Informal document ITC (2018) No. 4

Distr.: General
22 January 2018

English only

Economic Commission for Europe

Inland Transport Committee

Eightieth session
Geneva, 20-23 February 2018
Item 4 (a) (ii) of the provisional agenda
Strategic questions of a horizontal policy nature: Environment, climate change and transport - Decarbonisation and mitigation of environmentally harmful effects of inland transport

Results of the For Future Inland Transport Systems (ForFITS) Tool - Mannheim

Note by the secretariat

I. Introduction

1. Marking two hundred years since the invention of the Draisine, an ancestor of the bicycle, in Mannheim, Germany, the city hosted the twelfth Relay Race Workshop of Transport, Health and Environment Pan-European Programme (THE PEP) on “Cycling and walking make THE Link – Transport, Health and Environment” (21 September 2017). THE PEP relay race workshops form a series of national events on sustainable transport policies hosted by different cities in the UNECE region. They provide an opportunity to share knowledge across the pan-European region by passing the baton from city to city and recommending actions to policymakers.

2. As part of the efforts to develop policy-relevant knowledge and disseminate good practices, the UNECE Sustainable Transport Division, as one of the three pillars of THE PEP, was invited to develop an analysis of CO_2 emission projections in the city of Mannheim using the for Future Inland Transport Systems (ForFITS) tool. ForFITS is a monitoring and assessment tool for CO_2 emissions in inland transport, including a transport policy converter to facilitate climate change mitigation. Its application assists policy makers and supports governments in mitigating the negative impacts of transport on the environment.

A. Scope

3. This report addresses projected well to wheel (*WTW*[1]) CO_2 emissions stemming from the transport sector in Mannheim using the for Future Inland Transport Systems (ForFITS) tool.

4. The current impact of the transport sector of Mannheim on the overall CO_2 emissions is quantified and future emissions are projected based on a reference scenario where no major shifts in the development of the transportation sector take place.

5. Data were collected from local experts from the city of Mannheim. In some cases, data were adjusted when the scope of data provided did not match the required input definitions or if data were not internally consistent.

6. The report provides projections of transport sector CO_2 emissions under a reference scenario and three additional scenarios:

- Scenario A (reference): Accounts for the expected evolution of socio-economic parameters such as population and GDP. Includes default data in ForFITS on the expected evolution of fuel consumption characteristics by powertrain to reflect future improvements in vehicle technology and their associated costs. Other characteristics defining the transport system in the base year (e.g. fuel taxation schemes, road pricing, passenger/freight transport system structure, fuel characteristics, powertrain technology shares, behavioral aspects) remain unchanged in projections.
- Scenario B (environmental culture shift): Assumes a behavioral shift towards more environmentally conscious transport patterns. This would entail a decreased level of travel activity through a combination of telecommuting, residing closer to work as well as walking or cycling more. The decrease in activity is somewhat less for public transport modes, but is present in this mode as well. In addition, this scenario accounts for changes in driving style and/or driving routes to maximize energy efficiency. This is mimicked through the ForFITS input “environmental culture index” detailed in the Alternative Scenarios section.
- Scenario C (shift to public transport): Simulates a shift from private vehicles to public transport modes due to structural changes in the passenger transport system. This is mimicked through the ForFITS input “passenger transport system index” detailed in the Alternative Scenarios section.
- Scenario D (combined effect of scenarios B and C): Assumes that scenarios B and C occur simultaneous over the projection period.

B. Description of model

7. ForFITS is capable of satisfying two sets of key requirements:

- The estimation/assessment of CO_2 emissions in transport
- The evaluation of transport policies for CO_2 emission mitigation.

[1] Well to wheel (*WTW*) refers to CO_2 emissions from vehicle operation as well as emissions from the production of the fuel used for vehicle operation.

8. To achieve these targets, ForFITS evaluates transport activity (expressed in terms of passenger kilometres (pkm)[2], tonne kilometres (tkm)[3], and vehicle kilometres (vkm)), related vehicle stocks, energy use and CO_2 emissions in a range of possible policy contexts.

9. ForFITS is a sectoral model (Figure 1), covering both passenger and freight transport services on all transport modes (including aviation and maritime transport), but mainly targeting inland transport (especially road, rail, and inland waterways). Pipelines are also considered in the model. Each mode is further characterized in sub-modes (when relevant) and vehicle classes. Vehicle classes are further split to take into account of different powertrain technologies and age classes. Finally, powertrains are coupled with fuel blends that are consistent with the technology requirements.

10. ForFITS does not provide information on the evaluation of the overall effects of changes in the transport system on the economic growth.

11. The ForFITS tool was used for the analysis of CO_2 emissions in Mannehim as it has been proven through a series of pilot studies[4] to be a useful tool for projecting future emissions under different transport policy scenarios. For the analysis of Mannheim, projections account for road vehicles, non-motorized transport, and passenger rail transport (trams only). Projections for intercity and commuter passenger rail, freight rail, aircraft, pipelines and vessels are excluded as they were either not relevant for analysis or did not have sufficient data availability.

An important note is that due to data limitations, road vehicle use for the purposes of this analysis refers to all travel of ***vehicles registered in Mannheim*** *rather than the circulation of vehicles within the Mannheim city limits. This may limit some of the conclusions that can be drawn.*

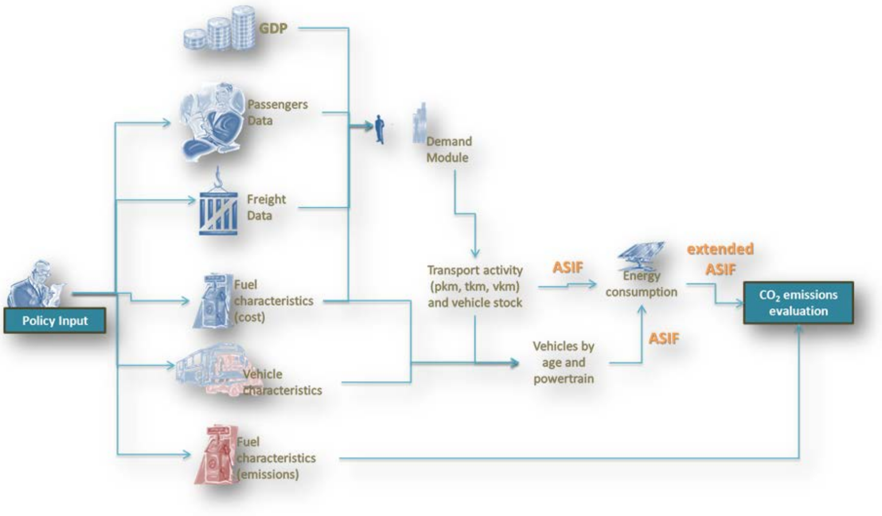
II. Baseline Status

A. Breakdown of Base Year ForFITS Inputs

12. Data were collected from official sources, estimates based on special requests to German ministries and on the judgement of local transport experts.

[2] A passenger kilometre is defined as a unit of passenger carriage equal to the transportation of one passenger one kilometre.
[3] A tonne kilometre is defined as a unit of freight carriage equal to the transportation of one metric ton of freight one kilometre.
[4] Pilot studies were performed in seven countries in 2013 - Chile, Ethiopia, France, Hungary, Montenegro, Thailand, and Tunisia.

Figure 1
ForFITS schematic



13. The primary source for data on vehicle stock was the **Federal Transport Authority**. Average vehicle fuel consumption data are sourced from the **Federal Environment Office**. The source for average road vehicle load data was a traffic survey conducted in 2013 by the **Technical University of Dresden**. Data on public transport (trams and buses) are from **Rhine-Neckar Transport.** In all cases, data from these sources were adjusted or supplemented with estimations based on expert judgement.

Table 1
Vehicle stock and historical new registration data: 2005, 2010, 2015

	Vehicle stock 2015				New vehicle registrations 2015		New vehicle registrations 2010		New vehicle registrations 2005	
	Active vehicles	Avg fuel cons (lge/ 100 km)	Avg travel /veh. (km/yr)	Avg load[1]	New reg.	Avg fuel cons (lge/ 100 km)	New reg.	Avg fuel cons (lge/ 100km)	New reg.	Avg fuel cons (lge/ 100 km)
Non-motorized transport										
Walking	285 970		490	1.0						
Cycling	295 708		595	1.0						
Two Wheelers	10 700	4.1	2 302	1.1	719	4.1	719	4.1	719	4.1
Three Wheelers	142	4.1	2 302	1.1	10	4.1	10	4.1	10	4.1
Passenger LDVs										
Personal	123 962	7.3	13 300	1.3	7 921	7.3	7 921	7.3	7 921	7.3
Public	315	6.9	50 000	2.5	20	8.1	20	8.1	20	8.1
Buses	253	42.7	69 033	12.0	14	42.7	14	42.7	14	42.7
Passenger Rail	93	0.6	69 367	44.0	5	0.6	5	0.6	5	0.6
Freight LDVs	21 023	9.6	16 254	0.2	1 711	9.6	1 711	9.6	1 711	9.6
Freight Trucks										
Medium-duty	8 618	22.6	18 914	3.0	1 060	22.6	1 060	22.6	1 060	22.6
Heavy-duty	655	39.1	39 289	10.8	81	39.1	81	39.1	81	39.1

Notes: [1]Passengers/vehicle for Passenger vehicles, Ton/vehicles for Freight vehicles. LDV = Light duty vehicle. lge = litres of gasoline equivalent.

Sources: Federal Transport Authority, Federal Environment Office, Technical University of Dresden, Rhine-Neckar Transport, UNECE estimates.

14. Data were adjusted when the rate of new registrations was incongruous with vehicle stock. Table 1 shows the breakdown of vehicle stock and historical new registration statistics used in the analysis of Mannheim.

15. The breakdown of powertrains in each vehicle type was also a required input for ForFITS and data for Mannheim are shown in Table 2. These data are averages from the state of Baden-Württemberg as reported by the **Federal Transport Authority**.

Table 2

Powertrain shares for vehicle stock and historical new vehicle registrations: 2005, 2010, 2015

	Powertrain Group (% of each technology in a vehicle class)													
	Gasoline	Gas-Electric Hybrid	Methane	LPG	Diesel	Diesel-Electric Hybrid	Electric	Gasoline	Gas-Electric Hybrid	Methane	LPG	Diesel	Diesel-Electric Hybrid	Electric
	Vehicle Stock -2015							**Vehicle New Registrations -2015**						
Passenger two wheelers	0.995	0.001		0.001	0.001		0.002	0.992				0.001		0.007
Passenger three wheelers	0.995	0.001		0.001	0.001		0.002	0.992				0.001		0.007
Passenger LDVs														
Personal	0.654	0.001	0.002	0.007	0.334	0.001	0.001	0.509	0.006	0.001	0.001	0.475	0.005	0.003
Public		0.032			0.968				0.032			0.968		
Buses	0.001		0.009		0.985	0.004	0.001			0.001		0.990	0.006	0.003
Passenger Rail							1.000							1.000
Freight LDVs	0.056		0.008	0.005	0.929		0.002	0.024		0.004	0.003	0.969		
Freight Trucks														
Medium-Duty	0.002		0.001		0.997			0.001		0.001		0.998		
Heavy-Duty	0.001				0.999					0.001		0.999		
	Vehicle New Registrations -2010							**Vehicle New Registrations -2005**						
Passenger two wheelers	0.992				0.004		0.004	0.995	0.001		0.001	0.001		0.002
Passenger three wheelers	0.992				0.004		0.004	0.995	0.001		0.001	0.001		0.002
Passenger LDVs														
Personal	0.563	0.002	0.002	0.002	0.429	0.002		0.701				0.298		0.002
Public		0.032			0.968				0.032			0.968		
Buses			0.005		0.983	0.011	0.001	0.001		0.009		0.985	0.004	0.001
Passenger Rail							1.000							1.000
Freight LDVs	0.056		0.008	0.005	0.929		0.002	0.056		0.008	0.005	0.929		0.002
Freight Trucks														
Medium-Duty	0.001	0.000	0.004	0.000	0.994	0.001		0.002		0.001		0.997		
Heavy-Duty	0.001				0.999			0.001				0.999		

Notes: LDV = Light duty vehicle. LPG = liquefied petroleum gas.
Sources: Federal Transport Authority (Baden-Württemberg), UNECE estimates.

B. Baseline Projections

16. Socio-economic data and data on fuel taxation were also collected as shown in Table 3. The source of population and 2014 GDP data was the **Statistical Unit of Mannheim**. The population of Mannheim is expected to increase at a moderate pace in future years with overall growth of almost 8 per cent projected by 2040

17. GDP projections are based on annual nationwide growth as projected by the **Federal Office of Statistics**. This level of growth would lead to a GDP increase of almost 30 per cent between 2015 and 2040.

Table 3
Socio-economic data and projections with fuel taxation data, 2015-2040

Value at base year & over time	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Population (thousand)	317 744	321 827	329 120	333 461	337 294	342 370
GDP (2005. constant PPP million)	18 280	19 386	20 375	21 415	22 507	23 655
Fuel price before taxation (USD/lge)						
Gasoline	0.51					
Methane	0.12					
LPG	0.26					
Diesel	0.61					
Electricity	1.31					
Fuel taxation (as % of the fuel cost)						
Gasoline	201%					
Methane	56%					
LPG	96%					
Diesel	145%					
Electricity	107%					

Notes: LDV = Light duty vehicle. LPG = liquefied petroleum gas. lge = litres of gasoline equivalent.

Sources: Statistical Unit of Mannheim, Federal Office of Statistics, General German Automobile Club (ADAC), Federal Ministry of Finance, Clean Energy Partnership, Gibgas

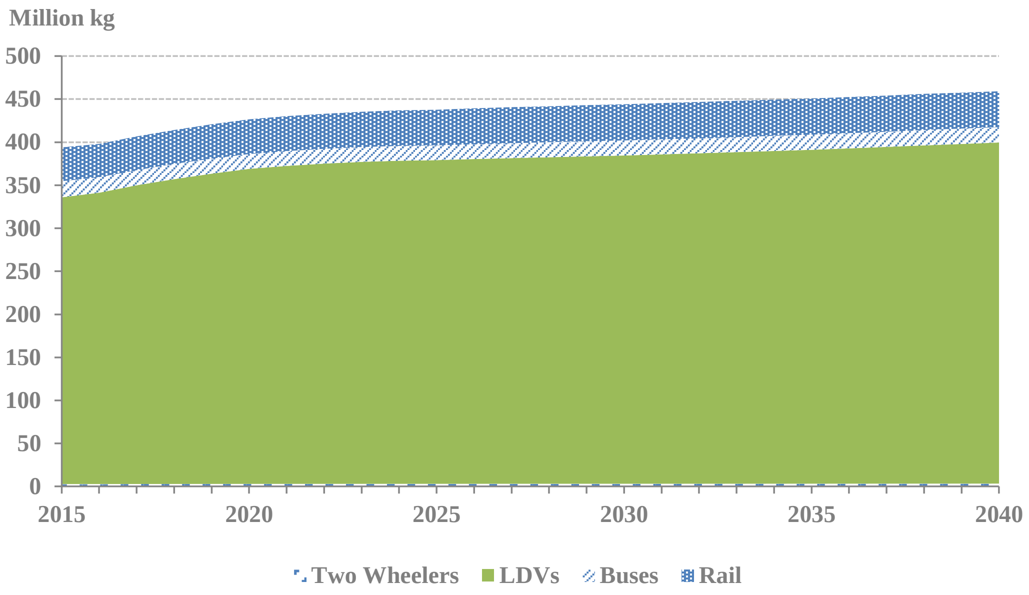
18. Fuel price and taxation data were derived from the **General German Automobile Club (ADAC)** (gasoline, LPG, diesel prices), **Federal Ministry of Finance** (taxes), **Clean Energy Partnership** (hydrogen price), **Gibgas** (methane price).

19. Figure 2a and Figure 2b show the projected *WTW* CO_2 emissions from Mannheim's transport sector by mode within passenger and freight transport, respectively. Projections are generated by the ForFITS tool based on transport-specific inputs given in the tables above as well as projections of socio-economic as specified in Table 3. This reference scenario also includes default data in ForFITS on the expected evolution of fuel consumption characteristics by powertrain in order to reflect future improvements in vehicle technology and their associated costs. The other characteristics defining the transport system in the base year (e.g. fuel taxation schemes, road pricing, passenger/freight transport system structure, fuel characteristics, powertrain technology shares, behavioural aspects) remain unchanged in projections.

20. As a result of Mannheim's projected change in population and GDP, the projected GDP per capita of the country is projected to increase by about 20 per cent (from 57,500 to 69,100) in constant 2005 Purchasing Power Parity (PPP) units) between 2015 and 2040. The per capita GDP level over the time period analyzed is at a level historically coupled with a saturation of the personal vehicle ownership so motorization rate is not projected to increase.

Figure 2a

***WTW* CO_2 emissions by mode in passenger transport under reference scenario, 2015-2040, kg CO_2/year**

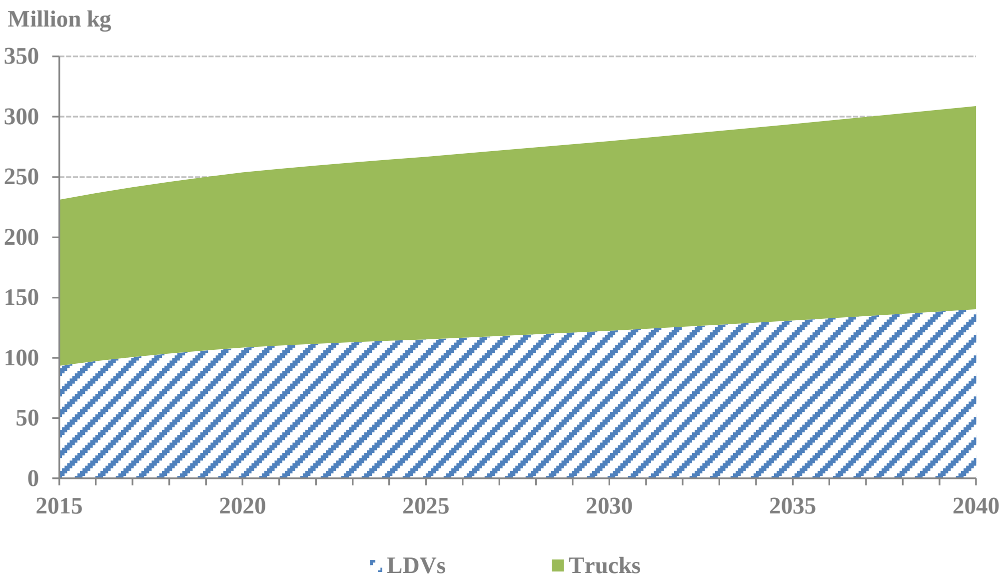


Notes: LDV = Light duty vehicle. Two Wheelers represent a very small proportion of CO_2 emissions and are not visible in this figure.

21. Energy use is projected to grow over time in line with projected transport activity. Fuel savings associated with the improving evolution of the powertrain technologies in terms of fuel consumption only partly offset the upward influence of growing transport activity.

Figure 3b

***WTW* CO_2 emissions by mode in freight transport under reference scenario, 2012-2030, Kg CO_2/year**



Notes: LDV = Light duty vehicle.

22. The projected growth of *WTW* CO_2 emissions follows closely the trend of the energy demand increase, since the emission factors remain constant. Shares of various modes of passenger transport in total emissions under the reference scenario are projected to remain somewhat constant. Overall, passenger emissions are projected to increase by 16 percent compared to 2015.

23. Similarly, shares of various modes of freight transport in emissions under the reference scenario are projected to remain somewhat constant, with the exception of a slight expected increase in the contribution of freight light duty vehicles (LDVs) to emissions (from 40 percent to 45 percent of total freight emissions). Overall, freight *WTW* CO_2 emissions are projected to increase by 36 percent compared to 2015. This increase is greater than passenger transport as a result of the slower projected growth in Mannheim's population over this period as compared to the projected increase in GDP. Freight emissions are projected to continue to be lower than passenger emissions, though the gap closes over this period.

III. Alternative Scenarios

24. This section is split in two different parts. Explanations of the reasons and interest in each of the scenarios are provided in the first section. Following this section, a summary of the transport activity, energy use and CO_2 emissions projections is provided through figures that show results under different scenarios.

A. Scenarios

1. Scenario B - Environmental Culture Shift

25. The *environmental culture shift* scenario assumes a behavioral shift towards more environmentally conscious transport patterns. The practical implementation of this input relies on the ForFITS environmental culture index[5]. An increase in this index implies a decreased level of travel activity through a combination of telecommuting, residing closer to work as well as walking or cycling more. The decrease in activity is somewhat less for public transport modes, but is present in this scenario as well. In addition, this scenario accounts for changes in driving style and/or driving routes to maximize energy efficiency. It should also be noted that moving towards a more environmentally conscious behavior accounts for passenger behavior in the model results and does not affect freight transport.

26. In Mannheim, the environmental culture index at the base year was set at 0.5. This indicates an average level of environmental consciousness compared to other cities. For this scenario, the index value grows to 1.0 (very high environmental consciousness) by 2045.

Due to lack of data, the environmental culture index is not well-calibrated. Projections based on this scenario should be viewed only as rough approximations of the effect of changes in environmental consciousness.

[5] This index ranges from 0 (low environmental consciousness) to 1 (high environmental consciousness). Between these values, the index measures differences in behavior independent of differences in GDP per capita, modal choice, and cost of driving. Index values represent passenger travel behaviour relative to countries or regions with similar socio-economic characteristics. More information available at www.unece.org/fileadmin/DAM/trans/doc/themes/ForFITS/A_-_Coverage__methodology_and_data_requirements.pdf

2. Scenario C - Shift to Public Transport

27. The *shift to public transport* scenario projects future emissions assuming an evolution of passenger transport modal split towards a higher relative usage of public transport. The practical implementation of this input relies on the ForFITS passenger transport system index[6], an instrument that was specifically developed to help understand the changes in the passenger transport system associated with shifts to/from private vehicles from/to public transport.

28. In the *shift to public transport* scenario, the gap between the passenger transport system index value calculated in the base year and the 0.7 target value characterizing regions which trend toward high density and high use of public transport as GDP increases is assumed to be progressively reduced by 20 per cent between the base year and 2040 (from 0.12 to 0.23). The evolution of the passenger transport system index between the base year and 2040 is assumed to be linear, for simplicity. In practice, this assumption represents the implementation of a wide number of policies favoring public transport over personal vehicles, such as parking and access restrictions for personal vehicles, land use policies that encourage the vertical development of the city and mixed use areas, and support for the provision of appealing, widely available and high-quality public transport services. It should also be noted that moving towards a higher passenger transport system index does not affect freight transport.

29. In Mannheim, the passenger transport characteristic index at the base year is 0.12. This indicates a relatively low level of public transport use compared to other cities at similar levels of economic development.This is a somewhat misleading result as commuter and intercity train travel is outside of the scope of this analysis. As a result, the impact of the *shift to public transport* scenario may be somewhat overstated in Mannheim given that the current passenger transport system index at the base year is not as far from the 0.7 target as calculated using the available data.

3. Scenario E – Combined

30. The cumulative effect of the previous two policy scenarios – Environmental Culture Shift and Shift to Public Transport– is shown in Scenario E. This scenario shows the result of implementing these policies concurrently.

B. Scenario Results

31. Figures 3 to 7 show the evolution of passenger/freight activity (pkm/tkm), energy use (toe) for passenger and freight transport separately and total kg of CO_2 emissions (*WTW*) for Mannheim in the three scenarios. All scenarios use the reference scenario as a starting point for evaluating policy changes. It should be noted that freight activity and emissions are unchanged under the alternative scenarios.

---

[6] This index ranges from 0 (the share of personal vehicles in pkm tends to 100 per cent when GDP increases) to 1 (the share of personal vehicles in pkm is 0 per cent). Between these extreme values, the index measures differences in modal choice independent of differences in GDP per capita, cost of driving and behavioural aspects. Index values represent the share of personal vehicles in pkm relative to countries or regions with similar socio-economic characteristics. Changes in modal shares over time for a country or region with a constant index value (the default option) are attributed to changes in GDP per capita, cost of driving and behavioural aspects. More information ia available at www.unece.org/fileadmin/DAM/trans/doc/themes/ForFITS/A_-_Coverage__methodology_and_data_requirements.pdf

32. Table 4 shows the values of the main outputs in the *reference* scenario for Mannheim, at the first and last year of the projections, as well as the projections in 2040 for the three additional scenarios described above.

Table 3
Main outputs: Reference and alternative scenarios

		2015	**2040**			
	Unit		**Reference**	**Culture Shift**	**Public Transport Shift**	**Combined**
Total pkm	million pkm	2 702.9	3 406.0	3 133.4	3 227.5	2 972.6
Total tkm	million tkm	899.6	1 203.9	1 203.9	1 203.9	1 203.9
Total energy use	million toe	172.57	209.74	194.82	196.17	183.06
Total WTW CO_2 emissions	million kg CO_2	625.45	768.10	714.02	728.02	679.78
Total WTW CO_2 emissions per capita	kg CO_2/person	1 968.4	2 243.5	2 085.5	2 126.4	1 985.5
Total WTW CO_2 emissions intensity	kg CO_2/GDP[1]*1000	34.2	32.5	30.2	30.8	28.7

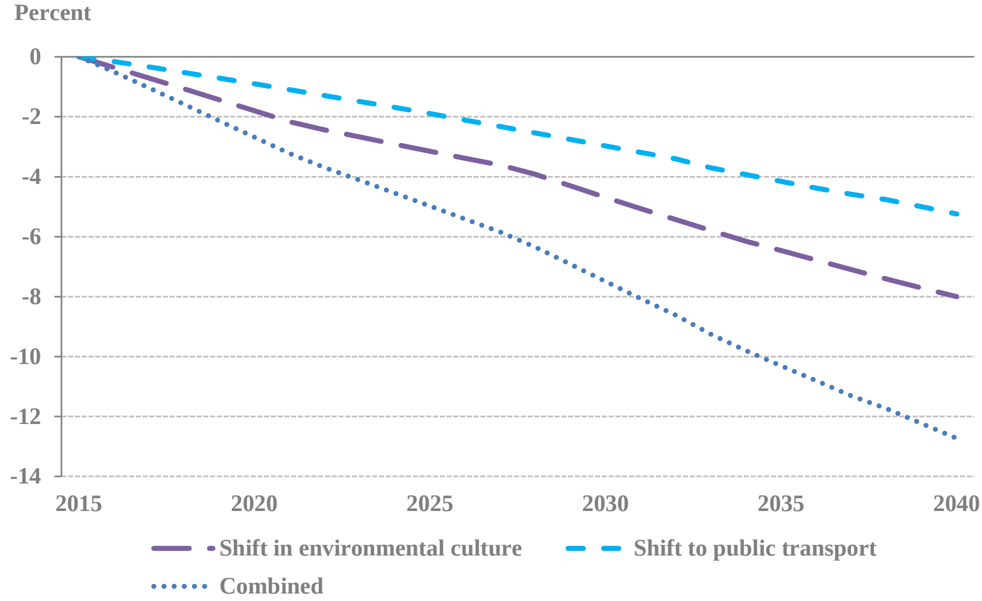
Note: GDP is measured in purchasing power parity (PPP) units at 2005 prices

33. In Figure 3, the passenger transport activity (measured by pkm) resulting from the *environmental culture shift, shift to public transport scenarios* and their *combined effect* are compared with the *reference* scenario.

34. Under the *shift to public transport scenario*, pkm is projected to decrease in comparison with the *reference* scenario (approximately 5 percent lower by 2040). This projected decrease in passenger travel is related to the assumption of movement toward conditions that are conducive to successful public transport systems such as increased population density through urbanization. As the population is more centralized in 2040 under this scenario, the average distance travelled by residents is projected to decrease.

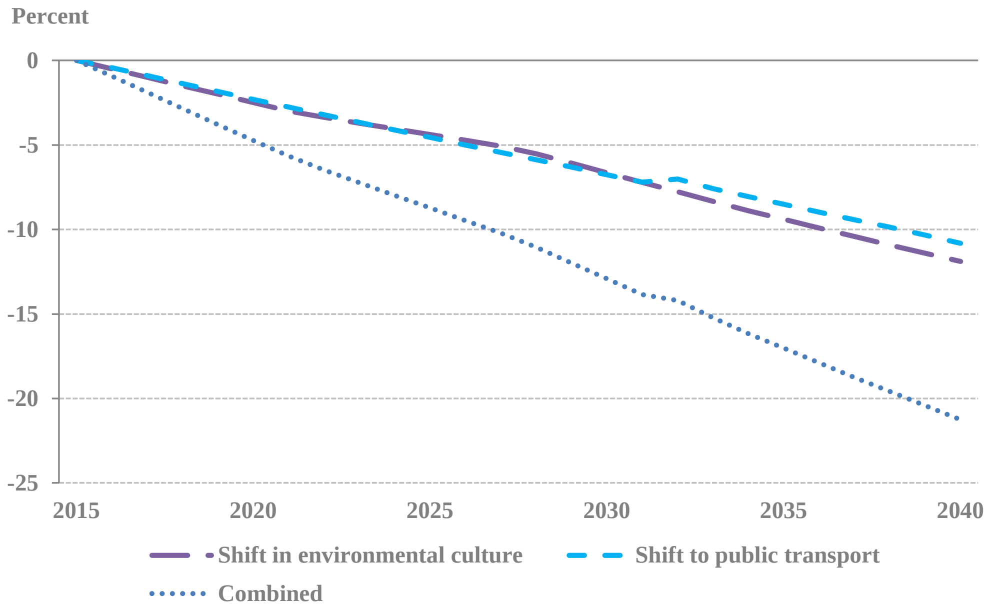
35. Passenger transport activity decreases more under the *environmental culture shift* scenario as compared to the *reference* scenario. This decrease (8 percent) is the result of projected changes in attitudes toward the environment as demonstrated through a combination of telecommuting, residing closer to work as well as walking or cycling more.

Figure 4
Projected percentage decrease in passenger kilometers (pkm) under various scenarios compared to the reference scenario: 2015-2040



36. The *combined* scenario projects a total decrease of almost 13 percent by 2040 in comparison with the *reference* scenario.

Figure 4
Projected percentage decrease in passenger transport energy use (toe) under various scenarios compared to the reference scenario: 2015-2040



37. Figure 4 shows the projected decrease in passenger transport energy use under the alternative scenarios as compared to the *reference* scenarios. Under the *shift to public transport* scenario, this projected decrease passenger transport energy use in the *reference*

scenario is almost 11 percent by 2040, partly because of the reduction of passenger transport activity explained earlier and partly because public transport modes are more energy efficient than personal transport modes. The *environmental culture shift* scenario projects a reduction of almost 12 percent by 2040, due to changes in driving style and/or driving routes to maximize energy efficiency. The *combined* scenario projects a total decrease of 21 percent by 2040 in comparison with the *reference* scenario.

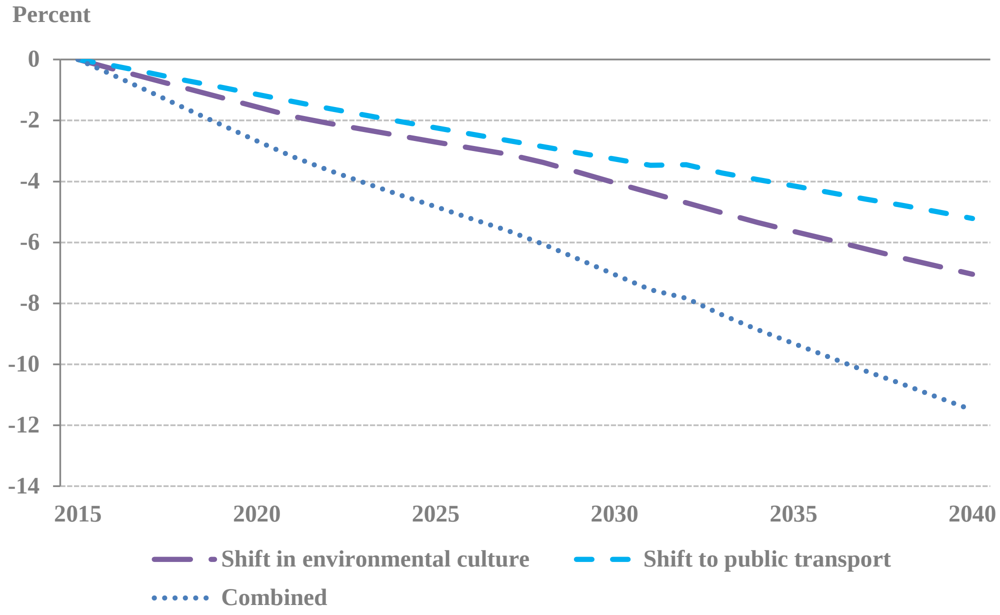
38. In Figure 5, the total projected decrease in *WTW* CO_2 emissions from transport activity (including both passenger and freight activity) are shown for each alternative scenario compared with the *reference* scenario.

39. Under the *shift to public transport* scenario, the decrease in WTW CO_2 emissions in 2040 compared to the *reference* scenario is approximately 5 percent. The impact of this scenario on energy use and WTW CO_2 by 2040 is the same (11 percent decrease in passenger transport only and no effect on freight transport).

40. Under the *environmental culture shift* scenario, the decrease in WTW CO_2 emissions in 2040 compared to the reference scenario is approximately 7 percent. As described earlier, this scenario reduces approximately 12 percent of the passenger transport energy use by 2030 in comparison with the *reference* scenario and does not affect freight transport energy use.

41. Overall, the *combined* scenario projects a total decrease of more than 11 percent by 2040 in total WTW CO_2 emissions for the transport sector in Mannheim in comparison with the *reference* scenario. This is the result of adding up the reductions achieved in each of the previous scenarios, since the simulated scenarios are not interconnected.

Figure 5
Projected percentage decrease in Well-To-Wheel CO_2 emissions for transport under various scenarios compared to the reference scenario: 2015-2040



IV. Conclusion

42. The estimated *WTW* CO_2 emissions in 2015 from the transport sector for Mannheim show that emissions from freight vehicles were about 40 per cent less than those from passenger vehicles (394 million kg vs 231 million kg).

43. Projections of CO_2 emissions from the transport sector in Mannheim show an overall increase of about 23 per cent by 2040, with higher increases in emissions resulting from freight transport in comparison to passenger transport. This difference can be largely explained by the slower projected growth in population over this time period in contrast with the projected economic growth. The increase in each sector, however, shows the impact of expected economic growth on CO_2 emissions.

44. While projections of future CO_2 emissions under the three alternative scenarios show this same increasing trend, several demonstrate opportunities to decrease future transport CO_2 emissions relative to the reference scenario. The *shift to public transport* scenario results in a 10 percent decrease in passenger transport energy use and a 5 percent decrease in total WTW CO_2 emissions in 2040 compared to the *reference* scenario. This decrease is attributed to two reasons: first, a decrease in total passenger transport activity associated with land use policies for denser cities and mixed use areas; second, a shift of passenger transport activity towards more energy efficient transport modes associated with policies favoring public transport over personal vehicles. In comparison with the reference scenario, the *environmental culture shift* scenario reduces passenger transport energy use and total WTW CO_2 emissions by 11 and 7 percent respectively in 2040. This scenario shows the potential difference changes in citizen behavior can make through more environmentally conscious travel behavior. These results together show the effect of steps that can be taken by Mannheim to limit emissions from the transport sector. Mannheim faces challenges in that its expected future economic growth would typically correspond with an increase in CO_2 emissions. However, improvements in the efficiency of its transport sector could help mitigate these issues.

45. The results provided in this report demonstrate the potential impact of increasing the share of public transport in passenger transport activity and increasing environmental consciousness. Projections generated by ForFITS based on these scenarios show that pursuing such policies can adjust the current trend of increasingly high *WTW* CO_2 emissions stemming from the transport sector of Mannheim downward. With an aim toward mitigating the impact of future CO_2 emissions from its transport sector, the city of Mannheim may wish to further investigate the relative cost of implementing the following measures:

(a) Developing conditions and policies so that cities are more favorable for the use of public transport and less favorable for the use of personal vehicles;

(b) Developing policies, such public service campaigns, to heighten environmental consciousness.