2019 – the highest of the four countries in which domestic flights played a role. The main reason for this increase were two connections: between Cluj and Bucharest which increased steadily in activity from 132k passengers in 2004, 370k in 2010 to 980k in 2018, and between Timisoara and Bucharest which increased from 130k in 2004 to 820k in 2018.

For Bulgaria, the only major domestic connection occurring every year is between Sofia and Varna with over 570k passengers in 2018 – an increase from less than 160k in 2007. For Czech Republic, the only country in which domestic aviation activity decreased, there were only two domestic connections: from Ostrava and Prague. The connection from Prague was cancelled in 2010 and from Ostrava decreased from 124k in 2010 to 29k in 2018.

Domestic flights for Hungary are not included because the only major domestic air connection was between Kosice and Bratislava, but no longer operates. In Poland, there were seven regular domestic connections starting from Warsaw and two not flying through the capital in 2018. Additional routes were operated between other cities, e.g. Bydgoszcz and Warsaw operated only three years, Poznań-Kraków and Szczecin-Kraków only in 2012 (see Table 3).

Country	Connection	Passengers in 2018	Distance in km by car	Connection by train
Bulgaria	Sofia - Varna	579.239	445 km	8 hours 5 min
Poland	Warsaw - Kraków	794.775	294 km	2 hours 16 min
Poland	Warsaw - Gdańsk	539.515	347 km	2 hours 46 min
Poland	Warsaw – Wrocław	532.038	355 km	3 hours 34 min

Poland	Warsaw – Szczecin	468.996	571 km	6 hours 17 min
Poland	Warsaw - Rzeszów	433.812	297 km	4 hours 6 min
Poland	Warsaw - Poznań	368.242	310 km	2 hours 53 min
Poland	Warsaw - Katowice	297.329	292 km	2 hours 18 min
Poland	Gdańsk – Kraków	194.998	586 km	5 hours 13 min
Poland	Gdańsk - Wrocław	94.781	481 km	5 hours 29 min
Romania	Bucharest – Cluj	981.073	450 km	8 hours 50 min
Romania	Bucharest – Timisoara	820.002	544 km	9 hours 26 min
Romania	Bucharest - Iasi	573.750	383 km	6 hours 34 min
Romania	Bucharest – Oradea	90.761	581 km	12 hours 12 min

Table 3: Domestic flight connections and alternatives by train. Connection for Czechia is excluded due to unclear destination (CFR Călători, 2019; Michelin, 2020; PKP Intercity, 2019).

In all analysed countries, except for Czechia, emissions intensity for domestic aviation per vehicle worsened. However, the limited number of flights led to significant changes between years. For example, in Czechia the overall improvement resulted from a decrease in emissions intensity by 32% between 2002 and 2003. In Bulgaria, the country with highest carbon intensity per vehicle for domestic aviation, emissions per kilometre travelled increased from 10.6 kg/km in 2007 to 20.8 in 2010, but decreased slightly in the following years. This variation could have been influenced by a switch to larger planes as traffic increased.

The higher emissions per vehicle were counterbalanced by an increase in the number of passengers per airplane. Whereas there were around 30 passengers per plane for domestic flights in 2000, this number has doubled or even in some cases tripled by 2019. An increased fleet of A320 and A321 planes in some of the countries caused the significant increase in number of seats to between 150 and 240. In Poland, Boeing 737s with the maximum seat capacity of 215 seats complemented much smaller Havilland-bombardiers. This resulted in passenger-kilometres emissions decreasing in all countries for domestic flights. However, with between 270 and 418 gCO₂/PKM, domestic flights were the highest of any kind of aviation, resulting mainly from short haul flights and thus higher emissions during the start and landing.

Intra-EU aviation

Between 2000 and 2019, there has been combined 4.7-fold increase in the PKM travelled to the other EU member states from the selected countries (see Figure 10). A clear correlation can be identified between the level of activity and the membership in the European Union, especially the removal of barriers for employment in the countries of the “old” EU.

The activity levels for intra-EU flights for Poland has almost tripled between 2004 and 2006 and continued increasing steadily until 2019 but at a slower pace. The number of flights between Poland and Ireland increased from 607 in 2004 to 1,593 in 2005 and peaked in 2007 at 9,067, then decreased to between 4,000 and 5,000 in the years of the economic crisis. The number of flights to the UK increased 5-fold – from around 7,000 in 2004 to the peak number of almost 34,000 in 2008 and varied between 25-34,000 until 2014, with subsequent increase to between 39-46,000 between 2015-2018. Similar trends can be observed for Slovakia and Czechia, where a multi-fold increase took place shortly after these countries joined the EU. For Hungary, this increase has been somewhat less volatile.

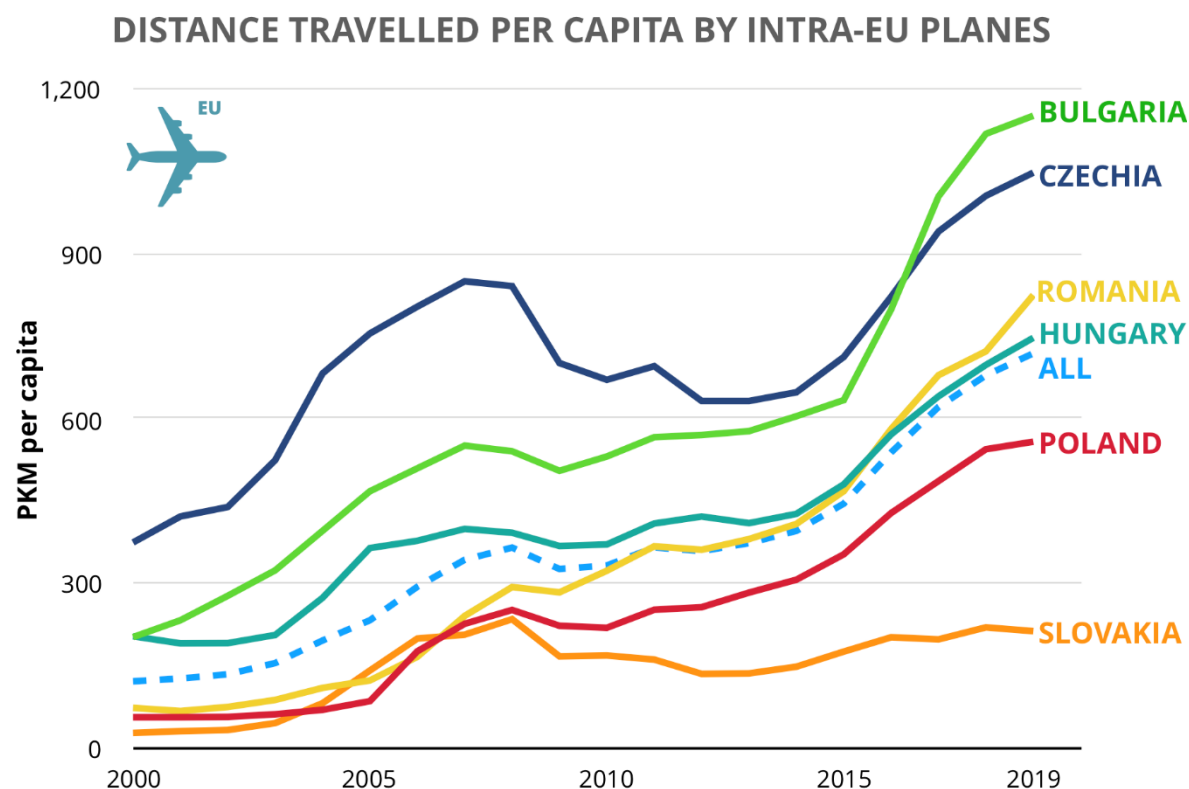


Figure 10: PKM per capita for intra-EU aviation.

For Romania and Bulgaria, a much smaller increase in the number of flights to the UK between 2004 and 2008 can be observed: 3-fold for the former and 1.5-fold for the latter. However, both countries experienced another significant increase (from a much higher basis) between 2013 and 2017: 3-fold for Romania and by 68% for Bulgaria. This could be related to the expiration of work restrictions on the citizens of these countries for the UK on 1 January 2014.

Unlike domestic aviation, a decrease in emissions per VKM can be observed in all countries. This can be explained by the fact that larger machines had already been used in 2000 and were later replaced by more efficient ones. This has been accompanied by an increase in passengers per vehicle, which in Hungary and Romania exceed 140 passengers, and in Bulgaria exceeded 150. This deepened the decrease in emissions per passenger-kilometre travelled for intra-EU aviation.

Extra-EU Aviation

Increasing levels of income had an impact on the number of people boarding extra-EU flights in the selected countries. Their numbers kept increasing continuously until 2007 and in some cases doubled in the following year, to decrease significantly in 2009 – supposedly due to the economic crisis. After some stabilization in the first half of the 2010s, the increase accelerated around 2016 (see Figure 11).

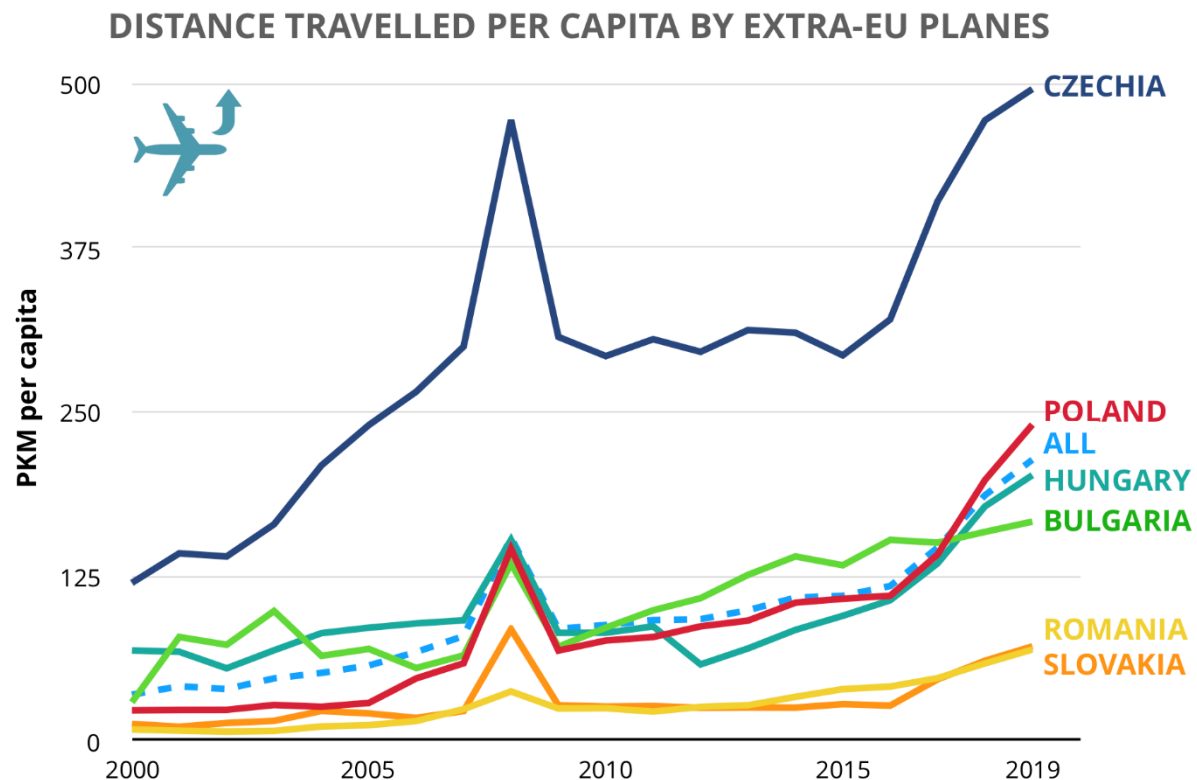


Figure 11: PKM per capita for extra-EU aviation.

A similar number of passengers for extra-EU flights boarded planes in Poland and Czechia, despite almost four-time bigger population in the former. This could be explained by the utilization of the Czech airports by citizens of the neighbouring countries, especially Slovakia. The destinations offered differed, with Polish airports serving more distant destinations such as the USA and Canada. The major exception was Ukraine, which in 2018 was responsible for 19.4% of total extra-EU flights starting in Poland.

For Bulgaria and Czechia, the largest number of people travelled to Russia – around 50% of all extra-EU flights for the former and a quarter for the latter. The most preferred destination for those travelling from Slovakia and Hungary was Turkey – with Russia a close second for the latter country. Next to Russia and Turkey, Israel was a close third destination with every 7th

passenger boarding a plane to a non-EU country choosing this destination (see **Error! Reference source not found.** and Figure 12).

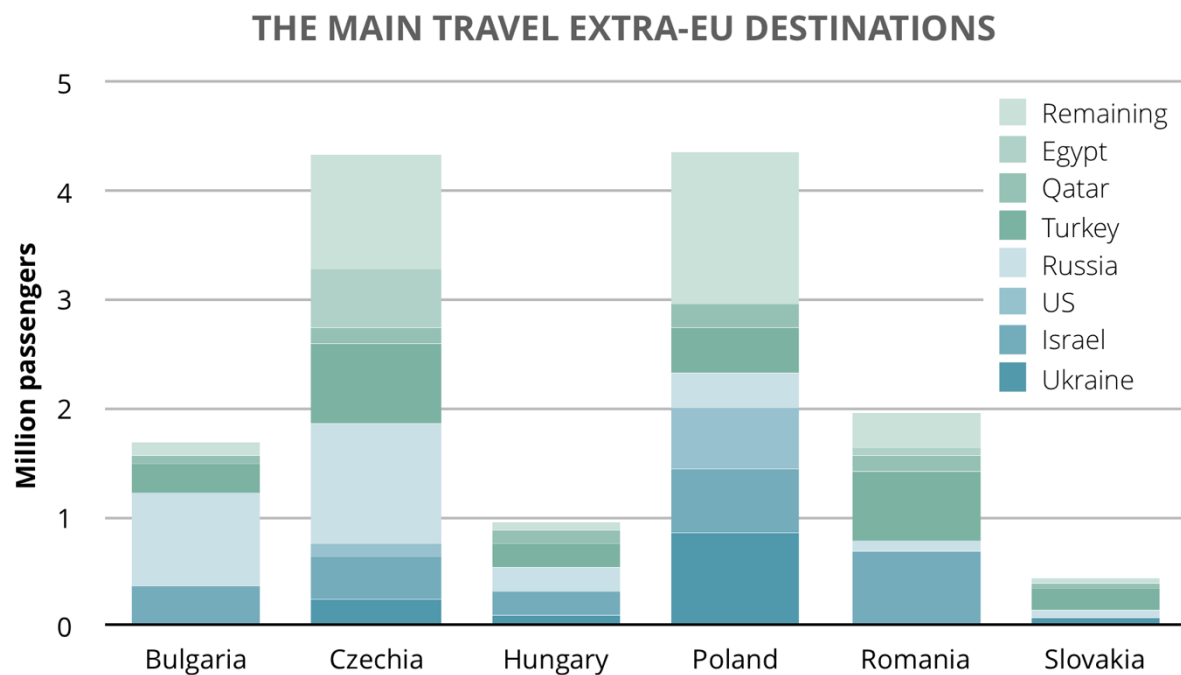


Figure 12: Main extra-EU destinations for selected countries (in million travelers).

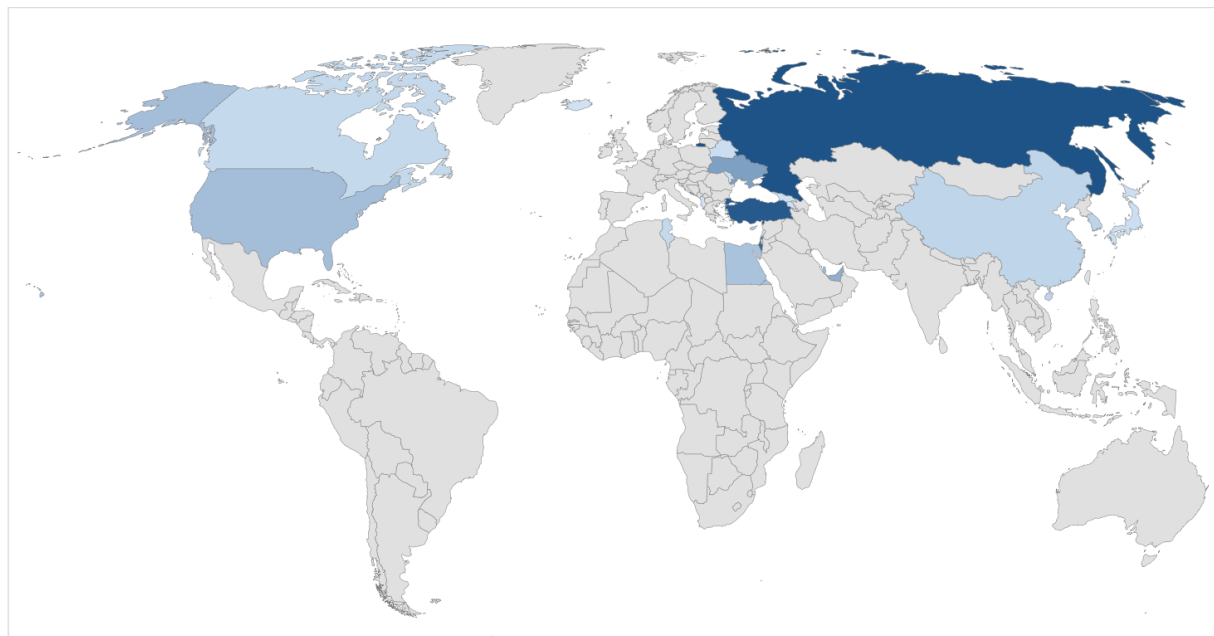


Figure 13: Main extra-EU destinations for the selected countries (Map).

It must be stressed that in all cases, but especially in the case of extra-EU travel, the destination does not only serve nationals of the respective countries, but also travellers from neighbouring countries. As a result, they can only vaguely represent the travel preferences of the citizens of the selected countries.

As pointed out earlier, the emissions intensity per VKM are much higher for extra-EU flights, than for intra-EU flights, which can be caused by the utilization of bigger planes and higher weight of the fuel transported for longer distances. However, the rate of improvement between 2000 and 2015 was also much higher, thus resulting in a decrease in the difference in emissions intensity. The emissions intensity improved in all countries by between 2% and 4.3% annually, except for Czechia, where it worsened by 0.3% annually.

The increase in the load factor for extra-EU flights – the highest at 3.8% annually in Romania – was slower than for the intra-EU flights (fastest increase by 5.6% in Slovakia). As a result, there were on average fewer passengers per extra-EU flight than for intra-EU for Bulgaria and Romania, and only slightly more for other countries. This could be counterintuitive, keeping in mind the utilization of bigger planes for extra-EU flights. The additional space occupied by first class could explain higher emissions despite not many more passengers.

3.1.4. Rail, Metro and Trams

Rail is the least emissions intensive mode of transport. Whereas in 2015 rail contributed less than 1% of the transport emissions, it provided over 6% of the passenger kilometers travelled. A common trend in all countries is a decreasing role of railways until the beginning of the 2010s. As a result, 2008 was the first year more people travelled by plane than by train in all six countries combined. This was already the case for Bulgaria in 2002 and Czechia in 2003, with other countries following. The only exception is Slovakia, where throughout the whole period more PKM were travelled by train than by plane. However, this can largely be explained by Slovaks using airports in other countries.

Between 2009 and 2017, the number of PKM travelled by train bottomed out and a steady increase began for all countries (see Figure 14). Between 2015 and 2019, the combined number of PKM for all countries increased by almost 22%, with the fastest increases in Czechia (+34%) and Poland (+28%). In Romania and Slovakia, around 20% more people travelled by train in 2019 than in 2015. Despite these increases, Slovakia and Czechia were the only two countries in which more people travelled by train in 2019 than in 2000. However, should the post-2015 increase continue, Poland would reach its 2000 level by around 2021. However, this

growth is much slower than the increase in PKM in aviation. This indicates the continually increasing gap between aviation and railways in terms of the activity levels.

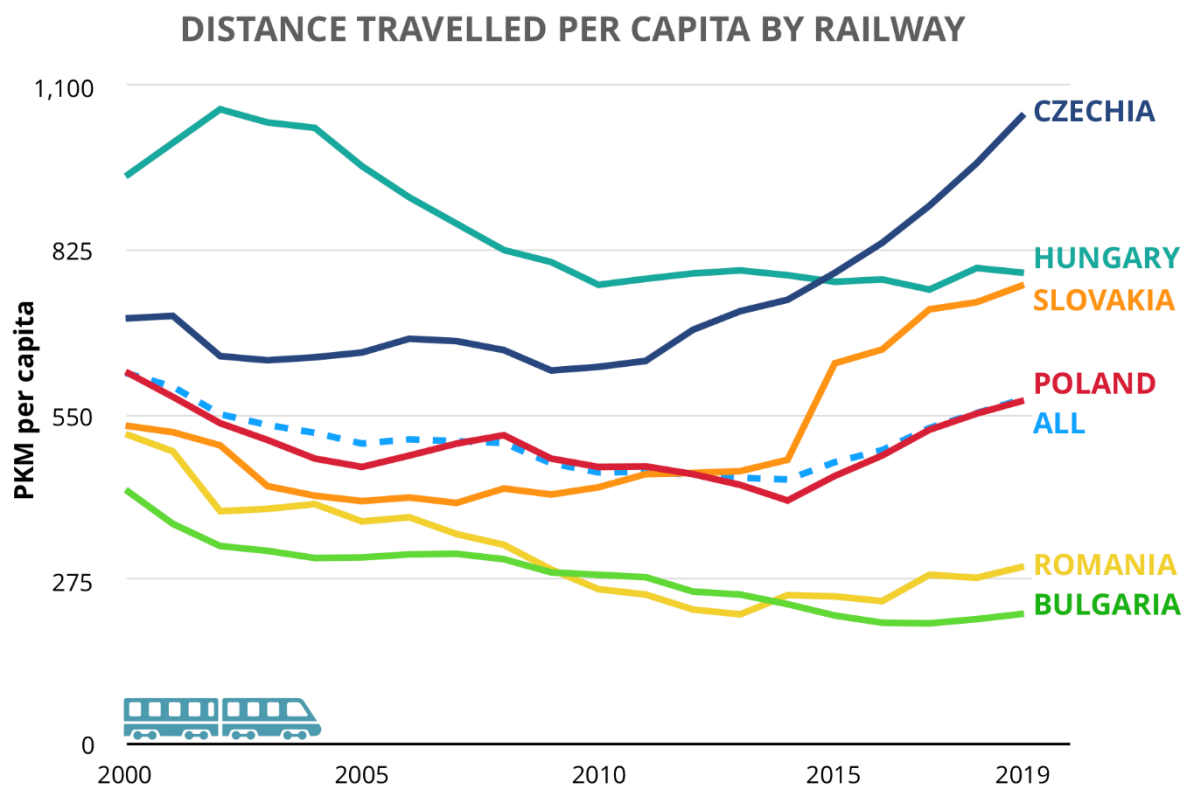


Figure 14: PKM per capita for railway.

Interestingly, this increase took place despite a decrease or only modest increase in the overall length of the railway lines between 2000 and 2017 (see Figure 15). Poland, the country ranking 3rd after Germany and France in the EU and 14th worldwide in terms of length of the railway lines, experienced a decrease between 2000 and 2003 and between 2012 and 2014 following the decommissioning of railway lines.

At the same time, some decommissioned lines were compensated by new ones and some of the existing lines were modernized allowing for increasing the maximum speed, e.g. in Poland, the share of railways tracks with the maximum speed exceeding 120 km/h increased from 20% in 2010 to almost 38%. The latter includes 11% of tracks where the trains can travel faster than 160 km/h (PKP Polskie Linie Kolejowe S.A., 2010, 2018). Some of these tracks are operated by the Pendolino trainset at a speed of up to 200 km on four lines radiating from Warsaw, thus significantly reducing travel times to the major Polish cities. Hungary experienced closure of old lines and opening of new connections, whereas in the other countries of the region, length of the lines remained constant.

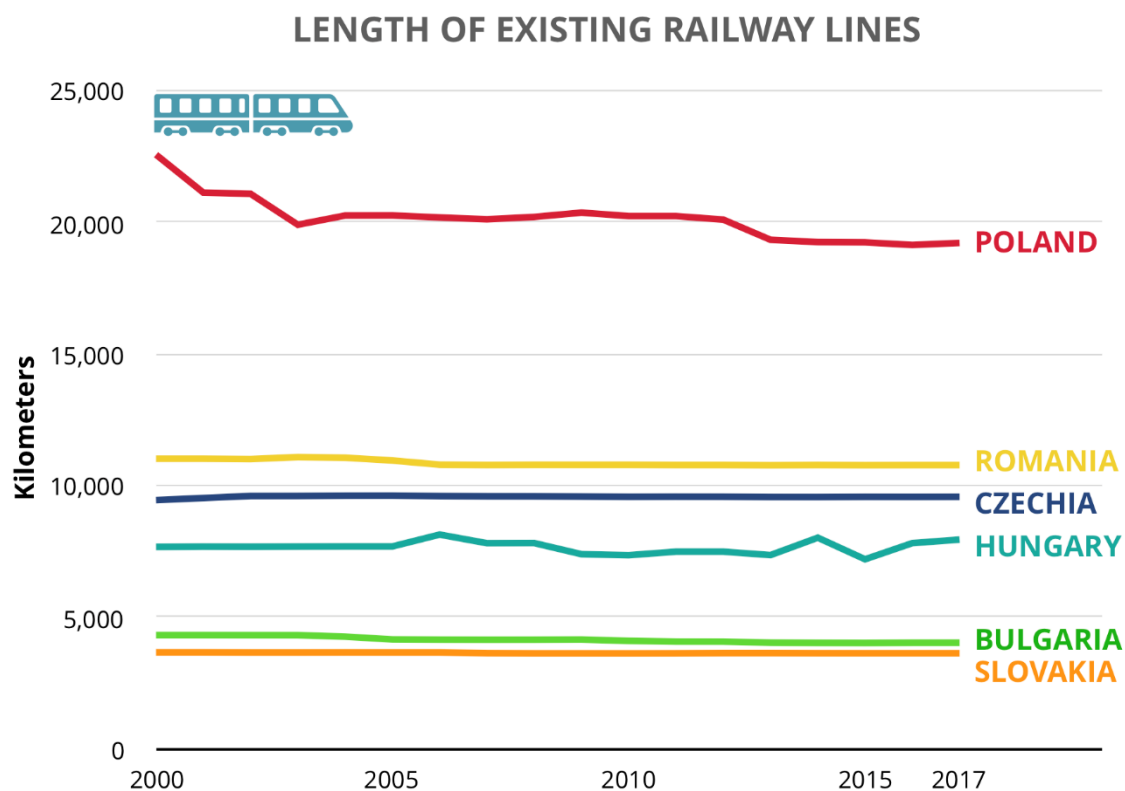


Figure 15: Length of existing railway lines in kilometers (Eurostat, 2020g).

Railways experienced the strongest improvement in emissions intensity. For all selected countries except for Slovakia, where no emissions from the railways sector are indicated, average emissions per vehicle kilometer decreased between 2000 and 2015: by 23% in Czechia and 66% in Poland, with Romania, Bulgaria and Hungary between these values. The major explanation for this improvement is steady electrification of connections (Figure 16), more efficient trains, and increasing utilization of smaller and electric railcars.

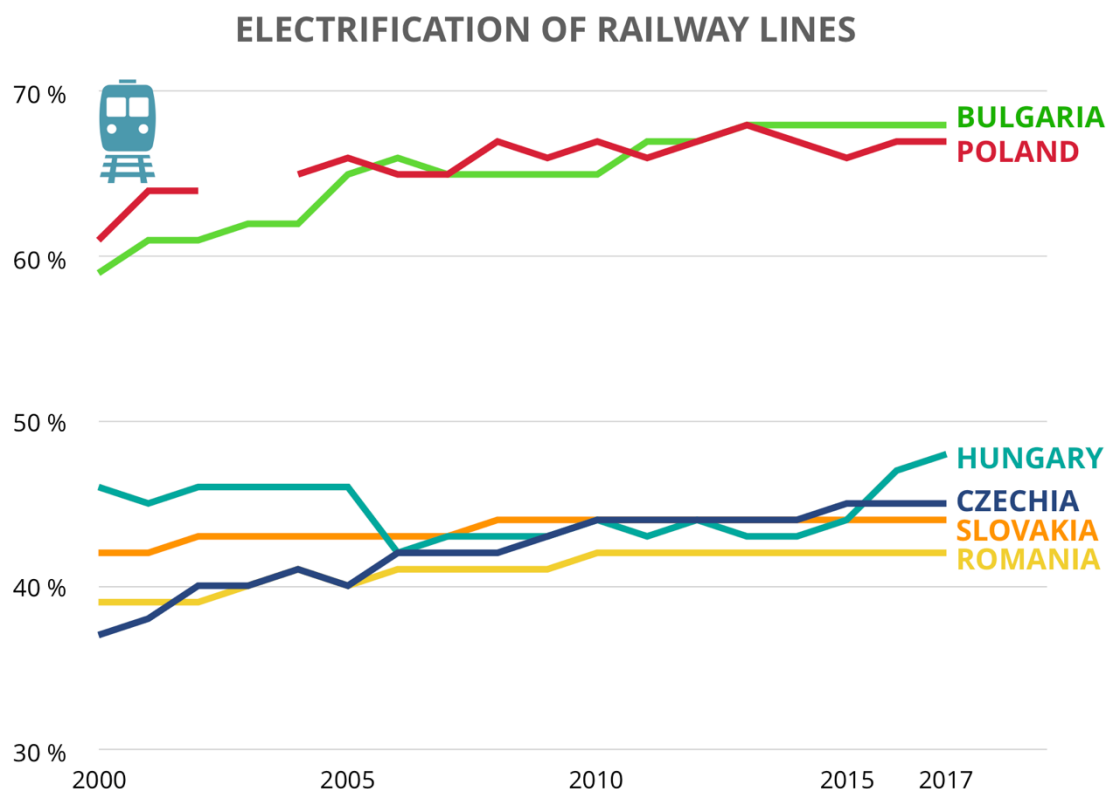


Figure 16: Percentage of electrified railway lines (data for 2003 are not available for Poland) (Eurostat, 2020h).

The utilization of railcars with up to 100 seats had an impact on the number of passengers per train. The load factor decreased in all countries except for Slovakia, and amounted to between 94 passengers per vehicle in Poland and 120 in Slovakia. This decrease was too small to counterbalance an improvement in emissions intensity per vehicle, resulting in lower emissions per capita for all selected countries.

On average, 1 out of 33 kilometers travelled in the selected countries was travelled by metro, tram, or light urban train. Being fully electrified, these means of transport did not contribute to the direct emissions from the transport sector, while at the same time increased the number of mobility options.

Czechia registered the highest share of trips by these modes of transport – between 7-9% of all PKM travelled. This largely results from almost 12% of the country's population living in Prague, where the utilization of these means of transport is common. Slovakia is the only of the selected countries without a subway line, making trams the only contribution to these modes of transport and resulting in the lowest value for the selected countries.

Between 2000 and 2017, the combined activity levels in passenger kilometers increased slowly but steadily (Figure 17). The major impact on the change resulted from the opening of new metro lines. The major change occurred for Bulgaria, where development and improvement of new tram connections and the opening of the second line of metro in August 2012 in Sofia correlated with a 20% increase in PKM travelled by electrified metropolitan public transport.

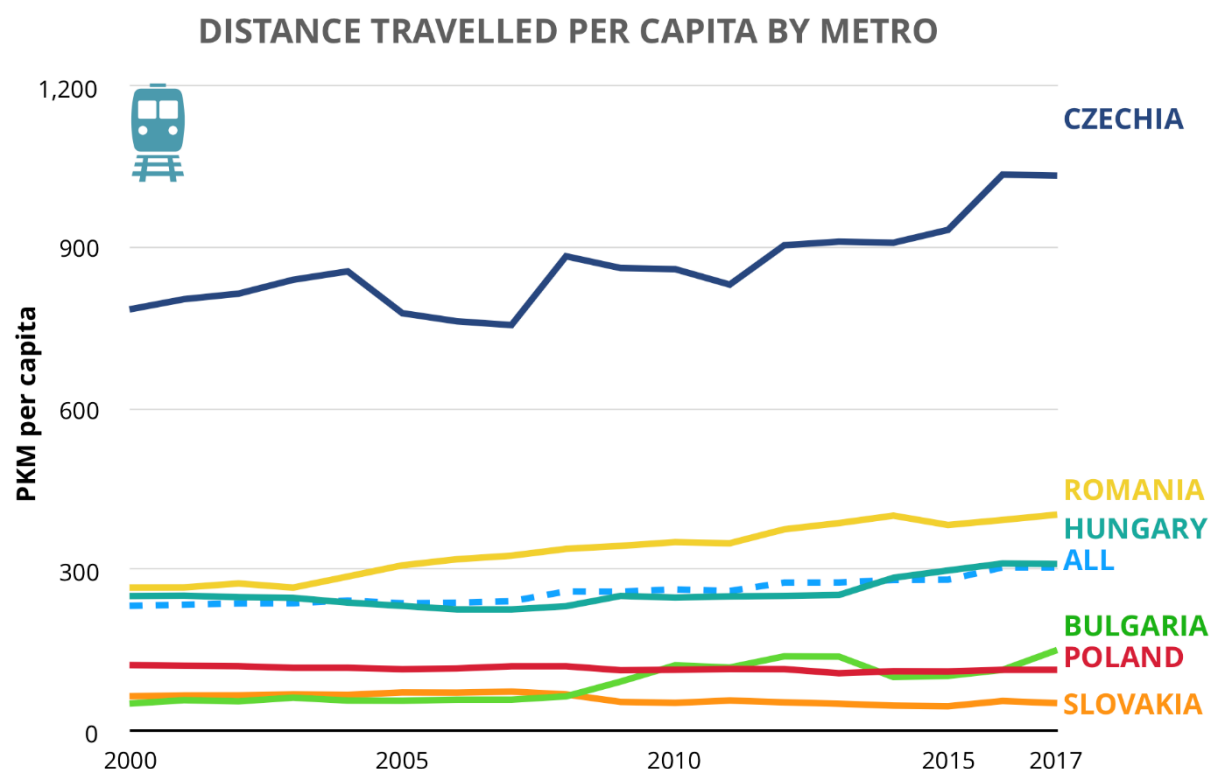


Figure 17: PKM per capita for metro.

Almost all countries are planning to expand their relatively underdeveloped subway network. In late 2019, Warsaw selected a company that will conduct feasibility studies for the third line of metro (Urbanowicz, 2019). In June 2019, construction work on the fourth metro line began in Prague and are due to last 8 years (Zasiadko, 2019). In early 2020, the third line of metro will open in Sofia (The Sofia Globe, 2019). Bucharest is planning to complement the already existing five metro lines with another one already under construction and a further one in the preliminary planning stages (Dimitrova, 2019). Extensions of existing metro lines are planned in Budapest (Kaszás, 2018). While these extensions will have a positive impact on the number of passengers using public transport, it must also be considered whether or not development of trams and other zero emissions modes of transport could have a more beneficial impact on access to low-carbon mobility.

3.2. RBP Scenario until 2030

The continuation of existing trends would result in combined passenger transport emissions for the selected countries increasing by 65.8% between 2015 and 2030. The highest increases in Bulgaria and Romania would be counterbalanced by a much slower increase in Poland and Hungary, with increases in Czechia and Slovakia in-between (see Figure 18).

EMISSIONS PROJECTIONS FOR PASSENGER TRANSPORT BASED ON BAU SCENARIO

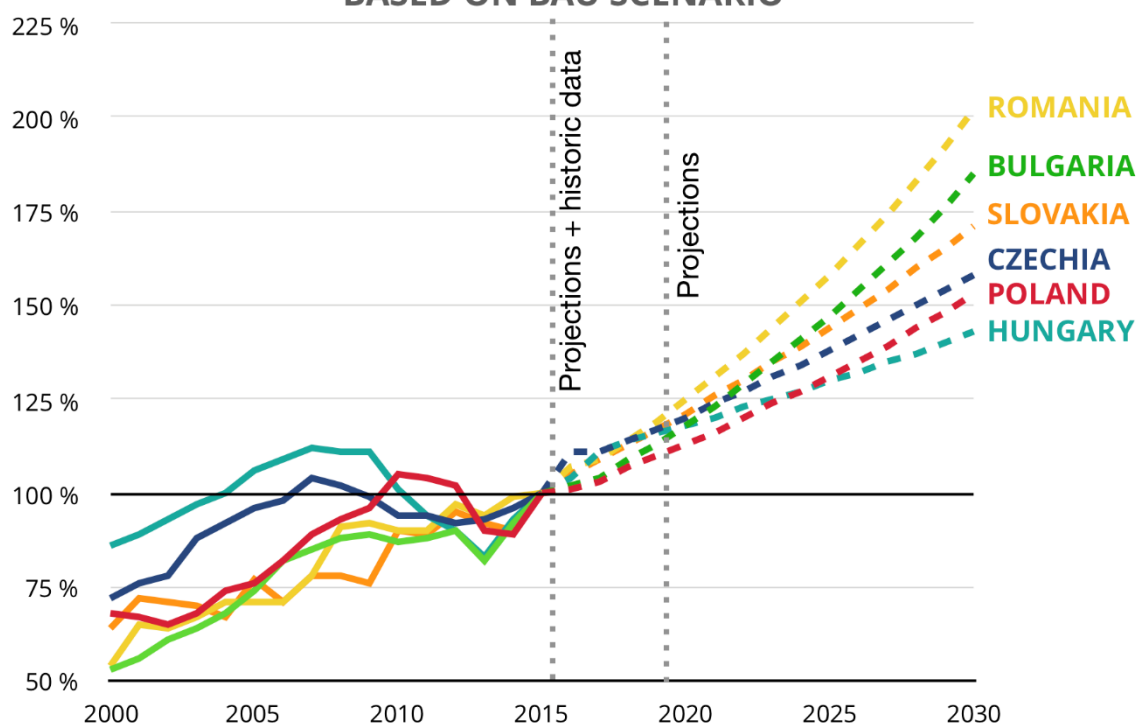


Figure 18: Change in emissions for passenger transport compared to 2000's level for BAU Scenario.

The number of total PKM travelled would increase by 65.5%. This indicates a minimal worsening in emissions intensity per PKM – from 93.8 gCO₂ in 2015 to 94.0 gCO₂ in 2030 on average for the six countries. This constancy is in fact a result of two countervailing factors: an improvement in emissions intensity for almost all means of transport for almost all countries (28 out of 33 indicators) and increasing activity for emissions intensive modes of transport, especially aviation. According to BAU Scenario, in 2030 more than 22% of all PKM travelled would have been travelled by plane, an increase from 7.1% in 2015 and 10.3% in 2019. This would be the result of a 2.5-fold increase in domestic flights, 4-fold increase in intra-EU flights, and almost 5-fold increase in extra-EU flights between 2015 and 2030. The distance travelled per person by an intra-EU flight would be the highest in Romania at 3,367 km, followed closely by Bulgaria at 3,041 kilometers, or an equivalent of less than two return flights per year.

A slight decrease in kilometers travelled by train combined with a significant increase of total kilometers travelled per person would result in the share of person-kilometers travelled by this mode of transport decreasing to 4.2% – a fifth of the distance travelled by plane. While trips by car would remain the most popular and their absolute number would increase by around 49%, their share would decrease from around 68% of all PKM travelled in 2015 to 61% in 2030.

The application of RBPs to the most recent available historic data would allow for a change in the emissions trend. Instead of increasing by 66%, emissions from passenger transport would stabilize at 2015 levels, or decrease by 3% in comparison to 2019 – the last years for which historic data for some modes of transport are available (see Figure 19).

EMISSIONS PROJECTIONS FOR PASSENGER TRANSPORT BASED ON RBP SCENARIO

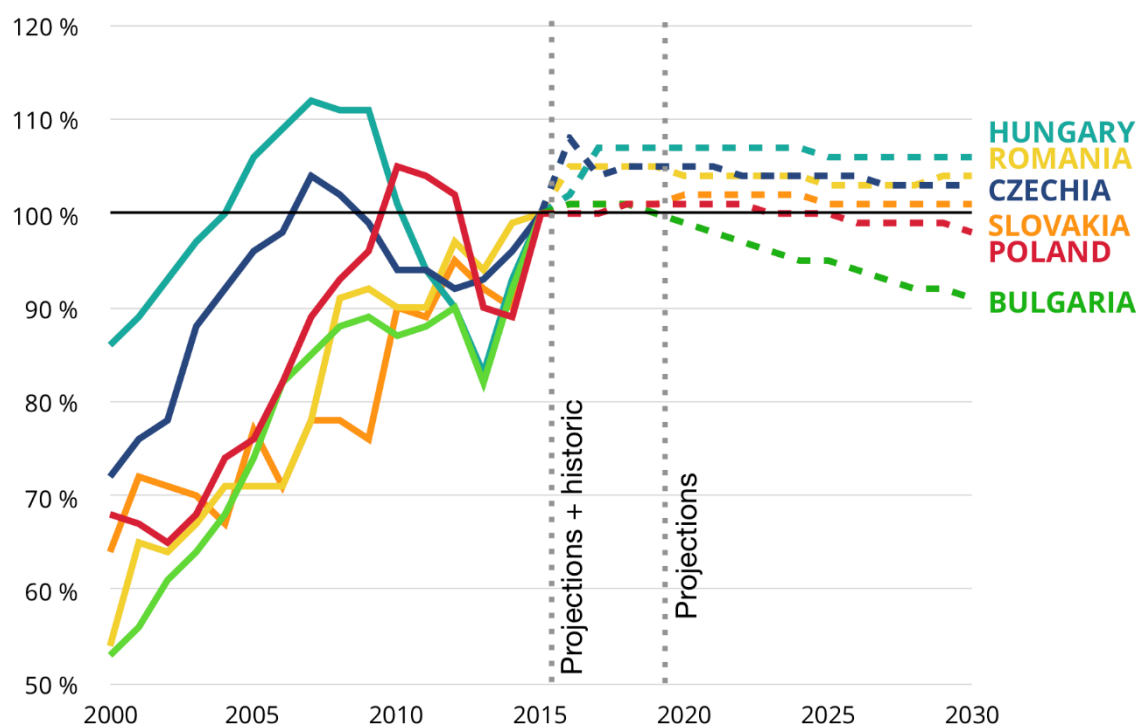


Figure 19: Change in emissions for passenger transport compared to 2000's level for RBP Scenario.

Despite the stabilization of emissions, the RBP Scenario would still allow for an increase in the number of PKM travelled by 45% in comparison to 2015, or 12% below the BAU Scenario in 2030. The biggest impact from the introduction of the RBP would be for Bulgaria and Romania, where instead of doubling, emissions from passenger transport would decrease or increase only slightly. Next to Bulgaria, Poland would be the only of the selected countries for which emissions would decrease instead of increasing (See Figure 20).

This is mostly due to the lower increase in activity levels for passenger cars in both countries (0.7% annual increase instead of 5.5% in Bulgaria, 4.7% in Romania, and 2.8% in Poland). For Bulgaria an important role was also played by a much faster improvement in emissions intensity of passenger cars – by 1.3% annually instead of 0.4%.

As mentioned earlier, the adoption of the RBP would result in a modest decrease of PKM travelled and a much larger decrease in emissions. This would result in emissions intensity per PKM decreasing to 65 gCO₂, or by 31% in comparison to BAU Scenario. The major decrease, with emissions intensity almost halved, would take place in Slovakia (-78 gCO₂/TKM), driven by an improvement of emissions intensity of passenger vehicles. The neighboring Czechia is the second in terms of improved emissions intensity (-53 gCO₂/TKM). The lowest improvement takes place in Romania and Poland (-21 and 20 gCO₂/TKM, respectively).

CHANGE IN EMISSIONS IN 2030 IN BAU AND RBP SCENARIOS

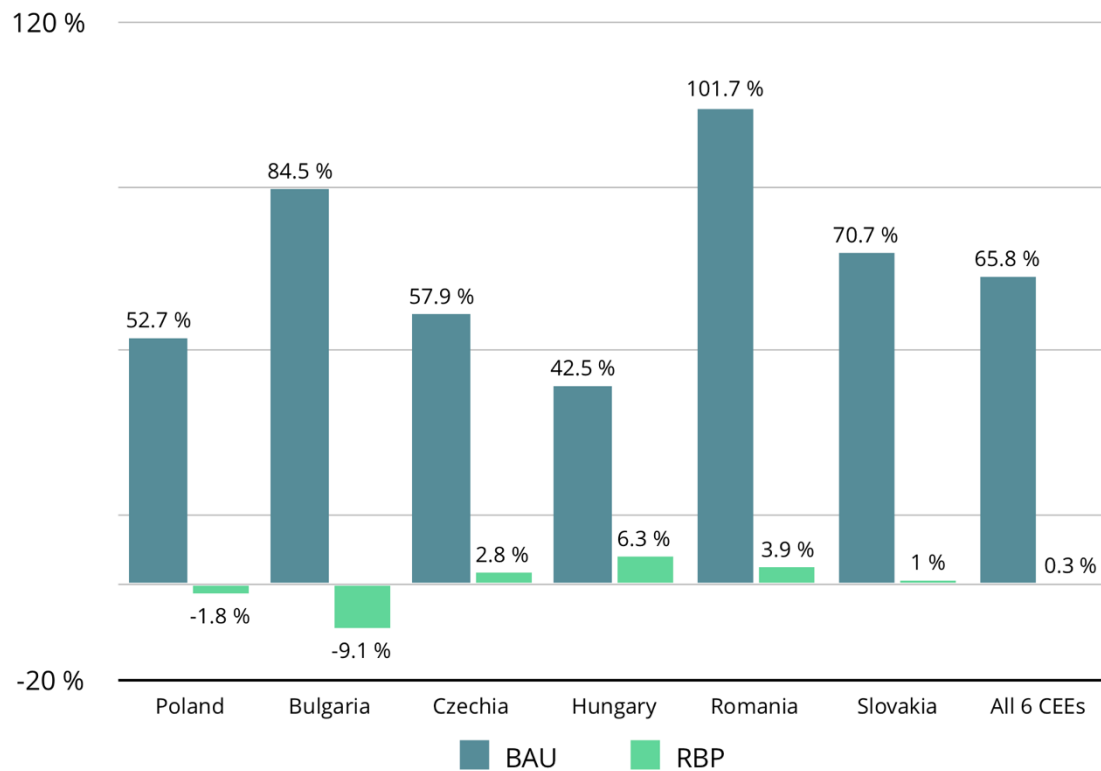


Figure 20: Impact on emissions from passenger transport in 2030 in BAU and RBP Scenarios.

EMISSIONS INTENSITY PER PKM

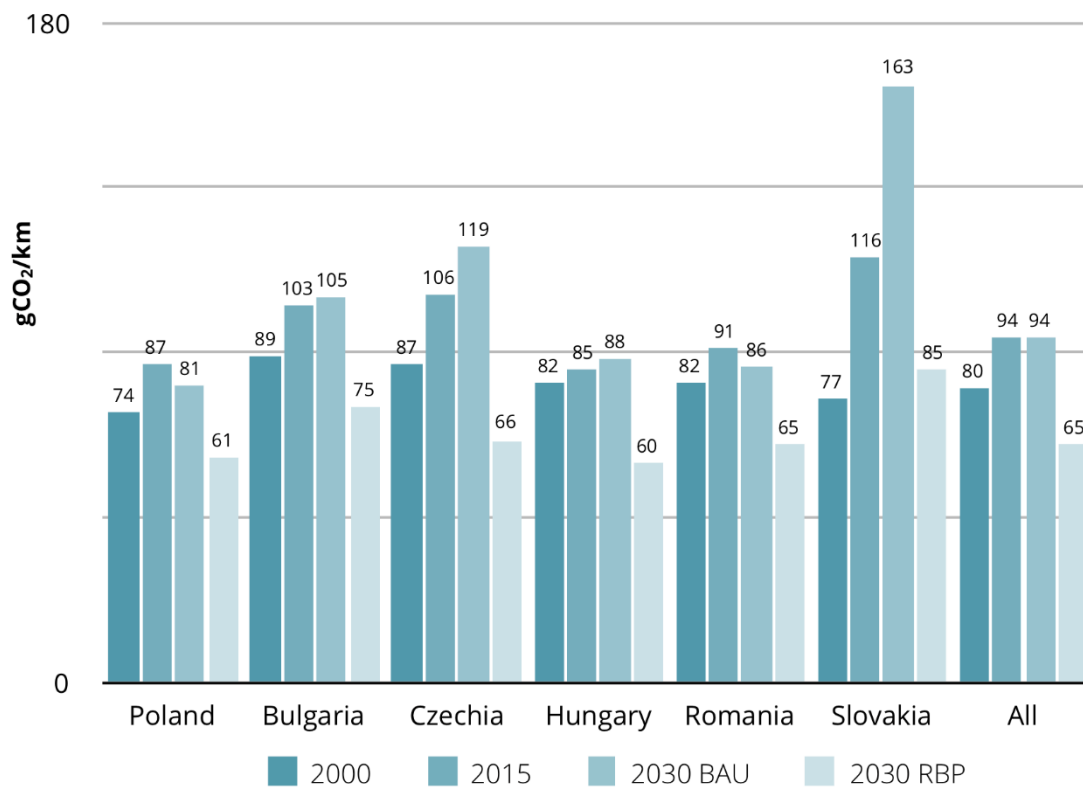


Figure 21: Emissions intensity per PKM travelled.

The difference between BAU and RBP depends both on the number of RBPs “imported” from other countries and on their comparative impact. With emissions intensity for subway the same for all countries, most of the remaining 23 best practices came from Czechia (8 RBPs). Slovakia and Romania were the source of 4 RBPs, Bulgaria 3 RBPs, and Hungary and Poland 1 RBP each (see Figure 22).









SUB-SECTORS	PASSENGER TRANSPORT							
								
CATEGORIES	2.1 % Czechia	6.6 % Bulgaria	-6.4 % Czechia	5.6 % Czechia	5.8 % Hungary	1.0 % Czechia	0.7 % Romania	Annual change in the activity level
	-8.1 % Bulgaria	0.0 % All	-2.6 % Czechia	-2.6 % Czechia	-4.3 % Romania	-3.8 % Poland	-1.3 % Poland	Annual change in emissions intensity per vehicle
	2.1 % Slovakia	0.4 % Slovakia	7.9 % Romania	5.6 % Slovakia	3.8 % Romania	0.0 % Bulgaria	-0.2 % Slovakia	Annual change in load factor per vehicle
INDICATORS	Rail	Metro	Aviation Domestic	Aviation Intra-EU	Aviation Extra-EU	2-Wheelers	Cars	Buses

Figure 22: Best practice values for passenger transport.

The importance of the RBPs differs significantly, with those referring to passenger cars the most impactful and resulting in emissions 33% lower than a BAU scenario in 2030 (see Figure 23). Application of only the first of these indicators – emissions intensity – at the RBP level of -1.3% annually in all countries would result in emissions reduction by 9.4 MtCO₂ or 8.2% of BAU emissions without any negative impact on the number of PKM travelled. When accompanied by a slower decrease in load factor of passenger vehicles from between 1.8% and 0.7% to 0.2% (Slovakia) per year, an emissions reduction of 19% or 22.3 MtCO₂ for all six countries combined would result – still without any decrease in the levels of activity.

Slowing down the increase in activity levels for passenger vehicles to 0.7% (registered in Czechia), instead of between 0.9% and 6.0%, is the most important contributor to emissions reduction out of all 32 RBPs. With all other elements remaining constant, changing only this variable would reduce combined emissions in the selected six countries by almost 20 MtCO₂ or 17% of the BAU emissions in 2030. Contrary to the other measures, it would also have an impact on the levels of activity, which would decrease by almost 16%.

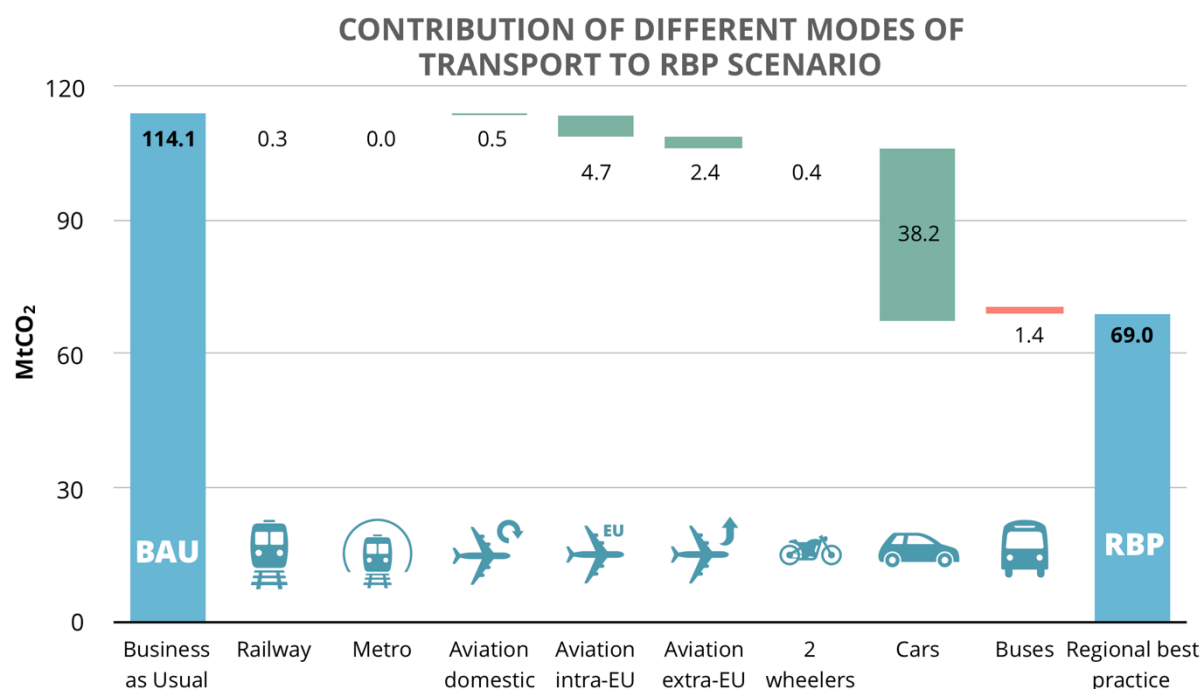


Figure 23: Contribution to emissions reduction from passenger transport resulting from the implementation of Regional Best Practices. Combined emissions in all six countries.

Adaptation of best practices in the aviation sector would reduce emissions by 0.5% for domestic flights, 4.1% for intra-EU flights, and 2.1% for extra-EU flights in comparison to BAU Scenario. The relatively small contribution of best practices in domestic aviation results from its relatively small role. However, the impact on this mode of transport is significant (overall decrease in emissions by 93% compared to BAU Scenario) and results mainly from the application of decreasing level of activity registered in Czechia (-6.4% annually) instead of growth in the remaining three countries where domestic aviation does play a role: Poland (4.0%), Bulgaria, and Romania (both above 12% annual increase).

The dynamics for intra and extra-EU aviation was positive for all countries – between 5.6% (Czechia) and 13.7% (Romania) annual increase for the former and between 5.8% (Hungary) and 13.1% (Poland) for the latter. Thus, selecting even the lowest increase of activity for both modes of transport would result in a significant increase in emissions in comparison to 2015. However, the mix of increasing load factor and improvement of emissions intensity would allow reducing emissions by 59% for intra-EU and 64% for extra-EU in comparison to BAU for the respective modes of transport. While the number of passenger kilometers travelled would be 43% and 40% lower, respectively, the overall impact on mobility would be relatively small – only 1.4% of combined number of PKM travelled in all countries.

As mentioned earlier, RBP for metro, railways and buses was the maximum increase in activity to allow for higher mobility at much lower emissions. Despite increasing activity for railways (by 2.1% annually registered in Czechia and expanded to all other countries), overall emissions from this mode of transport would decrease by 58% due to much faster decrease in emissions per vehicle, mostly resulting from electrification of railways tracks. At the same time, in 2030 there would be 25% more PKM travelled by train and 86% more travelled by subway or tram in comparison to BAU Scenario – without any increase in direct emissions resulting from the latter means of transport. For buses, the combination of higher load factor and improved

emissions intensity (by 2.2% annually in comparison to 1.3% for passenger cars) would allow for almost doubling the number of PKM while increasing emissions by 12%.

While application of the RBP would avoid a significant increase in emissions, stabilization of emissions from passenger transport is not enough to fulfill EU emissions reduction requirement from the Effort Sharing Regulation, which requires emissions reduction for the non-EU ETS sector by between 0 and 14%. It is also far away from what is needed to be compatible with the Paris Agreement (see Section 5). However, they constitute a starting point that can be achieved – and was achieved in some countries – with the existing technology. The subsequent section describes some mega trends that may significantly influence the discussed trends.

3.3. What will influence future emissions from passenger transport?

Expectations that past trends will continue into the future are somewhat naïve and simplistic. The major drivers of increasing mobility – and thus emissions – in the selected countries were due to one-time events. Joining the EU and the resulting opportunity to travel to other countries resulted in momentous increase in mobility, but will not be repeated. Also important was the impact of increasing welfare combined with worsening quality of public transport. This factor will not contribute to such a significant increase in mobility in the future without a major qualitative shift, e.g. mainstreaming of the habit of weekend excursions to other European cities.

At the same time, there are some new developments that may accelerate the increase in overall mobility. Whether the mobility trends move closer to the RBP or BAU Scenario depends on a number of factors, some of which are determined by government policies. Others are largely independent from them but can nonetheless be shaped to accelerate reduction in emissions from the passenger transport sector. The following subsections investigate qualitatively what the impact of selected mega trends could be on the determinants of emissions identified above.

3.3.1. Plane, train, or both?

Development of railway infrastructure is essential to shorten the travel time by train. A clear example are the train connections in some of the countries listed in Table 3 above, showing that in some cases up to 12 hours are needed to cover the distance of less than 600 km between the major cities in the country. In such cases, domestic aviation is the obvious alternative option. Effective utilization of domestic and European resources could change this situation and decrease the role of domestic aviation. Development of fast trains exceeding 200 km/h would shorten the trips' duration significantly and pose a viable alternative to plane.

However, the existence of faster connections is far from enough to stop and subsequently reverse the shift from train to plane described above. Over the last two decades a significant improvement in the speed and quality of train trips took place in Poland. Currently it takes less than three hours to get from the Warsaw's city center to Poznań. The trip from Warsaw to Katowice only takes slightly more than 2 hours – much less than getting to the airport ahead of time, flying and getting from the airport to the respective city. Still, in both cases around 300,000 people decided to take the plane.

This can be partly explained by the low price of flights and not always satisfactory train service. An improvement in both cases can be expected from the rail liberalization driven by the

European Commission. The implementation of the Fourth Railway Package from 2016 (European Commission, 2020a) – especially its market pillar – has already led to an increase in competition and efficiency in some of the countries (Lerida-Navarro, Nombela, & Tranchez-Martin, 2019; WNP, 2020). In addition, modal shift can be shaped by the national governments by lowering the VAT rate for cleaner modes of transport – especially railways, subways and buses – and keeping the maximum rate for domestic aviation. At the EU level, additional charges for the flights – similar to the one introduced already by some member states – could facilitate a move from plane to train.

	Train tickets		Plane ticket		Bus ticket	
	Domestic	International	Domestic	International	Domestic	International
Bulgaria	20%	0%	20%	0%	20%	0%
Czechia	10%	0%	15%	0%	10%	0%
Hungary	27%	0%	27%	0%	27%	0%
Poland	8%	0%	8%	0%	8%	8%
Romania	19%	0%	19%	0%	19%	0%
Slovakia	20%	0%	20%	0%	20%	0%

Table 4: VAT rates for different modes of transport in the selected countries (European Commission, 2019b).

Railway efficiency may also be improved by the more reliable positioning service offered by the Global Navigation Satellite System (GNSS). Currently, GNSS is mainly used for passenger information services, but expanding it to safety critical purposes would potentially increase throughput of the existing infrastructure (European GNSS Agency, 2020). It could also facilitate the harmonization of the European signaling and control systems, thus reducing costs of train operation across different signaling zones (European Commission, 2020b).

At the same time, increasing income in the selected countries may benefit plane travel, especially where train does not present a viable alternative. Between 2010 and 2019, GDP per capita in the selected countries increased by between 18-41% – much faster than the average growth of 11% for the EU27 (Eurostat, 2020e). The continuation of this trend will allow more citizens more frequent and longer(er)-distance travels. This may accelerate the increasing trend of intra-EU and, even more importantly from the emissions perspective, extra-EU flights.

This trend may to some degree be counterbalanced by behavioral changes influenced by the climate debate. According to a recent survey by the EIB, between 74% (Bulgaria) and 85% (Slovakia) of the citizens are planning to go on holidays in their own or neighboring country – 49% of Poles would do so systematically, compared to average 39% for the EU (European Investment Bank, 2020). This trend may be strengthened in the future by the trend towards “flight-shaming,” which has already been described by the International Air Transport Association (Iata) as a potential threat to the future growth of the industry (Topham, 2019).

3.3.2. The unclear future of passenger car

Due to its current dominant contribution to the overall passenger transport emissions, the role of individual-owned passenger cars will be of great importance for decarbonization of the EU’s transport sector. It will be influenced by a number of countervailing factors, three of which will be playing the most important role: decreasing emissions per vehicle, increasing suburbanization, and development of public transport. The role of self-driving cars and transition from owning cars to using car services is much less clear and dependent on the aforementioned drivers.

It can be expected that in the future electrification of the car fleet will have an increasing impact on emissions intensity of the car fleet. While all countries of the region are lagging behind Western European countries, there is a clear trend towards an increase in the share of electrically-chargeable vehicles, with the new sales in Hungary well ahead of the other countries but behind the average for the EU (See Figure 24). However, it can be expected that the decreasing costs of electric vehicles will also accelerate their spread in the selected countries. Combined with the requirement of the EU Regulation 2019/631 to reduce emissions intensity of passenger vehicles by 37.5% by 2030 in comparison to 2021 levels, this will result in lower emissions per vehicle (European Parliament and Council, 2019). However, the lower utilization costs resulting from the shift from oil to electricity as the fuel may result in a rebound effect eating up some of the benefits.

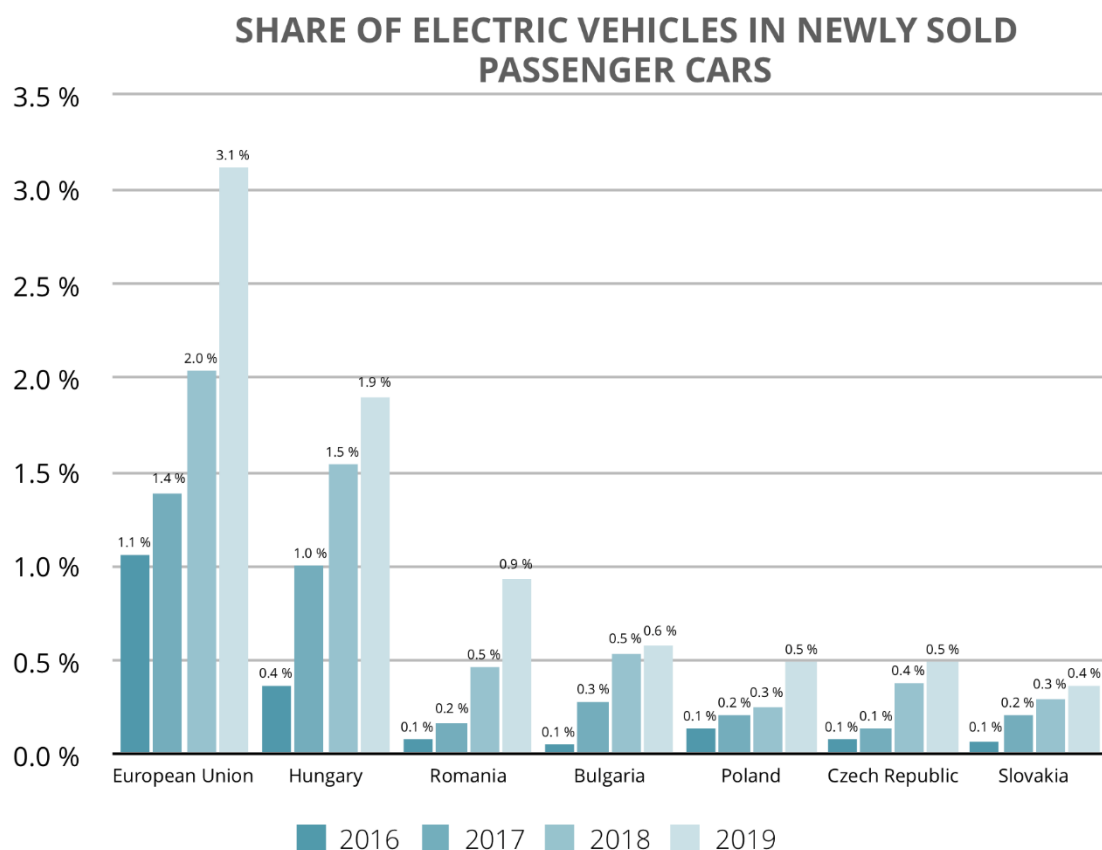


Figure 24: Share of EVs in the CEEs between 2016 and 2019 (ACEA, 2020).

This trend of higher activity levels may be strengthened by the progressing urbanization driven by rising incomes, trends towards house-ownership, and higher accommodation prices in the city center. This will result in the need for longer commutes to the city for work, education or recreational purposes. Forward-looking urban policy may counter the need for more mobility by development of public transit beyond the city borders. Should this foresight be missing, the trend towards emptier cars driven longer distances will result in more congestion, even if not necessarily higher emissions due to increased efficiency.

Public transport – both in cities and rural areas – will determine the need for car ownership in the future. The readiness to take advantage of public transport is there: between 69% and 76% of the citizens of the selected countries use public transport to fight climate change – many more than on average in the EU (European Investment Bank, 2020). Whether or not this potential will be used depends on whether public transportation at the local level is improved.

Some governments are pessimistic about their own ability to have an impact on car ownership. In its Strategy for Sustainable Transport Development from 2009, the Polish Ministry of Infrastructure assumed that the number of PKM travelled by car would increase by between 2.5 and 3.0% annually until 2030 – a combined increase of 33-44% in comparison to 2015 (Ministerstwo Infrastruktury, 2019). Such an increase would counterbalance an improvement in emissions intensity and result in higher overall emissions – the continuation of a trend contrary to the one needed to meet EU's emissions reduction goal.

In some cases, public transport may be complemented by on demand mobility. Services offered by private car owners via Uber or similar services may allow some citizens to give up their cars completely, especially if the utilization of such services is an exception due to the availability of other modes of transport for regular travels. However, there is also a risk of replacing public transport by such services, especially if their costs decrease.

This risk is further strengthened by the proliferation of autonomous vehicles (AVs), as it may lead to increased highway speeds, a greater willingness to commute long distances, and increase travel by underserved communities such as the young and the elderly, all of which would lead to higher emissions. But equally, they could reduce vehicle ownership and reduce emissions if electrified. In the latter case, however, traffic congestion could increase dramatically, especially if vehicles continued to drive around instead of parking.

In some cases, cars can also be replaced by E-bikes. In the Netherlands, Belgium and Austria, e-bikes now account for 30% of all bicycles sold annually; and for 10-20% of all sales in Italy, France, Sweden and Germany (Newson & Sloman, 2019). Most trips by e-bike substitute a journey that otherwise would have been by car and thus represent a net reduction in energy intensity. Furthermore, e-bikes are used for longer trips than conventional pedal cycles, so their beneficial contribution is correspondingly more.

3.3.3. Peak mobility?

In three out of the six countries analyzed, the number of PKM was higher in 2008 than in 2015. It started to grow again, however, due to an increase in the role of aviation after 2015. Nevertheless, this change exemplifies a situation in which the number of kilometers travelled per person peaks and either stabilizes or starts to fall. Such a situation is ignored in some national scenarios, e.g. the aforementioned Strategy for Sustainable Transport Development for Poland assumes a growth in the number of passenger kilometers by between 55% and 81% between 2015 and 2030 (Ministerstwo Infrastruktury, 2019). Unless the additional kilometers are travelled at a much higher speed – by plane or train – it is difficult to imagine such a scenario.

While sometimes associated with economic growth, an increase in mobility does not always indicate a better quality of life. In some cases, it may reflect longer daily commuting resulting from inability to find employment closer to home or vice versa. It may result from unnecessary travels for purposes which may easily be dealt with remotely. Technological solutions, especially in the form of teleconferencing and software allowing to work from home, may significantly reduce business-related travels. The increasing popularity of webinars replacing conferences may save time, money, and emissions. It needs to be stressed, however, that a significant decrease in mobility also shouldn't be expected: in many cases daily commuting or longer business trips cannot be avoided. Increasing welfare will also result in more leisure trips.

It can be assumed that a large share of the additional extra-EU flights post-2015 was driven by recreational travels resulting from increasing income. While this trend may continue, it may also be replaced by more local excursions – especially if trips by train allow visiting other cities and countries in rational amount of time. The availability of night trains allowing additional savings on accommodation in the city of destination may accelerate this trend. Finally, weekend excursions to another city on the other side of the continent may be replaced by fewer but longer stays abroad.

Emissions from passenger transport can be decreased even with an increase in mobility by shifting from planes to (rapid) trains. Decarbonization of the other modes of transport also offer numerous opportunities to reduce emissions by much more than 1% offered by the spread of best practices. However, peak mobility would make this challenge much easier to meet, without having necessarily negative impacts on the quality of life of European citizens.

4. Freight transport

In 2015 the combined emissions from freight transport for the six selected countries amounted to almost 41 MtCO₂ or 6.7% of their total emissions. Hungary and Poland had the highest shares of emissions from freight transport at 8.1% and 7.5%, respectively. In Bulgaria, freight transport contributed the smallest share of overall emissions at only 3.9%. These values exclude, however, indirect emissions from electricity used in transport sector, which plays an important role for railways. Also, only the activity within the respective country's territory is accounted for. This differentiation is important due to the role played by transport companies from some of the selected countries, especially Poland, in other EU member states.

Freight transport corresponds to around 38% of all transport emissions from the selected countries. However, there are some important differences between the respective countries: in Poland, emissions from freight transport constituted almost half of all transport emissions, while in Bulgaria, their share was below 20%. In the remaining countries, the share was in between, but not higher than 38%.

The total activity levels measured in tonne-kilometers (TKM) per capita in the selected countries increased between 2000-2015 by 38% or 2.2% annually. The largest increase took place in Poland by 63%, and the smallest in Hungary and Slovakia by 19% and 8%, respectively. As a result of these trends, the most PKM per capita were transported in Poland (5,376 TKM) and in Czechia (5,717 TKM). This was twice as much as in Bulgaria and Romania, which transported 2,969 and 2,325 TKM, respectively (see Figure 25).

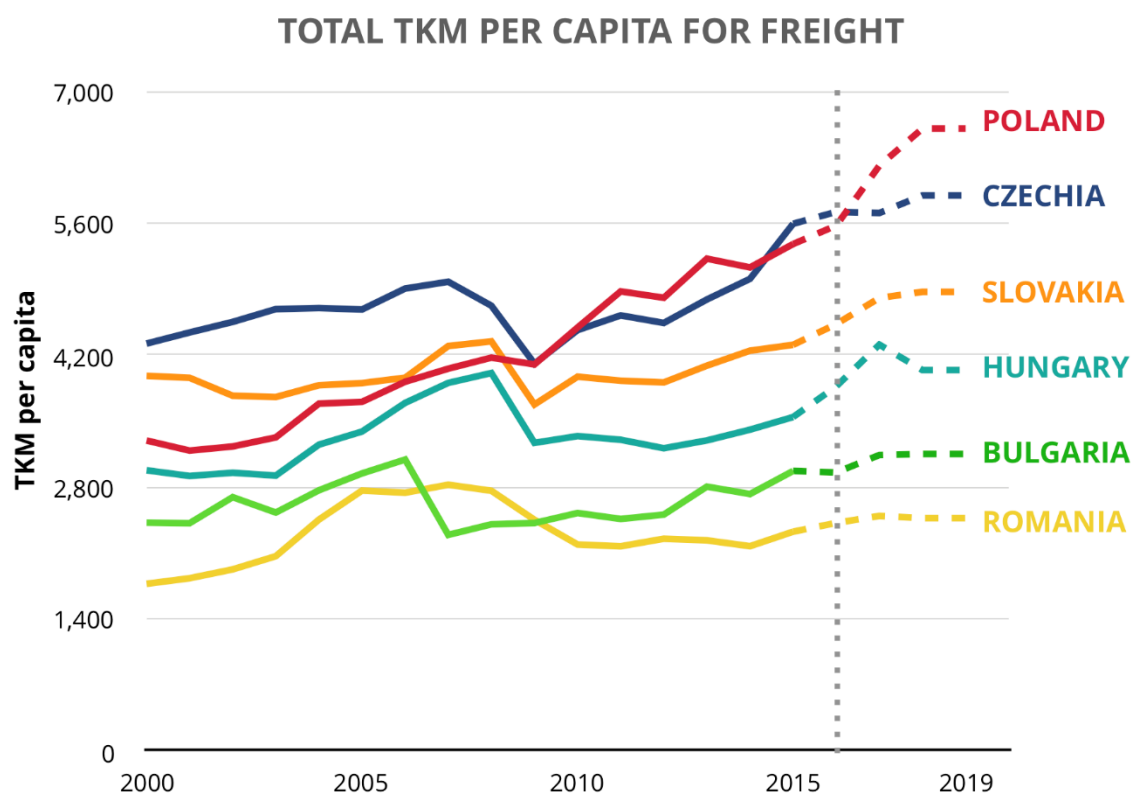


Figure 25: Change in freight activities between 2000-2018 (period 2016-2018 based on a mix of extrapolation and historic data.)

4.1. Assessing past trends

Similar to passenger transport, the shift away from railways is clearly visible in freight transport. Railway use in this sector has largely been replaced by heavy-duty vehicles and to a lesser extent light duty transport. The role of aviation was miniscule due to the low weight of the merchandise transported by plane. However, in absolute terms the number of TKM transported by plane from non-EU countries has more than tripled between 2000 and 2015. Despite improvements in emissions intensity for all modes of freight transport, the shift from rail (-14%-points) to road (+12%-points) resulted in increased emissions per TKM transported from 101 gCO₂ in 2000 to 114 gCO₂ in 2015. The highest increase in emissions intensity took place in Bulgaria by 32 gCO₂/TKM and in Slovakia by 62 gCO₂/TKM. In both countries, the increasing role of heavy-duty combined with a decreasing load factor contributed to this trend. Additionally, in Slovakia the emissions intensity of the entire freight transport sector more than doubled due to the worsening emissions intensity of heavy-duty transport (see Figure 26).

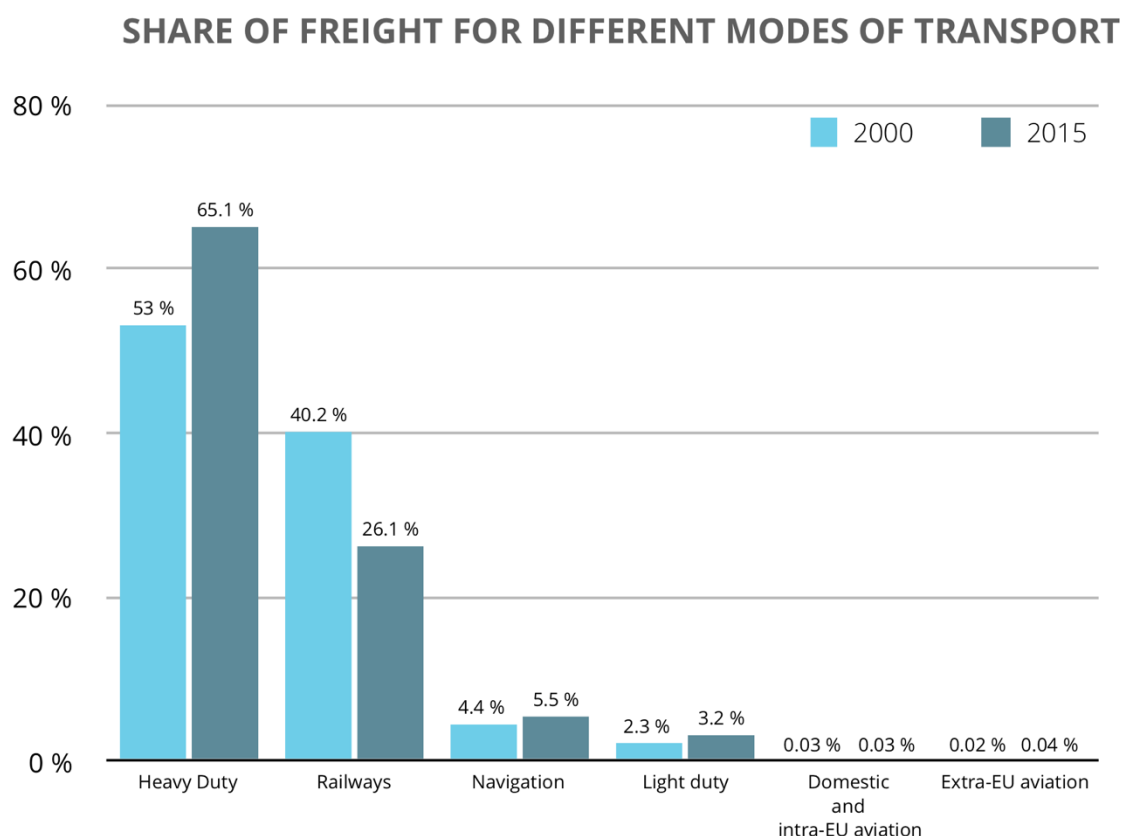


Figure 26: Share of different freight modes in total TKM transported.

The subsections below explain in more detail past trends for different modes of transport in terms of activity levels, load factor, and emissions per vehicle and passenger travelled.

4.1.1. Heavy and light duty

As pointed out earlier, heavy-duty is by far the largest contributor to overall freight transport. The weighted average share for the selected countries at over 65% is even higher in Poland (72.1%) and Czechia (72.2%). This excludes the freight transported by the transport companies from the respective countries beyond their borders. On the opposite side of the spectrum was Romania, the only country where not only the share of heavy-duty decreased (this happened

also in Hungary), but the absolute number of TKM also fell below the 2000-levels between 2010 and 2015. This decrease can be traced back to a significant increase in the role of navigation. This trend changed post-2015 and by 2017 TKM transported by heavy-duty vehicles increased by 19% (see Figure 28).

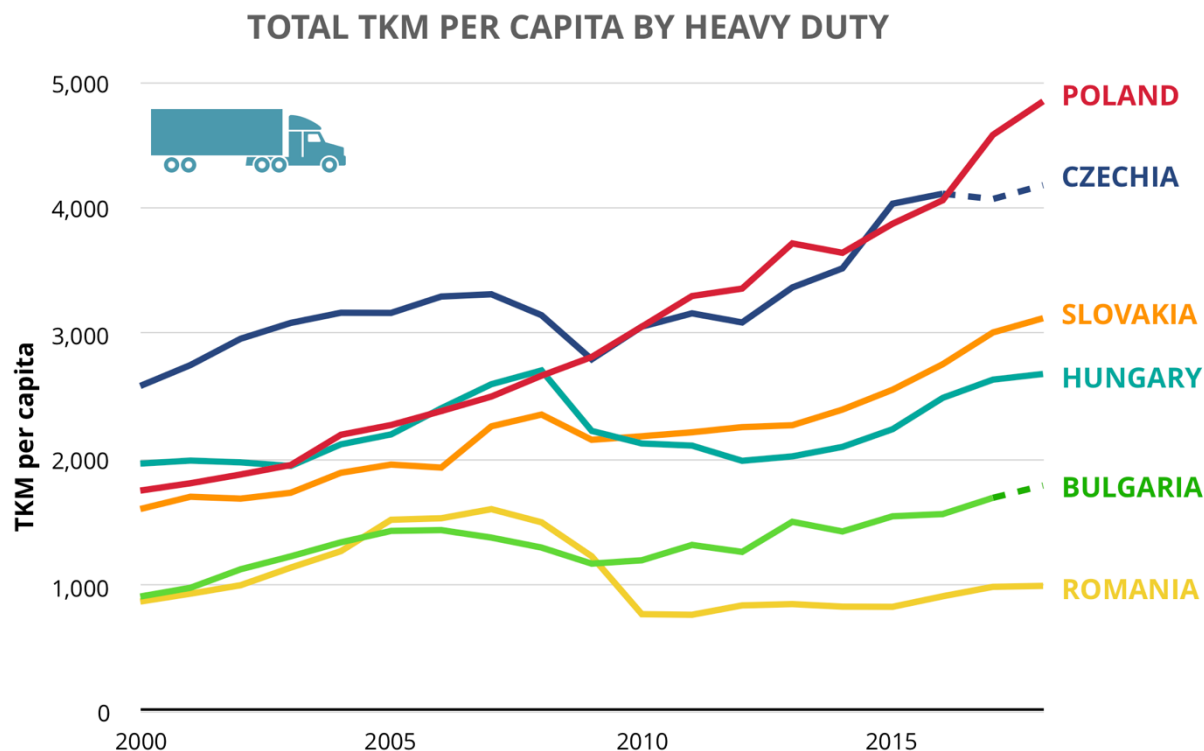


Figure 27: TKM per capita for heavy-duty vehicles.

Emissions intensity improved in all countries except Slovakia, but only slightly: between 0.4% and 0.6% annually between 2000 and 2015. In Slovakia, after some improvements between 2012 and 2014, emissions intensity of heavy-duty vehicles increased in 2015, resulting in almost 8% higher emissions per kilometer travelled in 2015 than in 2000. Despite this increase, emissions intensity of Slovakian heavy-duty vehicles was less than in Poland, Hungary, and Romania.

Load factor also influences the emissions intensity. The tonnage per vehicle was the highest in Romania with each heavy-duty truck transporting an average of 14.1 tonnes of freight in 2015, as much as in 2000 with only minimal changes in the years in between (between 14.1 and 14.6). The tonnage of the Slovakian heavy-duty trucks declined from 13.6 to 7.4 tonnes in the same period. In Poland, Czechia, and Bulgaria the tonnage was comparatively similar – between 9.2 and 9.8 tonnes per vehicle, around 10% below the tonnage of Hungarian heavy-duty vehicles with 10.6 tonnes per vehicle.

The role of light duty is much smaller, but increasing twice as fast (4.3% annually) than the total freight transport (2.2%) and faster than heavy-duty (3.2% annually) between 2000 and 2015. The fastest increase, but from the smallest basis, took place in Czechia at over 11% annually. The neighboring Slovakia registered the smallest increase at 3.2%. Slovakia also registered the smallest activity levels, with 56 TKM transported per light duty vehicle per person. This level is significantly below the average level of 136 tonnes-kilometers for the selected countries. Poland, with 164 TKM was above the average, and far ahead of Romania (145) and Bulgaria (133) (see **Error! Reference source not found.**). The explanation for these

significant discrepancies could be that in some cases light duty plays the role that heavy-duty plays in the other countries.

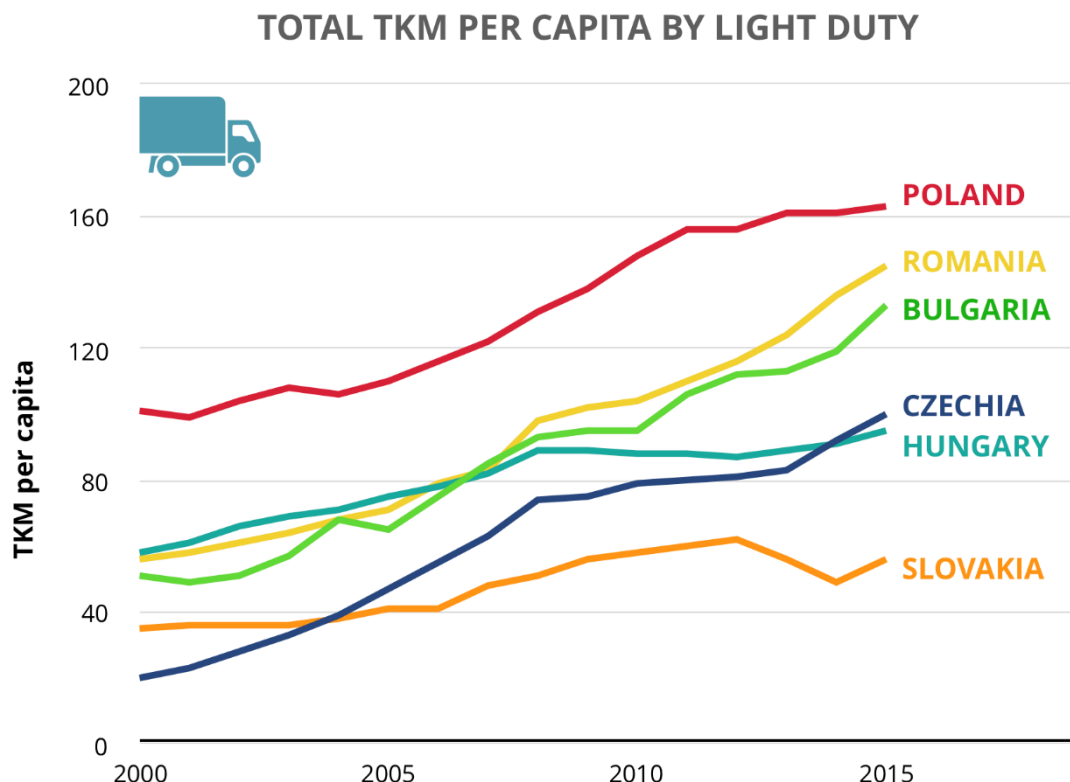


Figure 28: TKM per capita for light duty vehicles

There was a modest improvement in emissions intensity in all selected countries by between 0.1% (Hungary) and 1.3% (Bulgaria) annually between 2000 and 2015. As a result, in 2015 Bulgarian light duty vehicles were also the cleanest ones with 191 gCO₂/km. On the opposite side of the spectrum were light duty vehicles in Czechia, Hungary, and Romania with between 236 and 244 gCO₂/km.

The average load factor for light duty is comparatively low – between 0.11 (Slovakia) and 0.33 (Bulgaria) tonnes per vehicle. This could be due both to the low weight of merchandise transported and the use of light duty vehicles for passenger transport and thus less freight transported. The modest increase in load factors between 2000 and 2015 in all selected countries, except for Czechia, could be due to more package deliveries and consequent specialization of light duty vehicles in freight transport.

4.1.2. Railway transport

All selected countries, except for Hungary and Poland, share the common trend of reducing activity levels for freight transport by railways between 2000 and 2019. This trend was especially clear between 2000 and 2015, with a major dip in 2009, followed by some recovery and stabilization afterwards. The activity levels did recover after 2015. In Poland, 6% more freight was transported by train in 2019 than in 2015, thus returning to the activity levels from 2000. An increase by 7% in Czechia since 2015 was, however, not enough to compensate for a decrease in the preceding years.

In absolute terms, Poland, Czechia, and Slovakia competed in terms of TKM per capita, with Poland slightly ahead of both its southern neighbors for the first time in 2018 when 1,564

TKMs were transported by railways per capita (see Figure 29). Bulgaria and Romania remained far behind with 542 and 670 TKMs, respectively. Due to its overall high activity levels, Poland's lead in railways transport – which to a large degree reflects its dependency on coal and consequent need for coal transports – is not reflected in the share of railways in total freight transport. With 25% of TKM transported by railways, it was behind Czechia (26%), Hungary (30%), and Slovakia (36%).

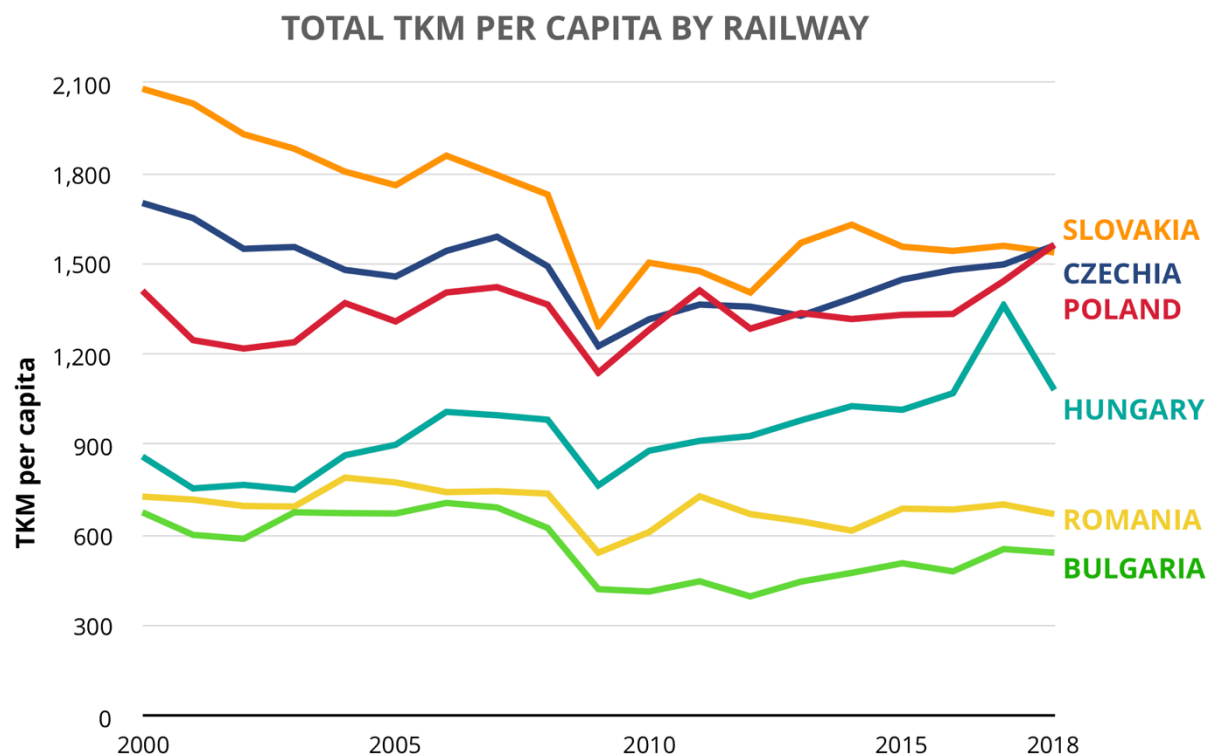


Figure 29: TKM per capita for railway.

Geographical location plays a huge role in the share of international transport (see Figure 30). In Poland, Romania, and Slovakia, more than 50% of freight transported comes from countries outside of the 28 EU-countries, with Poland being the highest at 69% of freight transported from non-EU countries. About 95% of the non-EU countries freight is coming from three countries: Russia, Ukraine, and Belarus. Romania and Slovakia both have 94% and 95% of their non-EU freight coming from Ukraine and Russia, respectively. In contrast, Bulgaria has approximately 43% of its non-EU freight coming from Serbia and 20% from Turkey.



Figure 30: Share of international transported goods in 2015 (Eurostat, 2020d)

In all countries except for Czechia, emissions intensity for freight trains (gCO_2/VKM) is much higher than for passenger trains. This can be explained by their higher weight and lower level of electrification. In Poland and Bulgaria, emissions per VKM are over four times as high. Czechia is the only country in which the emissions intensity for passenger and freight trains is very similar ($1,726 \text{ gCO}_2/\text{VKM}$ and $1,724 \text{ gCO}_2/\text{VKM}$, respectively). Unlike passenger railways, the trend is not necessarily downwards: in Poland and Hungary, emissions intensity actually increased by 0.4% and 1.6% annually, respectively. Bulgaria and Romania noted the biggest increase at 2% and 2.3% annually in the same period.

Romania also registered the biggest increase in load factor – the average freight transported by train increased by 2.8% annually between 2000 and 2018. A significant share of this increase (24%) took place between 2016 and 2018. Neighboring Bulgaria was the only country where load factor decreased – by 1.2% annually. As a result, Bulgaria was far behind Romania, with 357 and 909 tonnes per train transported, respectively. The remaining countries registered somewhere in between.

4.1.3. Navigation

There is a significant disparity between the selected countries in terms of the utilization of domestic coastal shipping and inland waterways, starting at 3 TKM transported per capita in Poland and 743 TKM in Bulgaria in 2017. The activity level for this mode of transport is also significantly volatile in relation to the overall: in Bulgaria, the number of TKM transported fell in 2007 to 17% of the 2000 value only to exceed these levels in 2010. In Romania, the activity

increased 5-fold between 2000 and 2017, whereas in Poland it decreased in 2017 to 13% of its 2000 value (see Figure 31).

This significant discrepancy between countries and volatility within countries is caused by the limited categories of goods that are usually transported. In 2018, metal ores and mining products accounted for the largest share of total tonnes transported at 30.7%. Coke and refined petroleum product accounted for the second largest share at 15.7% (Eurostat, 2020c). Additionally, the availability of the waterway network is a determining and potentially limiting factor, e.g. the transport potential offered by the Rhine-Danube corridor may not be fully utilized due to bottlenecks in Slovakia, Hungary, Romania and Bulgaria (European Court of Auditors, 2015).

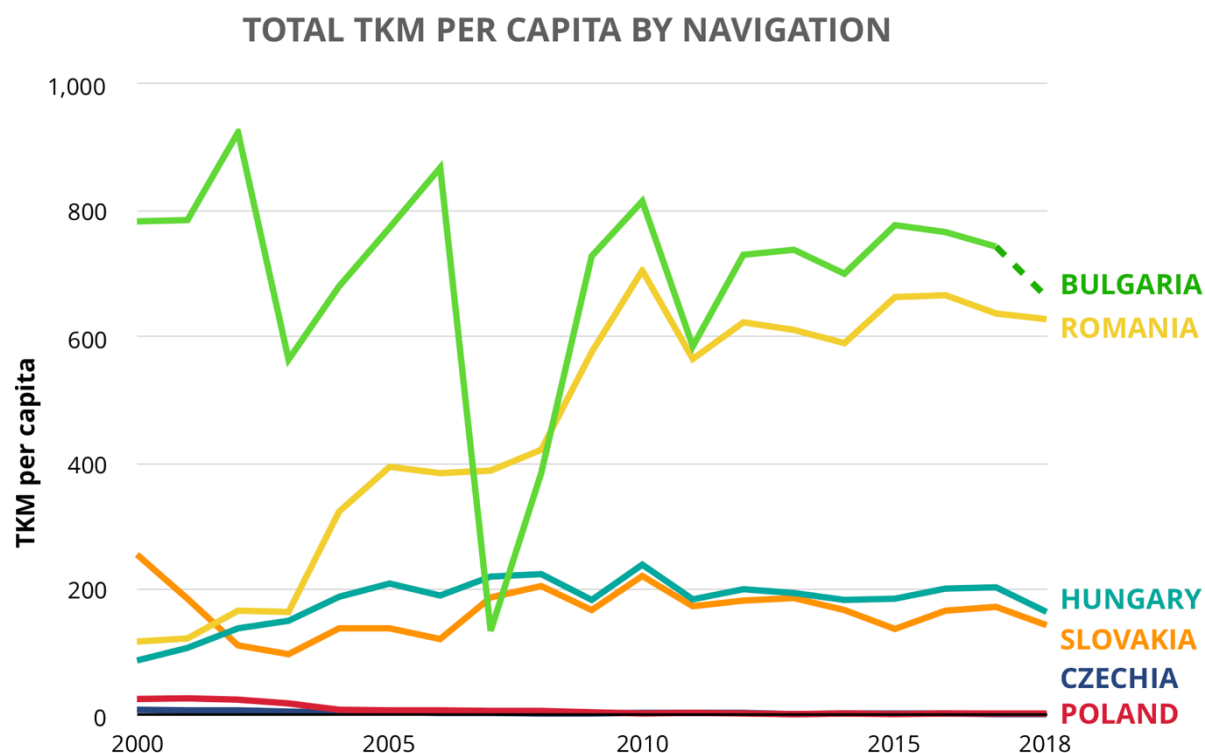


Figure 31: TKM per capita for navigation

There is a significant discrepancy between emissions intensity depending on the type and size of barges used and the weight of cargo. However, the change in emissions intensity per VKM was relatively modest: between an annual decrease in emissions intensity of 1.1% in Romania, and an increase of 0.7% in Poland. The significant capacity allows this mode of transport to achieve the second lowest (after railways) emissions per TKM – slightly above 10 gCO₂/tkm in Romania and Hungary.

4.1.4. Aviation

The role of aviation in the freight transport – which in this case also includes post mail - has been increasing much faster than the overall freight activity. The weighted average for all countries shows an annual increase of 4.3% between 2000 and 2018 for domestic and intra-EU aviation, and 9.2% for extra -EU aviation. This includes a significant acceleration in the dynamic between 2015 and 2018, when the annual rate of increase amounted to 10.4% for domestic and 17% for intra-EU aviation (see Figure 32 & Figure 33). As a result, there were on average 2 TKM per capita for domestic and intra-EU aviation and 2.9 TKM for extra-EU

aviation. While aviation still accounted for a small share of total TKM – 0.04% for domestic and intra-EU aviation, and 0.06% for extra-EU aviation in 2018 – it was already a notable relative increase from 0.03% and 0.04%, respectively, in 2015.

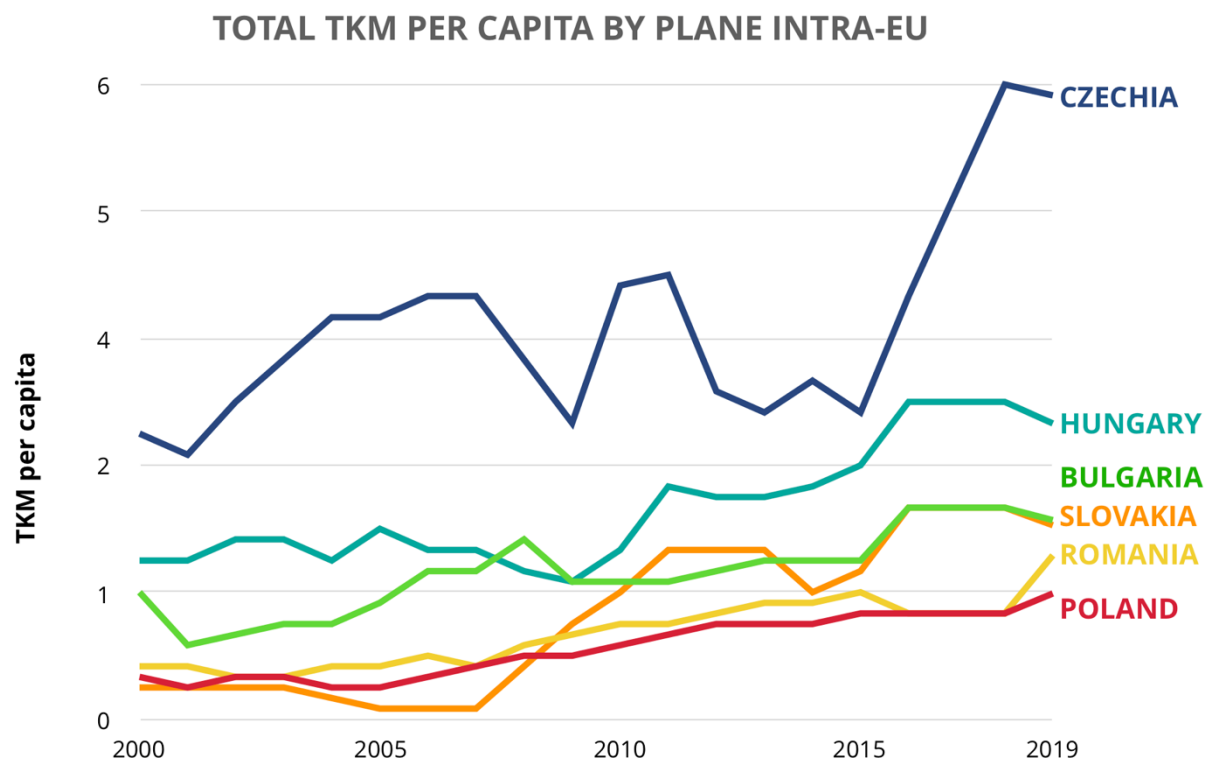


Figure 32: TKM per capita for intra-EU aviation.

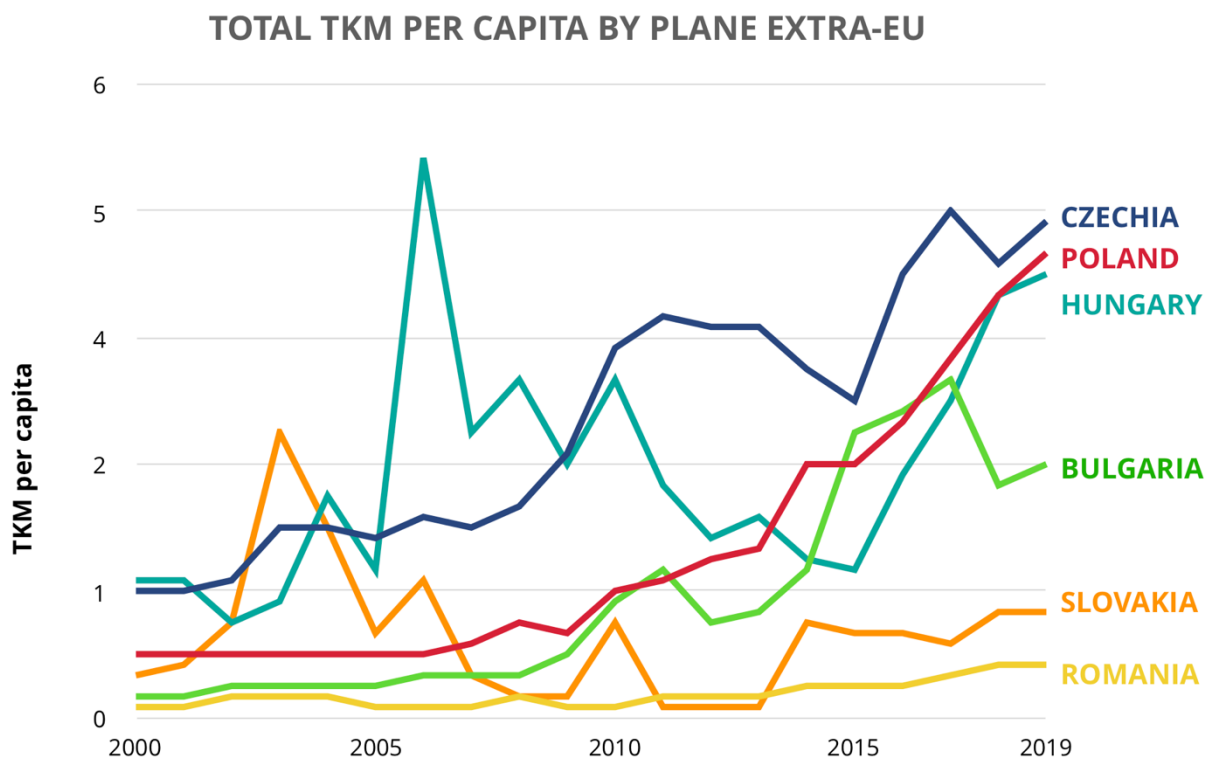


Figure 33: TKM per capita for extra-EU aviation.

Aviation is the most carbon intensive mode of transport. However, as some cargo is transported in passenger planes, the estimates of both emissions intensity and load factor can only be rough. Calculations based on JRC IDEES data indicate an annual reduction in emissions by between 1.0% (Czechia) and 4.2% (Romania) for domestic and intra-EU aviation, and between 0.6% (Czechia) and 4.6% (Slovakia) for extra-EU aviation. The load factor is estimated to have increased by 0.9% annually for domestic and intra-EU aviation and decreased by 0.4% for extra-EU aviation for all selected countries.

4.2. RBP Scenario until 2030

The continuation of existing trends would result in a 114% increase in combined freight transport emissions between 2015 and 2030. The highest increase in Slovakia (219%), Czechia (+142%), and Poland (+116%) would be counterbalanced by slower increase in Bulgaria (+98%), Romania (55%), and Hungary (45%) (Figure 34).

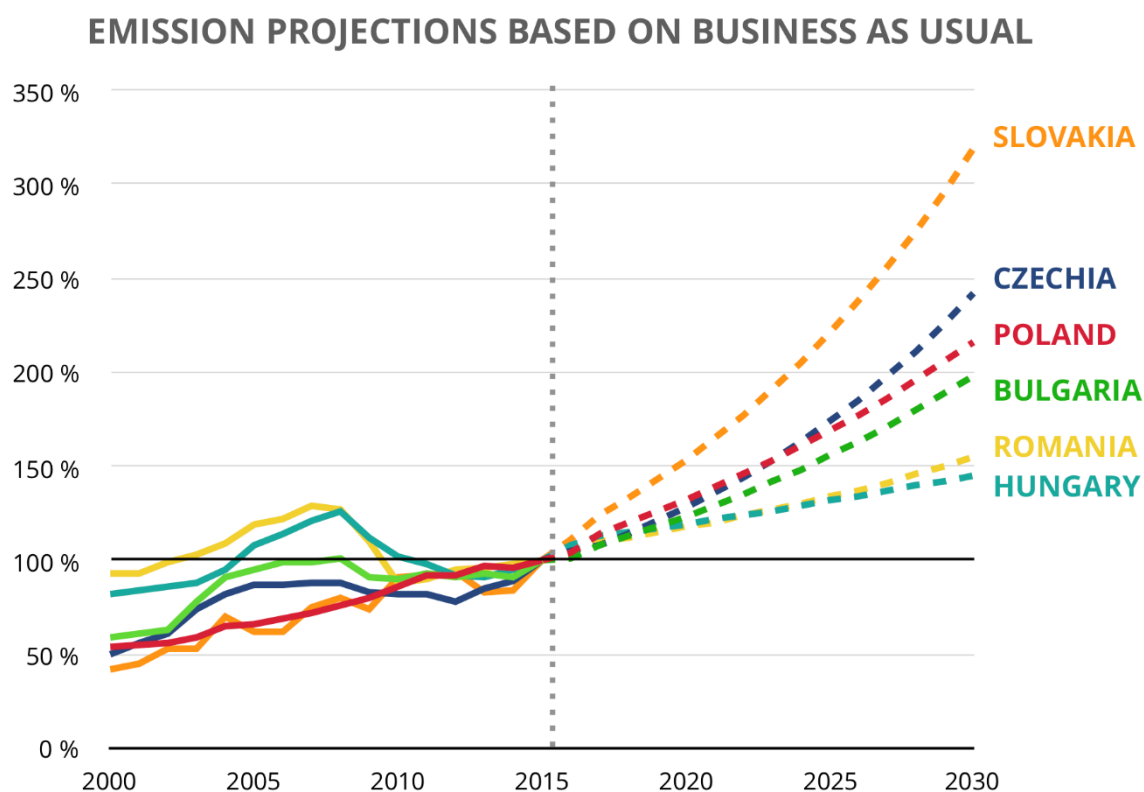


Figure 34: Change in emissions for freight transport compared to 2000's level for BAU Scenario.

The total number of TKM transported would increase by 76%. Disparity between the rapid increase in emissions and much slower increase in the TKM transported indicates the continuation of worsening emissions intensity per TKM transported – from 107 gCO₂ in 2015 to 130 gCO₂ in 2030 on average for the six countries. This worsening results mainly from an increasing role of heavy and light duty vehicles with high emissions intensity, which for the latter reached almost 2,000 gCO₂/TKM. The simultaneous increasing role of aviation and decreasing role of railways, the least emissions intensive mode of transport, exacerbates this trend.

The application of Regional Best Practices would alter the emissions trend much more significantly for freight transport than for passenger transport. While the emissions would still

increase by 12%, it would be 102%-points below the BAU Scenario – the corresponding difference for passenger transport is 66%-points (Figure 35).

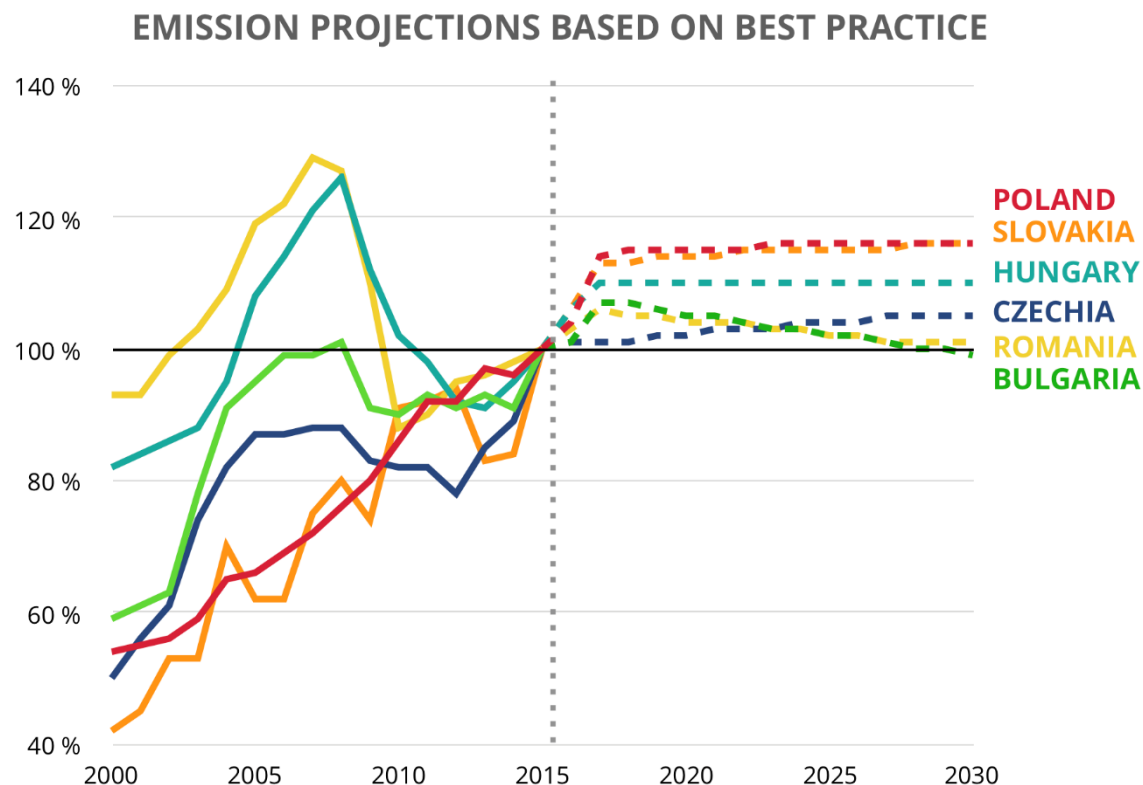


Figure 35: Change in emissions for passenger transport compared to 2000's level for RBP Scenario.

Slovakia would see the biggest impact as its emissions from freight transport would increase between 2015 and 2030 by 16% instead of 219% – an improvement by 203%-points. This results mainly (55% of the difference between BAU and RBP Scenarios) from the application of RBP in terms of emissions intensity of heavy-duty vehicles. Also, Czechia and Poland would register a significant slowdown in emissions increase: 5% instead of 142% for Czechia and 16% instead of 116% for Poland. Emissions would also increase in Hungary (10% instead of 55% in the BAU Scenario) and remain constant in Romania and Bulgaria (Figure 36).

CHANGE IN EMISSIONS BETWEEN 2030 AND 2015 IN BAU AND RBP SCENARIOS

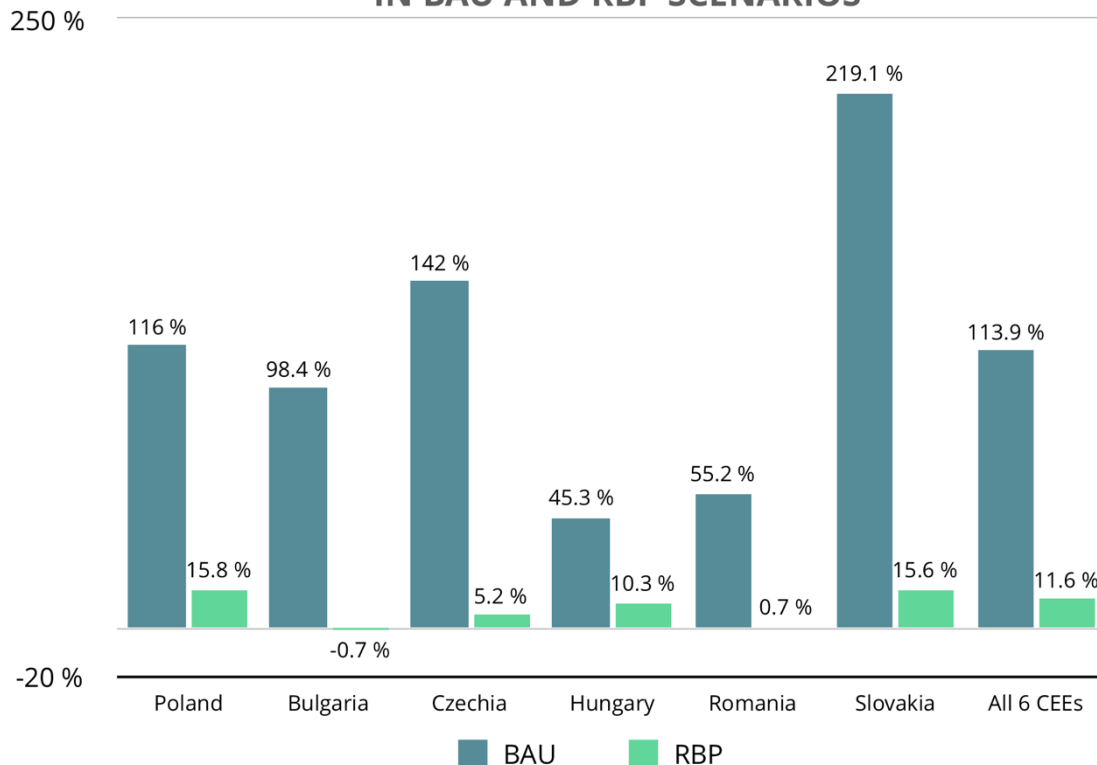


Figure 36: Impact on emissions from freight transport in 2030 in BAU and RBP Scenarios.

The significant slowdown in emissions increase would come at a cost of slightly lower activity levels in comparison to the BAU Scenario. Instead of increasing by 76% in comparison to 2015, the amount of TKM would increase by 20%

Despite this decrease in emissions, the RBP Scenario would still allow for an increase in TKM transported in 2030 by 35% in comparison to 2015, or 38% below the BAU Scenario. The biggest decrease would occur in Poland – instead of doubling, the amount of TKM would increase by 26%, still above the average for the selected countries. On the other hand, Slovakia, which registers the largest slowdown in emissions increase, would register only 24%-points decrease in the activity levels.

The application of the RBPs would result in emissions per TKM decreasing to 99 gCO₂. This is 7% below the emissions intensity in 2015 and 24% below the levels reached in the BAU Scenario in 2030. The least emissions intensive transport would take place in Romania (76 gCO₂/TKM) and Bulgaria (85 gCO₂/TKM) (See Figure 37). In both countries, the comparatively cleanest freight transport is attributable to their having the highest share of navigation. As noted in the Methodological Section, the activity levels for this mode of transport were frozen at 2015 levels, but nonetheless in 2030 this mode of transport covered 10% of all TKM in Bulgaria and 12% in Romania.

EMISSIONS INTENSITY PER TONNE-KILOMETER TRANSPORTED

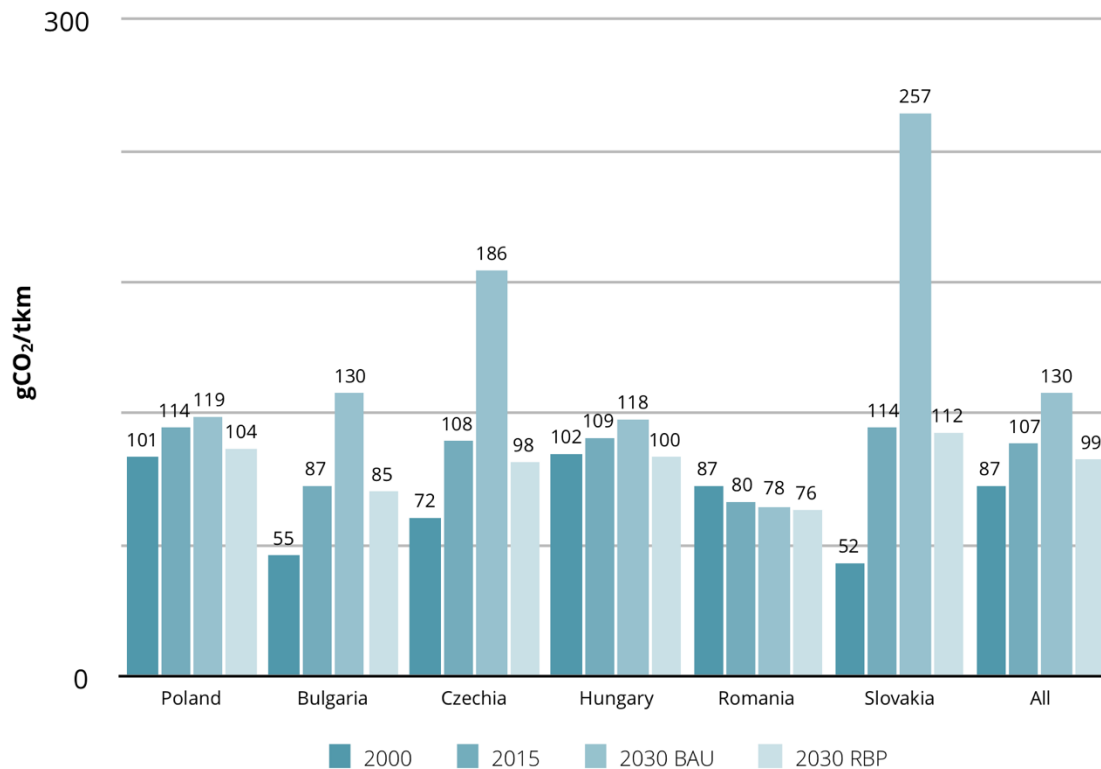


Figure 37: Emissions intensity per TKM transported.

With activity levels and load factor for navigation unchanged, the remaining 16 RBPs were rather equally distributed (See Figure 38). The largest number of 6 RBPs, especially concerning improvement in emissions intensity, came from Romania. Poland was the source of 3 RBPs, all of which concerned an increase in load factor. Slovakia was also the source of 3 RBPs, two of which concerned activity levels. Bulgaria was the source of 2 RBPs each while Czechia and Hungary were the source of only 1 RBP.

SUB-SECTORS	FREIGHT TRANSPORT					
	Rail	Aviation Domestic and intra-EU	Aviation Extra -EU	Light Duty	Heavy Duty	Navigation
CATEGORIES	1.1 % Hungary	2.2 % Bulgaria	4.4 % Slovakia	3.2 % Slovakia	0.7 % Romania	0.0 % NA
	-2.3 % Romania	-4.2 % Romania	-4.6 % Slovakia	-1.3 % Bulgaria	-0.6 % Czechia	-1.1 % Romania
INDICATORS	2.8 % Romania	0.9 % Poland	-0.4 % Poland	1.2 % Poland	0.0 % Romania	0.0 % NA
	Annual change in the activity level	Annual change in emissions intensity per vehicle	Annual change in load factor per vehicle			

Figure 38: Best practice values for freight transport.

As in the case of passenger transport, the importance of the RBPs differs significantly, with those referring to heavy-duty mode being most important. An annual improvement of the emissions intensity of heavy-duty vehicles by 0.64% (Czechia), instead of between 0.13% (Hungary) and 0.63% (Romania), would reduce emissions from total freight transport by 2.5 MtCO₂ in 2030, or almost 6% of the difference between BAU and RBP Scenarios in 2030.

Much more important would be the stabilization of load factor of heavy-duty vehicles in Romania, instead of a decrease by between 0.7% (Poland) and 4% (Slovakia). This would allow for emissions to decrease by almost 8 MtCO₂, or 20% of the difference between BAU and RBP Scenarios. Application of all three RBPs simultaneously to heavy-duty would result in emissions reduction by 32 MtCO₂ – 76% of the difference between BAU and RBP, and 36% of the BAU emissions in 2030.

Switching from road to rail would also allow for more freight transport at lower emissions. Application of RBPs in the railway sector would allow for an additional 13.2 billion TKM, or 3.4% of total freight transported in 2015 in all selected countries. At the same time, higher load factor (+2.8 annually) and accelerated reduction in emissions intensity (-2.3% annually) would allow for reducing emissions from this mode of transport by 46%, despite higher utilization rate.

Application of RBPs in light duty transport would reduce emissions from this mode by 42% and total emissions from freight transport by slightly over 8%. Due to an improvement in emissions intensity and load factor, this would result in much smaller decrease in the amount of TKM serviced by this mode of transported: by 24% or 0.9% of total freight transported.

With a combined share of 0.3% of total emissions in 2030 in BAU Scenario, application of RBPs in navigation and aviation would have a minimal impact on total emissions. This is different from passenger transport, where the continuation of existing trends in aviation would significantly contribute to an increase in total emissions (see Figure 39).

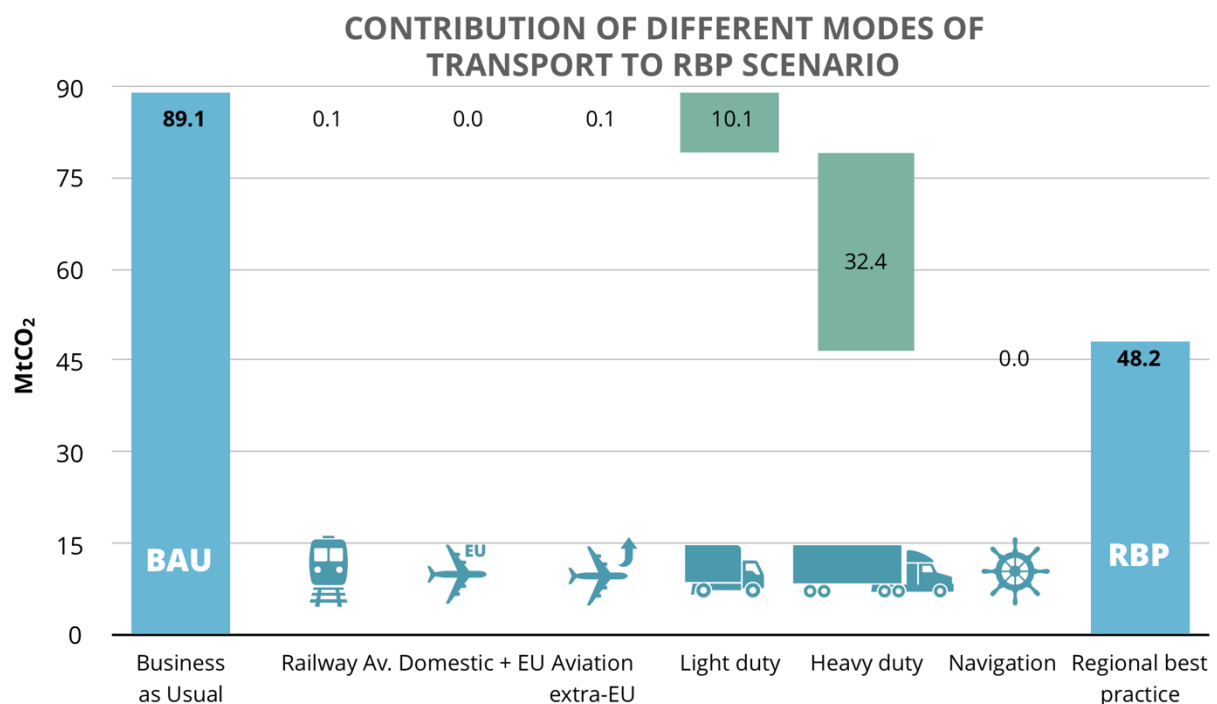


Figure 39: Contribution to emissions reduction from freight transport resulting from the implementation of Regional Best Practices. Combined emissions in all six countries.

While the application of the RBPs in freight transport would significantly slow down an increase in emissions, it would be far from what is needed by the EU Effort Sharing Regulation and the Paris Agreement (see section 5). In addition, contrary to passenger emissions, the simultaneous increase in load factor, especially in heavy-duty vehicles, may countervail an improvement in emissions intensity unless accompanied with a change of fuel (e.g. electricity

or hydrogen) or a shift to alternate modes of transport (e.g. from road to rail). The following section investigates some of the options that may significantly influence the RBPs in the coming decade and allow for a much faster reduction in emissions.

4.3. What will influence future emissions from freight transport?

As in the case of passenger transport, a number of factors may influence emissions in freight transport beyond the scope of the RBPs. The following subsections describe some of these trends that may impact emissions intensity, load factor, and activity levels.

4.3.1. Fuel switch

As in the case of passenger vehicles, electrification of freight transport may result in significant emissions reductions. Since 2019, a number of electrified heavy duty vehicles have been developed and introduced to the market. Many of them, however, have a comparatively short range, e.g. 200 km for BYD's Class 8 Day CAB and between 270 and 300 km for the two Freightliners offered by Daimler. The development of newer electric trucks will solve this issue, such as the different models of semi-trucks currently developed by Nikola Motors with a range of up to 1,100 kilometers (Downing, 2020).

Another way to electrify heavy-duty vehicles may be the construction of e-highways, which utilize an overhead line to charge heavy duty vehicles as they drive and allow for the use of smaller batteries. In 2018, Sweden opened the world's first 2-kilometer-long electrified road for charging vehicles. The cost of electrified roads was about €1m per kilometer and is said to be 50 times lower than that required to construct an urban tram line. In 2019, the first 5-kilometer-long electric highway dedicated to hybrid trucks was opened in Germany (Boffey, 2018; The Local, 2019).

To have a meaningful impact on emissions, a dense network of e-highways would have to be developed allowing heavy-duty vehicles to reach numerous destinations – often across different countries. This requires significant and coordinated investments in the infrastructure. Such an investment could be incentivized by the reduced costs of using electricity instead of oil and reduced upfront investment for smaller truck batteries. This puts companies from countries relying on electric mobility in a better competitive position than their oil-reliant competitors. In addition, decreasing reliance on volatile oil prices would reduce the potential shock of increasing oil prices.

In addition to electricity, trucks can switch to hydrogen. The major advantages in this case include lowering the weight (up to a third in comparison to batteries), shortening the charging time, and increasing the range of such vehicles (Molloy, 2019). The main challenge is hydrogen's unavailability as a fuel source and almost non-existing charging infrastructure in the selected countries (European Commission, 2019a). The European Commission's Fuel Cells and Hydrogen Joint Undertaking is already funding projects which aim to address this issue, but the participation of the selected countries is very limited (FCH, 2020).

In the short term, emissions from heavy-duty freight can also be accelerated by increasing the role of biofuels. However, it must be ensured that doing so does not result in higher emissions in the other sectors (e.g. the LULUCF sector) in the EU or beyond. Additionally, due to the lack of alternative low-carbon fuels for aviation, the use of biofuels in this sector should be prioritized.

Electrification of light-duty vehicles – the second major source of emissions for freight transport – can be implemented in a much shorter term. This especially concerned vans used for urban delivery services, which travel much shorter distances in areas increasingly well-equipped with charging opportunities. In addition to reducing emissions, this will also significantly reduce air pollution in densely populated areas.

4.3.2. Modal switch

The inflexibility of railways, which makes direct deliveries to the final destination (e.g. a supermarket) impossible, combined with low speed and frequent delays, has been driving the modal shift towards road transport. This process has been accelerated by significant improvement in road infrastructure and deterioration of railway infrastructure.

A significant improvement in railway networks and increasing train speed would create the potential to shift some freights from road to rail, the declared goal of the European Commission since the 1990s (European Commission, 2020b). A major push in this direction may result from the increasing railway connections with China in the framework of the Belt & Road Initiative. However, it must be accompanied by significant EU funding that could also allow the freight to reach Western European countries in an acceptable amount of time (Belt & Road News, 2019).

4.3.3. Digitalization

In 2018, over 20% of vehicle kilometers in Poland, Bulgaria, Slovakia, and Czechia, were empty runs. The average for Hungary was not much better, whereas data for Romania were missing (Eurostat, 2020i). This shows a significant potential for the same levels of activity at almost 20% lower emissions – even when higher fuel consumption resulting from higher weight of the vehicles is accounted for. The fragmented market and lack of information about the supply and demand for transport services make it challenging to take advantage of this potential.

The new IT solutions create the potential to solve this problem by better matching companies in need of transport services with those offering such services. For example, an app called Convoy, already broadly used in the United States, both increases market transparency and allows for better planning by providing estimates of a driver's arrival time (Bass, 2019). In the EU, major shippers are jointly examining the framework of the NEXTRUST projects for the ways in which new IT solutions can consolidate loads and cut down on unnecessary parallel trips, thus reducing emissions (INEA, 2020).

In the longer term, IT technologies could also facilitate better coordination between different modes of transport. This would allow maximum use of the available capacities and decrease emissions by reducing the number of empty runs. When combined with carbon pricing, this increased flexibility would tilt the balance towards lower emissions alternatives.

The activity levels in freight transport are correlated with the levels of economic growth. Whereas faster economic growth results in an increase in demand for transport services, economic slowdown or a recession have a negative impact on this demand. However, this economic cycle, which in the assessed period also included the great recession of 2008/2009, didn't stop emissions from the freight transport from increasing by 114% in the selected countries between 2000-2015 – much faster than the increase of the GDP of 63% in the same period (The World Bank, 2020a).

4.3.4. Dematerialization

However, it can be expected that in the longer term this correlation will decouple. This will be caused primarily by decreasing the role of manufacturing – the main driver of freight transport – as demand for manufactured products stabilizes and the contribution of industry to the GDP decreases. Such a trend can be observed at the global level, where the value added of manufacturing as the share of the GDP decreased from 17.1% in 2000 to 15.6% in 2015. It was above that level for all selected countries, except for Bulgaria. Even more importantly, it was increasing further in all countries except for Slovakia and Romania, where a small decrease could be noted (The World Bank, 2020b).

This diverging trend for the Central and Eastern Countries could be at least partly explained by their membership in the EU and transfer of manufacturing industries due lower labor costs. However, it can be expected that the impact of this factor will decrease as the costs of labor equalize and automatization will decrease its overall importance.

The EU may also contribute to reducing the role of transport through its push towards circular economy. Especially production of easier to repair and more durable products will reduce demand for freight transport. However, the focus on recycling of critical raw materials may counterbalance this decrease: A product that would end up at the landfill, will be disassembled and its different building blocks distributed among different companies using it as a raw product.

Finally, reduced demand for fossil fuels resulting from EU climate policy, will have a significant impact on the amount of freight transported. In 2017 around 28% of freight transport in Poland by train (in TKM) constituted coal, oil or gas. With 20% of all railway freight it also played an important role in Czechia (UTK, 2018). Fossil fuels played *comparatively* a much less important role in road freight transport – in 2018 they coal and petroleum products constituted 1.4% of all freight transported by heavy duty in Poland. But in absolute terms fossil fuels contributed to over 4 billion TKM in 2018 in this country (Eurostat, 2020a). Thus, replacement of these fossil fuels by renewables will not only result in a decrease of emissions from their combustion, but also from their transport.

5. Compatibility with the Paris Agreement

As noted in Sections 4 and 5, application of RBPs in passenger and freight transport would result in emissions stabilization in the former and increasing, albeit much slower than in the BAU Scenario, in the latter. The combined impact on emissions from the transport sector would be an increase of 5% – far below the levels reached if past trends were extrapolated into the future where emissions would increase by 84%.

Whereas the impact of RBPs would be the largest for freight transport – a decrease of 102%-points – their implementation would not stop emissions from increasing entirely in any of the selected countries, except for Bulgaria. In the remaining countries, emissions from freight transport would still increase by between 1% and 16%. The impact of RBPs on passenger transport would be slightly smaller – a decrease by 66%-points. But it would allow for emissions to decrease in Poland. Nonetheless, Romania remains the only country in which application of RBPs would cause the combined transport emissions to decrease (see Figure 40).

IMPACT OF RBP ON EMISSIONS IN THE SELECTED COUNTRIES

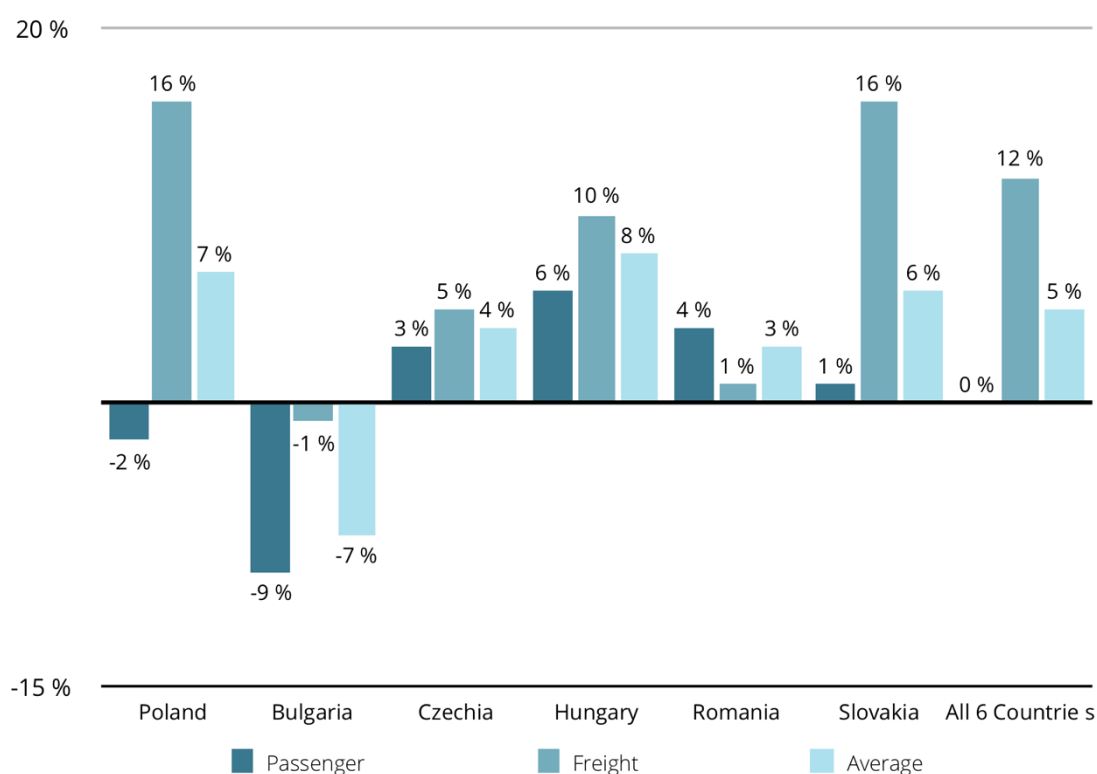


Figure 40: Impact of RBP on emissions in the selected countries.

The application of RBPs would have a significant impact in slowing down an increase in emissions from the transport sector. However, compatibility with the Paris Agreement temperature limit requires a significant emissions reduction instead of merely their stabilization at 2015 levels. Scaling down of the Beyond 2°C Scenario (see Section 2.2. on Methodology for more details) indicates emissions reduction by between 38% and 49%. This is by between 41%-points (Bulgaria) and 55%-points (Slovakia) below the RBP Scenario.

CHANGE IN EMISSIONS IN THE TRANSPORT SECTOR

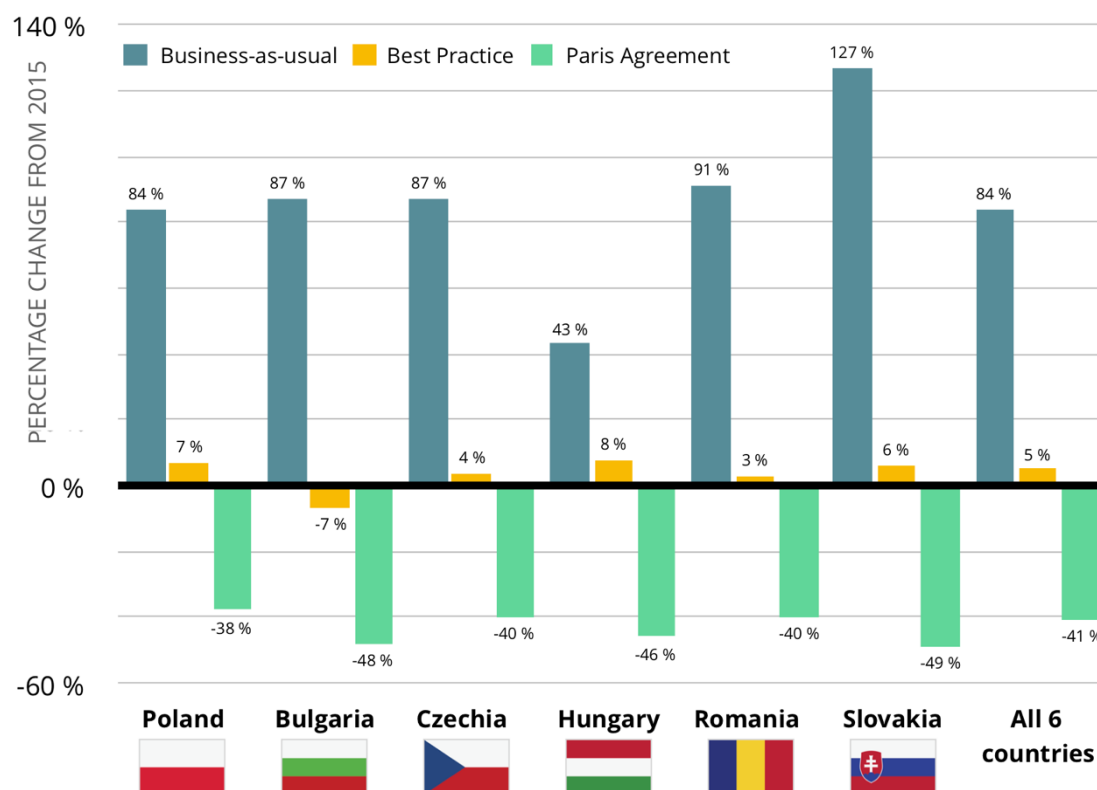


Figure 41: Emissions according to BAU, RBP and Paris Agreement compatible scenarios

At the same time, the application of the RBPs significantly reduces the distance between Paris-Agreement-compatibility and the results of the continuation of the current trends. For Bulgaria, 70% of the difference between BAU and Paris compatibility is already achieved by the implementation of the RBPs. For all remaining countries, except Hungary, around two thirds of the distance between BAU to PA-compatibility is already covered by the implementation of the RBPs. For Hungary, 40% of the difference between BAU and PA-compatibility would be covered by the implementation of the Regional Best Practices.

Thus, adoption of policies and measures that lead to specific emissions reduction in – whenever such trends can be determined by a policy – should be the first major step towards meeting Paris Agreement temperature limit. However, priority should be given to fuel switch and modal shift that could result in a transformational change needed for up to halving transport emissions by 2030.

6. Conclusions

Emissions from the transport sector in the selected Central and Eastern European Countries increased significantly over the period of time analysed in this report (2000-2015/2019), building upon an already significant increase in the preceding decade. With a 69% increase in combined emissions in all six countries, the increase for freight transport was slightly faster than for passenger transport, whose emissions increased by 51%.

Even more worryingly, this trend does not seem to have abated in recent years. On the contrary, a switch from rail to airplane in the case of passenger transport and from train to heavy-duty vehicles for freight transport was observed, much more emission intensive means of transport in both cases. While train travel increased, especially in passenger transport, low cost airplane tickets - whose price far from reflects the environmental costs of air travel - encouraged a higher rate of usage of this means of transport. Unlike passenger car travel, which may reach saturation in the coming years, it is still possible for activity levels in aviation to increase, and therefore increase its emissions.

Developments in some of the selected countries, however, offer a glimpse of hope that the significant growth in transport emissions can be slowed significantly (freight) or even stopped (passenger) if the existing Regional Best Practices are applied universally. In total, it would result in transport sector emissions for all selected countries increasing by 5% instead of 84% in the BAU Scenario.

What is needed, however, is not a slowdown in the increase of emissions. Instead, a significant decrease, not only to meet the EU's emission reduction goals – especially those resulting from the Effort Sharing Regulation – but also to achieve compatibility with the Paris Agreement is necessary. To achieve that, the emissions need to decrease by between 38 and 49% compared to 2015 levels. This indicates that, while the universal application of the Regional Best Practices, especially in heavy-duty and passenger car transport, is an essential first step to slow down the increase in emissions, it must be accompanied with transformative change in the transport sector in all selected countries.

This transformative change needs to go beyond an incremental improvement in emissions intensity. It must also address the possibilities for reduced activity whenever such mobility is not necessarily desired (e.g. long-distance commuting), without negative repercussions for quality of life. In addition to increasing load factors (e.g. using novel ICT solutions), such a transformative change would include a complete switch to carbon-neutral fuels in the coming decade, e.g. green hydrogen or renewable-based electricity. Alternatively, a switch to low carbon means of transport, especially rail, offers a viable alternative to reduce emissions.

While the report does not present any specific solutions – although some factors that can influence emissions from passenger and freight transport are presented in sections 3.3. and 4.3. – the disaggregation of the drivers of emissions conducted in this report allows for the quantification of their respective impact on emissions trends. This allows for more targeted policies and measures that could address these drivers and result in a meaningful reduction in emissions on the path to Paris Agreement compatibility.

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