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# Noise exposure scenarios in 2020 and 2030 outlooks for EU 28

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# 1 Key messages

General findings:

- The calculated projections show that the number of people exposed to high noise levels would increase in all noise sources (roads, railways and aircraft noise) except for industries inside agglomerations by 2020 (short term scenario).
- Prediction of exposure values for $L_{night}$ follow the same pattern obtained with the calculations for $L_{den}$ in short and mid-term scenario, with even a higher decrease of people exposed to road traffic noise inside urban areas (up to 28% of change when comparing 2020 and 2030 estimations).

Specifically concerning road traffic noise:

- Mid-term scenario (2030) with the consideration of urban policies and targets mainly for road transport inside cities could imply a decrease of the number of people exposed, predicting an important decrease of the number of people exposed to road traffic noise inside urban areas compared with the values estimated in 2017 baseline reference year.
- Specific urban targets on clean urban transport at European level established in 2011 Transport Policy White Paper to be implemented by 2030, could lead to a reduction of more than 22% of people exposed to high road traffic noise inside urban areas when comparing short and mid-term scenario, with a reduction of nearly 17% if the comparison is done between mid-term scenario and baseline data.

Specifically concerning railways traffic noise:

- Exposure to railway noise (both inside and outside agglomerations) potentially presents the higher increase in percentage of people exposed for both periods 2017 – 2020 and 2020-2030, with a final balance of nearly 20% increase of the people exposed to railways noise in 2030 if compared with values estimated in 2017 baseline reference year.

Specifically concerning the aviation sector:

- By 2030, future technological improvements could imply a stabilization of aircraft noise exposure and potentially a mean reduction of 2% compared with exposure values corresponding to 2017 reference year, both inside and outside urban agglomerations.

# 2 Introduction

Traditional traffic noise prediction models (as well as rail traffic and aircraft traffic models) are developed to fit for town planners and for noise abatement and control. They are not designed to estimate projections of noise exposure at regional scale.

Data required by noise traffic models include: roadway input (pavement type, local topography, roadway length, etc.), traffic characteristics (traffic volumes, vehicles categories, vehicles speed and flow, etc.), receptor locations, noise barriers description, building rows and meteorological conditions (e.g. relative air humidity). The availability of this local data, the high speed processing computers and skilled operators required to run these models, make them unsuitable for the calculation of large-scale projections.

Moreover, the majority of those models are not fitted to provide yearly-averaged noise indicators, such as $L_{den}$ and $L_{night}$ in accordance with the Noise Directive (END). From the 9 models developed in recent years and reviewed by Garg and Maji, (2014) only the CNOSSOS-EU model includes data on population exposure.

The proposed method looks for a final number of EU population exposed to noise levels to the future 2020 and 2030 years. Data of population exposed at the different noise bands (dB) by each source (i.e. road, rail, air, and industry), distinguishing between urban and rural population[1], are going to be aggregated both at country level and summarized at EU28 level, both for $L_{den}$ and $L_{night}$ exposure values. The spatial coverage of the calculations cover the EU28 member states: Switzerland, Iceland, Liechtenstein, Norway, Turkey are excluded from this assessment because the projections on transport activity are based on the “EU reference scenario 2016” (European Commission, 2016) which only contain estimated projections for the EU28 member states.

Differentiated methodological approaches and auxiliary data are proposed for each transport noise source. The reference population is the END database 2017 gap filled (methodology applied to produce the gap filled dataset is explained in Annex 1). The macroeconomic and demographic assumptions used in the Reference Scenario (European Commission, 2016) provide the framework projections on how the END exposed population 2017 will perform in the coming decades. Therefore, the noise exposure projection achieved in this assessment is driven by trends supplied by upstream models or other sources.

The proposed approach considered the positive impact of urban targets (i.e. urban target of the “2011 White Paper on Transport”) that will inevitably counteract the expansion of the transport networks and the demographic increase in urban areas, as well as technology developments foreseen in the aviation sector, which would influence the results obtained on the estimations of exposure to aircraft noise by 2020 and 2030.

## 3 Scope of the document

The aim of this document is to calculate a trend projection of noise population exposure changes across the EU-28 in a scenario at unchanged policies (i.e. baseline scenario or reference scenario). Results are presented distinguishing between two time periods: up to 2020 (the short term) and 2030 (the medium term) for both $L_{den}$ and $L_{night}$ indicators above the END thresholds.

As highlighted in the “EU reference scenario 2016” (European Commission, 2016), the exercise developed by the current task is focused on trend projections and not forecasts, with the provision of several noise exposure values to different noise sources as one of the possible future situations given certain conditions. The results obtained can help inform the debate on where currently adopted policies might lead the EU and whether further policy development, including the longer term, is needed (European Commission, 2016).

The calculated projections are based on the assumption that current policies and planned objectives related to population and transport trends will be achieved and implemented, as well as land use change projections developed by JRC (Lavalle et al., 2014). Therefore, the results obtained would correspond to a baseline scenario (also referred as reference scenario).

This document provides a description of the methodology, the data used to calculate the estimations of such projections and the results obtained per each noise indicator and each noise source.

[1] Rural population = outside END agglomeration

# 4 Data inputs

## 4.1 Reference population exposure data baseline

The data used for this assessment is based on the data reported by countries under the END. The data is reported in 5dB bands. The END distribution of $L_{den}$ consists of five dB intervals: 55-59, 60-64, 65-69, 70-74, >75, while the intervals for $L_{night}$ consist on the following dB values: 50-54, 55-59, 60-64, 65-69, >70.

The reference population (People exposed at $t_0$) is going to be the estimated gap filled population exposure to each noise source inside (air, industry, rail and road noise) and outside agglomerations (major roads, major railways and major airports exposure data) of the END database, for 2017 reference year. The dataset containing the 2017 baseline estimated exposure gap filled data has been calculated following the methodology described in Annex 1.

The spatial coverage of the calculations cover the EU28 member states: Switzerland, Iceland, Liechtenstein, Norway, Turkey are excluded from this assessment because projections on transport activity are based on the “EU reference scenario 2016” (European Commission, 2016) which only contain estimated projections for the EU28 member states.

## 4.2 EU population projection

The availability of population data at grid level provide detailed and accurate information about the population distribution in Europe. In this sense, the projected population distribution maps from 2010 to 2050 of the Land-Use based Integrated Sustainability Assessment (LUISA) (Lavalle et al., 2014) are used to calculate city-specific and country-specific population cumulative annual growth indices.

The population grid created by the JRC is based on LAU population (EUROPOP2010) and CORINE land cover (CLC 2006). The core module of LUISA allocates population, services and activities to the most optimal 100m grid cells, given predefined suitability maps, regional demands and the supply of resources in a region. LUISA simulates the dynamic process of population and land use change on an annual basis, starting in 2006 and continuing until 2050 (Kompil et al., 2015).

The EU28 population projection to 2020, 2030 and 2050 disaggregated at 100x100 m grid has been used in the current activity on noise exposure projection, allowing data aggregation to the desired level, i.e. agglomerations and countries. The population distribution rasters from the LUISA platform can be downloaded at: https://data.jrc.ec.europa.eu/collection/luisa.

## 4.3 EU Transport activity projection

Projections on transport activity are based on the “EU reference scenario 2016” (European Commission, 2016) which provides transport activity growth by countries. The Reference Scenario is a model-derived simulation to reflect current trends and developments in the EU energy system and in GHG emissions. The modelling suite used for the Reference Scenario is based on a series of interlinked models which combine technical and economic changes. The PRIMES-TREMOVE model provides detailed projections (per country[2]) for the evolution of the entire transport sector in terms of transport activity by mode and transport mean, energy consumption, emissions, fleet

[2] Download excel files per country level at: https://data.europa.eu/euodp/data/dataset/energy-modelling/resource/9c3eaead-81b8-4a3d-a23d-4dd4a13f3c6e

development, new technologies and alternative fuels. This information has been used to calculate the changes applied to the exposed population at country level. In Table 4.1, there is the summary of the values per EU-28 member states.

**Table 4.1. Summary energy balance and indicators per EU28: Reference scenario**

| SUMMARY ENERGY BALANCE AND INDICATORS (B) | | | | | | | | | | | EU28: Reference scenario(REF2016) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 | '00-'10 | '10-'20 | '20-'30 | '30-'50 |
| | | | | | | | | | | | | Annual % Change | | | |
| **TRANSPORT** | | | | | | | | | | | | | | | |
| **Passenger transport activity (Gpkm)** | **5964** | **6295** | **6449** | **6735** | **7152** | **7509** | **7880** | **8201** | **8507** | **8796** | **9053** | 0,8 | 1,0 | 1,0 | 0,7 |
| Public road transport | 549 | 541 | 528 | 546 | 570 | 587 | 604 | 622 | 636 | 653 | 667 | -0,4 | 0,8 | 0,6 | 0,5 |
| Private cars and motorcycles | 4466 | 4721 | 4843 | 5001 | 5255 | 5457 | 5676 | 5849 | 6003 | 6156 | 6279 | 0,8 | 0,8 | 0,8 | 0,5 |
| Rail | 450 | 464 | 499 | 540 | 591 | 644 | 693 | 739 | 788 | 833 | 878 | 1,0 | 1,7 | 1,6 | 1,2 |
| Aviation [3] | 458 | 528 | 539 | 608 | 693 | 776 | 860 | 944 | 1031 | 1104 | 1177 | 1,7 | 2,5 | 2,2 | 1,6 |
| Inland navigation | 42 | 42 | 40 | 40 | 43 | 44 | 46 | 48 | 49 | 51 | 52 | -0,3 | 0,5 | 0,7 | 0,6 |
| **Freight transport activity (Gtkm)** | **2295** | **2612** | **2556** | **2704** | **2981** | **3220** | **3457** | **3631** | **3802** | **3937** | **4051** | 1,1 | 1,5 | 1,5 | 0,8 |
| Heavy goods and light commercial vehicles | 1589 | 1853 | 1809 | 1915 | 2109 | 2277 | 2446 | 2564 | 2672 | 2763 | 2835 | 1,3 | 1,5 | 1,5 | 0,7 |
| Rail | 405 | 416 | 394 | 428 | 482 | 533 | 580 | 619 | 662 | 695 | 724 | -0,3 | 2,0 | 1,9 | 1,1 |
| Inland navigation | 300 | 343 | 354 | 361 | 389 | 411 | 432 | 449 | 467 | 480 | 492 | 1,7 | 1,0 | 1,0 | 0,7 |
| **Energy demand in transport (ktoe)** [4] | **341525** | **364526** | **359402** | **358062** | **350945** | **344898** | **341463** | **343372** | **347354** | **351233** | **355025** | 0,5 | -0,2 | -0,3 | 0,2 |
| Public road transport | 8775 | 8725 | 8834 | 9040 | 9281 | 9298 | 9281 | 9361 | 9431 | 9542 | 9649 | 0,1 | 0,5 | 0,0 | 0,2 |
| Private cars and motorcycles | 206270 | 212102 | 211618 | 204765 | 190035 | 179668 | 174380 | 172933 | 172584 | 172413 | 172419 | 0,3 | -1,1 | -0,9 | -0,1 |
| Heavy goods and light commercial vehicles | 67279 | 79273 | 76918 | 78507 | 81943 | 83785 | 85822 | 87786 | 89517 | 90948 | 92230 | 1,3 | 0,6 | 0,5 | 0,4 |
| Rail | 8168 | 7668 | 7129 | 7395 | 7863 | 8317 | 8637 | 8864 | 9044 | 9042 | 9018 | -1,4 | 1,0 | 0,9 | 0,2 |
| Aviation | 44876 | 49959 | 49230 | 53303 | 56489 | 58294 | 57606 | 58516 | 60692 | 63134 | 65483 | 0,9 | 1,4 | 0,2 | 0,6 |
| Inland navigation | 6156 | 6798 | 5673 | 5051 | 5334 | 5536 | 5737 | 5912 | 6086 | 6155 | 6225 | -0,8 | -0,6 | 0,7 | 0,4 |
| *By transport activity* | | | | | | | | | | | | | | | |
| Passenger transport | 266294 | 275041 | 273897 | 271237 | 260066 | 251683 | 245768 | 245422 | 247427 | 249871 | 252399 | 0,3 | -0,5 | -0,6 | 0,1 |
| Freight transport | 75231 | 89484 | 85505 | 86825 | 90878 | 93215 | 95695 | 97950 | 99926 | 101361 | 102626 | 1,3 | 0,6 | 0,5 | 0,4 |
| *Other indicators* | | | | | | | | | | | | | | | |
| Electricity in road transport (%) | 0,0 | 0,0 | 0,0 | 0,0 | 0,2 | 0,4 | 0,9 | 1,2 | 1,5 | 1,9 | 2,3 | | | | |
| Biofuels in total fuels (excl.hydrogen and electricity) (%) | 0,2 | 0,9 | 3,7 | 4,6 | 6,1 | 6,2 | 6,2 | 6,3 | 6,3 | 6,5 | 6,6 | | | | |

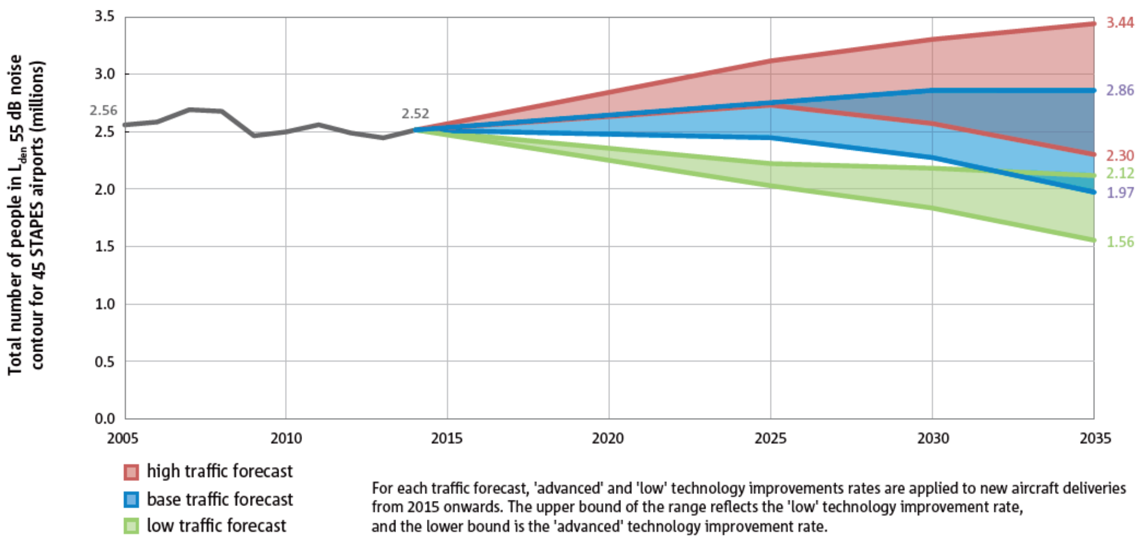
Source: Reference Scenario (European Commission, 2016)

## 4.4 Aircraft transport activity projection

The activities of the aviation sector in Europe are contributing to noise impacts (among others), and the past improvements in areas such as technology and design of the aircrafts has not compensate pressures on the environment due to the increase in the demand for air travel. As it is recognized in the European aviation environmental report 2016 (European Aviation Safety Agency, European Union and European Environment Agency, 2016), the number of flights has increased by 80% between 1990 and 2014 and this trend is forecast to continue. Environmental impacts of European aviation have increased over the past 25 years and therefore, the environmental challenge for this sector is going to increase.

In the European Aviation Environmental Report 2016, the STAPES noise model has been used to calculate the noise contour maps as well as the number of people exposed for 45 major European airports, covering both the EU28 and the EFTA region. For each traffic forecast of the number of airports, advanced and low technology improvements rates have been applied, as can be seen in Figure 4.1.

**Figure 4.1. Forecasts in the number of people exposed due to aircraft noise taking into consideration different traffic forecasts and technology improvements**




Source: European Aviation Environmental Report 2016 (EASA, EU and EEA, 2016)

## 4.5 Urban targets

With their high population densities and high share of short-distance trips, there is a greater potential for cities to move towards low-carbon transport than for the transport system as a whole, through the development of walking, cycling, public transport – and the early market introduction of vehicles powered by alternative fuels (EC, 2013).

In contrast to the forecast increase of transport intensity and population growth in EU28, an expected reduction of road noise emissions in urban areas is assumed due to specific urban regulations and technological improvements. While there have been several European policy initiatives targeting urban transport, it was not until the 2011 Transport Policy White Paper that an attempt was made to set clear goals for clean urban transport at the European level (Gudmundsson et al., 2015), namely:

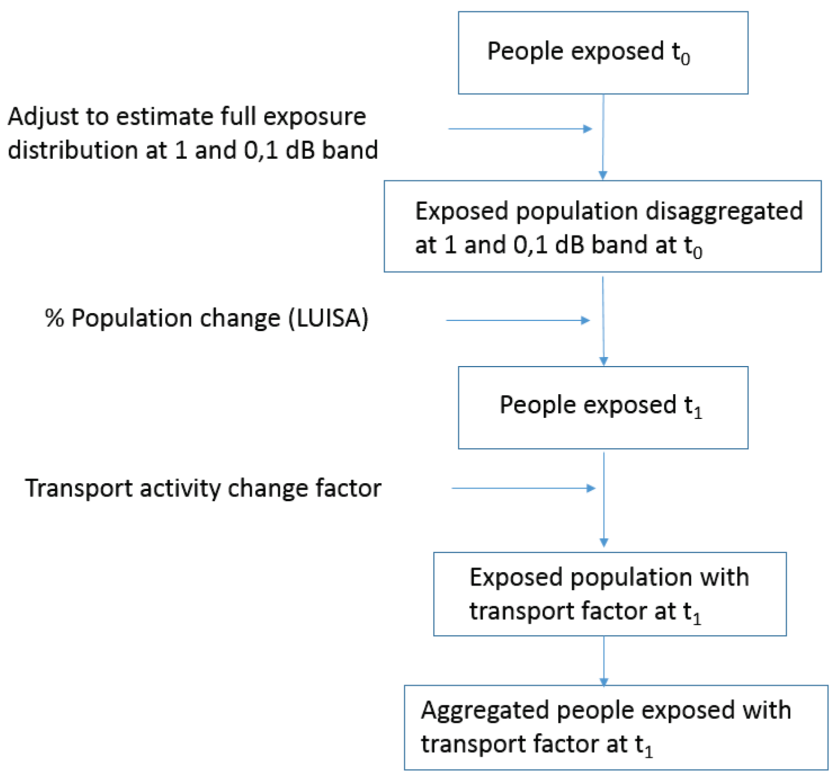
- “To halve the use of conventionally-fuelled cars in urban transport by 2030; and to phase them out by 2050;” and
- “To achieve essentially $CO_2$-free city logistics in major urban centres by 2030.”

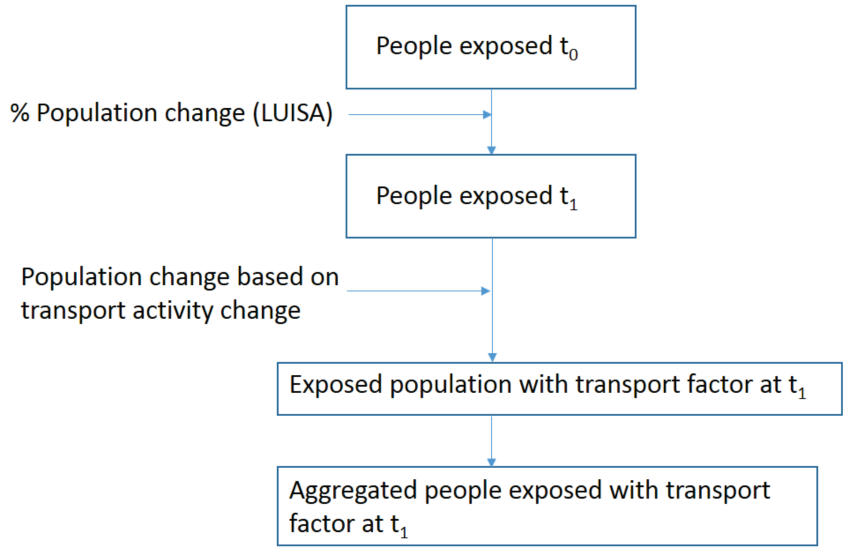
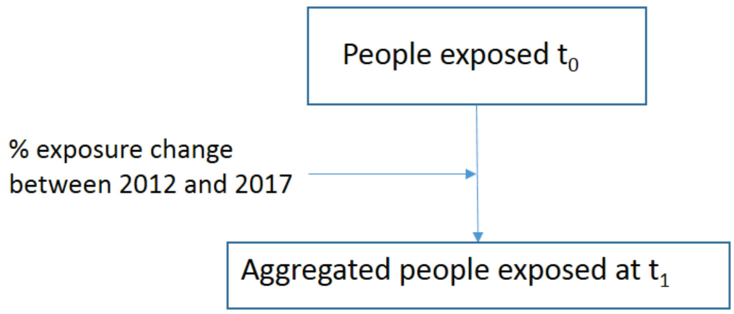
## 5 Conceptual model

The conceptual model presented arouse, as starting point, from the previous model developed by Extrium and Acustica for the European Environment Agency (Extrium, 2013), but it has been further refined with components identified in more recent publications.

The approach consists in the following phases depending on the noise source (see Table 5.1):

### Table 5.1. Conceptual model applied per each noise source

| Noise source | Conceptual model |
|---|---|
| 1. Road exposure inside agglomerations<br>2. Rail exposure inside agglomerations<br>3. Major roads exposure outside agglomerations<br>4. Major rails exposure outside agglomerations |  |

<table>
<tr>
<td>1. Air exposure inside agglomerations<br>2. Major air exposure outside agglomerations</td>
<td>
</td>
</tr>
<tr>
<td>1. Industrial exposure inside agglomerations</td>
<td>
</td>
</tr>
</table>

Main steps in the model are:

(i) Disaggregation of population exposed from 5 dB band to 1 dB band with precision of 1 decimal. This is required to apply, at the end, the dB change for the projected period for road and rail exposure (inside and outside urban areas).

(ii) Apply the population growth rate (obtained from the LUISA model (Lavalle et al., 2014)) to the population disaggregated at 0,1 dB noise level, for road, rail and air exposure both inside and outside urban areas

(iii) Estimate noise level change at noise source (dB) according to: transport activity change, regulations and technology improvements

   a. In the case of road and rail exposure, the dB change is derived from the transport activity change factor (input data EU Reference Scenario (2016))
   b. In the case of air exposure, forecast of the number of people exposed due to aircraft noise has been used to estimate the percent change to be applied (input data European Aviation Environmental Report (2016))

(iv) In the case of industrial noise, the percent annual change encountered when comparing 2007-2012-2017 reference years have been applied to the baselined data to calculate the number of people exposed to 2020 and 2030. This noise source is considered different than the rest of transport noise sources because (1) is highly dependent on the location of the industrial areas in the municipalities and therefore the influence of the population growth could be considered negligible and (2) the changes foreseen in industrial areas would not directly imply a change in the number of people exposed.

This conceptual model is applied to the number of people exposed to both $L_{den}$>=55dB and $L_{night}$>=50dB indicators.

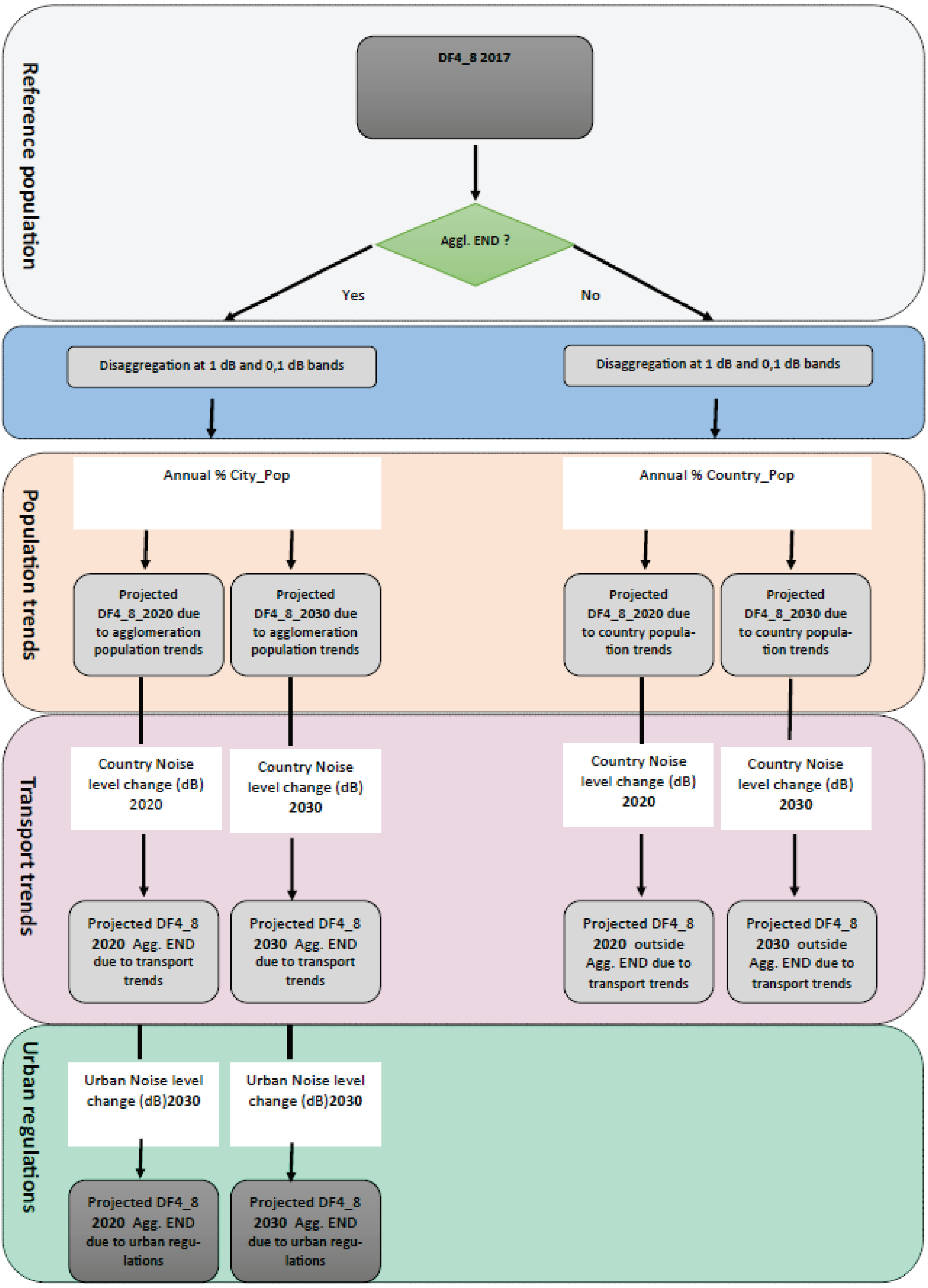
# 6 Methodology

## 6.1 Overview

Factors influencing noise exposure behave differently inside and outside urban areas. Assigning the same projected trend to the entire exposed population as a whole (i.e. regional average rates) entails to assume a broad generalization that might strongly bias results; i.e. country population annual rates cannot reflect urbanization processes or other differentiated territorial demographic behavior within countries.

Therefore, the proposed approach differentiates between exposure calculations inside and outside agglomerations reported under the END (2002/49/EC), adding specific urban regulations and technological improvements forecasted to be implemented in 2030. This differentiation can be observed in the following detailed model developed for road transport noise (Figure 6.1), but the differentiation between exposure calculations inside and outside END agglomerations is also applied in the calculations for rail and air noise exposure.

**Figure 6.1. Detailed conceptual model**




## 6.2 Disaggregation of population at 1dB (with precision of 1 decimal)

In order to quantify the potential impact of future dB changes on population, the exposed population need to be disaggregated at 1 dB and at 0,1 dB, as most of the projected dB changes to 2020 and 2030 are non-integer values.

The following workflow have been followed in the case of exposure values due to road and rail transport infrastructures inside and outside agglomerations:

1. Estimate the percentage of people exposed to lower dB bands: 50-54 dB and 45-49 dB $L_{den.}$, and 40-44 dB and 45-49 dB $L_{night}$
2. Redistribute the population exposed into 1 dB
3. Redistribute the population exposed into 0,1 dB

In Table 6.1, there is a summary of the method used for the estimation of population exposed to lower noise levels in case the country is not providing voluntarily this information. Assumptions taken in each case have been also highlighted.

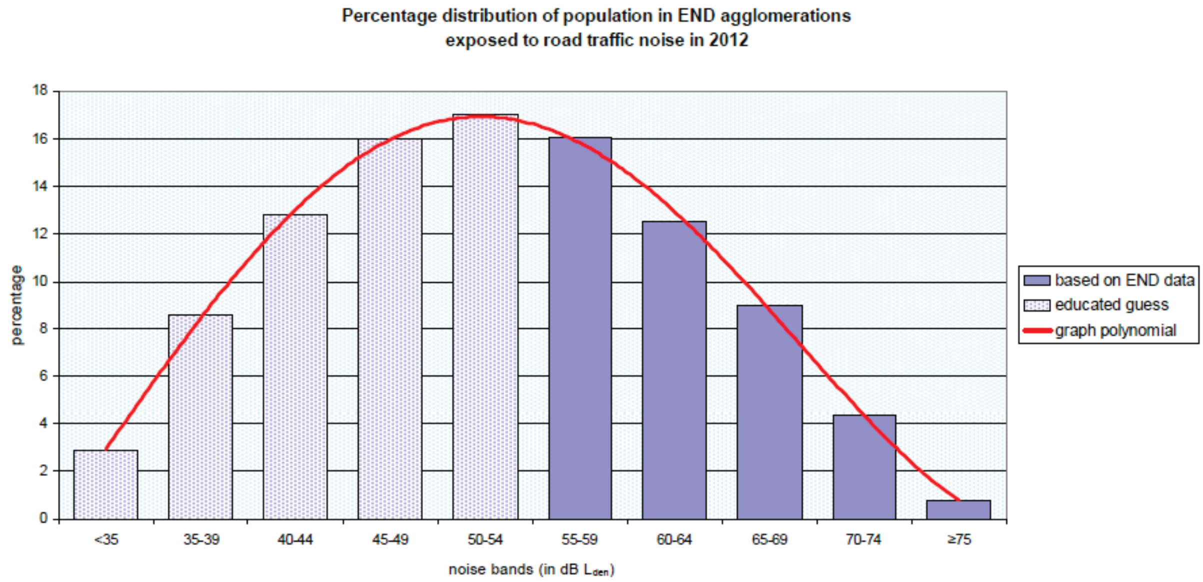
### Table 6.1. Method to estimate lower noise levels per noise source

| NOISE SOURCE | EXPOSURE ESTIMATION AT LOWER NOISE LEVELS METHOD | ASSUMPTIONS |
|---|---|---|
| Road noise exposure inside agglomerations | Option 1: Use the values provided by the country<br>Option 2: Use the estimations calculated at country level in Houthuijs et al., 2017 | Distribution over all noise bands has a normal distribution |
| Rail noise exposure inside agglomerations | Option 1: Use the values provided by the country<br>Option 2: Use the percentages calculated at European level in Wiebe et al., 2016 | Distribution over all noise bands has an exponential distribution.<br>Proportionate distribution assumed as the same behavior as for major roads outside agglomerations. |
| Major roads exposure outside agglomerations | Option 1: Use the values provided by the country<br>Option 2: Use the percentages calculated at European level in Wiebe et al., 2016 | Distribution over all noise bands has an exponential distribution |
| Major rail exposure outside agglomerations | Option 1: Use the values provided by the country<br>Option 2: Use the percentages calculated at European level in Wiebe et al., 2016 | Distribution over all noise bands has an exponential distribution<br>Proportionate distribution assumed as the same behavior as for major roads outside agglomerations. |

### 6.2.1 *Extrapolation to lower noise levels for road noise exposure inside agglomeration*

If there is no information available for lower noise values, the percentages for noise bands distribution below 55 dB $L_{den}$ and 50 dB $L_{night}$ has been calculated based on the assumption that the distribution over all noise bands has a normal distribution (see Figure 6.2) (Wiebe et al., 2016).

**Figure 6.2. END agglomeration population exposed to road traffic noise in 2012**




Source: Wiebe et al., 2016

But, instead of using global estimations at EU level, country percentages of noise bands below 55 dB $L_{den}$ and below 50 dB $L_{night}$ have been used, based on the statistical approach for the extrapolation of exposed population to lower noise levels proposed in the ETC/ACM technical paper (Houthuijs et al., 2017). This technical report estimates road traffic noise distribution per decibel for a range of 40-70 dB $L_{den}$ and for a range of 30-60 dB $L_{night}$, for non-END agglomerations, for END agglomerations and for the total population separately. The statistical methodology approach is explained in more detail in Van Den Hout et al. (2011).

Distribution values per 5 dB band applied at country level can be consulted at Houthuijs et al., 2017.

Once the estimated exposure values at lower dB bands have been calculated, the method redistributes the percentage of people exposed into 1 dB, using the extended END distribution with the two additional intervals 45-49 and 50-54 dB for $L_{den}$ and 40-44 and 45-49 dB for $L_{night}$ (calculated in the previous step), with percentages *N*-1 and *N*0 respectively.

For each 5 dB interval, the mean gradient dN/dL (in % per dB) is calculated, given by:

$$(dN/dL)_j = \tfrac{1}{2}[\tfrac{1}{5}(N_{j+1} - N_j) + \tfrac{1}{5}(N_j - N_{j-1})]$$

Where:

dN/dL: Mean gradient
$N_j$: Interval j (e.g. 55-59dB)
$N_{j+1}$: Upper interval
$N_{j-1}$: Lower interval

Next, the distribution is refined by replacing each 5 dB interval by five 1 dB intervals.

$$N_{j,k} = \tfrac{1}{5}[N_j + (dN/dL)_j (k-3)]$$

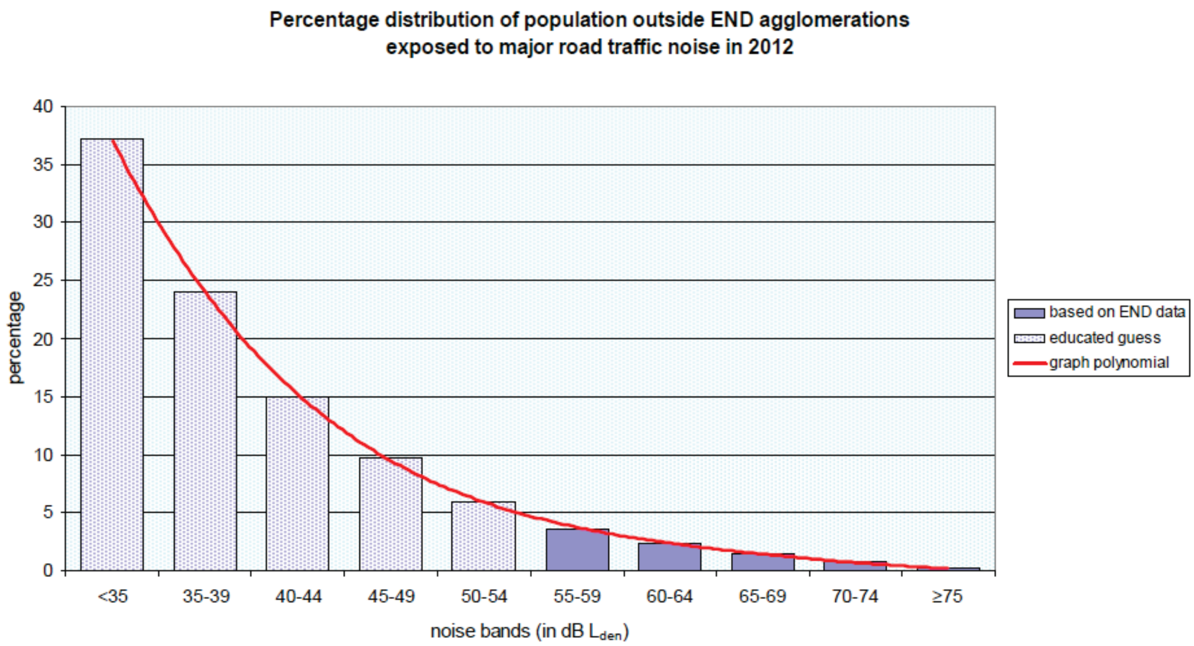
Where:
index k = 1, 2, …, 5 runs over the five 1 dB intervals in 5 dB interval j.

The output of this process is the percentage of the population exposed to road traffic noise inside agglomerations at 1 dB per each agglomeration.

### 6.2.2 *Extrapolation to lower noise levels for rail noise exposure inside agglomerations and for major roads and major railways exposure outside agglomerations.*

If there is no information available for lower noise values, the percentages for noise bands distribution below 55 dB $L_{den}$ and 50 dB $L_{night}$ has been calculated based on the assumption that the distribution over all noise bands has an exponential distribution (see Figure 6.3) (Wiebe et al., 2016).

**Figure 6.3. Population outside END agglomeration exposed to major road traffic noise in 2012**




Source: Wiebe et al., 2016

EU estimations calculated by Wiebe et al. (2016), have been used to derive the relative fraction of the lower bands based on the total population exposed equal or higher than 55 dB $L_{den}$ and 50 dB $L_{night}$. The relative fractions applied for $L_{den}$ are detailed in Table 6.2.

**Table 6.2. Calculated relative fraction for lower noise bands based on Wiebe et al., 2016 estimations for major road traffic noise in 2012 ($L_{den}$)**

| | ***Lden*** | ***<35*** | ***35-39*** | ***40-44*** | ***45-49*** | ***50-54*** | ***55-59*** | ***60-64*** | ***65-69*** | ***70-74*** | ***>75*** | ***total*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Noise exposure (in million) | Reported data (2012) | | | | | | 12,2 | 7,9 | 4,9 | 2,4 | 0,6 | 337,2 |
| | Wiebe et al., 2016 calculations | 125,1 | 80,9 | 50,6 | 32,7 | 19,9 | | | | | | |
| *Calculated relative fraction* | *As percentage of total exposed ≥ 55dB* | | | | | *0,71071* | | | | | | |
| | *As percentage of total exposed ≥ 50dB* | *2,61169* | *1,68894* | *1,05637* | *0,68267* | | | | | | | |

Source: Wiebe et al., 2016. Calculations RIVM, 2018.

It has been assumed that the difference between $L_{den}$ and $L_{night}$ is a 10 dB shift, so the relative fractions applied for $L_{night}$ are the ones detailed in Table 6.3.

**Table 6.3. Calculated relative fraction for lower noise bands based on Wiebe et al., 2016 estimations for major road traffic noise in 2012 ($L_{night}$)**

| | ***Lnight assumption (10 dB shift)*** | ***<25*** | ***25-29*** | ***30-34*** | ***35-39*** | ***40-44*** | ***45-49*** | ***50-54*** | ***55-59*** | ***60-64*** | ***>65*** | ***total*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Noise exposure (in million) | Reported data (2012) | | | | | | 12,2 | 7,9 | 4,9 | 2,4 | 0,6 | |
| | Wiebe et al., 2016 calculations | 125,1 | 80,9 | 50,6 | 32,7 | 19,9 | | | | | | 337,2 |
| *Calculated relative fraction* | *As percentage of total exposed ≥ 50dB* | | | | | | *0,77215* | | | | | |
| | *As percentage of total exposed ≥ 45dB* | *4,46786* | *2,88929* | *1,80714* | *1,16786* | *0,71071* | | | | | | |

Source: Wiebe et al., 2016. Calculations RIVM, 2018.

Finally, it has been assumed that the relative fractions used to estimate the percentage of people exposed to lower bands applied for major road traffic noise (Table 6.3) can also be used to estimate the percentage of people exposed to lower noise bands due to rail noise exposure inside agglomerations and major rail exposure outside agglomerations.

### 6.2.3 *Redistribute the people exposed into 0,1 dB*

Most of the projected dB changes to 2020 and 2030 are non-integer values. Consequently, we need again to increase the dB resolution and refine it up to 0,1 dB intervals (δL decibels), and this will be done by dividing into 1/10 the percentage of people exposed per each dB band.

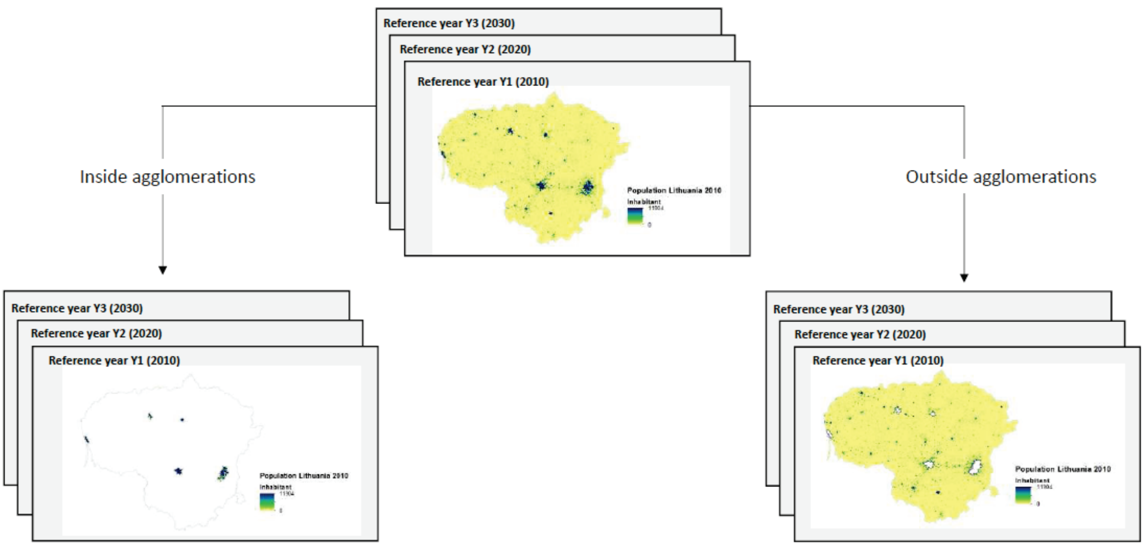
## 6.3 Demographic projections

The second step followed is the projection of population exposed disaggregated at 0,1 dB at $t_0$ according to expected population change to obtain the projected population at $t_1$ (2020 and 2030 respectively).

In order to calculate the expected population change, the LUISA population grid model (https://data.jrc.ec.europa.eu/collection/luisa) has been used. This model allows the calculation of different growth rates per each urban area defined by the END, and also at country level discarding the END urban agglomerations.

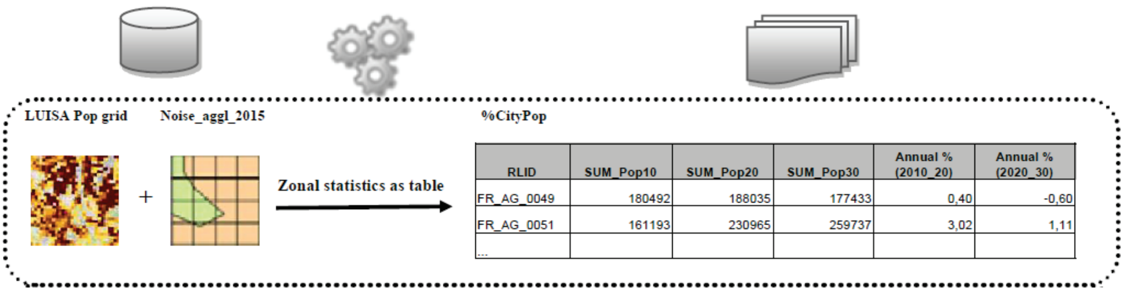
Accordingly, the corresponding population values (at $t_{2010}$, $t_{2020}$, $t_{2030}$) have been determined using spatial metrics from LUISA population grid for the years 2010, 2020 and 2030. An example of how the population values for each specific END agglomeration have been calculated, is illustrated in Figure 6.4. The area of END agglomerations delimitates the area to sum up the population values for each year. The same areas are used to erase its surface from the country coverage and sum up the population values at country level for each year.

**Figure 6.4. Process to calculate the sum of the population values for each country and END agglomeration (example: Lithuania) in years 2010, 2020 and 2030.**




Once the population have been assigned to each of the studied areas, the Cumulative Average Growth Rate, often expressed as CAGR, for the period 2010-20 and 2020-2030 has been calculated. Cumulative growth is a term used to describe a percentage of increase over a set period of time. The resulting rate for each period will be applied to the reference population (People disaggregated and exposed at $t_0$).

**Figure 6.5. Cumulative annual growth to estimate the impact of demographic trends in noise exposed population**




| RLID | SUM_Pop10 | SUM_Pop20 | SUM_Pop30 | Annual % (2010_20) | Annual % (2020_30) |
|---|---|---|---|---|---|
| FR_AG_0049 | 180492 | 188035 | 177433 | 0,40 | -0,60 |
| FR_AG_0051 | 161193 | 230965 | 259737 | 3,02 | 1,11 |
| ... | | | | | |

As a result, a specific CAGR for each END agglomeration and for each country, or countryside population (excluding population living in agglomerations) is obtained (e.g. Figure 6.5). CAGR calculated per each agglomeration and country (excluding population living in agglomerations) can be found in Annex 3 and Annex 4 respectively.

In order to calculate CAGRs, the essential values are: the population $P_0$ (or starting value), the population at $P_1$ (or ending value), and the T (or period of time to measure growth).

$$CAGR_{t0\text{-}t1} = ((Pop_1/Pop_0)^{\wedge}\ 1/T)) - 1$$

Once the complete list of CAGR have been calculated, the resulting rates are used to project future values of population exposed to noise using the following formula per each studied period:

$$P_{exposed\ 2020} = P_{exposed2017}(1 + CAGR)^{\wedge}3$$

$$P_{exposed\ 2030} = P_{exposed2020}(1 + CAGR)^{\wedge}10.$$

It should be highlighted that overseas parts of the European territory (France and Spain, in this case) are not covered by LUISA population grid model. In these two cases, the mean value for agglomerations at country level per each country have been applied in the following agglomerations:

- France: Saint-Denise-de-la-Reunion, Saint-Pierre, Fort-de-France, Pointe-a-Pitre – Les Abymes
- Spain: Las Palmas de Gran Canaria, Santa Cruz de Tenerife, Telde, San Cristóbal de la Laguna

## 6.4 Road and rail transport projections: freight and passenger transport

The macroeconomic and demographic assumptions used in the Reference Scenario (European Commission, 2016) provide the framework projections on how the END exposed population in 2017 will evolve in the coming decades.

Based on the expected EU transport sector behavior for years 2020 and 2030, the dB changes expected can be obtained. This process entails:

(i) calculate rates of growth by countries,
(ii) traduce the activity change into dB change,
(iii) determine the differentiated impact of road freight transport inside urban agglomerations.

An overview of projected transport activity at EU-28 is presented in Table 6.4 based on PRIMES model. This data is also available at country level (see section 4.1.3), which allows to reflect interregional differences. While the traffic parameter used by the END directive is traffic volume, the transport activity data obtained from the EU Reference scenario refers to number of passengers and tones of goods (Gpkm and Gtkm respectively). Therefore, it has been assumed a linear relationship between the increase of passengers and the increase of the traffic volume (i.e. constant occupancy of vehicles over the period analysed).

### Table 6.4. Transport activity (Passanger-Gpkm & Freight-Gtkm) projected to 2020 and 2030 at EU-28

| | | 2020 | 2030 |
|---|---|---|---|
| **Road** | | | |
| *Road-passenger* | Public road transport | 570,5 | 604 |
| | Private cars and motorcycles | 5255,3 | 5676,5 |
| *Road- freight* | Heavy goods and light commercial vehicles | 2109,5 | 2445,6 |
| **Rail** | | | |
| *Rail-passenger* | | 590,8 | 692,7 |
| *Rail- freight* | | 482,2 | 580,3 |

Source: Compiled from Appendix 2 (pp. 144-145) from the report European Commission, (2016)

The EU Reference Scenario 2016 estimates the activity transport change expressed in passenger-kilometres (and tonne-kilometre for freight transport). These transport statistics are breaking down by transport type up to 2050 (intervals of 5 years) and presented separately for each EU28 member state. Rates of growth have been calculated in Table 6.5 (using the projected values aggregated at EU28). A complete list of transport activity rates by country have been calculated to estimate the noise exposure outlook at country level.

From the growth rates calculated for both periods, the decibel change has been derived using the criteria: “a doubling in traffic flow produces a 3dB increase in noise level”. Applying this criteria to the potential change in the transport activity, a specific dB change per each transport activity is obtained (see Table 6.6).

### Table 6.5. Summary of traffic growth forecast and indicated change in noise emission levels at EU28

| | | 2015[3]-2020 | | 2020-2030 | |
|---|---|---|---|---|---|
| | | Activity change (%) | **dB change** | Activity change (%) | **dB change** |
| **Road**<br>*Road-passenger* | Public road transport | 4,5 | 0,2 | 5,9 | 0,2 |
| | Private cars and motorcycles | 5,1 | 0,2 | 8 | 0,3 |
| *Road- freight* | Heavy goods and light commercial vehicles | 10,2 | 0,4 | 15,9 | 0,6 |
| **Rail**<br>*Rail-passenger* | | 9,4 | 0,4 | 17,3 | 0,7 |
| *Rail- freight* | | 12,8 | 0,5 | 20,4 | 0,8 |

Source: Activity rates change calculated according to EU Reference data values (see Table 6.4)

[3] The two years of projected transport activity change from 2015-2017 are ignored.

Due to the fact that freight transport is expected to grow at higher rates than passenger transport, if the dB increase from freight transport (see Table 6.5) is imputed equally inside and outside END agglomerations, it will result in an overestimation of the noise impact of freight transport in urban areas.

As cited by (Russo and Comi, 2012) several empirical studies confirmed that the total urban road freight vehicles account for 6– 18% of total urban travel (Cambridge Systematics, 2012; Figliozzi, 2010; Hunt et al., 2004). For the purpose of this project it is assumed that 12% (i.e. the mean value extracted from those empirical studies) of the road freight activity change will be imputed to END agglomerations. In Table 6.6 the new values for *Heavy goods and light commercial vehicles* specifically for urban agglomerations and corresponding dB change are presented in bold.

**Table 6.6. Summary of traffic growth forecast and indicated change in noise emission levels at EU28, applying a reduction for road freight transport inside agglomerations**

| | | **2015[4]-2020** | | **2020-2030** | |
|---|---|---|---|---|---|
| | | Activity change (%) | **dB change** | Activity change (%) | **dB change** |
| **Road**<br>*Road-passenger* | Public road transport | 4,5 | 0,2 | 5,9 | 0,2 |
| | Private cars and motorcycles | 5,1 | 0,2 | 8 | 0,3 |
| ***Road- freight*** | Heavy goods and light commercial vehicles | 10,2<br>**1,2 (inside Agglomerations)** | 0,4<br>**0,1** | 15,9<br>**1,9 (inside agglomerations)** | 0,6<br>**0,1** |
| **Rail**<br>*Rail-passenger* | | 9,4 | 0,4 | 17,3 | 0,7 |
| *Rail- freight* | | 12,8 | 0,5 | 20,4 | 0,8 |

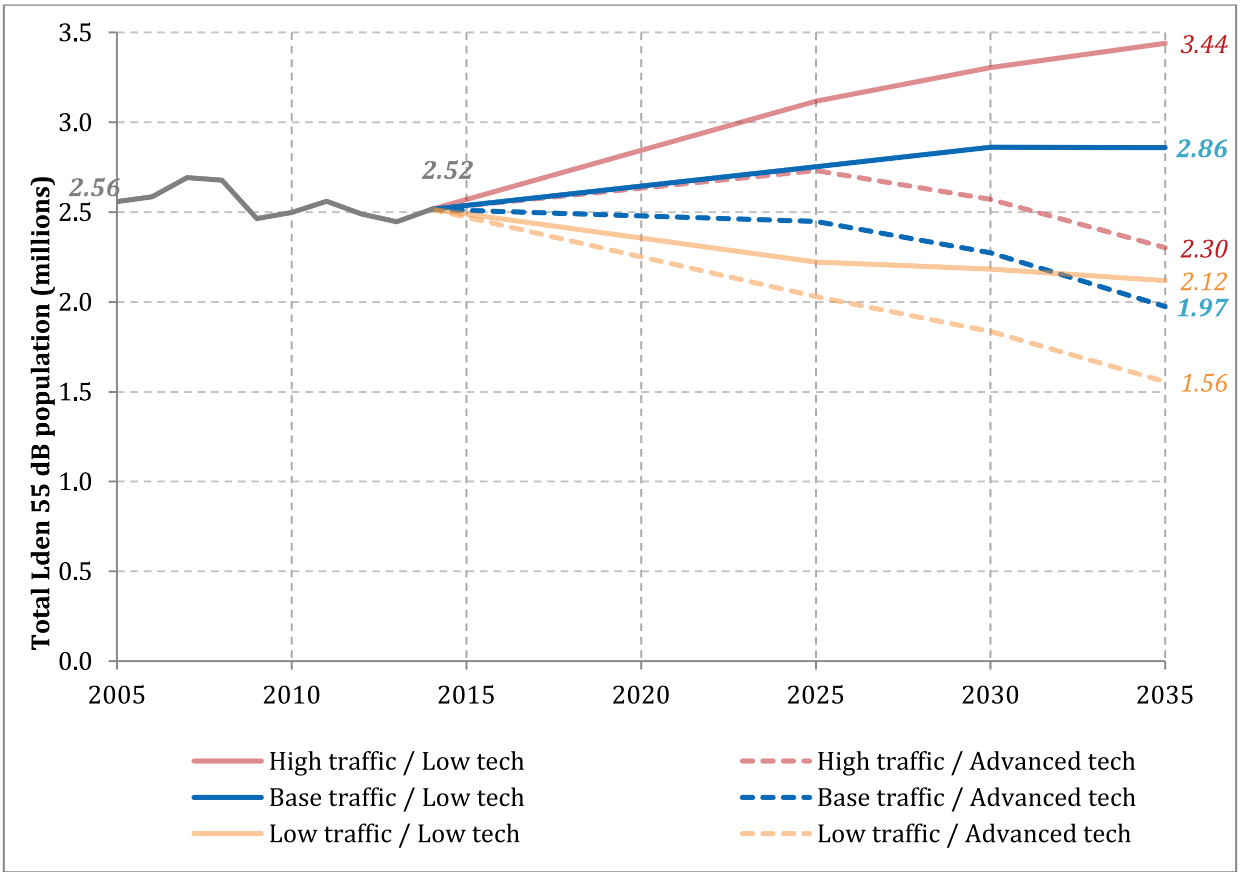
Detailed tables at country level with the dB reduction applied per noise source can be found in Annex 5.

## 6.5 Aircraft transport projections

For the purpose of the current analysis and using the results published in the European aviation environmental report 2016 (European Aviation Safety Agency, European Union and European Environment Agency, 2016), the mean value between "advanced" and "low" technology improvement from the base traffic forecast have been used to estimate the projected noise exposure at EU-28 level of the aviation sector (Figure 6.6).

[4] The two years of projected transport activity change from 2015-2017 are ignored.

**Figure 6.6. Forecasts in the number of people exposed due to aircraft noise taking into consideration different traffic forecasts and technology improvements**




Source: EASA, EU and EEA, 2016

The Cumulative Average Growth Rate (CAGR) has been calculated both for 2020 and 2030, obtaining the following values that have been directly applied to the population exposed at $t_1$ (with the demographic projection already implemented):

- CARG 2020: 0,00276628567511361
- CAGR 2030: -0,00252873862702041

## 6.6 Urban targets

The growth trends of both the population and the activity of transport induce to a potential increase of noise exposure in EU by 2030. However, the proposed approach, also includes the positive impact of urban regulations (i.e. urban target of the "2011 White Paper on Transport") that will inevitably counteract the transport and population trend, as well as technology developments in the aviation sector.

Knowing that most probably there will be a strong variation in local circumstances, it has been assumed that END agglomerations will achieve the urban target of the White Paper. Accordingly, the 50% decline by 2030 applies in the same way to all END agglomerations.

Consequently, the projected dB increase due to the growth of transport activity (Table 6.4) will be counteracted by the impact of the urban measure.

The justification to choose a measure covering solely road traffic is due to its higher impact compared to other transport sources. Road traffic noise, both inside and outside urban areas, is still the most dominant source affecting human exposure above the action levels defined by the END, with the latest available information reported by Member States (ETC/ACM, 2017).

## 6.7 Model assumptions

### 6.7.1 *General assumptions*

- The noise level reduction at source is the same as the noise level reduction at the receptor.
- All END agglomerations will achieve the urban target of the 2011 White Paper on Transport
- Relative transport activity change i.e. Passenger (Gpkm) & Freight (Gtkm) is equivalent to relative END traffic volumes
- dB change is derived according to: "a doubling in traffic flow produces a 3dB increase in noise level"
- A dB "shift" of 10 dB to calculate $L_{night}$ relative values below the 50dB threshold (see Table 6.3)

### 6.7.2 *Assumptions concerning the input data used*

The noise exposure projection proposed in this assessment is driven by future trends supplied by upstream models or other sources. Mainly, on population projection (LUISA) and transport activity projection (EU Reference Scenario, 2016 and European Aviation Environmental Report, 2016). Both demographic and transport projections should ideally be mutually consistent in terms of scenario assumptions. In this sense, the sources feeding the proposed model build on the same assumptions, this is the EU Reference Scenario.

Both start from the assumption that "*the legally binding GHG and RES targets for 2020 will be achieved and that the policies agreed at EU and Member State level until December 2014 will be implemented*."

However, the main constraint from the input projections proposed is the fact that they differ in the base year used to project data. While the transport activity projection is based on the EU Reference scenario 2016 and on the European Aviation Environmental Report 2016, the population projection from LUISA is based on the previous EU Reference scenario published in 2013, (or an updated configuration 2014) (Barbosa et al., 2015).

The "2015 Ageing Report" (European Commission, 2014) is the starting point of the EU 2016 Reference Scenario giving long term population and GDP growth trends while the short and medium term GDP growth projections were taken from DG ECFIN. Thus, while the Reference scenario 2016 is based on the latest available statistical data from Eurostat at the time of the modelling (EUROPOP2013), the LUISA population projection is based on EUROPOP2010.

### 6.7.3 *Assumptions concerning the data used for the calculations of exposure* to lower noise *for road traffic noise exposure inside agglomerations*

The method used to estimate exposure to lower noise levels for $L_{den}$ (below 55dB) inside agglomerations was been developed in ETC/ACM (2016), using as input data the estimations from the modelling of the complete territory of Switzerland and The Netherlands.

In the Netherlands, STAMINA (Standard Model Instrumentation for Noise Assessments) is used to calculate the road traffic noise exposure for the whole of the country. Data from 2011 was used in previous assessments, and a new dataset from 2017 for motorways over 2016 and a dataset for all roads is available at RIVM.

In Switzerland, the Sonbase model (BAFU, 2009) is used to calculate exposure to the road traffic noise for the whole of Switzerland. Data from 2012 was used in previous years.

# 7 Results

The calculated projections show that the number of people exposed to high noise levels would increase in all noise sources except for industries inside agglomerations by 2020 (short term scenario) (Table 7.1 and Figure 7.1). Mid-term scenario (2030) with the consideration of urban policies and targets mainly for road transport inside cities and in the aviation sector, could imply a decrease of the number of people exposed, predicting similar exposure values than the ones estimated in 2017 baseline reference year concerning aircraft noise, and an estimation of an important decrease of the number of people exposed to road traffic noise inside urban areas compared with the values estimated in 2017 baseline reference year (Figure 7.2). Estimated exposure to industrial noise by 2020 and 2030 have been calculated considering the change in reported data in 2012 and 2017, considering a constant change per year.

**Figure 7.1. Estimated projections of number of people exposed due to different noise sources at 2020 and 2030 ($L_{den}$).**

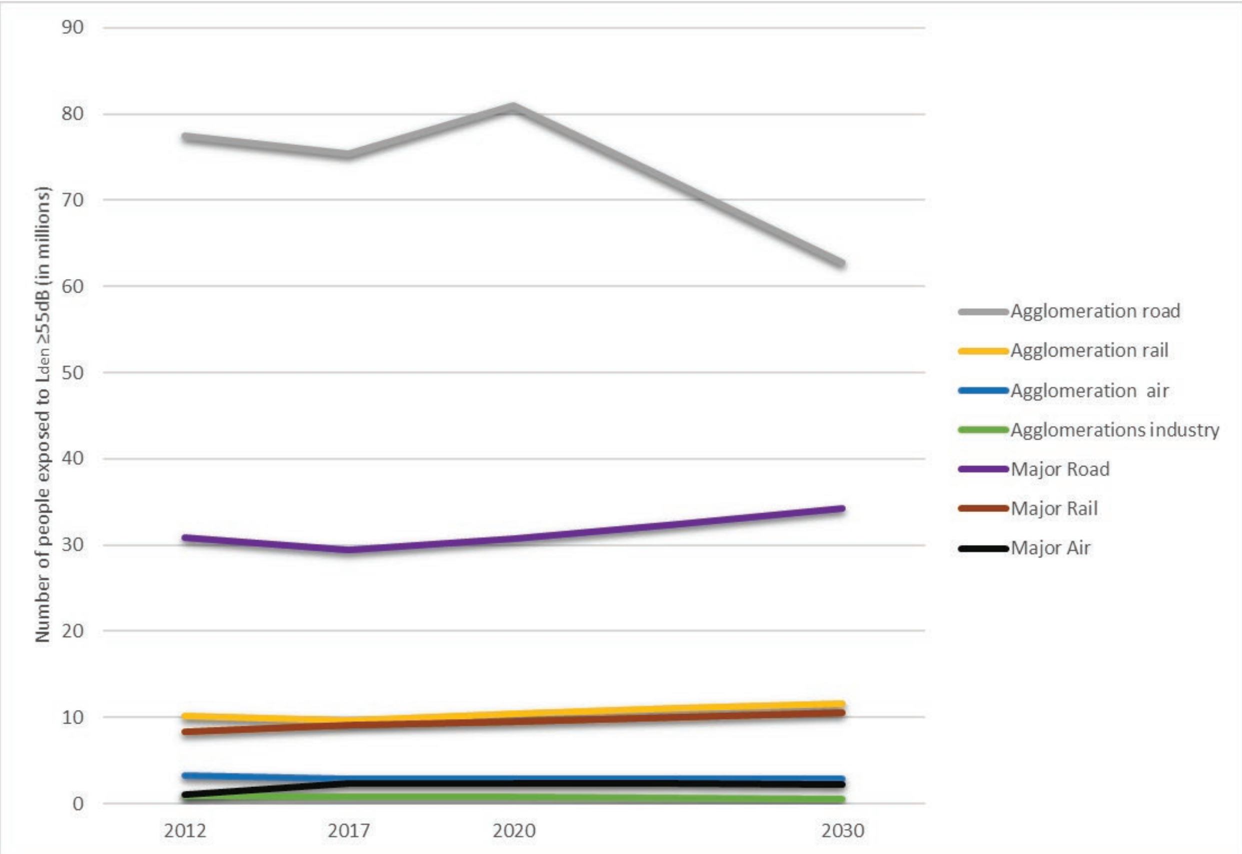
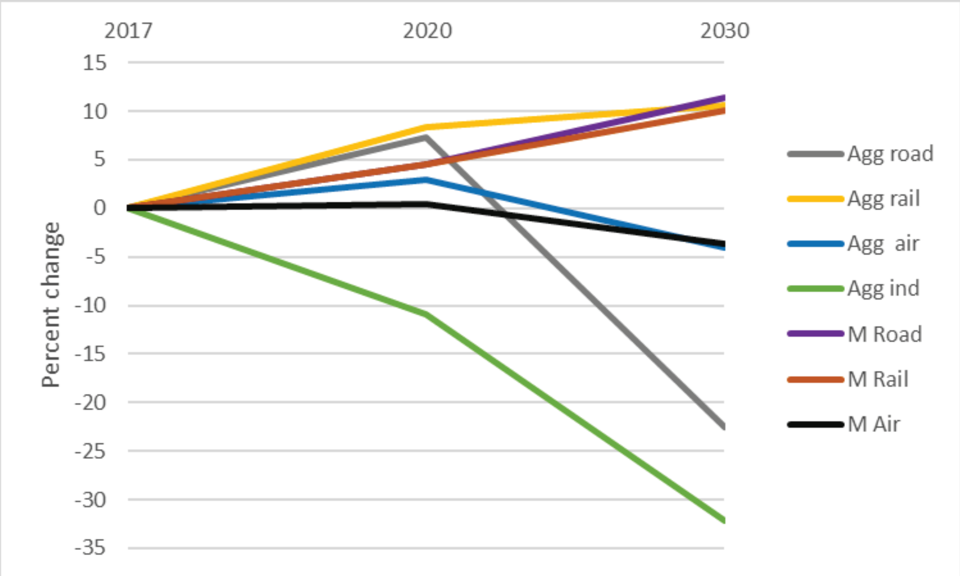



**Table 7.1. Estimated projections of number of people exposed due to different noise sources at 2020 and 2030 ($L_{den}$).**

| | Inside Urban Areas | | | Outside Urban Areas | | |
|---|---|---|---|---|---|---|
| | **2017** | **2020** | **2030** | **2017** | **2020** | **2030** |
| **Road noise** | 75451500 | 81002322 | 62701576 | 29371800 | 30693518 | 34196389 |
| **Rail noise** | 9656700 | 10459868 | 11569935 | 9145100 | 9556451 | 10514118 |
| **Aircraft noise** | 2848100 | 2932956 | 2814062 | 2334800 | 2344706 | 2259170 |
| **Industrial noise** | 827700 | 736882 | 500206 | - | - | - |

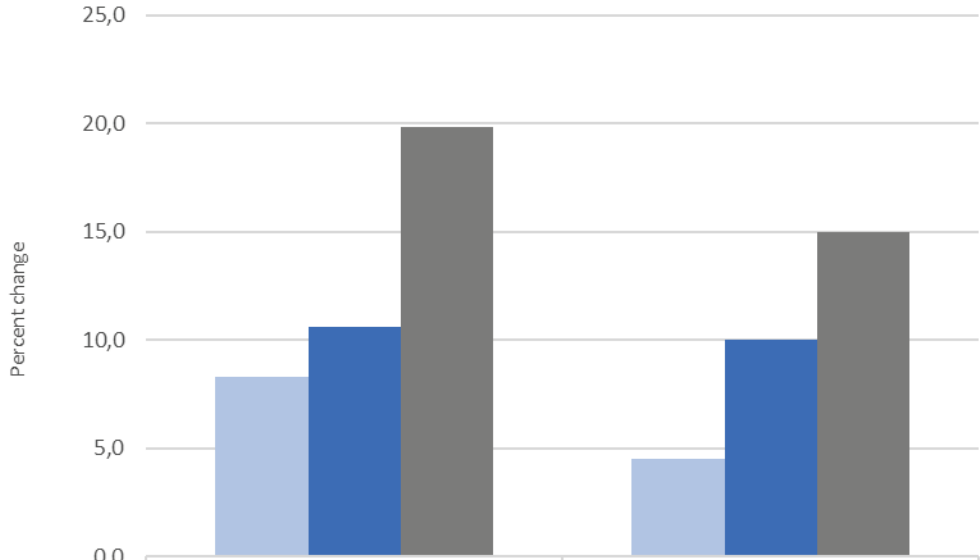
**Figure 7.2. Estimated percent change exposure at short term (2020) and mid-term (2030) considering 2017 baseline reference year, per noise source.**




These results are in line with the expected increase of the number of people exposed by 2020, provided the growth trends of both the population and the transport activity. As regards demographic assumptions, EU population is projected to increase over coming decades up to 2050, although with declining growth rates. As regards transport sector assumptions, it is projected a significant activity growth in the EU Reference Scenario (2016), based on transport demand usually linked to GHG emissions (Rijkee and van Essen, 2012).

The highest increase takes place during the period 2010 to 2030, driven by developments in economic activity. This is especially relevant in the case of rail transport, which has the highest incremental rates than the rest of transport sources. And so, exposure to railway noise (both inside and outside agglomerations) potentially presents the higher increase in percentage of people exposed for both periods 2017 – 2020 and 2020-2030: an overall 17% of increase of the whole period taking into consideration exposure to railway noise both inside and outside agglomerations, being higher inside urban areas. Short term scenario shows an increase of 8% inside urban areas and an extra 10% of increase in mid-term scenario, providing a final balance of nearly 20% of increase of the people exposed to railways noise compared with the values estimated in 2017 baseline reference year (Figure 7.3). It should also be considered that the freight transport sectors is growing at higher rates than passenger transport, following more closely the GDP developments (European Commission, 2016), which has a direct impact on the rail freight transport forecasts. It needs to be taken also into consideration that freight transport activity forecasts at country level cannot reflect the same noise exposure impact in urban areas or outside urban areas, relating the urban freight transport and logistics mainly to the last miles of supply chains (Russo and Comi, 2012).

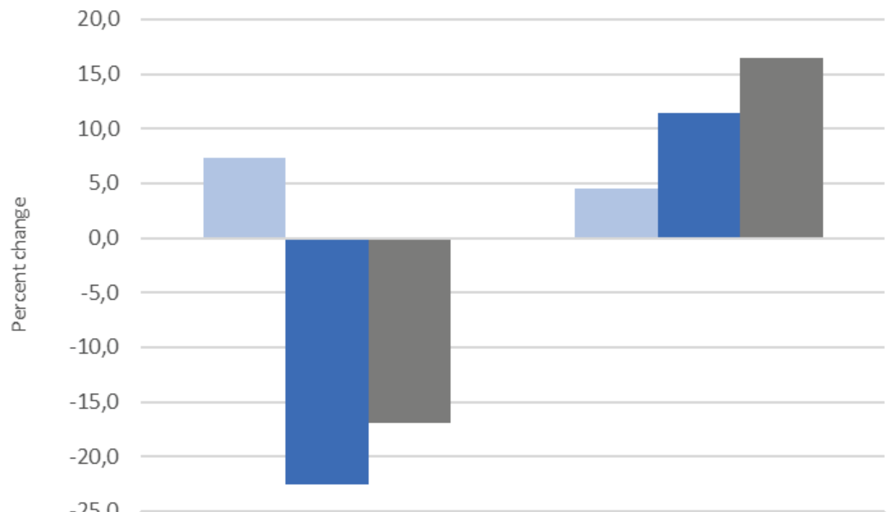
**Figure 7.3. Change in the number of people exposed to high levels of railway noise inside and outside urban areas. In light blue, estimated percent change from 2017 to 2020 and in dark blue, estimated percent change from 2020 to 2030. In dark grey, percent change for the overall period: 2017-2030.**




| | Agglomeration rail | Major Rail |
|---|---|---|
| 2017-2020 | 8,3 | 4,5 |
| 2020-2030 | 10,6 | 10,0 |
| 2017-2030 | 19,8 | 15,0 |

The proposed approach also includes the positive impact of urban targets that will inevitably counteract the transport and population trend in urban areas and therefore influence on the projected number of people exposed to certain noise levels in urban areas. The Clean Urban Transport target established in 2011 Transport Policy White Paper to “halve the use of conventionally-fueled cars in urban transport by 2030; and to phase them out by 2050;” and “to achieve essentially $CO_2$-free city logistics in major urban centres by 2030.” Based on the assumption that this policy will be implemented and the goal achieved, a reduction of 3dB due to road transport noise could be envisaged, leading to a reduction of more than 22% of people exposed to road traffic noise inside urban areas when comparing short and mid-term scenario, but with a reduction of nearly 17% if the comparison is done between mid-term scenario and baseline data (2017 gap filled reference year) (Figure 7.4).

**Figure 7.4. Change in the number of people exposed to high levels of road noise inside and outside urban areas. In light blue, estimated percent change from 2017 to 2020 and in dark blue, estimated percent change from 2020 to 2030. In dark grey, percent change for the overall period: 2017-2030.**



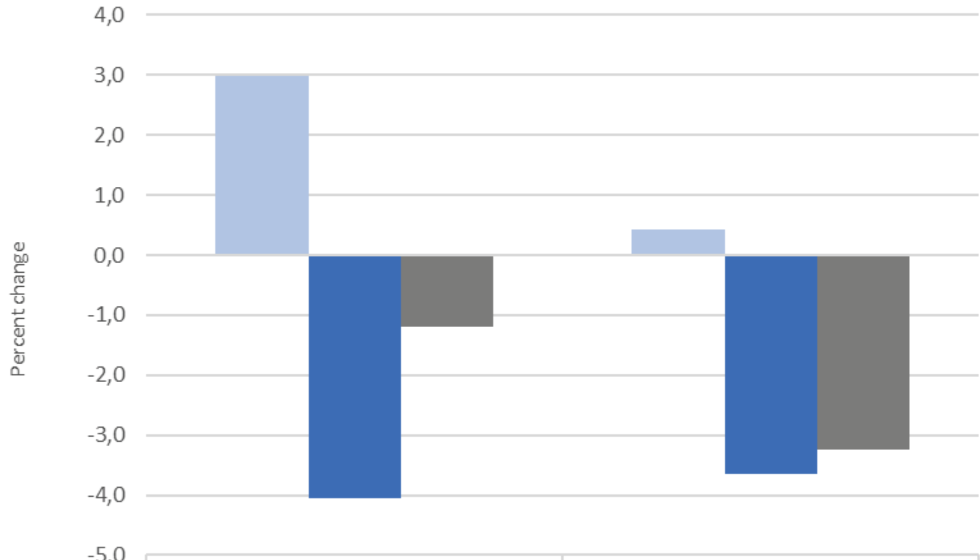

| | Agglomeration road | Major Road |
|---|---|---|
| 2017-2020 | 7,4 | 4,5 |
| 2020-2030 | -22,6 | 11,4 |
| 2017-2030 | -16,9 | 16,4 |

In the aviation sector, EASA (2016) highlighted the fact that emissions and noise exposure in 2014 were around 2005 levels, with the study of 45 European major airports from both Eu28 and EFTA region using the STAPES noise model. The stabilization of the noise exposure situation over this 10 year period in those 45 airports is due to technological improvements, fleet renewal, increased Air Traffic Management efficiency and the economic crisis in 2008 (EASA, 2016).

The current projection under the base (most likely) traffic forecast increase and a 0,2 dB reduction per annum for new aircraft deliveries [5], could maintain the stabilization observed in the period 2005-2014 for the period 2017 – 2020 considering the exposure to aircraft noise both inside and outside urban areas (nearly 3% of increase and 0,5% respectively), and potentially a mean reduction of 2% compared with exposure values corresponding to 2017 baseline reference year (Figure 7.5).

[5] Mean value between 0,1 dB reduction per annum considering the low technology improvement rate and the 0,3 dB reduction per annum considering the advanced technology improvement rate.

**Figure 7.5. Change in the number of people exposed to high levels of aircraft noise inside and outside urban areas. In light blue, estimated percent change from 2017 to 2020 and in dark blue, estimated percent change from 2020 to 2030. In dark grey, percent change for the overall period: 2017-2030.**




| | Agglomeration air | Major Air |
|---|---|---|
| 2017-2020 | 3,0 | 0,4 |
| 2020-2030 | -4,1 | -3,6 |
| 2017-2030 | -1,2 | -3,2 |

Finally, current noise regulations referring to aspects of environmental health are designed to have impact on populated areas, especially urban agglomerations. In this case, of special interest would be the projections calculated for $L_{night}$ exposure values. As can be seen in Figure 7.6, prediction of exposure values for $L_{night}$ follow the same pattern obtained with the calculations for $L_{den}$ in short and mid-term scenario: an increase of the number of people exposed from the baseline reference year 2017 to the short term scenario (2020) but even a higher decrease of people exposed to road traffic noise inside urban areas up to 28% of change when comparing 2020 and 2030 estimations.

**Figure 7.6. Estimated projections of number of people exposed due to different noise sources at 2020 and 2030 ($L_{night}$)**

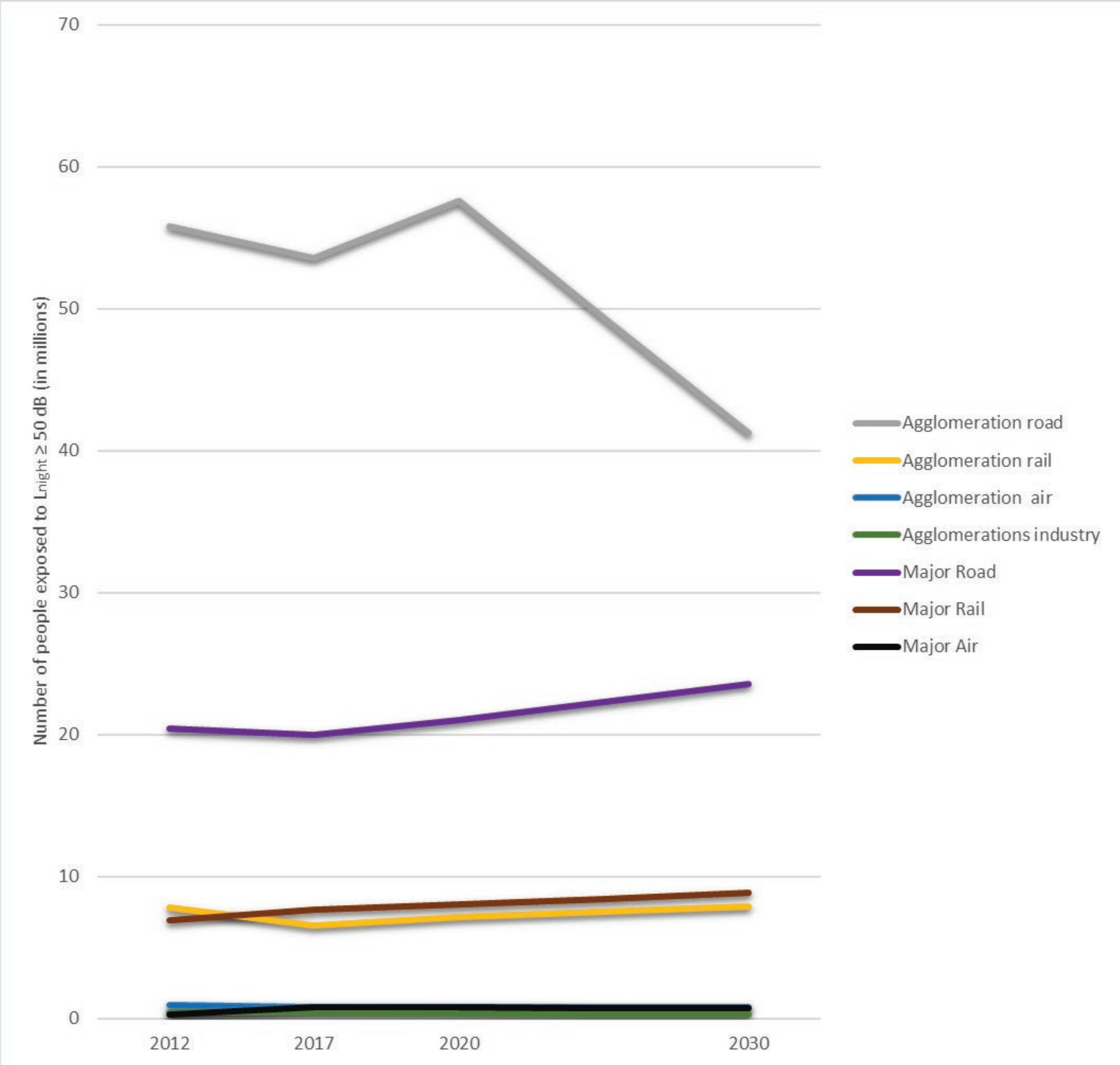



**Table 7.2. Estimated projections of number of people exposed due to different noise sources at 2020 and 2030 ($L_{night}$)**

| | Inside Urban Areas | | | Outside Urban Areas | | |
|---|---|---|---|---|---|---|
| | **2017** | **2020** | **2030** | **2017** | **2020** | **2030** |
| **Road noise** | 53532900 | 57577409 | 41244118 | 19982700 | 20988214 | 23553076 |
| **Rail noise** | 6552200 | 7115643 | 7852148 | 7621700 | 7994800 | 8838670 |
| **Aircraft noise** | 797800 | 821572 | 789971 | 752500 | 755134 | 724608 |
| **Industrial noise** | 382500 | 341594 | 234300 | - | - | - |

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# Annex 1 – Methodology to gap fill noise exposure data

Due to gaps in the reported data, a gap-filling routine is used to estimate the number of people exposed to high levels of noise for the two noise indicators $L_{den}$ and $L_{night}$. Different gap filling methodologies are used depending on the reporting year, the source and the available reported data.

The methodology employed is based on modelling the relationship between reference information such as the population data or the length of certain transport networks and the officially reported number of people exposed to noise. Additionally, when this approach was not possible to be applied, country averages or European averages have been used instead.

## 1.1 Gap Filling 2012

Partial gap filling is applied where exposure information provided is not complete.

### *1.1.1 Major roads and major railways*

- Gap filling for scenario 1: Incomplete data is provided for the 2012 round of noise mapping but information on the length of major roads/railways is provided.
  The gap filling is based on a relationship between the number of people exposed to high levels of noise and the length of major roads/major railways reported. The coefficients of the relationship are derived from the countries that submitted completed datasets of number of people exposed and length of major roads/railways. The same procedure applies for $L_{den}$ and $L_{night}$.

  In order to calculate the number of people exposed in each noise band, an average distribution of people per noise bands from the countries that have reported complete data is used. The same procedure applies for $L_{den}$ and $L_{night}$.

- Gap filling for scenario 2: Neither population exposure data or road/rail length is provided for the 2012 round of noise mapping but data is available for 2007 round of noise mapping.
  The gap filling is based on the correlation factor between the number of people exposed to high levels of noise and the length of major roads/major railways using the 2007 round of noise mapping reported data. All countries providing data for 2007 (first round of noise mapping) are considered complete, and no distinction between length inside and outside agglomerations is taken into account. A factor is multiplied in order to adjust the 2007 data to 2012 data using the method described in Jones (2013). The factor for $L_{den}$ and another for $L_{night}$ is calculated by comparing the exposure data reported in 2007 vs 2012.

  The weighting factor is calculated as the total percentage of change between 2012 and 2007 data. That is : (sum of people exposed to $L_{den} \geq 55$ dB 2012 for all countries considered) - (sum of people exposed to $L_{den} \geq 55$ dB 2007 for all countries considered) / (sum of people exposed to $L_{den} \geq 55$ dB 2007 for all countries considered) * 100. The same method applies for $L_{night}$.

  In order to calculate the number of people exposed in each noise band, an average distribution of people per noise bands from the countries that have reported complete data is used. The same procedure applies for $L_{den}$ and $L_{night}$.

- Gap filling for scenario 3: No population or length information is provided for 2007 and 2012.
  Countries are discarded from the assessment. In the case of major roads, the region of Brussels (Belgium) and Turkey have been excluded. For major railways, Cyprus, Liechtenstein and Turkey.

### *1.1.2 Agglomerations (Road)*

- Gap filling for scenario 1: No population exposure data is provided for the 2012 round of noise mapping but information on the number of inhabitants is provided.
  The gap filling is based on the relationship between the total number of inhabitants and the total number of people exposed >= 55 dB $L_{den}$ and to >= 50 dB $L_{night}$. The coefficients of the relationship are derived from the agglomerations that submitted completed datasets of number of people exposed and the number of inhabitants of the agglomeration. The same procedure applies for $L_{den}$ and $L_{night}$.

  In order to calculate the number of people exposed in each noise band, an average distribution of people per noise bands is applied as follows:

  - For agglomerations in which with no other country data on agglomeration is available, the general European mean derived is used to calculate the distribution over different noise bands.
  - For agglomerations with other data at country level, the predominant distribution is chosen and the agglomerations with that distribution are used to calculate the percentage of population per noise band and mean.

  The same procedure applies for $L_{den}$ and $L_{night}$.

- Gap filling for scenario 2: Neither population exposure data or inhabitants are provided for the 2012 round of noise mapping but data is available for the 2007 round of noise mapping.

  The agglomeration is gap filled with the same data reported for the 2007 round of noise mapping.

- Gap filling for scenario 3: No exposure information available for 2007 or 2012 and information on the number of inhabitants not provided for 2012 but available for 2007.
  The total number of inhabitants in 2012 is taken from the data reported in 2007. The gap filling is the same as for 'scenario 1' .

### *1.1.2 Agglomerations (railway, aircraft, industry)*

- Gap filling for scenario 1: No population exposure data is provided for the 2012 round of noise mapping but information is available for the 2007 round of noise mapping.
  The gap filling is based on using the data for 2007 to fill in the gaps of the data from 2012.

- Gap filling for scenario 2: No population exposure data is provided for the 2012 round of noise mapping but information on the number of inhabitants is provided.
  The gap filling is based on using the mean percentage of the people exposed using all the agglomerations with data reported. In order to calculate the number of people exposed in each noise band, an average distribution of people per noise bands from the agglomerations that have reported complete data is used. The same procedure applies for $L_{den}$ and $L_{night}$.

Agglomerations with 0 people exposed are excluded to calculate the average distribution of people per noise bands.

- Gap filling for scenario 3: Only information on the number of inhabitants for the 2007 round of noise mapping is available.
  The total number of inhabitants in 2012 is taken from the data reported in 2007. The gap filling is the same as for 'scenario 2'.

### *1.1.2 Major Airports (outside agglomerations)*

- Gap filling for scenario 1: No population exposure data is provided for the 2012 round of noise mapping but information is available for the 2007 round of noise mapping.
  The gap filling is based on deriving a weighting factor to convert 2007 data to 2012 data. A factor is multiplied in order to adjust the 2007 data to 2012 data using the method described in Jones (2013). The factor for $L_{den}$ and another for $L_{night}$ is calculated by comparing the exposure data reported in 2007 vs 2012.

  The weighting factor is calculated as the total percentage of change between 2012 and 2007 data. That is: (sum of people exposed to $L_{den} \geq 55$ dB 2012 for all major airports) - (sum of people exposed to $L_{den} \geq 55$ dB 2007 for all major airports) / (sum of people exposed to $L_{den} \geq 55$ dB 2007 for all countries major airports) * 100. The same method applies for $L_{night}$.

  In order to calculate the number of people exposed in each noise band, an average distribution of people per noise band from the airports that have reported complete data is used. The same procedure applies for $L_{den}$ and $L_{night}$.

## 1.2 Gap Filling 2017

Partial gap filling is applied where exposure information provided is not complete.

The gap filling for 2017 is based on using the data reported in 2012 if available. If data reported in 2012 is not available, the gap filled routine used is the same as the one reported in section 1.1. Gap Filling 2012. This routine is adapted to the 2017 data by using the estimates and weighting factors derived from the 2017 total European data. The conversion factors used are based on the last available year's data.

## 1.3 Data Used

The primary data used for deriving the gap filled values in this assessment can be found in the link below:

- Reported data 2007, 2012 and 2017 (updated 18-09-12)
  https://www.eea.europa.eu/data-and-maps/data/data-on-noise-exposure-6

The gap-filled data used for this assessment can be found in the links below[6]:

- Data gap filled 2017:
  https://forum.eionet.europa.eu/etc-acm-consortium/library/subvention-2018/task-deliveries-ap2018/task-1118-noise-data-operational-compilation-and-management/b.-final-drafts-approval-eea/subtask-6.-gap-filling/end_gapfilled2017_uab181026

- Data gap filled 2012:

[6] These data is protected

https://forum.eionet.europa.eu/etc-acm-consortium/library/subvention-2018/task-deliveries-ap2018/task-1118-noise-data-operational-compilation-and-management/b.-final-drafts-approval-eea/subtask-6.-gap-filling/end_gapfilled2012_uab181026

## Annex 2 – Acronyms

| | |
|---|---|
| CAGR | Cumulative Average Growth Rate |
| CLC | CORINE Land Cover |
| CNOSSOS-EU | Common Noise Assessment Methods in Europe |
| CORINE | Coordination of Information on the Environment |
| dB | Decibel |
| EFTA | European Free Trade Association |
| END | Environment Noise Directive |
| ETC/ACM | European Topic Centre on Air Pollution and Climate Change Mitigation |
| EU | European Union |
| EUROPOP2010 | Population projection scenario developed by Eurostat |
| JRC | Joint Research Centre |
| $L_{den}$ | The day-evening-night time noise level indicator |
| $L_{night}$ | The night time noise level indicator |
| LAU | Local Administrative Units (Eurostat) |
| LUISA | Land-Use based Integrated Sustainability Assessment |
| PRIMES-TREMOVE | Transport Model |
| STAPES | System for Airport Noise Exposure Studies |

## Annex 3 – Cumulative Average Growth Rate (CAGR) for END urban agglomerations

| RLID | SUM_POP_10 | SUM_POP_20 | SUM_POP_30 | CAGR10-20 | CAGR20-30 |
|---|---|---|---|---|---|
| AT_AG_0001 | 1549212 | 1329244 | 1198463 | -0,0152 | -0,0103 |
| AT_AG_0002 | 231158 | 220595 | 211406 | -0,00467 | -0,00425 |
| AT_AG_0003 | 204913 | 188595 | 177103 | -0,00826 | -0,00627 |
| AT_AG_0004 | 146144 | 145214 | 142593 | -0,00064 | -0,00182 |
| AT_AG_0005 | 118354 | 107869 | 101118 | -0,00923 | -0,00644 |
| BE_AG_0001 | 481870 | 508317 | 498468 | 0,005357 | -0,00195 |
| BE_AG_0002 | 1061538 | 1096245 | 1041573 | 0,003222 | -0,0051 |
| BE_AG_0003 | 249525 | 271799 | 263925 | 0,008587 | -0,00294 |
| BE_AG_0004 | 122396 | 130500 | 123217 | 0,006432 | -0,00573 |
| BE_AG_0005 | 224460 | 259209 | 263578 | 0,014498 | 0,001673 |
| BE_AG_0006 | 205893 | 218588 | 207909 | 0,006001 | -0,005 |
| BG_AG_0001 | 310419 | 317008 | 293937 | 0,002103 | -0,00753 |
| BG_AG_0002 | 1208726 | 1305220 | 1271839 | 0,00771 | -0,00259 |
| BG_AG_0003 | 384965 | 432391 | 416541 | 0,011686 | -0,00373 |
| BG_AG_0004 | 174780 | 163551 | 141853 | -0,00662 | -0,01413 |
| BG_AG_0005 | 132765 | 126849 | 114029 | -0,00455 | -0,0106 |
| BG_AG_0006 | 137950 | 124846 | 104845 | -0,00993 | -0,01731 |
| BG_AG_0007 | 103363 | 102260 | 88777 | -0,00107 | -0,01404 |
| CY_AG_0001 | 198653 | 232916 | 153269 | 0,016039 | -0,04098 |
| CY_AG_0002 | 150650 | 173176 | 104054 | 0,014032 | -0,04966 |
| CZ_a_ag001 | 1566198 | 2078018 | 2323687 | 0,02868 | 0,011237 |
| CZ_a_ag002 | 579645 | 927695 | 1103359 | 0,048152 | 0,017492 |
| CZ_a_ag003 | 510263 | 671867 | 742820 | 0,027895 | 0,01009 |
| CZ_a_ag004 | 205462 | 262912 | 269671 | 0,024962 | 0,002542 |
| CZ_a_ag005 | 287837 | 505708 | 621430 | 0,057975 | 0,02082 |
| CZ_a_ag006 | 187921 | 237626 | 232933 | 0,023745 | -0,00199 |
| CZ_a_ag007 | 133208 | 208527 | 250106 | 0,045835 | 0,018348 |
| DE_AG_0001 | 264774 | 278841 | 281175 | 0,00519 | 0,000834 |
| DE_AG_0002 | 284910 | 326697 | 320448 | 0,01378 | -0,00193 |
| DE_AG_0003 | 417360 | 424436 | 372072 | 0,001683 | -0,01308 |
| DE_AG_0004 | 683745 | 698862 | 667651 | 0,002189 | -0,00456 |
| DE_AG_0005 | 526358 | 564612 | 538778 | 0,00704 | -0,00467 |
| DE_AG_0006 | 280732 | 287948 | 282233 | 0,002541 | -0,002 |
| DE_AG_0007 | 3384877 | 3372401 | 3187817 | -0,00037 | -0,00561 |
| DE_AG_0008 | 337066 | 351915 | 332247 | 0,00432 | -0,00573 |
| DE_AG_0009 | 408169 | 424301 | 410386 | 0,003884 | -0,00333 |
| DE_AG_0010 | 318154 | 317214 | 300898 | -0,0003 | -0,00527 |
| DE_AG_0011 | 565590 | 613790 | 603568 | 0,008212 | -0,00168 |
| DE_AG_0012 | 567983 | 582531 | 564426 | 0,002532 | -0,00315 |
| DE_AG_0013 | 601413 | 624036 | 604305 | 0,003699 | -0,00321 |
| DE_AG_0014 | 508842 | 530779 | 522585 | 0,00423 | -0,00155 |
| DE_AG_0015 | 607976 | 622313 | 606302 | 0,002333 | -0,0026 |
| DE_AG_0016 | 277413 | 303712 | 298306 | 0,009098 | -0,00179 |
| DE_AG_0017 | 2210164 | 2500753 | 2523483 | 0,012429 | 0,000905 |

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|---|---|---|---|---|---|
| DE_AG_0018 | 543209 | 591955 | 581385 | 0,008631 | -0,0018 |
| DE_AG_0019 | 1020657 | 1042346 | 998314 | 0,002105 | -0,00431 |
| DE_AG_0020 | 294899 | 312099 | 308348 | 0,005685 | -0,00121 |
| DE_AG_0021 | 281759 | 292651 | 281100 | 0,0038 | -0,00402 |
| DE_AG_0022 | 253683 | 243859 | 234643 | -0,00394 | -0,00385 |
| DE_AG_0023 | 337160 | 378508 | 385646 | 0,011635 | 0,00187 |
| DE_AG_0024 | 1426845 | 1675360 | 1699658 | 0,016186 | 0,001441 |
| DE_AG_0025 | 524188 | 562482 | 546639 | 0,007076 | -0,00285 |
| DE_AG_0026 | 631640 | 679804 | 661079 | 0,007376 | -0,00279 |
| DE_AG_0027 | 348569 | 337509 | 318971 | -0,00322 | -0,00563 |
| DE_AG_0028 | 245398 | 258558 | 241338 | 0,005238 | -0,00687 |
| DE_AG_0029 | 227665 | 224396 | 198939 | -0,00145 | -0,01197 |
| DE_AG_0030 | 110233 | 115880 | 115225 | 0,005008 | -0,00057 |
| DE_AG_0031 | 129369 | 143420 | 144228 | 0,010364 | 0,000562 |
| DE_AG_0032 | 254170 | 277704 | 277421 | 0,008895 | -0,0001 |
| DE_AG_0033 | 120602 | 128198 | 125799 | 0,006127 | -0,00189 |
| DE_AG_0034 | 135626 | 149255 | 139553 | 0,009622 | -0,0067 |
| DE_AG_0035 | 145196 | 150087 | 146817 | 0,003319 | -0,0022 |
| DE_AG_0036 | 107102 | 114069 | 111452 | 0,006322 | -0,00232 |
| DE_AG_0037 | 126282 | 136824 | 136573 | 0,00805 | -0,00018 |
| DE_AG_0038 | 194017 | 191292 | 180117 | -0,00141 | -0,006 |
| DE_AG_0039 | 197372 | 202270 | 178408 | 0,002454 | -0,01247 |
| DE_AG_0040 | 155485 | 175741 | 181292 | 0,012321 | 0,003115 |
| DE_AG_0041 | 182273 | 190854 | 184188 | 0,004611 | -0,00355 |
| DE_AG_0043 | 111537 | 128123 | 131641 | 0,01396 | 0,002712 |
| DE_AG_0044 | 148944 | 201756 | 226419 | 0,030814 | 0,0116 |
| DE_AG_0045 | 211630 | 241247 | 231277 | 0,013184 | -0,00421 |
| DE_AG_0046 | 116741 | 129416 | 124434 | 0,010361 | -0,00392 |
| DE_AG_0047 | 246880 | 256953 | 255207 | 0,004007 | -0,00068 |
| DE_AG_0048 | 173375 | 189494 | 194421 | 0,00893 | 0,00257 |
| DE_AG_0049 | 267556 | 291885 | 289149 | 0,008741 | -0,00094 |
| DE_AG_0050 | 180016 | 202743 | 205604 | 0,01196 | 0,001402 |
| DE_AG_0051 | 198956 | 205839 | 196142 | 0,003407 | -0,00481 |
| DE_AG_0052 | 107953 | 109380 | 108095 | 0,001314 | -0,00118 |
| DE_AG_0054 | 180419 | 190643 | 190413 | 0,005527 | -0,00012 |
| DE_AG_0055 | 280074 | 293059 | 287561 | 0,004542 | -0,00189 |
| DE_AG_0056 | 152775 | 154205 | 150038 | 0,000932 | -0,00274 |
| DE_AG_0057 | 231086 | 247381 | 248622 | 0,006837 | 0,000501 |
| DE_AG_0058 | 119271 | 123167 | 119527 | 0,003219 | -0,003 |
| DE_AG_0059 | 166674 | 187173 | 188032 | 0,011667 | 0,000458 |
| DE_AG_0060 | 186559 | 231748 | 247236 | 0,021927 | 0,00649 |
| DE_AG_0061 | 126500 | 137959 | 139292 | 0,008709 | 0,000962 |
| DE_AG_0062 | 149450 | 162247 | 163891 | 0,00825 | 0,001009 |
| DE_AG_0063 | 129871 | 142933 | 142238 | 0,00963 | -0,00049 |
| DE_AG_0064 | 149093 | 180970 | 178965 | 0,019565 | -0,00111 |
| DE_AG_0065 | 116159 | 114652 | 112525 | -0,0013 | -0,00187 |
| DE_AG_0066 | 126859 | 154843 | 158738 | 0,020134 | 0,002487 |

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|---|---|---|---|---|---|
| DE_AG_0067 | 247786 | 267558 | 261864 | 0,007707 | -0,00215 |
| DE_AG_0068 | 175000 | 191310 | 196868 | 0,008951 | 0,002868 |
| DE_AG_0069 | 126895 | 150237 | 151376 | 0,017029 | 0,000756 |
| DE_AG_0070 | 149392 | 169433 | 165210 | 0,012668 | -0,00252 |
| DE_AG_0071 | 218546 | 217266 | 198538 | -0,00059 | -0,00897 |
| DE_AG_0072 | 115391 | 122649 | 119766 | 0,006119 | -0,00238 |
| DE_AG_0073 | 130136 | 142137 | 140439 | 0,00886 | -0,0012 |
| DK_AG_0001 | 1137899 | 1348925 | 1453101 | 0,017158 | 0,007467 |
| DK_AG_0002 | 310353 | 353392 | 396558 | 0,013071 | 0,011591 |
| DK_AG_0003 | 199698 | 220474 | 234956 | 0,009946 | 0,006382 |
| DK_AG_0004 | 180568 | 200209 | 215724 | 0,010379 | 0,007492 |
| EE_AG_0001 | 455754 | 563847 | 559782 | 0,021511 | -0,00072 |
| EE_AG_0002 | 116528 | 134151 | 123905 | 0,014183 | -0,00791 |
| ES_AG_0001 | 319876 | 326786 | 313990 | 0,002139 | -0,00399 |
| ES_AG_0002 | 487839 | 498600 | 480272 | 0,002184 | -0,00374 |
| ES_AG_0003 | 1789821 | 1870483 | 1818672 | 0,004418 | -0,00281 |
| ES_AG_0004 | 388082 | 425624 | 431381 | 0,009277 | 0,001344 |
| ES_AG_0005 | 383355 | 379469 | 371362 | -0,00102 | -0,00216 |
| ES_AG_0006 | 334658 | 332388 | 321954 | -0,00068 | -0,00318 |
| ES_AG_0007 | 298625 | 293211 | 285273 | -0,00183 | -0,00274 |
| ES_AG_0008 | 0 | 0 | 0 | 0,004327 | 0,000858 |
| ES_AG_0009 | 3519455 | 3708045 | 3715433 | 0,005234 | 0,000199 |
| ES_AG_0010 | 478073 | 477444 | 467449 | -0,00013 | -0,00211 |
| ES_AG_0011 | 455915 | 529907 | 614822 | 0,015153 | 0,014974 |
| ES_AG_0012 | 210971 | 197056 | 173267 | -0,0068 | -0,01278 |
| ES_AG_0013 | 0 | 0 | 0 | 0,004327 | 0,000858 |
| ES_AG_0014 | 741498 | 779048 | 838938 | 0,004952 | 0,007434 |
| ES_AG_0015 | 861252 | 935573 | 972086 | 0,008312 | 0,003836 |
| ES_AG_0016 | 303196 | 276955 | 252116 | -0,00901 | -0,00935 |
| ES_AG_0017 | 339192 | 352070 | 338005 | 0,003733 | -0,00407 |
| ES_AG_0018 | 658397 | 653671 | 645309 | -0,00072 | -0,00129 |
| ES_AG_0019 | 316877 | 330990 | 341211 | 0,004367 | 0,003046 |
| ES_AG_0020 | 107574 | 100614 | 93375 | -0,00667 | -0,00744 |
| ES_AG_0021 | 195357 | 222478 | 258239 | 0,013085 | 0,015017 |
| ES_AG_0022 | 228479 | 233699 | 220662 | 0,002262 | -0,00572 |
| ES_AG_0023 | 154607 | 162426 | 156405 | 0,004946 | -0,00377 |
| ES_AG_0024 | 196567 | 183246 | 164573 | -0,00699 | -0,01069 |
| ES_AG_0025 | 113472 | 128285 | 135922 | 0,012345 | 0,005799 |
| ES_AG_0026 | 173017 | 177736 | 180387 | 0,002695 | 0,001482 |
| ES_AG_0027 | 118181 | 124366 | 125652 | 0,005114 | 0,001029 |
| ES_AG_0028 | 170797 | 176705 | 176166 | 0,003406 | -0,00031 |
| ES_AG_0029 | 169868 | 170311 | 167102 | 0,00026 | -0,0019 |
| ES_AG_0030 | 108561 | 107833 | 103663 | -0,00067 | -0,00394 |
| ES_AG_0031 | 167176 | 187384 | 195898 | 0,011477 | 0,004453 |
| ES_AG_0032 | 181611 | 190953 | 188094 | 0,005029 | -0,00151 |
| ES_AG_0033 | 125592 | 144778 | 174530 | 0,014318 | 0,018865 |
| ES_AG_0034 | 199916 | 212507 | 209943 | 0,006126 | -0,00121 |

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|---|---|---|---|---|---|
| ES_AG_0035 | 188978 | 188469 | 194999 | -0,00027 | 0,003412 |
| ES_AG_0036 | 170428 | 232721 | 289696 | 0,031643 | 0,022141 |
| ES_AG_0037 | 123727 | 121254 | 112085 | -0,00202 | -0,00783 |
| ES_AG_0038 | 263266 | 288366 | 305006 | 0,009148 | 0,005626 |
| ES_AG_0039 | 158984 | 165236 | 165653 | 0,003865 | 0,000252 |
| ES_AG_0040 | 118375 | 123049 | 123983 | 0,00388 | 0,000756 |
| ES_AG_0041 | 212688 | 230913 | 241540 | 0,008255 | 0,00451 |
| ES_AG_0042 | 214533 | 258527 | 295410 | 0,018829 | 0,013426 |
| ES_AG_0043 | 137809 | 136148 | 130961 | -0,00121 | -0,00388 |
| ES_AG_0044 | 123235 | 111509 | 96415 | -0,00995 | -0,01444 |
| ES_AG_0045 | 151051 | 153265 | 152287 | 0,001456 | -0,00064 |
| ES_AG_0046 | 148317 | 197049 | 239990 | 0,028817 | 0,01991 |
| ES_AG_0047 | 113867 | 116763 | 115876 | 0,002515 | -0,00076 |
| ES_AG_0048 | 210337 | 208018 | 198034 | -0,00111 | -0,00491 |
| ES_AG_0050 | 233980 | 224324 | 213981 | -0,00421 | -0,00471 |
| ES_AG_0051 | 104857 | 98501 | 88135 | -0,00623 | -0,01106 |
| ES_AG_0052 | 155057 | 151843 | 145089 | -0,00209 | -0,00454 |
| ES_AG_0053 | 0 | 0 | 0 | 0,004327 | 0,000858 |
| ES_AG_0054 | 204053 | 212498 | 220663 | 0,004064 | 0,003778 |
| ES_AG_0055 | 176861 | 176894 | 173236 | 1,87E-05 | -0,00209 |
| ES_AG_0056 | 126782 | 122572 | 112074 | -0,00337 | -0,00891 |
| ES_AG_0057 | 108600 | 102670 | 93774 | -0,0056 | -0,00902 |
| ES_AG_0058 | 267087 | 300206 | 316143 | 0,011758 | 0,005186 |
| ES_AG_0059 | 227051 | 251895 | 275770 | 0,010438 | 0,009097 |
| ES_AG_0060 | 242059 | 226994 | 214101 | -0,00641 | -0,00583 |
| ES_AG_0066 | 102341 | 111765 | 122143 | 0,008848 | 0,008919 |
| ES_AG_0068 | 0 | 0 | 0 | 0,004327 | 0,000858 |
| FI_AG_0001 | 630473 | 839624 | 918868 | 0,029063 | 0,00906 |
| FI_AG_0002 | 261676 | 355724 | 418292 | 0,031181 | 0,016334 |
| FI_AG_0003 | 221969 | 291598 | 323054 | 0,027659 | 0,010297 |
| FI_AG_0004 | 237762 | 350230 | 435555 | 0,039492 | 0,022043 |
| FI_AG_0005 | 169847 | 145550 | 107500 | -0,01532 | -0,02985 |
| FI_AG_0006 | 157543 | 184692 | 206400 | 0,016026 | 0,011175 |
| FI_AG_0007 | 97480 | 81121 | 57568 | -0,0182 | -0,03372 |
| FI_AG_0008 | 14753 | 19423 | 21411 | 0,027883 | 0,009792 |
| FI_AG_0009 | 130151 | 141991 | 131654 | 0,008745 | -0,00753 |
| FI_AG_0010 | 122185 | 138897 | 142812 | 0,012902 | 0,002784 |
| FR_AG_0001 | 268144 | 287260 | 293552 | 0,00691 | 0,002169 |
| FR_AG_0002 | 1035795 | 1369903 | 1454666 | 0,028352 | 0,006022 |
| FR_AG_0003 | 328009 | 379289 | 377437 | 0,014632 | -0,00049 |
| FR_AG_0005 | 445840 | 495241 | 491720 | 0,010564 | -0,00071 |
| FR_AG_0006 | 1233372 | 1289240 | 1280859 | 0,00444 | -0,00065 |
| FR_AG_0007 | 1510448 | 1807536 | 1943741 | 0,018118 | 0,007291 |
| FR_AG_0008 | 2046245 | 2361542 | 2639500 | 0,014434 | 0,01119 |
| FR_AG_0009 | 352128 | 382197 | 377724 | 0,008228 | -0,00118 |
| FR_AG_0010 | 470197 | 587622 | 628727 | 0,022544 | 0,006784 |
| FR_AG_0011 | 251618 | 267925 | 259113 | 0,006299 | -0,00334 |

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|---|---|---|---|---|---|
| FR_AG_0012 | 762843 | 947356 | 977564 | 0,021899 | 0,003144 |
| FR_AG_0013 | 554787 | 574334 | 563903 | 0,003469 | -0,00183 |
| FR_AG_0014 | 322832 | 396921 | 416438 | 0,020875 | 0,004812 |
| FR_AG_0015 | 7529214 | 8049708 | 8121095 | 0,006707 | 0,000883 |
| FR_AG_0016 | 690994 | 1122767 | 1390148 | 0,049739 | 0,021591 |
| FR_AG_0017 | 568879 | 645040 | 659467 | 0,012644 | 0,002214 |
| FR_AG_0018 | 504375 | 554311 | 581593 | 0,009485 | 0,004816 |
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| UK_AG_0037 | 148309 | 167941 | 178953 | 0,012509 | 0,006371 |
| UK_AG_0038 | 145391 | 158526 | 169639 | 0,008687 | 0,006798 |
| UK_AG_0039 | 222834 | 241357 | 246106 | 0,008017 | 0,00195 |
| UK_AG_0040 | 106273 | 121502 | 129781 | 0,013482 | 0,006614 |
| UK_AG_0041 | 88671 | 86464 | 82709 | -0,00252 | -0,00443 |
| UK_AG_0042 | 111656 | 122152 | 127315 | 0,009025 | 0,004148 |
| UK_AG_0043 | 116394 | 129532 | 135066 | 0,010752 | 0,004192 |
| UK_AG_0044 | 122155 | 124548 | 123011 | 0,001942 | -0,00124 |
| UK_AG_0045 | 104731 | 103154 | 99699 | -0,00152 | -0,0034 |
| UK_AG_0046 | 95401 | 114406 | 127470 | 0,018332 | 0,010871 |
| UK_AG_0047 | 134315 | 145139 | 146097 | 0,007781 | 0,000658 |
| UK_AG_0048 | 78179 | 88057 | 90077 | 0,011969 | 0,002271 |
| UK_AG_0049 | 205260 | 224637 | 230152 | 0,009062 | 0,002428 |
| UK_AG_0050 | 131689 | 145263 | 152663 | 0,009859 | 0,004981 |
| UK_AG_0051 | 180049 | 206262 | 219483 | 0,013685 | 0,006232 |
| UK_AG_0052 | 176328 | 195820 | 203334 | 0,01054 | 0,003773 |

| | | | | | |
|---|---|---|---|---|---|
| UK_AG_0053 | 180627 | 192812 | 190680 | 0,00655 | -0,00111 |
| UK_AG_0054 | 87962 | 93327 | 95576 | 0,005938 | 0,002384 |
| UK_AG_0055 | 111643 | 119902 | 122885 | 0,007162 | 0,00246 |
| UK_AG_0056 | 139361 | 162570 | 170726 | 0,015523 | 0,004907 |
| UK_AG_0057 | 241365 | 255615 | 253860 | 0,005753 | -0,00069 |
| UK_AG_0058 | 117801 | 125524 | 131805 | 0,00637 | 0,004895 |
| UK_AG_0059 | 94616 | 94424 | 93901 | -0,0002 | -0,00056 |
| UK_AG_0060 | 97369 | 112013 | 128888 | 0,014109 | 0,014132 |
| UK_AG_0061 | 138433 | 138478 | 136111 | 3,25E-05 | -0,00172 |
| UK_AG_0062 | 152274 | 158903 | 158789 | 0,00427 | -7,2E-05 |
| UK_AG_0063 | 93573 | 100851 | 102967 | 0,007518 | 0,002079 |
| UK_AG_0064 | 98582 | 95159 | 90731 | -0,00353 | -0,00475 |
| UK_AG_0065 | 196934 | 194225 | 187664 | -0,00138 | -0,00343 |
| UK_AG_0066 | 99253 | 108550 | 110758 | 0,008994 | 0,002016 |
| UK_AG_0067 | 142280 | 158843 | 166958 | 0,011073 | 0,004995 |
| UK_AG_0068 | 120284 | 128198 | 133512 | 0,006392 | 0,00407 |
| UK_AG_0069 | 115734 | 120653 | 120140 | 0,004171 | -0,00043 |
| UK_AG_0070 | 89379 | 106064 | 115777 | 0,017263 | 0,008801 |
| UK_AG_0071 | 153435 | 163899 | 164535 | 0,006619 | 0,000387 |
| UK_AG_0072 | 188725 | 203174 | 205251 | 0,007404 | 0,001018 |
| UK_AG_0073 | 110382 | 128574 | 134613 | 0,015373 | 0,0046 |
| UK_AG_0074 | 282061 | 283365 | 279710 | 0,000461 | -0,0013 |

## Annex 4 – Cumulative Average Growth Rate (CAGR) for EU-28 countries (extracting END urban agglomerations)

| COUNTRY_ID | SUM_2010 | SUM_2020 | SUM_2030 | CAGR10_20 | CAGR20_30 |
|---|---|---|---|---|---|
| AT | 5772842 | 6289563 | 6709439 | 0,00861 | 0,006483 |
| BE | 8218580 | 8830697 | 9516827 | 0,00721 | 0,007511 |
| BG | 4879714 | 4270318 | 3934613 | -0,01325 | -0,00815 |
| CY | 416810 | 449020 | 668992 | 0,007471 | 0,040676 |
| CZ | 6749648 | 5714848 | 4998965 | -0,0165 | -0,01329 |
| DE | 54936130 | 51714876 | 50327392 | -0,00602 | -0,00272 |
| DK | 3432639 | 3341410 | 3333292 | -0,00269 | -0,00024 |
| EE | 710000 | 571623 | 539527 | -0,02145 | -0,00576 |
| EL | 8242827 | 8299171 | 7883533 | 0,000681 | -0,00512 |
| ES | 23979321 | 25145961 | 26847957 | 0,004762 | 0,006571 |
| FI | 3060396 | 2760435 | 2634616 | -0,01026 | -0,00465 |
| FR | 31209562 | 29646120 | 30332647 | -0,00513 | 0,002292 |
| HR | 2931173 | 2502770 | 1785820 | -0,01568 | -0,03319 |
| HU | 6950087 | 6050904 | 5463873 | -0,01376 | -0,01015 |
| IE | 2520709 | 2372195 | 2611344 | -0,00605 | 0,009651 |
| IT | 45036816 | 46603752 | 48215365 | 0,003426 | 0,003405 |
| LI | 1525 | 1558 | 1596 | 0,002143 | 0,002413 |
| LT | 1541585 | 1161439 | 1080886 | -0,02792 | -0,00716 |
| LU | 385357 | 427000 | 468886 | 0,010314 | 0,009401 |
| LV | 1043098 | 741270 | 658270 | -0,03358 | -0,0118 |
| NL | 132367 | 134383 | 142187 | 0,001513 | 0,005661 |
| PL | 8193650 | 8227796 | 8364552 | 0,000416 | 0,00165 |
| PT | 24950982 | 23196565 | 22800307 | -0,00726 | -0,00172 |
| RO | 8104072 | 8105275 | 8157896 | 1,48E-05 | 0,000647 |
| SE | 14775256 | 13401185 | 12989498 | -0,00971 | -0,00312 |
| SI | 5773762 | 6025736 | 6312261 | 0,004281 | 0,004656 |
| UK | 1459775 | 1423753 | 1358634 | -0,0025 | -0,00467 |
| MT | 30408111 | 33044738 | 36726646 | 0,00835 | 0,01062 |
| SK | 4514399 | 4576528 | 4562247 | 0,001368 | -0,00031 |

## Annex 5 – Decibel (dB) change at country level derived from the transport activity change, for 2020 and 2030

### A3.1. Road exposure inside agglomerations

| Country code | dB change 2010-2020 | dB change 2020-2030 |
|---|---|---|
| AT | 0,2 | -2,3 |
| BE | 0,2 | -2,5 |
| BG | 0,3 | -2,4 |
| CY | 0,2 | -2,5 |
| CZ | 0,3 | -1,7 |
| DE | 0,2 | -2,6 |
| DK | 0,3 | -2,4 |
| EE | 0,4 | -2,4 |
| ES | 0,1 | -2,1 |
| FI | 0,1 | -2,6 |
| FR | 0,4 | -2,3 |
| GR | 0,1 | -2,8 |
| HR | 0,3 | -2,2 |
| HU | 0,3 | -2,0 |
| IE | 0,2 | -1,8 |
| IT | 0,1 | -2,5 |
| LT | 0,2 | -2,6 |
| LU | 0,5 | -1,4 |
| LV | 0,2 | -2,4 |
| MT | 0,1 | -2,6 |
| NL | 0,2 | -2,4 |
| PL | 0,5 | -1,9 |
| PT | 0,1 | -1,9 |
| RO | 0,4 | -1,7 |
| SE | 0,2 | -2,1 |
| SI | 0,2 | -2,3 |
| SK | 0,6 | -0,9 |
| UK | 0,2 | -2,5 |

### A3.2. Major roads exposure outside agglomerations

| Country code | dB change 2010-2020 | dB change 2020-2030 |
|---|---|---|
| AT | 0,4 | 1,1 |
| BE | 0,4 | 1,2 |
| BG | 0,5 | 1,1 |
| CY | 0,3 | 0,9 |
| CZ | 0,4 | 1,9 |
| DE | 0,4 | 0,9 |
| DK | 0,6 | 1,1 |
| EE | 0,8 | 1,1 |
| ES | 0,2 | 1,4 |
| FI | 0,2 | 0,9 |
| FR | 0,6 | 1,5 |
| GB | 0,4 | 0,9 |
| GR | 0,2 | 0,5 |
| HR | 0,5 | 1,4 |
| HU | 0,4 | 1,6 |
| IE | 0,5 | 2,2 |
| IT | 0,2 | 0,9 |
| LT | 0,6 | 0,6 |
| LU | 1,0 | 2,2 |
| LV | 0,5 | 1,3 |
| MT | 0,3 | 1,0 |
| NL | 0,4 | 0,9 |
| PL | 0,9 | 2,0 |
| PT | 0,2 | 1,6 |
| RO | 0,9 | 2,3 |
| SE | 0,3 | 1,3 |
| SI | 0,6 | 1,5 |
| SK | 0,8 | 2,8 |

### A3.3. Rail exposure inside agglomerations and major railways exposure outside agglomerations

| Country code | dB change 2010-2020 | dB change 2020-2030 |
|---|---|---|
| AT | 0,4 | 1,2 |
| BE | 0,4 | 2,1 |
| BG | 0,5 | 1,6 |
| CY | 0,0 | 0,0 |
| CZ | 0,6 | 1,5 |
| DE | 0,4 | 1,0 |
| DK | 0,4 | 1,5 |
| EE | 0,6 | 2,0 |
| ES | 0,6 | 2,2 |
| FI | 0,4 | 1,1 |
| FR | 0,6 | 1,9 |
| GB | 0,5 | 1,0 |
| GR | 0,2 | 1,0 |
| HR | 0,3 | 0,8 |
| HU | 0,5 | 1,9 |
| IE | 0,3 | 1,0 |
| IT | 0,4 | 1,1 |
| LT | 0,7 | 1,1 |
| LU | 0,6 | 2,4 |
| LV | 0,5 | 2,1 |
| NL | 0,4 | 1,2 |
| PL | 0,7 | 2,7 |
| PT | 0,4 | 1,7 |
| RO | 0,7 | 1,7 |
| SE | 0,5 | 1,5 |
| SI | 1,0 | 3,1 |
| SK | 0,6 | 2,4 |

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