

Distr.: General
12 February 2015

English only

Economic Commission for Europe

Inland Transport Committee

Seventy-seventh session

Geneva, 24–26 February 2015

Item 3.4. (b) (ii) of the provisional agenda

Transport policy and regulatory issues that require decisions by the Committee:

Environment, climate change and transport:

Mitigation of environmentally harmful effects of inland transport

For Future Inland Transport Systems (ForFITS)

Implementation for UNECE member States

Status Report for Inland Transport Committee (ITC)

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I. Project Background and Executive Summary

1. The goal of the For Future Inland Transport Systems (ForFITS) UNECE-wide implementation project is to produce estimations of future CO₂ emissions attributed to the transport sector of member States of the United Nations Economic Commission for Europe (UNECE) using the ForFITS tool.¹ ForFITS has already been tested successfully in pilot studies in seven countries around the world and building on these results through this study is expected to offer a unique service to member States by assessing future policy impacts on overall transport CO₂ emissions at a region-wide level.

2. The results of this project are intended to provide a useful basis for analysis of region-wide trends in vehicle activity, energy use, and CO₂ emissions stemming from the transport sector for UNECE member States. It also demonstrates how member States can use ForFITS to assess trends at national or sub-regional levels. This analysis will complement existing national tools for measuring and projecting emissions by providing results which are comparable and can be aggregated at a regional level. The use of ForFITS will allow for analysis of countries where detailed data are not available. The initial output for each country will reflect a reference scenario, or baseline, where no significant changes in the drivers of transport activity, energy use, and emissions are modelled. Transport policy changes, including those that could mitigate CO₂ emissions, are not within the scope of this scenario. Alternative scenarios will be investigated in later phases of the project and will assess the changes in the baseline as a result of different policy options (see the *Future Tasks* section in this report).

3. Though projections are generated separately for each member State, provisional results generated for this report provide a region-wide assessment. To date, initial assessments have been made using ForFITS for 22 UNECE member States.² As a percentage of the UNECE region, these countries represent 56 per cent of the population and 77 per cent of the Gross Domestic Product (GDP) measured in Purchasing Power Parity (PPP) units in 2012. For several graphs the countries have been divided into two regional groups (Central and Eastern Europe,³ Western Europe and North America)⁴ in order to highlight different characteristics of projections among member States.

4. The graph below shows the provisional projected trend in well-to-wheel (WTW)⁵ CO₂ emissions between 2012 and 2040, with no policy intervention, for the member States analyzed. The change over time primarily reflects projections of population growth and GDP growth. Differences in economic maturity also play a factor as countries with a lower GDP per capita in 2012 are projected to have increased freight and passenger activity in the future as their economies close the gap to countries with higher GDP per capita. Overall, CO₂ emissions from passenger transport are projected to decrease by more than one fifth

¹ More information on ForFITS, including the tool and user manual, is available on the UNECE website – www.unece.org/trans/theme_forfits.html

² Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Georgia, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Montenegro, Netherlands, Norway, Poland, Slovakia, Slovenia, Switzerland and the United States of America

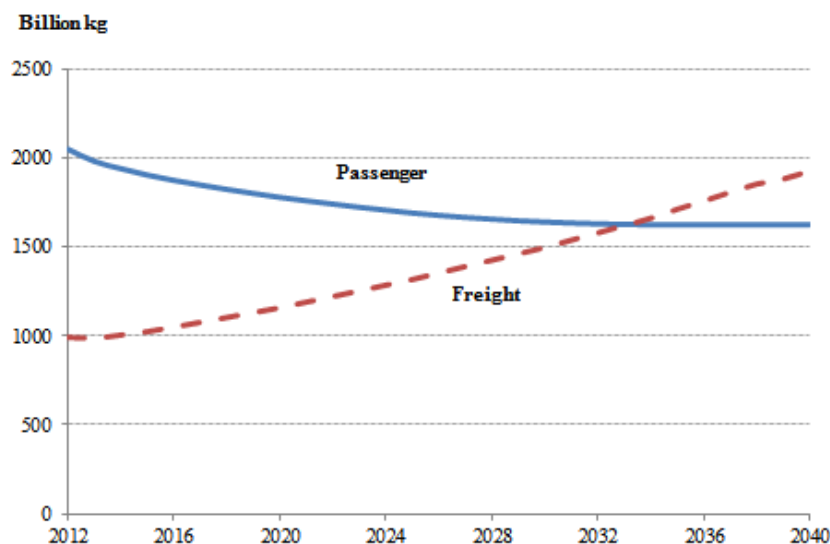
³ Central and Eastern Europe = Czech Republic, Georgia, Hungary, Latvia, Lithuania, Montenegro, Poland, Slovakia and Slovenia.

⁴ Western Europe and North America = Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Norway, Switzerland, United States of America.

⁵ Well to wheel (WTW) refers to CO₂ emissions from both a vehicle itself through its operation as well as emissions from the production and distribution of the fuel used for the vehicle's operation.

(21 per cent) by 2040 while emissions from freight transport are projected to nearly double (+ 94 per cent) in the same time period.

Figure 1
Well-to-wheel CO₂ emissions from freight and passenger inland transport in selected UNECE member States: 2012–2040



Note: Vessels and aircraft are not included. Well-to-wheel = CO₂ emissions from both vehicle operation and emissions from production and distribution of fuel used for operation.

5. As mentioned above, this data is based on a subset of member States and significant further work needs to be done to increase the amount of source data available in order to use the ForFITS tool for the full UNECE region.
6. The remainder of this document will set out the work done to date and the challenges faced, provide provisional results and provide a tentative schedule of further tasks to be completed.

II. Status

7. For an analysis of UNECE member States several distinct tasks were necessary. Each of these tasks are briefly described below:

A. Historical data collection

8. Since April 2014, relevant data from international agencies and websites of national statistics offices for each UNECE member State have been gathered and entered into a ForFITS database. In addition, questionnaires were sent to member states giving member States the opportunity to confirm data collected from public data sources and add missing data where possible. The final letters were disseminated in early November 2014. As of 1 February, twelve countries⁶ had completed and submitted their completed questionnaires to UNECE. The completed questionnaires have provided welcome insight into the transport

⁶ Austria, Belgium, Bulgaria, Canada, Czech Republic, Denmark, Finland, Ireland, Lithuania, Netherlands, Slovakia and Switzerland.

systems of these countries. Useful results require good input data and all other UNECE member States are invited to complete and return the questionnaire to ensure the quality of future analyses remains high.

B. Input data estimation where data gaps exist

9. Though the member States on which analysis was focused were those with the highest level of available data or those which had been the subject of past UNECE studies using ForFITS, estimation was still required for a number of missing inputs. Techniques such as interpolation, analogies, as well as more advanced statistical methods as necessary were utilized in order to estimate missing data.

C. Development of input projections

10. The ForFITS tool requires inputs of the projected changes in a country's economy and population. Projections were analyzed to ensure they were within the range of international historical norms and aligned with projections performed by other international organizations. Economic projections take into account International Monetary Fund (IMF) projections while population projections focus on the UN Population Division biannual projections except in cases where countries provided projections in completed questionnaires.

D. Generation of projections of CO₂ emissions and analysis of results

11. After the assembly of input data, ForFITS was used to generate projections of CO₂ emissions. The separate analysis of each country ensures that results reflect realistic scenarios and comparisons can help to identify any outliers. In some cases, data have been revisited where results were not in line with realistic expectations.

III. Challenges

12. The large number of minimum data requirements and the gaps in international transport statistics present a difficult issue for developing projections of activity and CO₂ emissions. It shows that transport statistics are in need of much better coordination at the international level, data availability at individual country level may vary greatly and breakdowns of statistics are not standardized as much as it is the case in some other sectors.

13. With this in mind, the reliability and comparability of the data were assessed throughout the process. Where data are estimated, numerous checks on the data were performed to ensure that such inputs were reasonable and justifiable. In addition, differences in terminology between country databases are analyzed and adjustments are made to data where necessary to ensure that regional totals are cohesive. Despite data quality checks, there is some uncertainty around not only the estimations, but also around the official data in the database. For these reasons, countries are being analyzed at a deliberate pace and results will not be finalized until they have been properly audited.

14. In general, data on vehicle stock were available, but many other important input data were more difficult to find. Common data gaps included the following:

- Average fuel consumption for vehicles other than passenger cars.
- Average annual distance travelled for vehicles other than passenger cars.

- Average vehicle load
- Breakdown of vehicles by powertrain
- Vessel related data
- Aircraft data

15. Based on these data gaps, the results given in this report do not include inland water, maritime and air transport. Difficulties in estimating data in these modes due to differences in vehicle size, fuel consumption and average travel within each sector and between countries contributed to the decision to delay their inclusion in analysis. However, it is noteworthy that preliminary indications suggest that a large portion of freight vehicle activity and freight CO₂ emissions may result from inland water and maritime vessels in some countries.

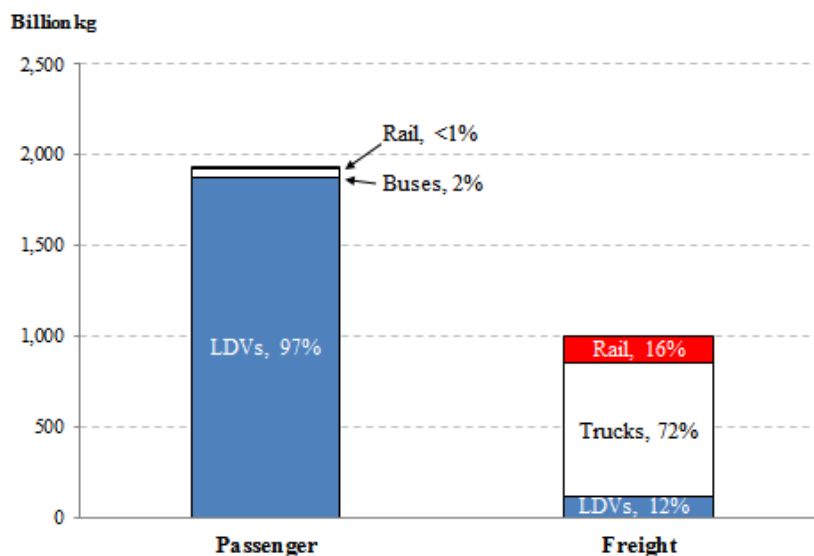
IV. Provisional results

A. Current status in UNECE Region

16. The provisional breakdown of estimated WTW CO₂ emissions in 2012 from the transport sector for the UNECE member States analyzed is shown in Figure 2. Emissions from passenger transport in 2012 are estimated to be nearly twice as much as those from freight transport. For freight transport, trucks are estimated to be responsible for the majority of CO₂ emissions (72 percent); while for passenger transport and mobility, passenger light duty vehicles (LDVs) are estimated to be by far the largest emitter of CO₂ (97 percent).

Figure 2

Relative inland transport sector well-to-wheel CO₂ emissions by mode of transport, selected UNECE member States: 2012



Note: LDV = Light duty vehicle (classified as passenger or freight depending on usage). Passenger two-wheelers (not shown) <0.1 per cent of passenger CO₂ emissions. Vessels and aircraft not included. Percentages may not sum to 100 per cent due to rounding. Well-to-wheel = CO₂ emissions

from both vehicle operation and emissions from production and distribution of fuel used for operation.

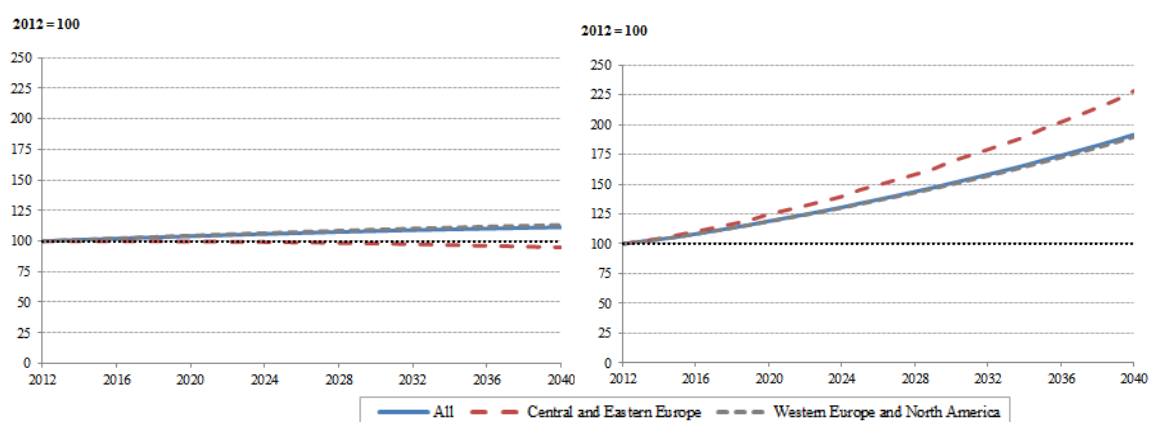
17. These emissions figures compare with the fact that passenger buses and rail are estimated to account for 12 per cent of passenger kilometers (pkm)⁷ vs 3 percent of CO₂ emissions. Correspondingly, the share of passenger LDVs in total pkm is 88 per cent compared to 97 per cent of CO₂ emissions. For freight vehicles, trucks remain responsible for the majority of freight transport activity⁸ (64 per cent), though the share of rail is much greater than for CO₂ emissions (34 per cent vs 16 per cent). This shows the higher efficiency level of public vs private transport and of freight rail vs freight truck with regard to CO₂ emissions.

B. Forecasts to 2040

18. Projected population and GDP trends for the countries analyzed are shown below in Figure 3. Regional differences are evident as GDP growth in Central and Eastern Europe is projected to be stronger than Western Europe and North America for countries in the study (average annual growth of 3.0 per cent vs 2.3 per cent). In addition, a slight population decrease is expected in the Central and Eastern European countries analyzed while a mild population increase is expected for Western European and North American countries studied. Each of these factors as well as the substantially higher growth of GDP as compared to population for all regions has a direct impact on the projections for CO₂ emissions.

Figure 3

Projected population (left) and Gross Domestic Product (GDP) trends (right) in selected UNECE member States, by region: 2012–2040



Note: 2012 = 100. Economic trends shown in terms of constant (inflation-adjusted) Purchasing Power Parity (PPP) growth. See report for definitions of regions.

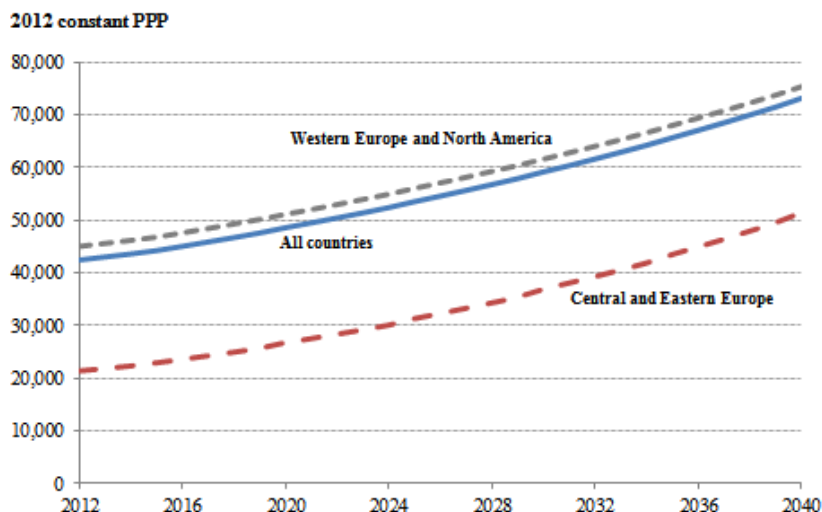
19. As a result, the gap between per capita GDP between Central and Eastern European countries and the region as a whole is projected to narrow. While in 2012, the per capita GDP of countries analyzed in this region was 48 per cent that of Western Europe and North

⁷ A passenger kilometer is defined as a unit of passenger carriage equal to the transportation of one passenger one kilometer.

⁸ Freight activity is measured in tonne kilometers – defined as a unit of freight carriage equal to the transportation of one metric ton of freight one kilometer.

America countries analyzed, this percentage is projected to increase to 68 per cent by 2040. Projected per capita GDP trends for the countries analyzed are shown below in Figure 4.

Figure 4
Projected per capita Gross Domestic Product (GDP) in selected UNECE member States, by region: 2012–2040



Note: Data shown in 2012 constant (inflation-adjusted) Purchasing Power Parity (PPP) units. See report for definitions of regions.

20. Figure 1 (see summary section) shows projections of CO₂ emissions stemming from inland transport for all countries analyzed in this study. These projections are based on an assumption of improvements in vehicle by powertrain and shifts in transport due to changes in the economic situations of countries. These projections are steady-state changes and reflect the following:

- unchanged fuel prices and taxes,
- changes in the share of transport on personal motorized passenger vehicles based on historical trends in economic development rather than policy changes
- unchanged powertrain technology shares for all vehicles and all modes,
- improvement of the fuel consumption characteristics of each powertrain technology based on historical trends
- unchanged CO₂ well-to-tank and tank-to-wheel emission characteristics

21. Overall, CO₂ emissions from passenger transport and mobility are projected to decrease by more than one fifth (21 per cent) by 2040 as a result of several factors including low population growth and improved fuel efficiency. Emissions from freight transport are projected to nearly double (+ 94 per cent) in the same time period due primarily to sustained economic growth.

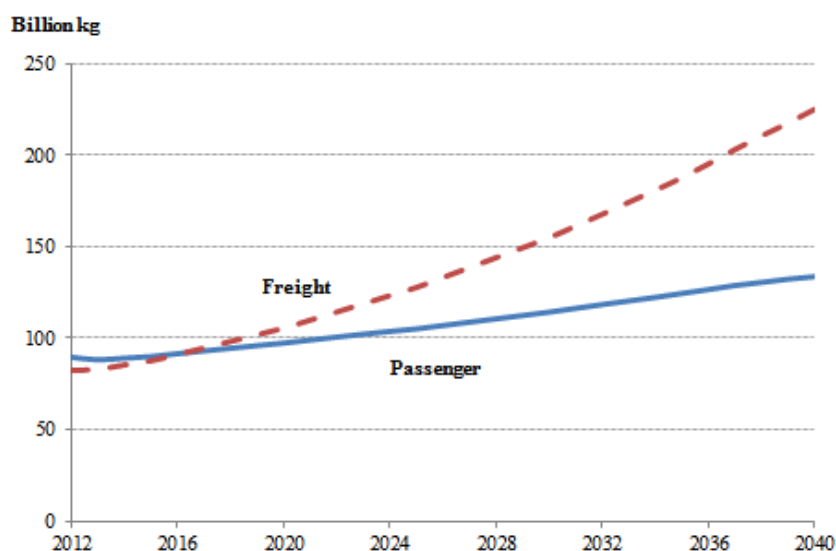
22. Focusing specifically on Central and Eastern European countries as shown in Figure 5 below,⁹ the relative growth of emissions from the freight sector compared to the passenger sector is similar to the overall trend in all the countries studied. While the trend is

⁹ As the contribution of Central and Eastern European countries to total emissions of countries studied is relatively small, the projections for Western Europe and North America are similar to those in Figure 1.

similar, the starting points differ. Notably, emissions from freight transport in 2012 in this region are at nearly the same level as emissions from passenger transport, partly as a result of the lower motorization rate of citizens in these countries compared to the rest of the countries studied. For the full set of countries included in this report freight transport accounted for approximately half the emissions of passenger transport.

Figure 5

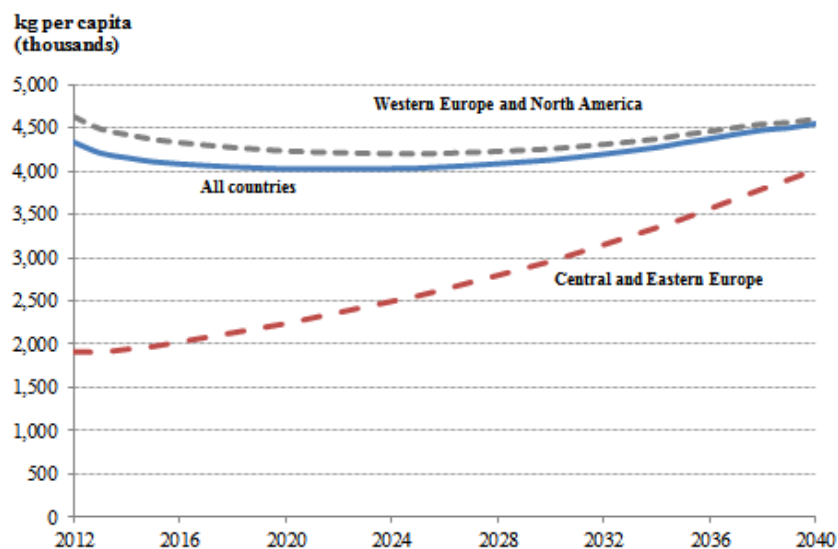
Well-to-wheel CO₂ emissions from freight and passenger inland transport in selected UNECE member States in Central and Eastern Europe: 2012–2040



Note: Vessels and aircraft not included. Well-to-wheel = CO₂ emissions from both vehicle operation and emissions from production and distribution of fuel used for operation. See report for definitions of regions.

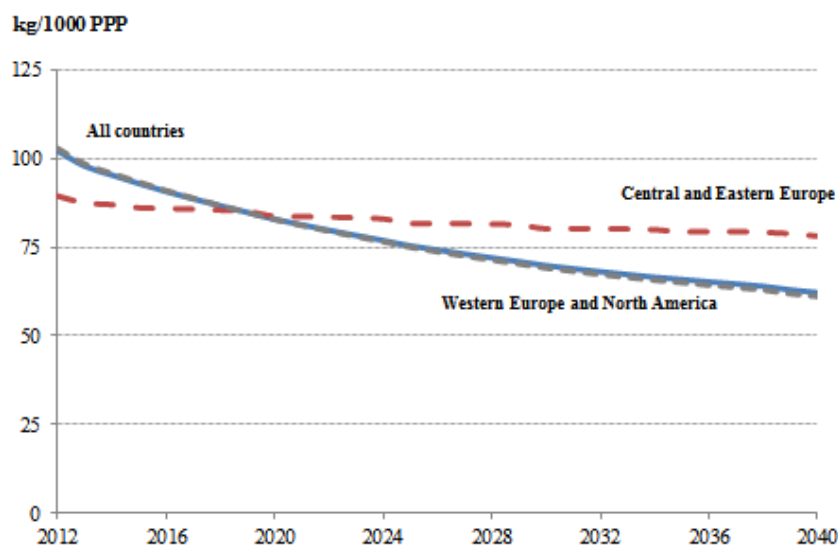
23. Projected CO₂ emissions per capita and per unit of GDP are shown in Figure 6 and Figure 7. Regional differences are again evident when looking separately at the two groups of countries mentioned previously. Central and Eastern European countries show large growth in per capita emissions compared to Western European and North American countries in the study. For emissions per unit of GDP, the Central and Eastern Europe region projects to have a decrease that is less pronounced than that for Western European and North American countries analyzed.

Figure 6
Well-to-wheel CO₂ emissions per capita from inland transport in selected UNECE member States, by region: 2012–2040



Note: Vessels and aircraft not included. Well-to-wheel = CO₂ emissions from both vehicle operation and emissions from production and distribution of fuel used operation. See report for definitions of regions.

Figure 7
Well-to-wheel CO₂ emissions per 1000 units of GDP from inland transport in selected UNECE member States, by region: 2012–2040



Note: GDP = Gross Domestic Product. Solid line represents all countries. Vessels and aircraft not included. Well-to-wheel = CO₂ emissions from both vehicle operation and emissions from production and distribution of fuel used for operation. GDP calculated in 2012 constant (inflation-adjusted) Purchasing Power Parity (PPP) units. See report for definitions of regions.

C. Conclusions

24. Based on UNECE projections, freight transport will be the main driver of increases in CO₂ emissions in the next decades for the countries analyzed due to continued economic growth and moderate to low population growth. Though freight transport activity is projected to be closely correlated to economic growth, the overall intensity of emissions (as measured by emissions per unit of GDP) is expected to decrease over this time, possibly due to improvements in the efficiency of various powertrains. The countries analyzed seem to have reached a plateau in per capita CO₂ emissions as very little growth or decrease is projected in future years. However, these overall trends mask regional differences such as increasing emissions intensity ratios for countries in Central and Eastern Europe with lower economic output per person today. This change for these countries is expected as the sub-region approaches average economic standards in the UNECE region.

25. This is only the first step in a continuing work programme aimed at increasing the functionality and reliability of the model based on increasing source data within the model. Some areas will continue to be omitted due to resource constraints (for example inland water, maritime and air transport due to lack of vessel and aircraft data). Including these modes of transport, which could represent a large proportion of CO₂ emissions in some countries, would give a more complete view of the impact of transport overall, but for the moment the model remains focused on road and rail in inland transport. In the interim period, the UNECE will continue to research this topic in order to better estimate typical average distances travelled and average fuel consumption (among other parameters). In addition, lack of data on load, fuel consumption and distance travelled for passenger and freight limit the information that can be gleaned from analysis in some cases. Bias in the analysis is also possible if countries which have provided data for these areas exhibit characteristics that are not representative of countries which have not provided data. Where possible UNECE has limited this shortcoming.

26. Overall, the provisional results given in this report show the added value of the ForFITS tool in assessing future trends in CO₂ emissions related to the transport sector as well as transport activity. Most importantly, the analysis shows that important regional differences and sectors requiring particular attention in the future can be identified using the tool. It is recommended that additional countries help to fill in data gaps so this analysis can be expanded to the full UNECE membership. This will also assist in the evolution and greater functionality of the tool as discussed below.

V. Future Tasks

27. The next steps for the ForFITS model can be divided into two broad categories:

- (a) Consolidating the current functionality
- (b) Adding functionality focused on assessing the effects of different policy decisions on CO₂ emissions

28. The most immediate task for this project is to **consolidate current functionality** by continuing to search for data and implement ForFITS for the remaining 37 member States which have not yet been analyzed. Member States are encouraged to complete the ForFITS questionnaire which was disseminated in November 2014. Where data remain unavailable, estimations will be used based on those data that are available. However, as the level of required estimation increases, the robustness of projections decreases. This is largely due to the nature of estimations in a limited data environment. Countries with good data are often those with higher per capita incomes and using these data as estimates may result in biased

projections. In addition, distinct characteristics of some countries could be masked by using such estimations of input data.

29. After initial analyses are complete for all countries, several general **policy scenarios will be reviewed at regional and subregional levels** to assess their effect on future activity and CO₂ emissions. The policies analyzed will represent realistic scenarios that could be implemented over the next 30 years and will be chosen with an aim of providing results that will help member States to make informed decisions on which transport policies are more appropriate to achieve their CO₂ emission reduction targets in the future. The definition of the scenarios will depend on the results of the baseline analysis but could include such options as changes in taxes/subsidies on various types of fuel and road use or changes in powertrain technology among others. External scenarios that are less controllable such as changes in oil prices or economic projections may also be included to provide a fuller picture of how transport activity and related emissions could evolve in the next decades. The final scenarios to be modelled will be identified after further discussion over the coming months.

30. Governments of member States which submitted data will be provided with results for their own country upon request, both in terms of the current baseline and potential future results from different policy interventions. The secretariat will be prepared to discuss these results individually.
