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Tagung der Alpenkonferenz
Réunion de la Conférence alpine
Sessione della Conferenza delle Alpi
Zasedanje Alpske konference

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REPORT OF THE
Transport Working Group (TWG)
on the 2016-2019 mandate

1. Overview of 2016-2019 mandate or relevant decision of the Alpine Conference

Brief summary of the main activities according to the 2016-2019 mandate or relevant decision of the Alpine Conference
Description of core activities: 1. Continuation of work relating to art. 14 of the Transport Protocol of the Alpine Convention: - infrastructure charging for heavy goods vehicles; - external costs of HGV; - external costs in mountainous areas. - Perspectives on a further revision of the Eurovignette Directive. 2. Continuation of work on innovative logistics solutions; 3. Continuation of work on alternative fuels infrastructure; 4. Knowledge exchange with Zürich Process and EUSALP; 5. Relating to art 15: addition of data 2015 on existing maps. 6. Relating to art. 16: appropriate measures in terms of tolling / transport management instruments for heavy goods transport related to the environmental impact and emissions (air pollutants, CO_2-emissions, noise). Description of main outputs: ▪ Updated synthesis on present application of Eurovignette Directive; ▪ Progress report on calculation of external costs of transport (HGV); ▪ Detailed document on innovative logistics solutions for freight transport; ▪ Gathering of national plans for alternative fuels infrastructure. Communication activities: Intensified exchange with other bodies working with transport in the Alpine Convention area.

2. Meetings

Summary of the meetings
• Paris, Nov. 4, 2016: discussion of the scope of the studies to be carried out. • Vienna, May 5, 2017 (first meeting under the new Chair Michel Rostagnat, hosted by the Austrian ministry of transports): progress review of the ongoing activities, visit of the Vienna Cargo centre south; Ewald Moser and Patrick Skoniezki (EUSALP AG4) welcomed as guests. • Paris, Dec. 1, 2017: progress review. • Chamonix-Mont-Blanc, May 16, 2018: progress review, first discussion on the next mandate, presentation by ATMO Auvergne Rhône Alpes air quality survey body, welcome by Eric Fournier, mayor of Chamonix-Mont-Blanc, vice-president of the Auvergne Rhône Alpes Regional Council in charge of environmental issues. • Paris, Dec. 4, 2018: final discussion on the reports on alternative fuels and noise external costs, discussion on draft reports on air pollution and innovative rail logistics, and presentation of a proposed Interreg project on cable car use for public transport (French national cable car federation); Patrick Skoniezki officially WG observing member as EUSALP AG4 representative.

3. Activities carried out

Report on activities carried out (including meetings, conferences)
• Gmunden, Oct. 4-5, 2017: participation of the Chair in PC64 and in the 1st Alpine Convention – EUSALP Exchange Workshop. • Chamonix-Mont-Blanc, May 16-17, 2018: team building visit of the Mont-Blanc tunnel. • Schaan, June 13, 2018: verbal report to the Permanent Committee on the TWG activities. • Vienna, Sep. 10-11, 2018: 2nd Exchange Workshop Alpine Convention – EUSALP, TWG Secretary François Lamoise represented TWG. • Altdorf (CH), Oct. 17-18, 2018: Logistics dialog, Matthias Rinderknecht (CH) and Ernst Lung (AT) represented TWG. • Vienna, Dec. 6, 2018: Rail Freight Forum, Ernst Lung (AT) represented TWG.

4. Results and outputs

Description of main results and outputs achieved
Reports on the external costs induced by noise, on alternative fuels infrastructure and on innovation in rail freight, coordinated respectively by France, Italy and Austria, were finalised. A preliminary report on external costs induced by air pollution was also prepared by France and will serve as input for the upcoming RSA8 on air quality.

5. Cooperation

Description of cooperation initiatives and activities with other Alpine Convention Thematic Working Bodies and other relevant bodies and processes (e.g. EUSALP)
• Participation in the two AC / EUSALP Exchange Workshops (see above). • Participation in EUSALP AG4 meetings (TWG Secretary, other members and/or Permanent Secretariat). • Admission of EUSALP AG4 representative as TWG observer (see above). • Matthias Rinderknecht, Swiss delegate at the TWG, chairs the EnvALP Working Group of the Zurich Process, other TWG members and the Permanent Secretariat participate.

6. Attachments

List of the documents attached to the report
• Assessment of external costs induced by noise in mountainous areas, CEREMA (FR), 2019. • Deployment of Alternative Fuels Infrastructure - Implementing the EU Directive 2014/94/EU on the Alpine territory, Working Group Transport, 2019. • Innovation in Rail Freight: an important contribution to more competitiveness of rail transport, Ernst Lung (AT), 2019.

Alpine Convention
Working Group Transport

Assessment of external costs induced by noise in mountainous areas

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May, 2018

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• Assessment of external costs induced by noise in mountainous areas

Context of the survey

Within the framework of the Alpine Convention1, DGITM (*Mission des Alpes et des Pyrénées*) asked Cerema for technical support in assessing the impacts of external costs in the Alps. The aim was to assess whether the recommendations of the European Eurovignette III Directive (DEEIII) factored in fully all environmental impacts related to traffic in mountainous areas, and more particularly the impact of air and noise pollution. This action was launched in 2016 with a literature review of surveys and reference values in various countries applied to mountainous areas. The first conclusions were:

- The heterogeneity of values used by DEE III and values integrated in the literature review;
- The lack of surveys covering environmental external costs and taking account of the specificity of mountainous areas;

This survey aims at furthering the conclusions of the 2016 literature review by accurately assessing external costs induced by noise on two French transalpine routes. The results presented hereafter were generated by modelling exercises of the exposure of populations, done in compliance with calculation methods recommended by Directive 1999/62/EC. Routes or route portions included in international transit routes and presenting non-mountainous characteristics, i.e. “flat areas”, were also included in this survey and used as reference situations.

1 - Impact and cost of noise

Along with air pollution, noise in the environment is one of two sources of disturbance integrated in the computing of external costs generated by transport activities. Induced externalities are generally classified under three categories [1]:

- ***Impacts on human health:*** if recorded noise levels in the neighbourhood of transport infrastructure do not (or rarely) generate hearing pathologies, they are still, in a proven way [2], associated with so-called "extra-auditory" effects. More particularly, they generate discomfort; sleep disruption; cognitive effects (learning difficulties); and long-term cardiovascular pathologies. International Health Studies conducted to date allow us to correlate part of these effects with a chronic exposure to morbidity indicators, several healthy life years lost, a certain level of cost…
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- ***Ecological impacts:*** these can be effects on living organisms (fauna), or the deterioration of the ambient noise in certain places, natural areas, leisure grounds and tourist areas… These effects are generally not integrated in the calculation of external costs under acoustic impacts because they are difficult to predict and to quantify.
-
- ***Impact on the built environment:*** noise can generate planning constraints by restricting the use of land. It can also lead to the depreciation of land. Based on the Hedonic Pricing Method (willingness to pay), the "Boiteux 2" report [3] suggested depreciating rental prices according to noise exposure categories. In France, this method was used as a reference to monetize the impacts of transport infrastructure projects. One of the limits identified in this method is the absence of an explicit integration of the impacts of noise on human health, even though the proposed values did integrate, to some extent, the effects of discomfort (extra-auditory effect).

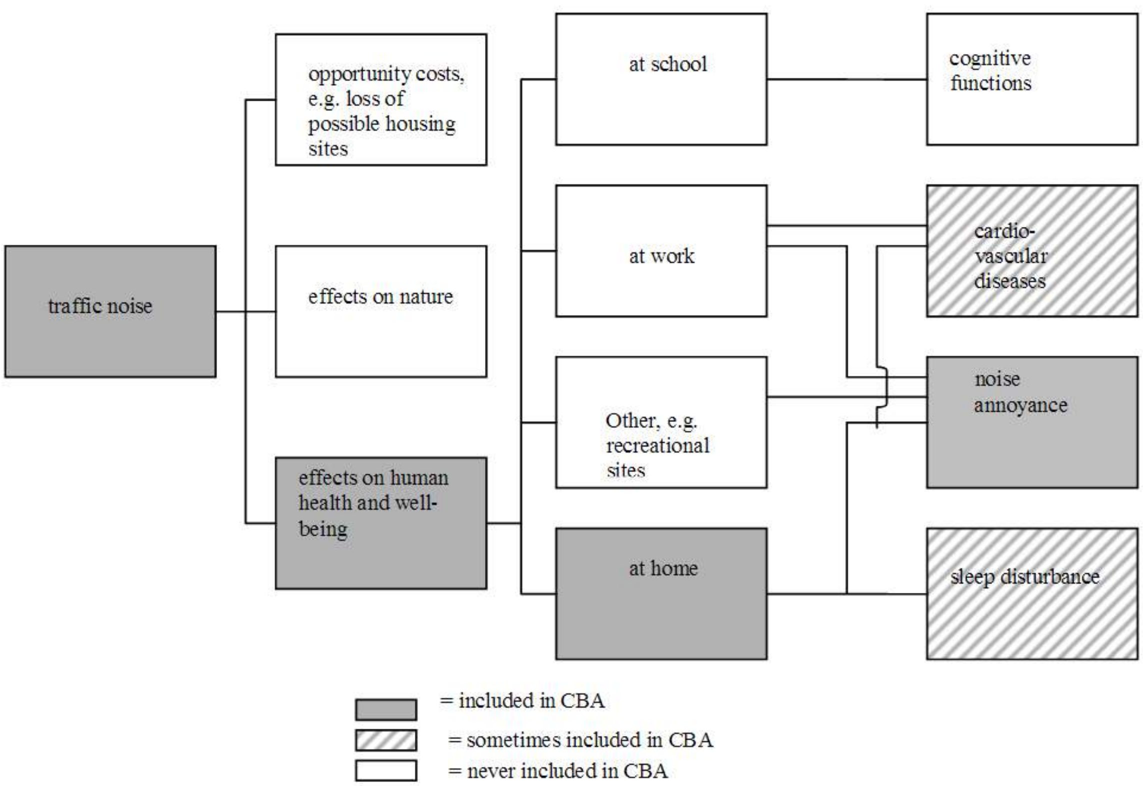


Illustration 1: Conceptual model for calculating external costs induced by traffic noise [1]- CBA=Cost-Benefit Analysis

Cost-Benefit Analysis methods used for assessing noise are currently based mainly on sanitary dose-response values and include the best-documented extra-auditory effects (discomfort) and, increasingly include effects such as sleep disruption, or impact on the cardio-vascular system.

Therefore, the evaluation method and the calculation reference values proposed by the Eurovignette Directive (see below) are based on the quantification of noise effects on exposed populations. The Directive does not specify the nature of effects that should be taken into account. The wording "exposed population" suggests that sanitary effects should be taken into account; however it does not explicitly exclude other externalities.

2 - European "Eurovignette" Directive 1999/62/EC

Directive 1999/62/EC, so-called the "Eurovignette" Directive of the European Parliament and the Council, of 17 June 1999 on the charging of heavy goods vehicles for the use of certain infrastructures, was amended several times. The next pages of this document will refer to the consolidated version of this text, dated April 1st, 2016, which is the latest version available at the time this report is being drafted.

A proposed amendment for Directive 1999/62/EC was filed on May 31st, 2017. It suggests significant modifications regarding the assessment of external costs related to air pollution and noise. These proposals are also discussed in our analysis.

2.1 - Principles for calculating the cost of noise pollution due to traffic

One of the difficulties encountered when estimating the cost of noise disturbances generated by heavy goods vehicles (HGVs) lies in the fact that effects are not linear. Therefore, adding a HGV in mixed traffic situations generates an increase of impacts (logarithmic increase of sound levels), which depends on initial traffic and its composition.

The Eurovignette Directive specifies the calculation modalities applicable to traffic noise generated by HGVs. Two methodologies can be used:

- **Method n°1: detailed calculation**

The detailed method may be used when a Member State wishes to apply fees because of external costs higher than reference values (see Illustration 2).
In this case, the cost of noise pollution generated by HGVs on a type *j* road is calculated as follows:

$$NCV\left(daily\right)=\frac{e\sum_{k_k} NC_{jk}\times POP_k}{WADT}$$

where:

- NC_{jk} represents the cost of disturbance per person exposed on a type *j* road with a *k* noise level. It is clarified that: "the cost per person exposed to a *k* noise level must be estimated by the Member State, or, where applicable, by an independent Authority, taking account of the latest innovations in the field of assessment".

- *e* is an equivalence factor applied between HGVs and light vehicles (LVs).

The proposed modification of Directive 1999/62/EC of May 31st, 2017 clarifies that this factor is "established based on noise emissions corresponding to an average for cars and an average for HGVs". This clarification specifies the assessment conditions for factor *e* versus the text of the Directive.

- POP_k represents the population exposed to *k* daily noise levels per kilometre.

The proposed modification of Directive 1999/62/EC dated May 31st, 2017 clarifies that this variable is estimated according to strategic noise maps developed pursuant to the "Environmental Noise" Directive

2002/49/EC. This particular method was used in this survey.

WADT is the weighted average daily traffic (expressed as private cars equivalent). It is calculated as follows:

$$WADT = (1 - \%PL) \times TMJA + e \times \%PL \times TMJA \text{ (veh./d)}$$

This cost (NCV) can also be calculated for day-time or night-time traffic by applying differentiated weighting factors to NC_{jk} .

- **Method n° 2: application of appended unitary values (appendix III ter):**

In this case, values establishing a difference between day-time and night-time traffic are specified (expressed as €ct/veh.km), by making a difference between suburban routes and inter-urban routes (Illustration 2). It is specified "**these values can be multiplied by a maximum factor of 2 in mountain areas".** The proposed arguments justifying this increase are discussed in §8.

Maximum chargeable noise cost

cent/vehicle.kilometre	Day	Night
Suburban roads (including motorways)	1,17	2,12
Interurban roads (including motorways)	0,22	0,32

The values in Table 2 may be multiplied by a factor of up to 2 in mountain areas to the extent that it is justified by the gradient of roads, temperature inversions and/or amphitheatre effect of valleys.

Illustration 2: Extract from Eurovignette Directive (1999/62/EC, Version dated April 1st 2016)

The proposed modification of Directive 1999/62/EC dated May 31st, 2017 replaces these unitary values by "baseline values for external costs charges, included the cost of air and noise pollution". These values aggregate the cost of impacts (see Tables 1 and 2 in the appended Directive proposal).

Moreover, external costs are differentiated depending on vehicle classes, EURO standards for HGVs and coaches, and depending on context, whether suburban or interurban. It clarifies that these values "**may be multiplied by a maximum factor of 2 in mountainous areas and around cities, insofar as this is justified by dispersion, road gradient, altitude or temperature inversions"**. The proposed amendment notably erases the "amphitheatre effect" which was identified as a parameter that could justify the increase of values. Adding cities in areas where a surcharge could be applied translates the will to take account of exposure risks related to the presence of higher population densities.

2.2 - Assessment methods for the cost of noise exposure of populations

- ***Reference values applied in France***

In 2013, the assessment methods for externalities proposed in the so-called "Boiteux" reports were revised [4]. Regarding noise, disturbances and other sanitary hazards (myocardial infarction, angina pectoris, hypertension), the values previously proposed by the HEATCO Project (Harmonised European Approaches for Transport Costing and Project Assessment) were integrated by revising and adapting them to the French context. [5]

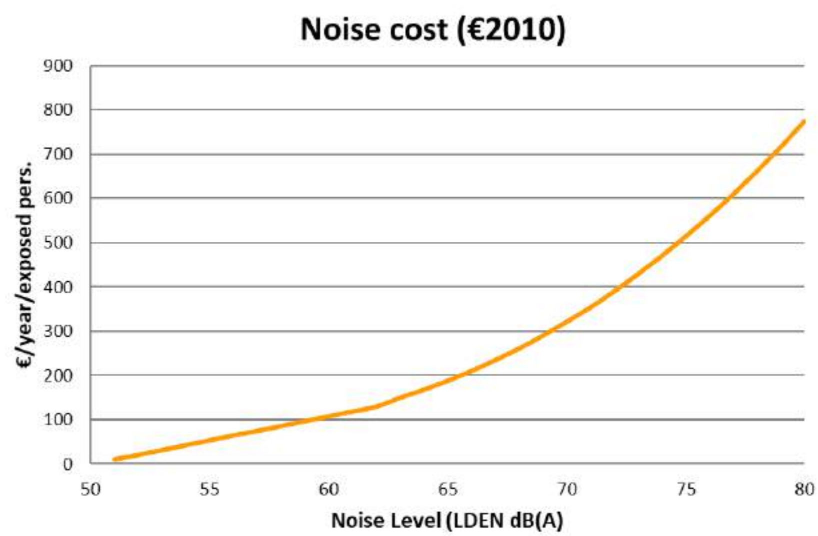


Illustration 3: Reference values expressed in €2010/exposed person/year according to noise exposure levels (cost factor) – detailed values are presented in appended documents – Sources [4] et [5].

These values were selected for estimating external costs in this document.
One should note that no difference was made between vehicle categories (light vehicles/HGVs). Values are established for mixed types of traffic. Only acoustic emissions were calculated based on a difference between light vehicles and HGVs. To the best of our knowledge, no results have been published in scientific literature that would allow discriminating between impacts generated by light vehicles or HGVs that could be applied for estimating external costs.

- ***Noise exposure indicator***

The Eurovignette Directive (V. 04/01/2016) suggests that Strategic Noise Maps produced to implement 2002/49/EC for the assessment and management of environmental noise, should be used to determine which populations are exposed to noise.
As a reminder, this Directive notably requires Members States to establish a mapping of noise levels

around major transport infrastructures (road, rail, air traffic) and around major cities (over 100,000 inhabitants).
LDEN is the noise exposure indicator used at European level. This indicator – annual average daily traffic – includes the "discomfort" aspect and is calculated, based on noise levels assessed during three periods (D: Day, E: Evening, N: Night) and weighted (+5dB in the evening, +10 dB at night) to take account of differences in the level of discomfort expressed for each of these three periods:

$$L_{DEN} = 10 \log\left(\frac{12.10^{\frac{L_{Day}}{10}} + 4.10^{\frac{L_{Evening}+5}{10}} + 8.10^{\frac{L_{Night}+10}{10}}}{24}\right) \text{ (dB(A))}$$

Strategic noise maps are drawn up by modelling (calculating) noise source emissions and noise propagation in an environment described in tri-dimensional features. Benchmarking or metrological properties can potentially be used to ensure that these models are accurate. However, these maps are most often established without using measurements, based solely on the knowledge of both the modelled data reflecting source emissions and the description of the environment. These calculation methods have given rise to EU recommendations.
In France, the Prefect approves European strategic noise maps,which are then published by the competent authorities (major cities, infrastructure managers, local authorities, State departments). These competent authorities are also responsible for developing Environmental Noise Prevention Plans listing actions aimed at reducing the noise exposure of populations, as well as identifying and preserving "Clear Zones".
Strategic Noise Maps and Environmental Noise Prevention Plans have been reviewed every 5 years since 2007. Year 2017 corresponds to the 3rd review of Strategic Noise Maps (2018 for Environmental Noise Prevention Plans which were originally developed one year later).

- ***Noise levels calculation methods***

Calculations of populations exposed to the noise level required to determine external costs were carried out according to the same principles used to draw up strategic noise maps. For the routes selected in this study, only acoustic contributions of the main infrastructures (motorways) that could be subject to "Eurovignette" taxation were considered. The following methodology was applied:

- **Modelling of acoustic sources:**

Each section of each route is broken down into "acoustically homogeneous" sections, taking into account the supported traffic parameters: traffic volume, regulatory speed, % of heavy goods vehicles. An acoustic emission power is assigned to each source line based on these parameters. Acoustic emissions are calculated in accordance with the applicable French calculation method (NMPB08) [6].

- **3D modelling of the environment:**

A 3D digital model of the propagation environment is used to describe: topography, buildings, acoustic protection, ground conditions (absorbent/reflective) ...

- Calculation of noise levels at 4 meters above ground level and on the facades of residential buildings.

In compliance with regulatory requirements, the method takes into account the effects of weather conditions (so-called favourable or unfavourable propagation situations).

- **Counting the exposed populations**

The noise levels calculated on the facades of residential buildings affected by the modelled acoustic sources are related to the number of inhabitants in each of these buildings.

All databases used in this study come from the Auvergne-Rhône-Alpes Regional Harmonised Observatory (www.orhane.fr).

The various modelling steps described above were carried out using the Mithra-SIG © software developed by the CSTB (Scientific and Technical Centre for Building / *Centre Scientifique et Technique du Bâtiment*) and distributed by GEOMOD.

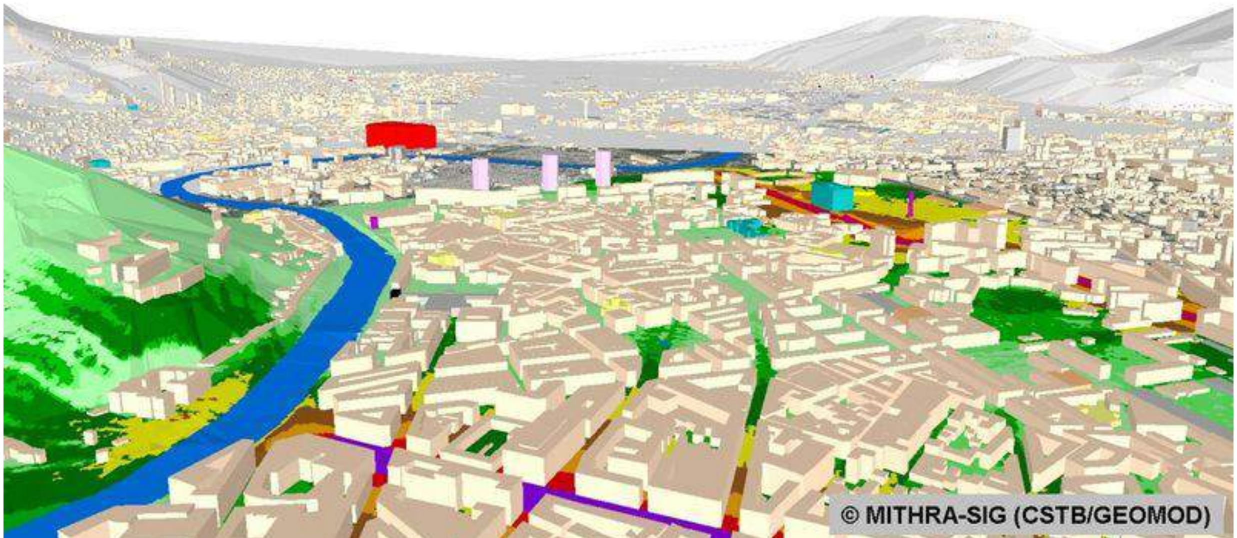


Illustration 4: 3D visualization of an acoustic model made under Mithra-Sig ©

All maps modelled on the three routes studied are shown in Appendix B.

In addition to noise exposure data, the calculation method described in the Eurovignette Directive (see 2.1) requires the setting of an "e" equivalence factor HGV/LV reflecting the more "emissive" nature of HGVs from an acoustic point of view. **The setting of this value is left to the discretion of each Member State.** An estimation proposal, consistent with the exposure calculations, is submitted below.

- ***Equivalence factor "e" for HGVs/LVs***

The "e" equivalence factor for the weighting of the relative weight of noise impacts between HGVs and LVs partly determines the result of the external cost. The Eurovignette Directive does not specify its calculation method. The proposed amendment of May 31st, 2017, however, states that it must be based on the average emission data for both vehicle categories.

Several factors influence the ratio of HGV/LV noise emissions: the (regulatory) speed of both categories of vehicles, the speed or dynamics of traffic (stabilized/pulsed), the slope of the roadway (which exclusively affects HGV emissions), the nature of the pavement surface. Three categories of road coating are used, ranging from low noise (R1) to high noise (R3). The state of deterioration of the coating, generally linked to its age, can also be included in the calculation parameters.

The values presented in Table 1 are based on the emission calculation charts of the French method (NMPB08, [6]). These graphs make it possible to establish the average emission laws of the "engine" and "rolling" components, which relative weight varies with speed. Noteworthy is the fact that they overlap in real life. On the infrastructures studied (motorways) and factoring in regulatory speeds and velocity (assumed as stabilized), the rolling noise component is predominant, with noted differences exceeding 10 dB(A) at emission.

	Acoustic power level Lw/m (1 veh/h)								
	Rolling noise		Engine (steady state)		Rolling noise+ Engine (steady state)				
Speed limit (km/h)	130	90	130	90	130	90	90		
Road cover (less than 2 years)	LV	HGV	LV	HGV	LV	HGV	HGV (slope 6%)	*e*	*e* (slope 6%)
R1	52.8	60.1			53.3	60.6	61.2	5.3	6.1
R2	56.6	63.1	44.1	50.6	56.8	63.4	63.7	4.5	4.8
R3	59.3	64.1			59.4	64.3	64.6	3.1	3.3
Road cover (more than 10 years)	LV	HGV	LV	HGV	LV	HGV	HGV (slope 6%)	*e*	*e* (slope 6%)
R1	56.8	62.5			57.0	62.8	63.2	3.8	4.2
R2	58.6	64.3	44.1	50.6	58.8	64.5	64.8	3.8	4.0
R3	60.9	65.1			61.0	65.3	65.5	2.7	2.8

Table 1: Equivalence factors HGV/LV

These results show that factor e can vary between 2.7 and 6.1 depending on parameters. For all routes subsequently studied, the **value of 4.5** was selected and corresponds to traffic on a "moderately noisy pavement less than 2 years old with moderate slopes, representative of motorway routes analysed." 12

3 - Detailed study of three French routes

In order to identify potential differences in external costs related to the mountainous nature of certain road transport routes, three major corridor sections linking France to neighbouring countries were studied, using the detailed method for calculating external costs (see 2.1 and 2.2). These routes are located in the Rhône-Alpes region and include a structuring highway carrying significant international transit traffic. The acoustic contribution of each structuring motorway axis, which carries most of this transit traffic, is studied below. Noise emissions from other transport routes are not taken into account in the estimation of exposed populations.

The first route links Pont d'Ain (Ain) to Chamonix (Haute-Savoie) via Scientrier. The A40 motorway (E21/E25), known as the " Titans' motorway " runs between Pont-d'Ain and Bellegarde, then the so-called "White Motorway " between Bellegarde and Chamonix. It includes some sections characterized as "mountainous areas". This axis provides road transit between France and Switzerland via the Chamonix Tunnel. It was split into two homogeneous sections, one on each side of the Vuache tunnel, for a total length of 131 km.

The second route is the French portion of the Lyon-Turin axis. It is a mixed plain-and-mountain route, focusing on the A43 motorway (E70), originating east of Lyon (Rhône), crossing the Maurienne valley and leading up to the Fréjus Tunnel (Savoie). The total length of this route under study is about 140 km. It was divided into two main sections separated at the level of the Epine Tunnel (Chambéry).
The third route, which serves as a reference "plain area" in this study, is the A7 motorway (E15) over a stretch of nearly 84 km between Chasse-sur-Rhône (Rhône) and Valence sud (Drôme).
Each **section** of each of the three routes was divided into **subsections** characterized by some homogeneity in terms of traffic, percentage of HGVs, population density and topography.

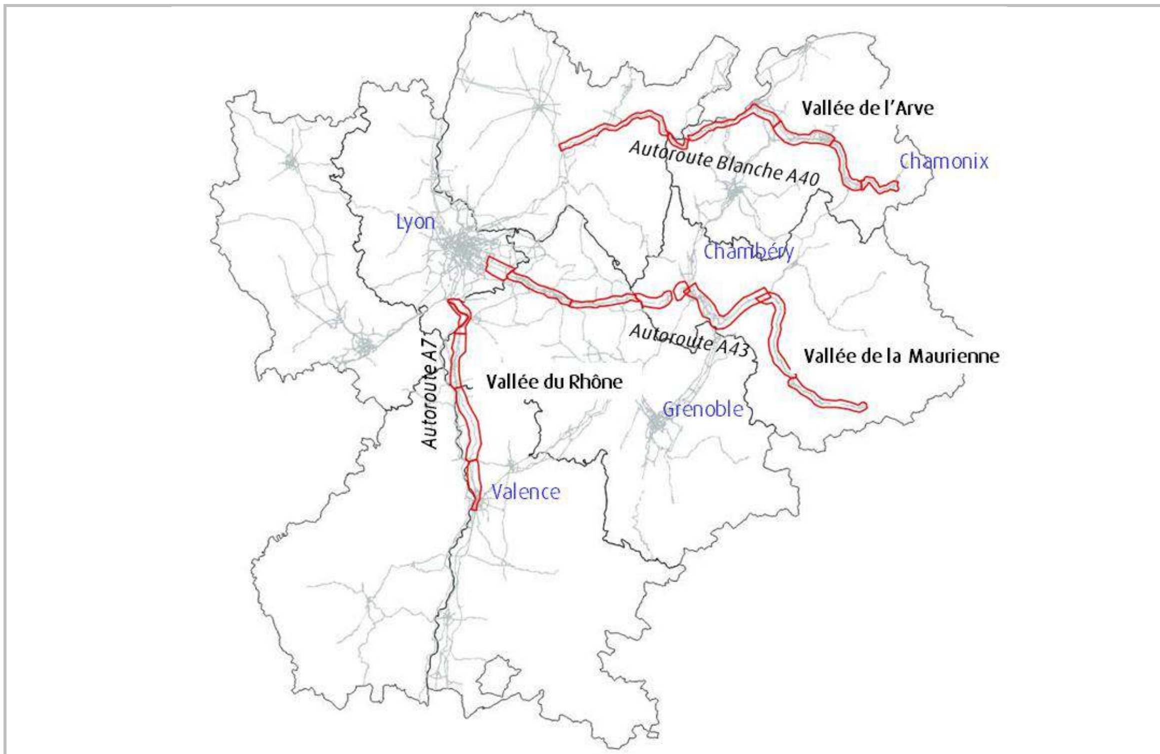


Illustration 5: the three selected routes and their breakdown into homogeneous sub-sections

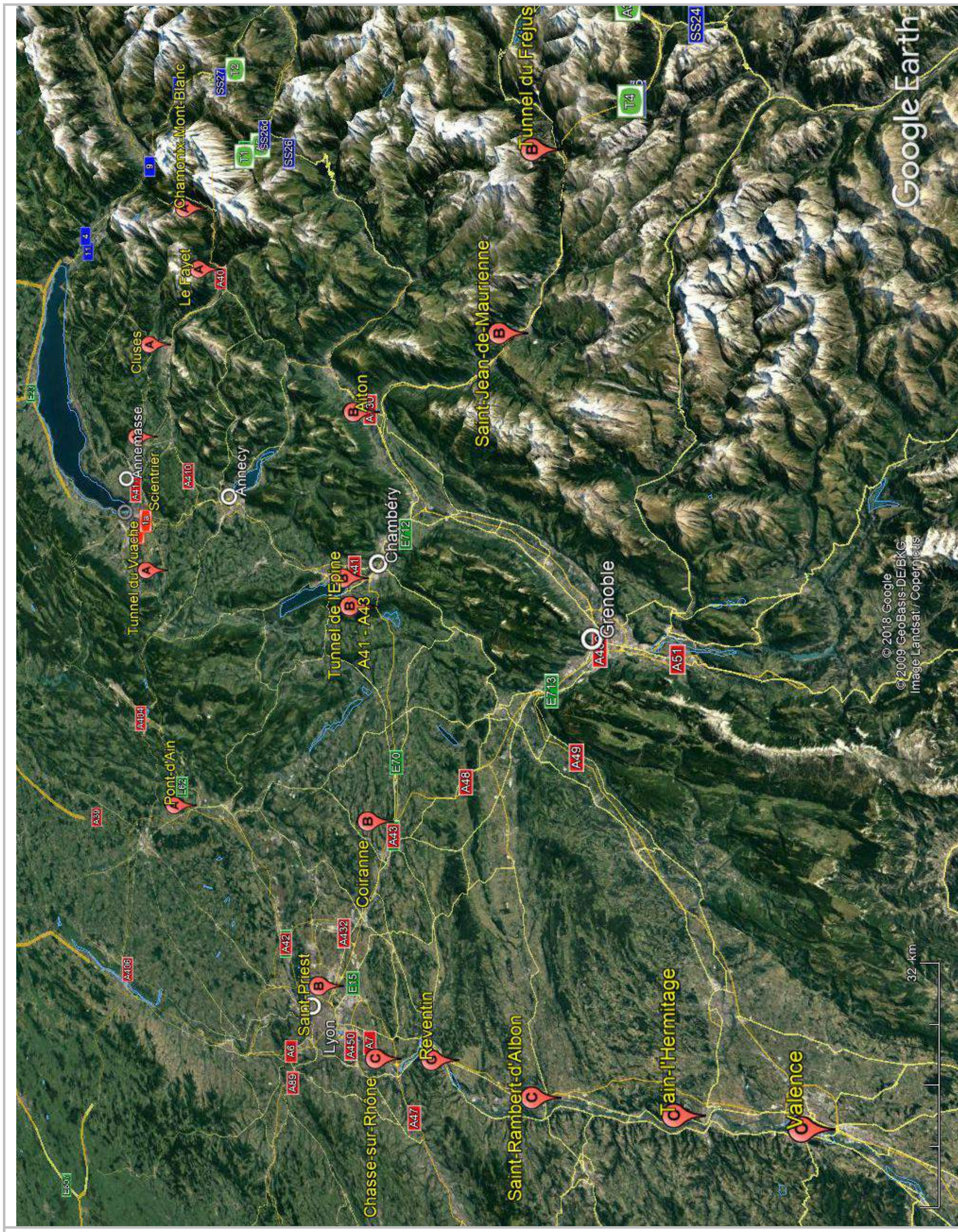


Illustration 6: aerial photograph presenting location plan of the three corridor sections (A7, A40, A43) east of Lyon. Red markers show boundaries of studied subsections (Google Earth).

4 - A40 Route: Pont d'Ain - Chamonix

4.1 - A40, Titans' motorway – section: Pont d'Ain to Scientrier

This first section of the A40 route was divided into two subsections crossing the departments of Ain (01) and Haute-Savoie (74) and broken down as follows: Pont d'Ain - Tunnel du Vuache – Scientrier.

- ***Traffic characteristics***

Subsections / Section	Terrain Mountain/Plains	AADT (Vh./d)	%HGVs	Length (km)	Maximum Regulatory Speed (HGV/LV) (km/h)
Pont d'Ain/Tunnel du Vuache	Plains/hills	20 307	14.10%	11.8	90//130
Tunnel du Vuache/Scientrier	Plains	29 061	8.64%	38.7	90//130
Pont d'Ain / Scientrier	Plains to hills	27 020	9.60%	50.5	90//130

Table 2: Pont d'Ain – Scientrier – Traffic and topographical characteristics per subsection

This section of the route carries around 27,000 vehicles/day with an average rate of HGVsunder 10%. The regulatory speeds match those associated with the standard French motorway network (130 km/h for light vehicles and 90 km/h for HGVs). The difference in traffic between the two subsections is due to the junction with the A41 at Saint-Julien-en-Genevois, then with the A411 at Annemasse.

- ***Topographic profiles***

This first section of the A40 runs through a landscape of plains, hills or medium-high mountains. The motorway is alternately higher or level with built areas or runs along the valleysfloors. The difference in altitude between sources and receivers range from a few dozen meters to barely one hundred. These configurations do not have a marked mountainous character, but each topographical situation can play a role in terms of noise propagation: a dominant source will generally tend to decrease noise levels on buildings located below the source (screen effect due to the presence of a platform); whereas buildings located on hillsides will suffer from diminished noise mitigation and may be more exposed to noise levels (see 8.2).

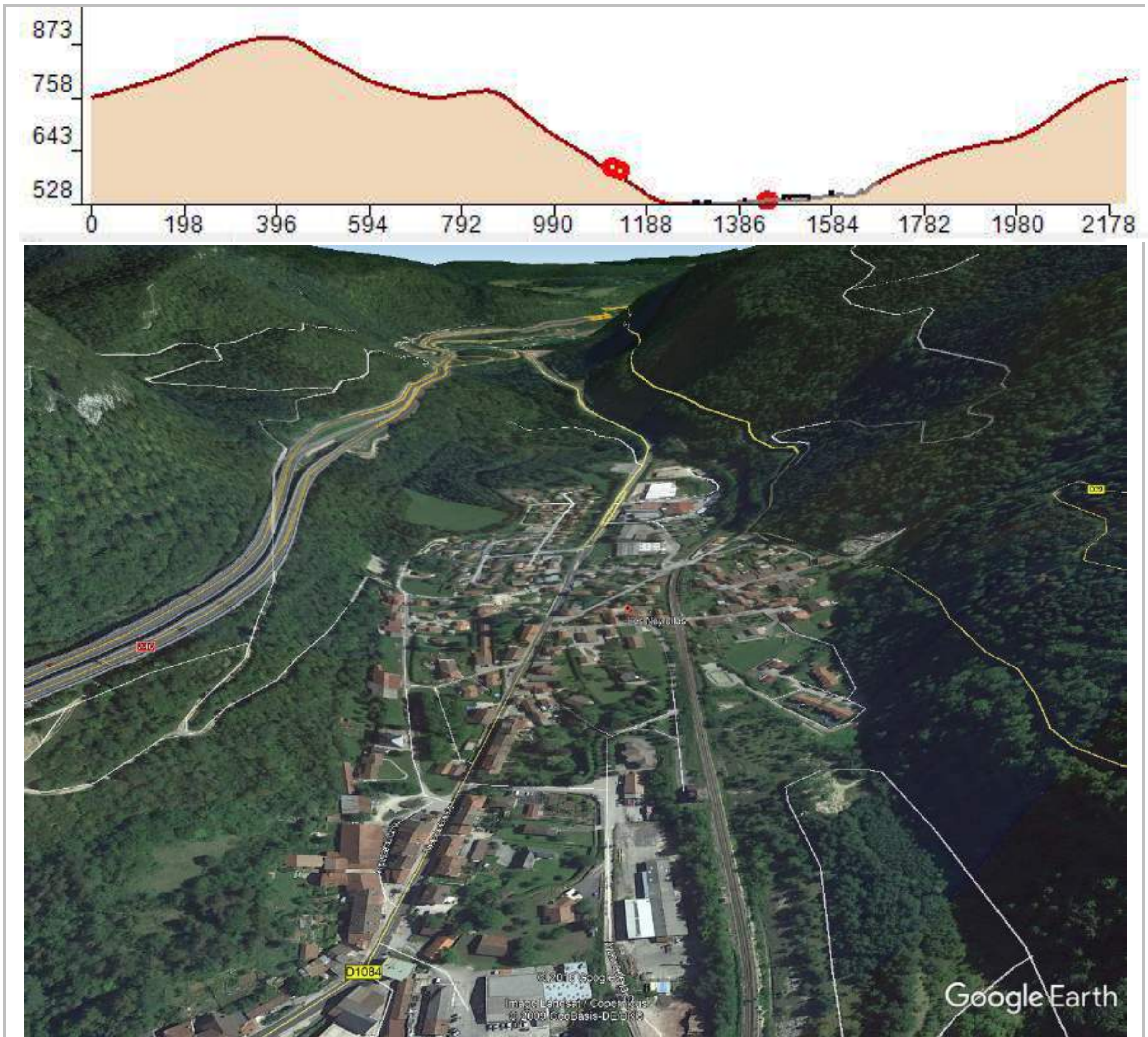


Illustration 7: A40 Pont d'Ain – Tunnel du Vuache. Typical cross-profile of section. Red dots on hillside indicate position of road infrastructure (A40) modelled as acoustic source. Horizontal and vertical scales in meters and aerial photograph (GoogleEarth) of the valley located after the exit of the Vuache Tunnel the Les Neyrolles side.

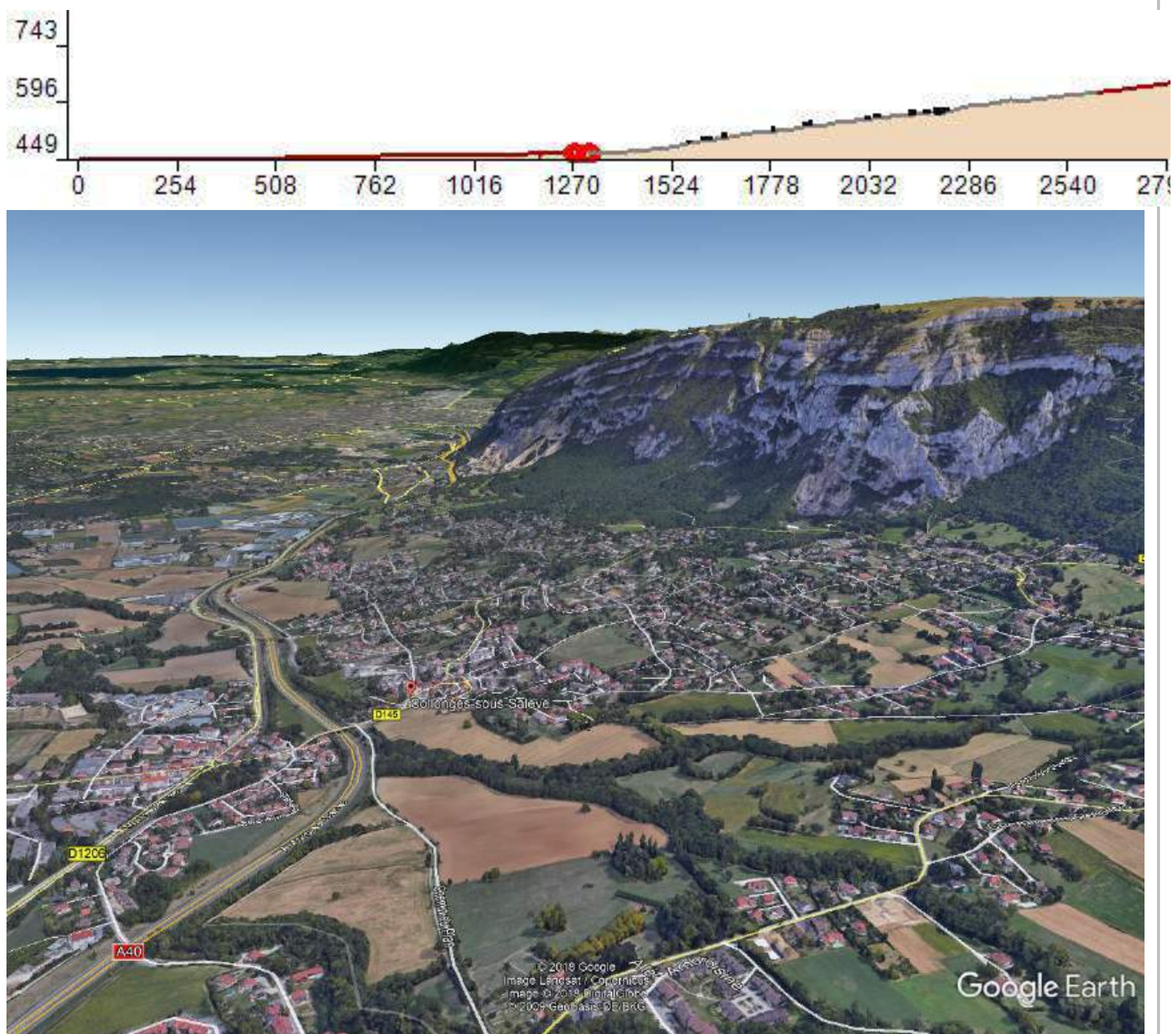


Illustration 8: A40 Tunnel du Vuache – Scientrier. Typical cross-profile of section located next to Collonges-sous-Salève. Red dots indicate position of road infrastructure (A40) modelled as acoustic source. Horizontal and vertical scales in meters and aerial photograph (GoogleEarth) of area close to Collonges-sous-Salève

Along this section, the motorway is occasionally located lower than the built-up areas (Illustration 8). This situation of exposure to noise, or so-called "amphitheatre" exposure, can be construed as unfavourable (for local residents), as the ground effect is restricted by the relative topographical situation of the source and receptors (houses).
However, in this location the motorway is excavated, and the natural terrain protects buildings from noise. (Illustration 9).

Illustration 9: View from the A40 to Collonges-sous-Salève.

- ***Noise related external costs Pont d'Ain to Scientrier***

External costs related to noise generated by HGVs using the A40 were assessed using the methodology described under 2.2. This study only computed populations living in residential buildings and exposed to noise levels above 50 dB(A). The table below shows both the overall annual and per capita external costs (related to the circulation of LVs and HGVs), as well as the specific cost related to HGV traffic (NCV).

Subsections / Section	**Terrain Mountain/Plains**	**External cost of noise (All Vehicles)**	**Approx. population density (inhab/km²)**	**Cost/Pers./yr**	**NCV (1999/62/EC) ct€/veh.km**
Pont d'Ain / Vuache Tunnel	Plains to hills	476 682 €	654	62 €	1.65
Vuache Tunnel / Scientrier	Plain	1 645 267 €	518	82 €	1.39
Pont d'Ain / Scientrier	Plain/Hills	2 121 949 €	460	76 €	1.44

Table 3: Pont d'Ain – Scientrier – External costs for both subsections between Pont d'Ain and Scientrier.

A more detailed analysis, submitted in the following graphs (Figures 10, 11 and 12), identifies the number of people exposed per 1 dB(A) noise level class, as well as the cost associated with each exposure class for both subsections and for the entire section.

The external cost /km on that route is assessed at about 42 k€/km/year.

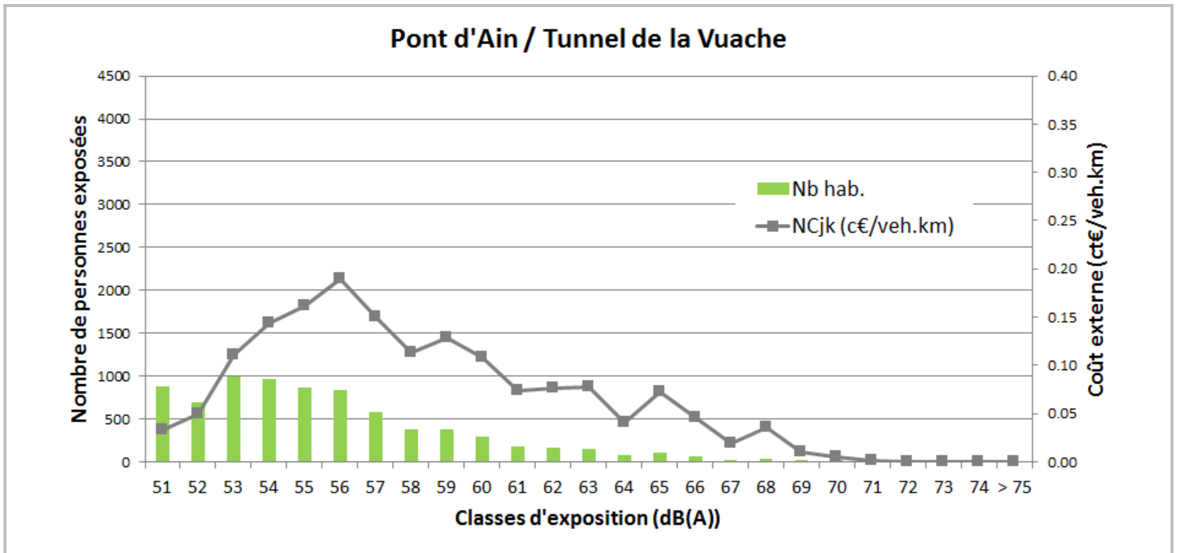


Illustration 10: A40 Pont d'Ain – Vuache Tunnel: Population exposed by noise level class (LDEN (dB(A)) and associated external costs per HGV and per noise level class.

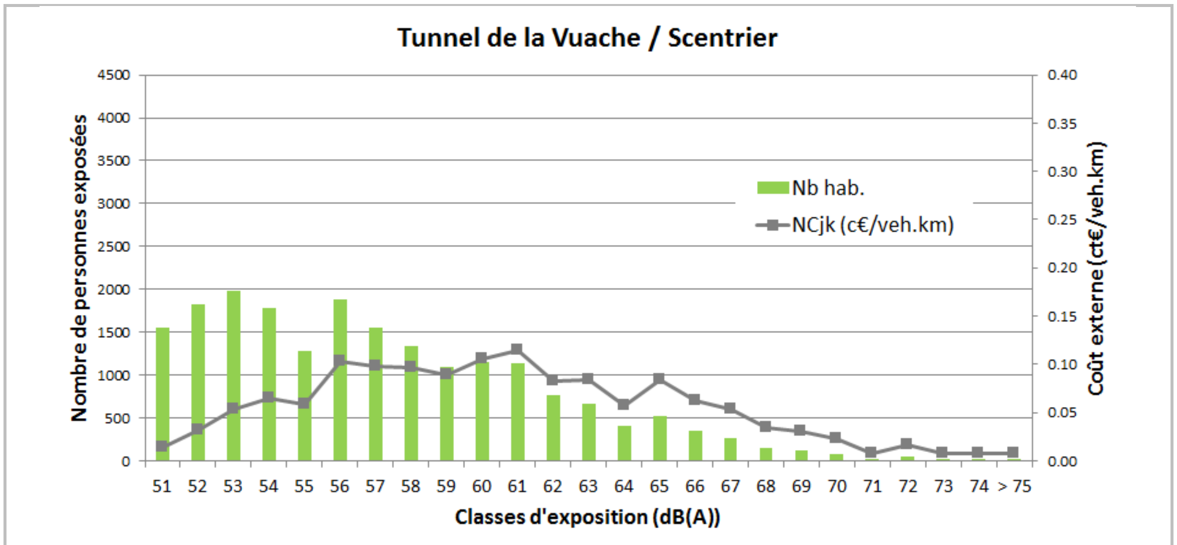


Illustration 11: A40 Vuache Tunnel – Scientrier: population exposed per noise level class (LDEN (dB(A)) and associated external costs per HGV and per noise level class.

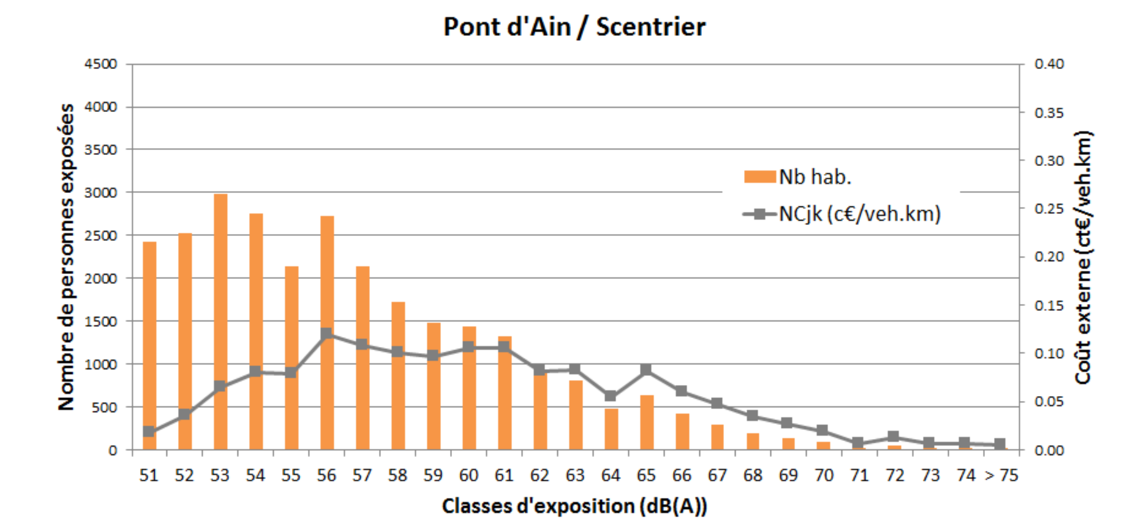


Illustration 12: A40 Pont d'Ain – Scientrier: Population exposed per noise level class (LDEN (dB(A)) and associated external costs per HGV and by noise level class.

It can be noted that, along this section, a large portion of the population is exposed to noise levels below 60 dB(A). Most of the estimated external costs are generated by exposure levels below 68 dB(A) (limit value according to Directive 2002/49/EC), and the overall cost on this section has therefore been reduced (1.44 €ct/HGV. km). This cost remains slightly higher than the maximum chargeable daytime cost proposed in the Eurovignette Directive (1.17 €ct/HGV.km), but lower than the night-time cost (2.12 €ct/HGV. km), given that the LDEN indicator takes a full day into account, by weighting the evening and night-time periods (see 2.2.2).

According to the indicators that were analysed, it is difficult to identify exposure levels on this route that could be qualified as specific to mountainous areas.

4.2 - A40 White Motorway / RN205: Scientrier to Chamonix

This route was broken down into 3 subsections: Scientrier – Cluses – Le Fayet – Chamonix.

Part of the route has motorway characteristics (Scientrier-Le Fayet), and UK type A road n° 205 extends the A40 up to the Mont-Blanc Tunnel.

Located some ten kilometres east from Annemasse, Scientrier marks the entrance into the Arve valley. This valley remains quite wide up to Cluses, then narrows until Saint-Gervais-Le Fayet, before winding tighter all the way up to Chamonix.

Like most French Alpine valleys, built-up areas are mainly located on the floor of the valley in the foothill zone, with the exception of cities located on plateaus at the edge of the mountain level: Les Carroz-d'Arâches, Les Juliars, the Plateau d'Assy... The distance between these sites and main road infrastructures (over 1.5km),plus the plateau topography mitigate noise exposure from valley sources. In the Arve lower valley, cities such as Passy, are located on hillsides, with residential homes less than 1km from the motorway (Illustration 13).

Illustration 13: view from the A40 looking towards Passy

This specific situation, which is more impactful, was identified in the Environmental Noise Prevention

Plan (PPBE 2015) and forced the manager to take action by planning acoustic insulation of certain facades and the construction of acoustic screens (erected between 2016-2019).

Illustration 14: view from the A40 showing acoustic insulation around Scionzier-Cluses

- ***Traffic characteristics***

Subsections / Section	Terrain Mountain/Plain	AADT (Veh./day)	%HGV	Length (km)	Maximum regulatory speed (HGV/LV) (km/h)
Scientrier / Cluses	Plain	26 396	8,82 %	23,6	90//130
Cluses / Le Fayet	Mountain	17 216	11,23 %	21,1	90//110/130
Le Fayet / Chamonix	Mountain	13 876	15,35 %	35,6	50/70/80/90//50/70/ 90/110
Scientrier / Chamonix	Mixed Plain/Mountain	18 432	11,59 %	80,4	50/70/80/90//50/70/ 90/110/130

Table 4: Scientrier - Chamonix – Traffic and topographic characteristics per subsection

In these sections, there is a significant drop in “all types of vehicles” traffic towards Chamonix. There is however an increase in the relative share of HGV traffic (transit).
Noteworthy also, is the fact that access to the Chamonix tunnel area involves changes in regulatory speed.

• *Topographic profiles*

The three following illustrations represent the various topographic situations and the passing from the lower to the upper Arve valley where the valley floor increasingly narrows.

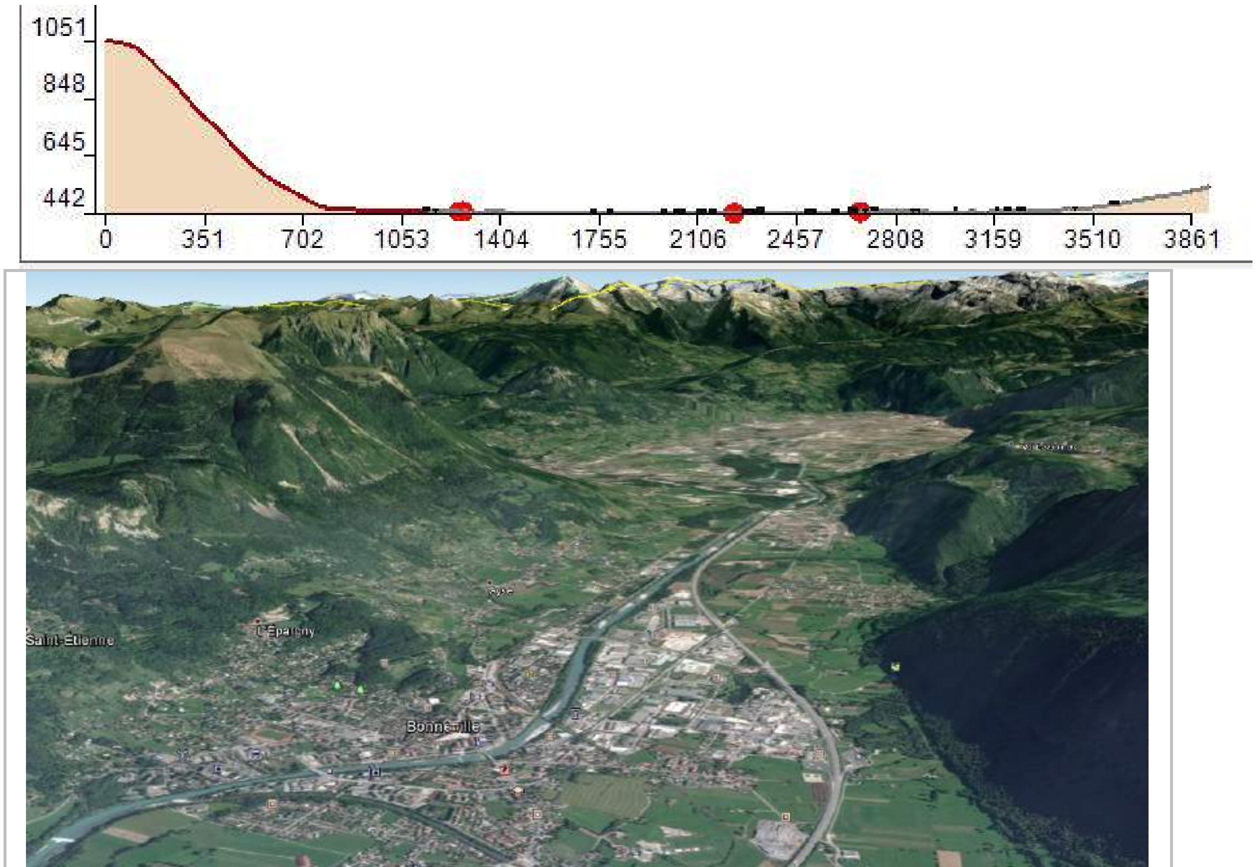


Illustration 15: A40 Scientrier – Cluses - Typical cross-profile of this section. Red dots mark the location of road infrastructure modelled as acoustic sources. Horizontal and vertical scales in meters and aerial view (GoogleEarth) of the area around Bonneville (Arve lower valley).

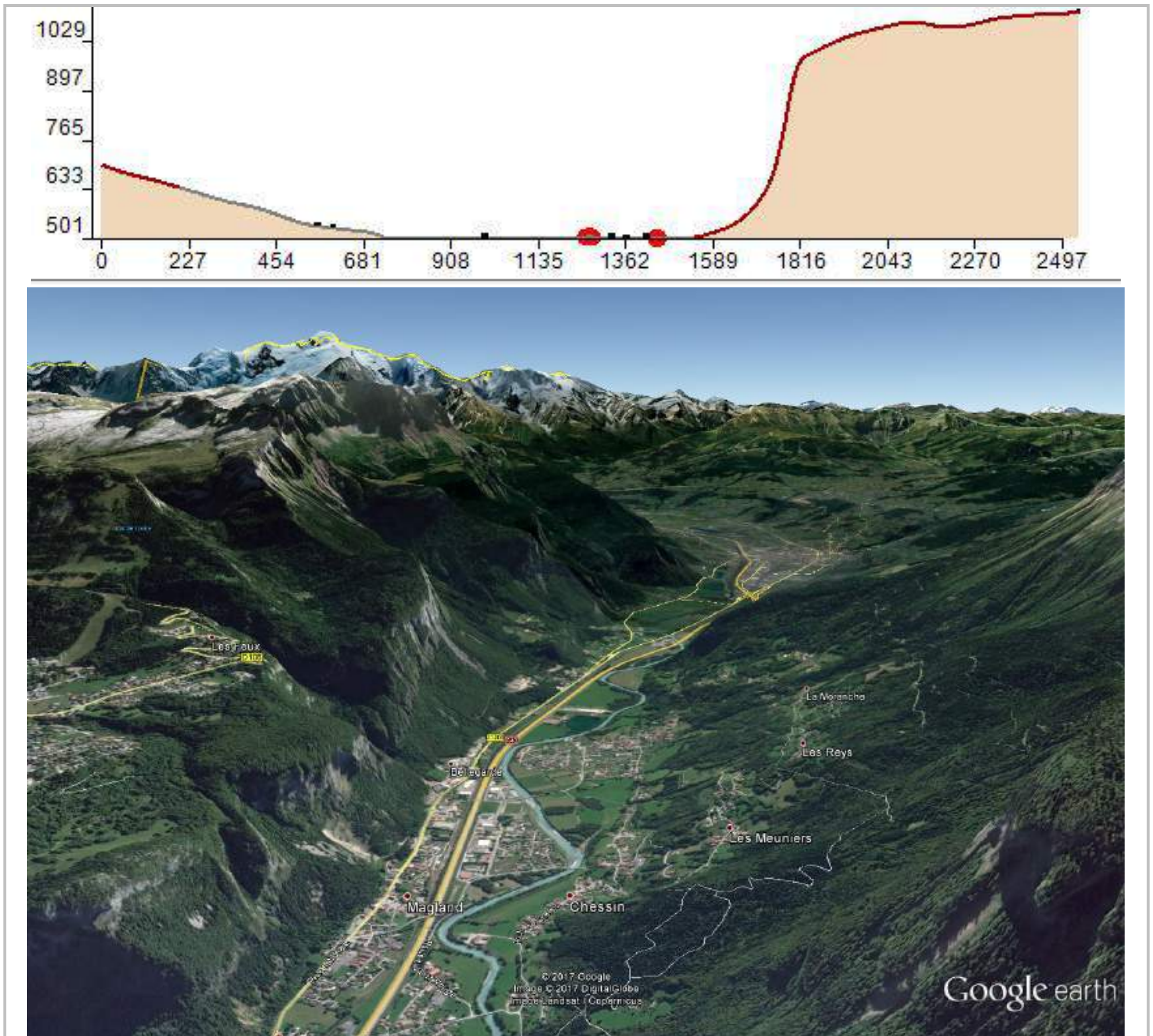


Illustration 16: A40 Cluses - Le Fayet - Typical cross-profile of this section. Red dots mark the location of modelled road infrastructure as acoustic sources. Horizontal and vertical scales in meters and aerial view (GoogleEarth) of the area around Bellegarde.

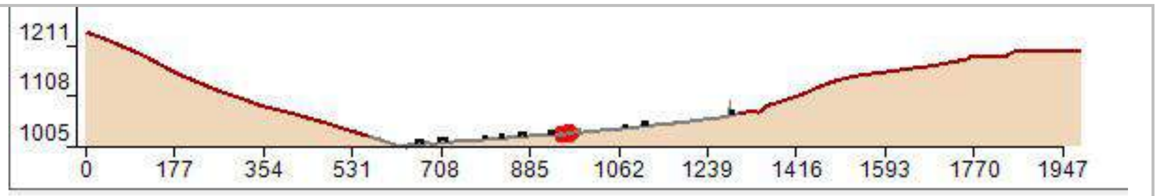


Illustration 17: RN205 Le Fayet - Chamonix - Typical cross-profile of this section. Red dots mark the location of road infrastructure modelled as acoustic sources. Horizontal and vertical scales in meters and aerial view (GoogleEarth) of the area around the Bossons.

- ***Noise related external costs***

Subsections / Section	Terrain Mountain/Plain	External cost of noise (all vehicles)	Approx. population density (inhab/km²)	Cost/Pers./year	NCV (1999/62/CE) ct€/veh.km
A40 Scientrier / Cluses	Plain	2 012 415 €	983	87 €	3.04
A40 Cluses / Le Fayet	Mountain	1 027 053 €	665	73 €	2.50
RN205 Le Fayet / Chamonix	Mountain	360 603 €	149	68 €	0.59
Scientrier / Chamonix	Plain/Mountain	3 400 071 €	530	80 €	2.01

External and NCV costs are quite contrasted across the different subsections. They range from 0.59 €ct/veh.km for the most characteristic portion of a mountainous area (Le Fayet/Chamonix) to 3.04 €ct/veh.km at the entrance of the valley. This difference is mainly due to the higher degree of urbanization in the Bonneville and Cluses sectors, multiplying the number of potentially exposed persons and therefore also external costs. The lowest cost (per vehicle.km) on the last subsection is also due to a higher proportion of HGVs, which is nearly double and thus more spread out. According to these indicators, it is therefore not possible to identify a "mountainous area" specificity on this route (influence of the environment on propagation). Rather,the specificity of this route is related to a lower population density associated with proportionally higher HGV traffic.

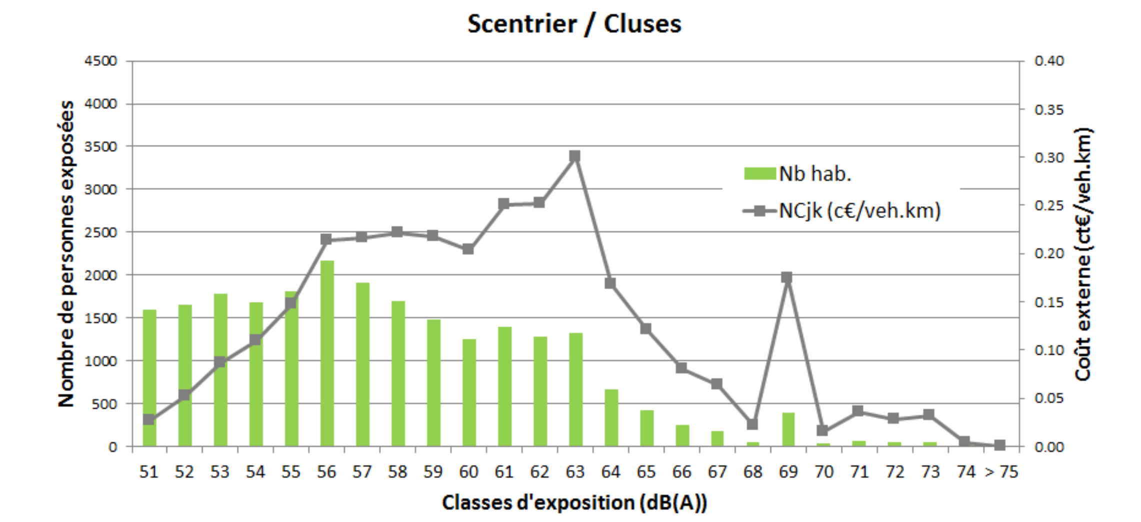


Illustration 18: A40 Scientrier – Cluses: Population exposed per noise level class (LDEN (dB(A)) and associated external costs per HGV and per noise level class.

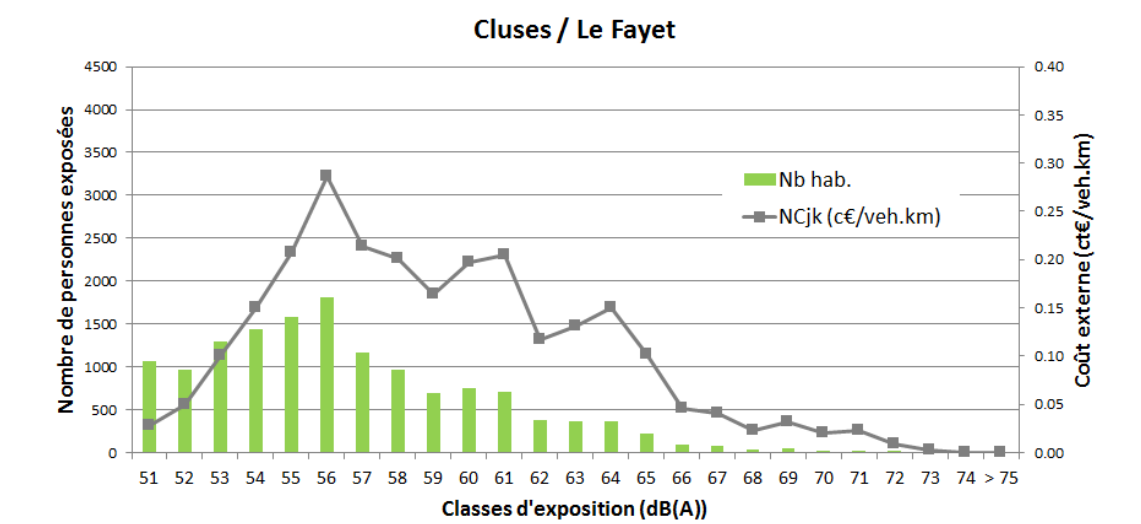


Illustration 19: A40 Cluses – Le Fayet: Population exposed per noise level class (LDEN (dB(A)) and associated external costs per HGV and per noise level class.

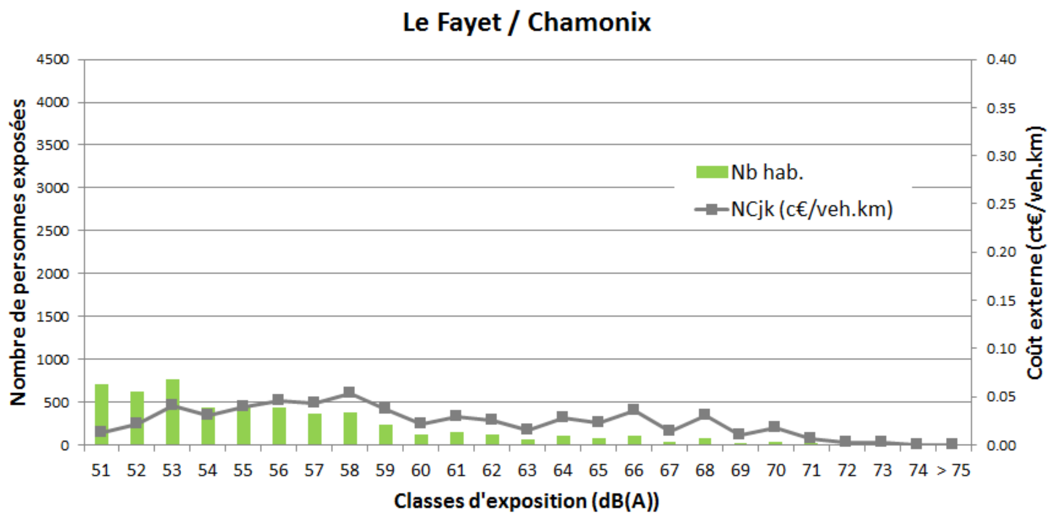


Illustration 20: RN205 Le Fayet – Chamonix: Population exposed per noise level class (LDEN (dB(A)) and associated external costs per HGV and per noise level class.

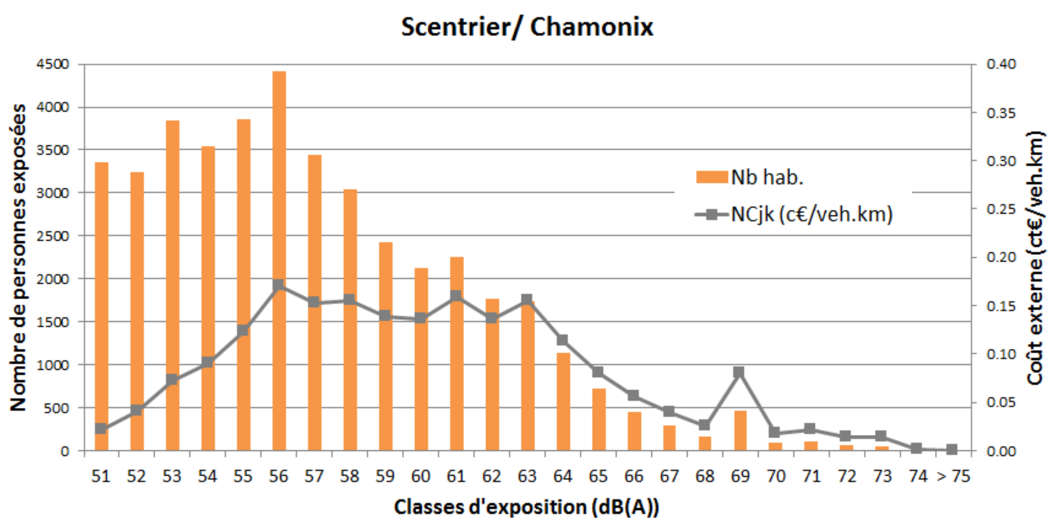


Illustration 21: A40/RN205 Scientrier – Chamonix: Population exposed per noise level class (LDEN (dB(A)) and associated external costs per HGV and per noise level class.

The analysis of exposure results by noise level class shows that external costs are mainly associated with levels below 65 dB(A), i.e. below the exposure limit values of the (68 dB(A)). This observation should be considered in the context of the implementation of noise mitigation policies in France (Noise Black Spot Mitigation Policy, Environmental Noise Prevention Plans). Some buildings have exposure levels above 68 dB(A) and may have been subjected to specific treatment (facade insulation). The Environmental Noise Prevention Plan also includes the protection of 39 buildings exceeding 66 dB(A):

- A40: 22 buildings (Eloise, Archamps, Collonges, Bossey, Gaillard, Scionzier, Cluses);
- RN205: 17 buildings (Passy, Les Houches).

To be noted: the Environmental Noise Prevention Plan for Savoie *département* (74), approved in 2015, includes a description of the vertical protection systems implemented along the A40 (Illustration 22).

Nature	Sens de circulation	Date de réalisation	Commune
Ecran	PK 6.565 au PK 7.045 sens Chamonix-Genève	2004	Sallanches
Ecran	PK 26.025 au PK 25.725 sens Chamonix-Genève	2008	Marnaz
Ecran	PK 16.942 au PK 16.290 sens Genève-Chamonix	2008	Magland
Ecran	PK 16.140 au PK 16.920 sens Chamonix-Genève	2009	Magland
Merlon	PK 32.75 au PK 32.95 sens Genève-Chamonix	2013	Bonneville

Illustration 22: Summary report on vertical protection systems implemented along the A40 from 2004 to 2014. Source: PPBE dpt74 (http://www.haute-savoie.gouv.fr)

The Environmental Noise Prevention Plan also specifies that: "to supplement the 5,747 linear meters of screens erected from *1994 to 2003, ATMB (Highway and tunnel of MtBlanc) installed new acoustic screens, i.e. 2,212 linear meters of protection thus screening 18 private homes and 4 buildings".*

Before being transferred to ATMB, the RN205 road also benefitted from protection works erected at the time by DREAL (Regional Directorate for the environnement, Planning and Housing) and DIRCE (Inter-Departemental Directorates for roads).

Commune	Lieu-dit	Longueur (en ml)
Servoz		550
Les Houches	RD 243	124
Les Houches	RD 243	24
Les Houches	Fond de Taconnaz	78
		120
Les Houches	Taconnaz	54
Les Houches	Taconnaz	141
Les Houches	Route des granges	305
Les Houches	Route des Granges	97
Les Houches	Montquarts	80
Les Houches	Montquarts	92
Les Houches	Montquarts	35
Les Houches	Montquarts	96
Les Houches	Bretelle Montquarts	41
Les Houches	Rives	104
Les Houches	Praz d'en Bas	64
Les Houches	Chemin de la Cliaz	80
Les Houches	Chemin de la Cliaz	168
Les Houches	Taconnaz	124
Les Houches	Vers Creusaz.	60
ChamonixVigie	Pélerins du Bas	130
	Pélerins du Haut	90
	Pélerins du HautClos de	80
	l'Ours	120
Total		2307 ml

Illustration 23: Summary report on vertical protection systems (screens) erected along the RN205 between 2004 and 2014. Source: Environmental Noise Prevention Plan for dpt74 (http://www.haute-savoie.gouv.fr).

Site	Désignation	Longueur (en ml)
Les Houches	Montquarts	500 160
Les Houches	Praz d'en Bas	300
Les Houches	Chemin de la Cliaz	180
Les Houches	Chemin de la Cliaz	150
Chamonix	Creusaz Pélerins du Haut Clos de l'Ours	300 80 100
Total		2400

Illustration 24: Summary report on vertical protection systems (walls) erected along the RN205 between 2004 and 2014. Source: Environmental Noise Prevention Plan for dpt74 (http://www.haute-savoie.gouv.fr).

5 - Route A43: Saint-Priest - Fréjus Tunnel

Via the Fréjus Tunnel,the A43 motorway is the main west-to-east link between Lyon (France) and Modane (Italy).Outbound out of Lyon, it crosses very densely urbanised areas, then less so, passing through more rural areas from Isère to Savoie and the city of Chambéry;upstream from Chambéry, the A43 mergers with the A41,northbound towards Aix-Les-Bains/Annecy; downstream from Chambéry,the A41 becomes southbound towards Grenoble. The A43 then continues on towards the Maurienne valley, which it enters near Aiton. The variety of topographical typologies along this same route thus makes it possible to highlight contrasts in exposures between plains and mountainous areas.

5.1 - Section A43 Savoie Foreland: St-Priest to L'Epine

The first part of the itinerary is characterized by sections of plains and hills. This portion is further divided into two subsections, with a first segment fromSt-Priest to Coiranne, then from Coiranne to L'Epine (tunnel), marking the access to Alpine slopes.

- ***Traffic characteristics***

Subsections / Section	Terrain Mountain/Plain	AADT (Veh./d)	%PL	Length (km)	Maximum regulatory speed (HGV//LV) (km/h)
St-Priest N346/ A43-A48 Coiranne	Plain	73 170	10.54%	26.2	80/90//110/130
A43-A48 Coiranne/ L'Epine	Plain	71 874	13.08%	12.6	90//130
St Priest / L'Epine	Plain	72 750	11.35%	38.8	130/110/90

Table 1: St-Priest – L'Epine – Traffic and topographic characteristics per subsection

Both subsections are relatively homogeneous in terms of traffic volumes, with a slightly higher level of HGV traffic on the Coiranne/L'Epine portion. Except for the peri-urban areas of Lyon and Chambéry, the regulatory speeds in force match those of a standard French motorway network (90/130 km/h).

- ***Topographic profiles***

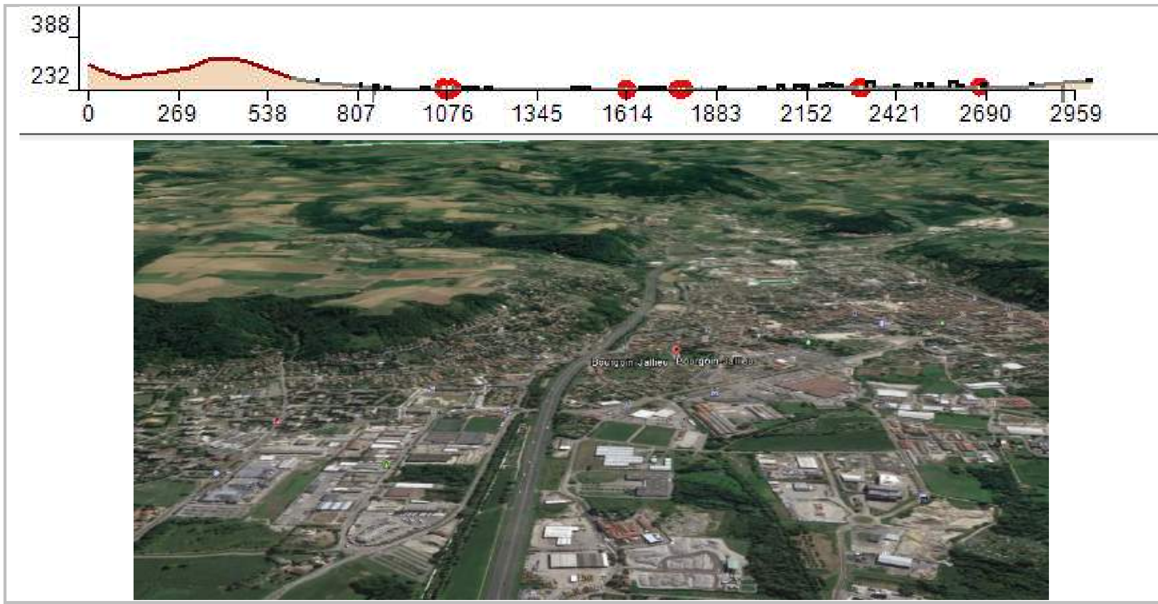


Illustration 25: A43 St-Priest – Coiranne. Typical cross-profile on this subsection. Red dots mark the location of road infrastructure modelled as acoustic sources. Horizontal and vertical scales in meters and aerial photograph (GoogleEarth) of the area near Bourgoin-Jaillieu.

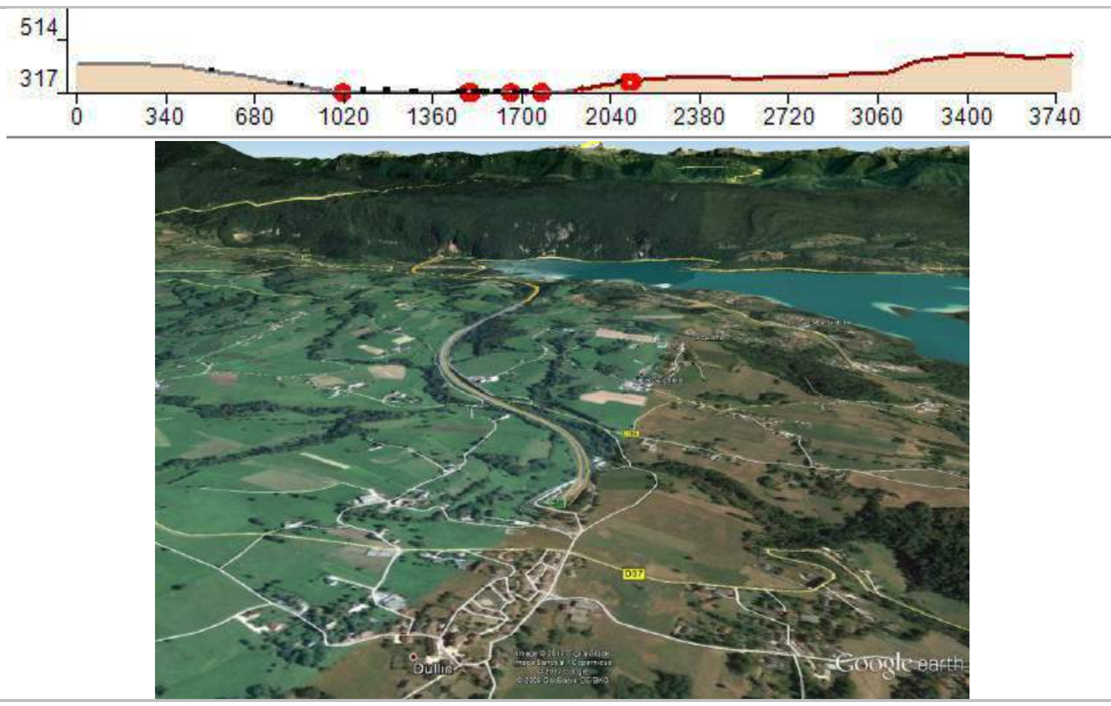


Illustration 26: A43 Coiranne – L'Epine. Typical cross-profile on this subsection. Red dots mark the location of road infrastructure modelled as acoustic sources. Horizontal and vertical scales in meters and aerial photograph (GoogleEarth) of the area near Dullin (Lac d'Aigueblette).

- ***Noise related external costs***

Subsections / Section	Terrain Mountain/Plain	External cost of noise (All vehicle)	Approximate population density (inhab/km²)	Cost/Pers./yr	NCV (1999/62/CE) €ct/veh.km
St Priest N346/ A43-A48 Coiranne	Plain	3 719 216 €	1204	118 €	1.75
A43-A48 Coiranne/ L'Epine	Plain	780 238 €	820	76 €	0.73
St Priest / L'Epine	Plain	4 499 454 €	1080	107 €	1,41

The highest estimated external costs are recorded in the first subsection, where built-up areas near the A43 obviously display a higher density. Throughout the second subsection (Coiranne-L'Epine), built-up areas are more scattered or located farther from the infrastructure, thus limiting populationexposure to noise. The annual external cost per km on this route is estimated at approximately 115.9 k€/km/yr, i.e.the highest cost of all the investigated routes, on par with the external costs estimated on the A7.

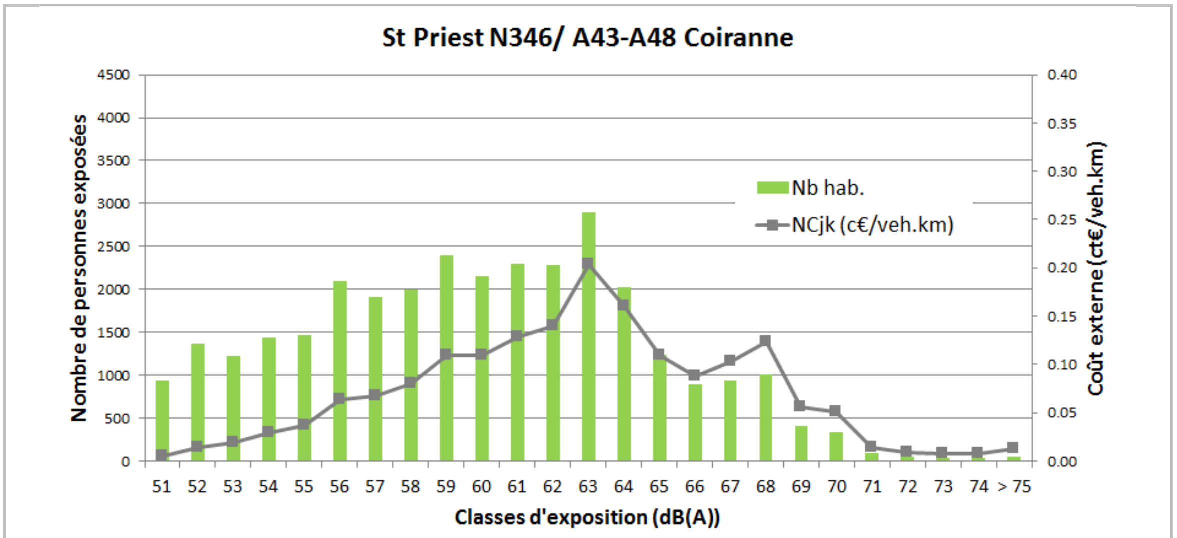


Illustration 27: A43 St-Priest - Coiranne: Population exposed per noise level class (LDEN (dB(A)) and associated external cost per HGV and per noise level class.

External costs on the St-Priest – Coiranne section are mainly associated with exposure levels below 65 dB(A). However, modelling also recorded populations exposed to noise levels reaching around 68 dB(A), which is the threshold value for road noise, according to the European Noise Directive.

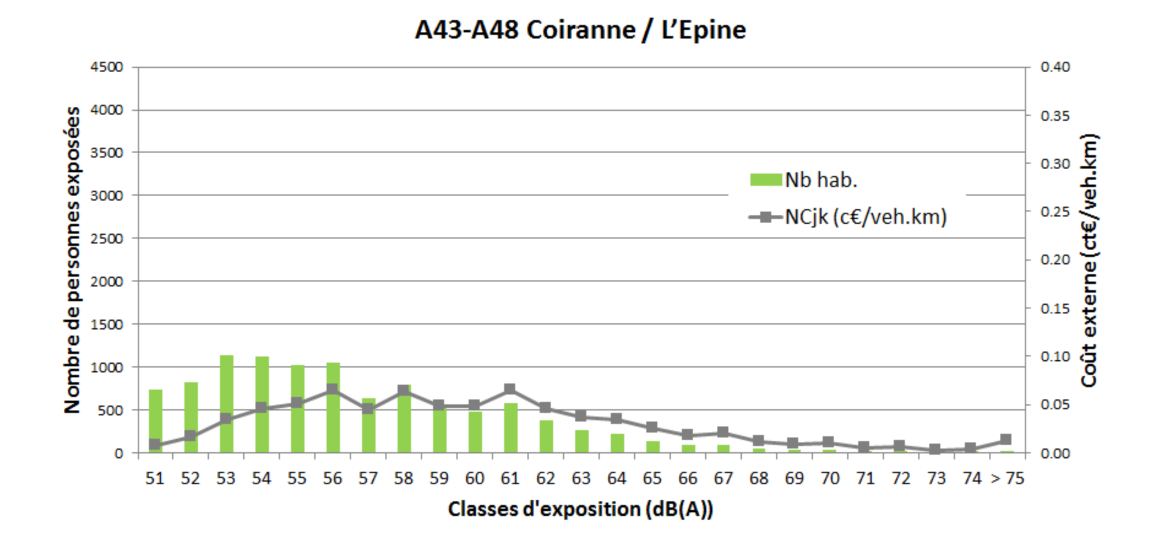


Illustration 28: A43 Coiranne - L'Epine: Population exposed per noise level class (LDEN (dB(A)) and associated external cost per HGV and per noise level class.

The relative distance from urban areas and the protection offered by natural terrain explain why, on the portion between Coiranne and Epine, a majority of people are exposed to levels below 60 dB(A).

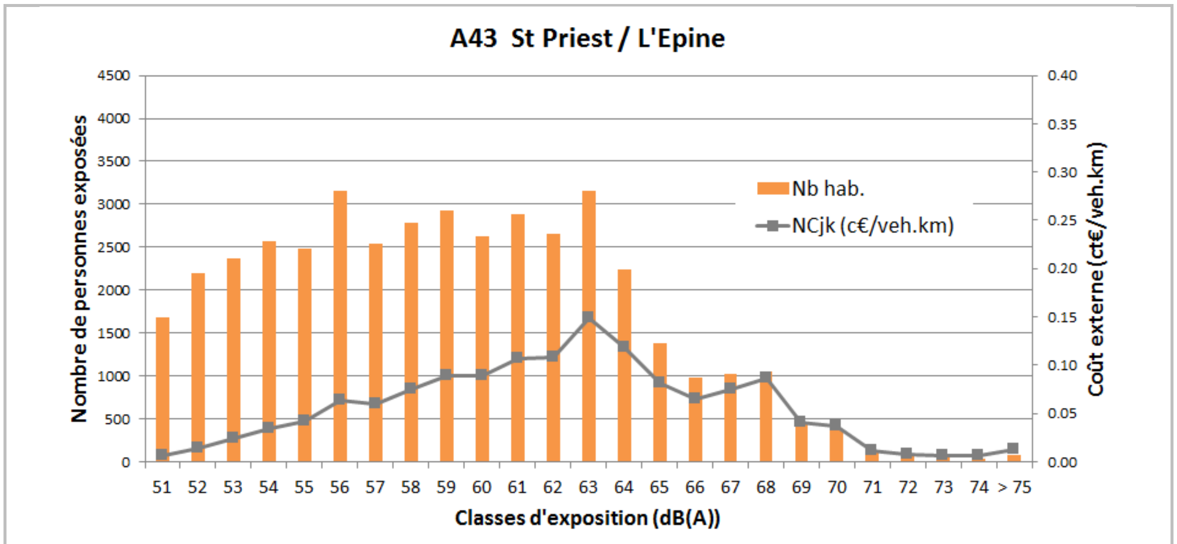


Illustration 29: A43 St Priest - L'Epine: Population exposed per noise level class (LDEN (dB(A)) and associated external cost per HGV and per noise level class.

It should be noted that once again, populations exposed to exposure levels above 68 dB(A) may have been subject to protective measures (particularly facade insulation), as part of the Environmental Noise Prevention Plans implemented(see publications at: http://www.isere.gouv.fr) or of other noise abatement policies (mitigation of black spots). The method for calculating external costs does not take into account the benefit of these treatments of the building envelope since acoustic levels used to calculate the NCV are assessed on the facades of buildings.

5.2 - Section A43: Chambéry - Maurienne Valley

This part of the route marks the access to Alpine slopes. The A43 winds along the valley floors, passing north of Chambéry, before entering the Combe de Savoie and the Maurienne Valley bound towards Italy. For the purposes of the study, the itinerary was broken down into four subsections as follows: L'Epine (tunnel)- the A41-A43 interchange - Aiton - St-Jean de Maurienne - the Fréjus Tunnel.

5.2.1 - *Traffic characteristics*

Subsections/Section	Terrain Mountain/Plain	AADT (Veh./d)	% HGVs	Length (km)	Maximum regulatory speed (HGV//LV) (km/h)
Epine / A41-A43	Plain	47 387	12.70%	5,5	90//90
A41-A43 / Aiton	Plain	32 040	12%	32	90//110/130
Aiton / St-Jean-M	Mountain	10 229	22%	37,4	90//130
St-Jean-M / Fréjus	Mountain	7 220	36%	25	90//130
Epine/Frejus	Mixed Plain/Mountain	18 501	16.49%	99,9	130/110/90

The two first sub-sections have the same characteristics as inter-city motorways in this region, with dense traffic as a whole and a moderate percentage of HGVs (around 12%). Ingress into the Maurienne Valley marks a significant change in traffic volumes and composition, with a marked decrease in AADT, and a relativelysignificant increase in HGV traffic,reaching 36% in the last subsection i.e. St-Jean-de-Maurienne - Fréjus Tunnel.

- ***Topographic profiles***

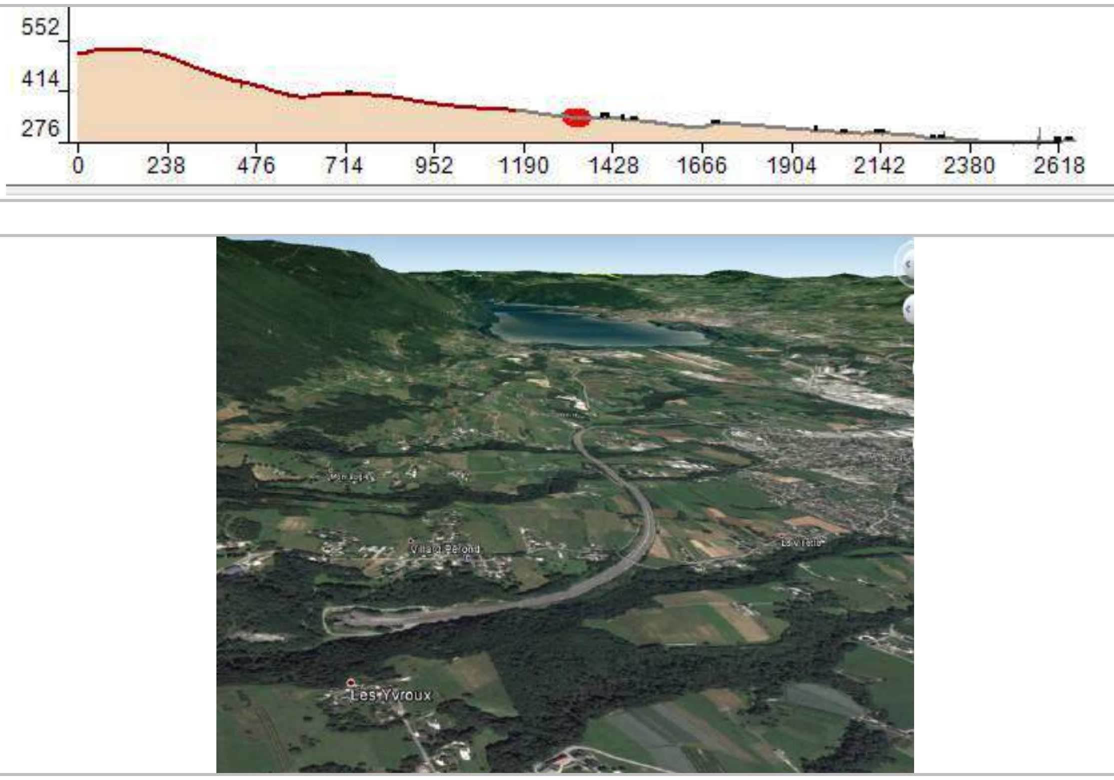


Illustration 30: A43 L'Epine – A41-A43. Aerial photograph (GoogleEarth) of the area close to Chambéry.

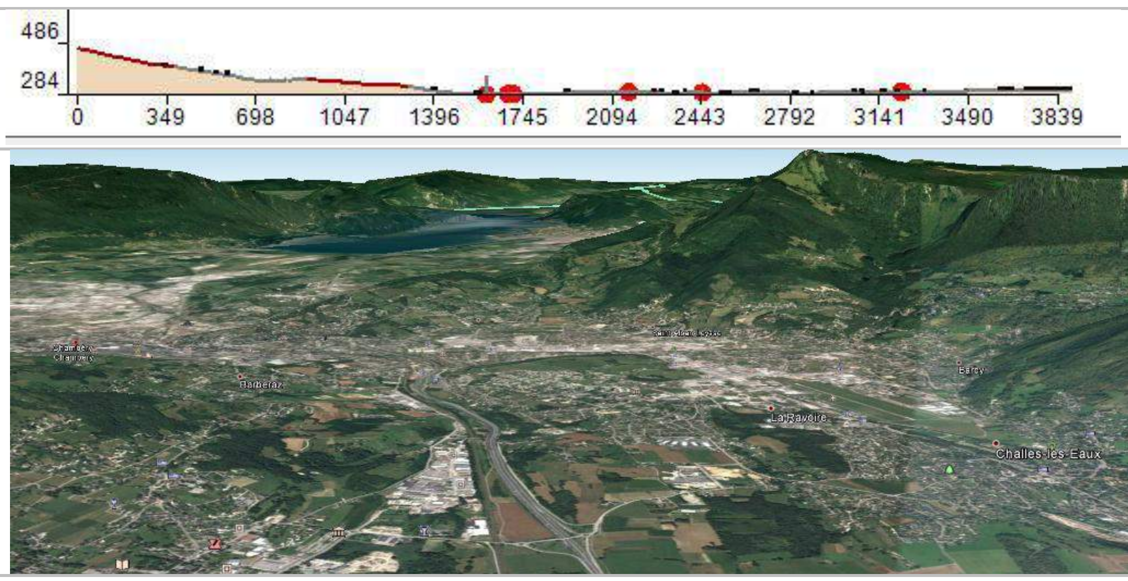


Illustration 31: A43 A41-A43 - Aiton. Typical cross-profile of this section. Red dots mark the location of road infrastructure modelled as acoustic sources. Horizontal and vertical scales (in meters) and aerial view (GoogleEarth) of the area.

The areas in these two first sections are characterized by their heavily built-up flat plainstypology.

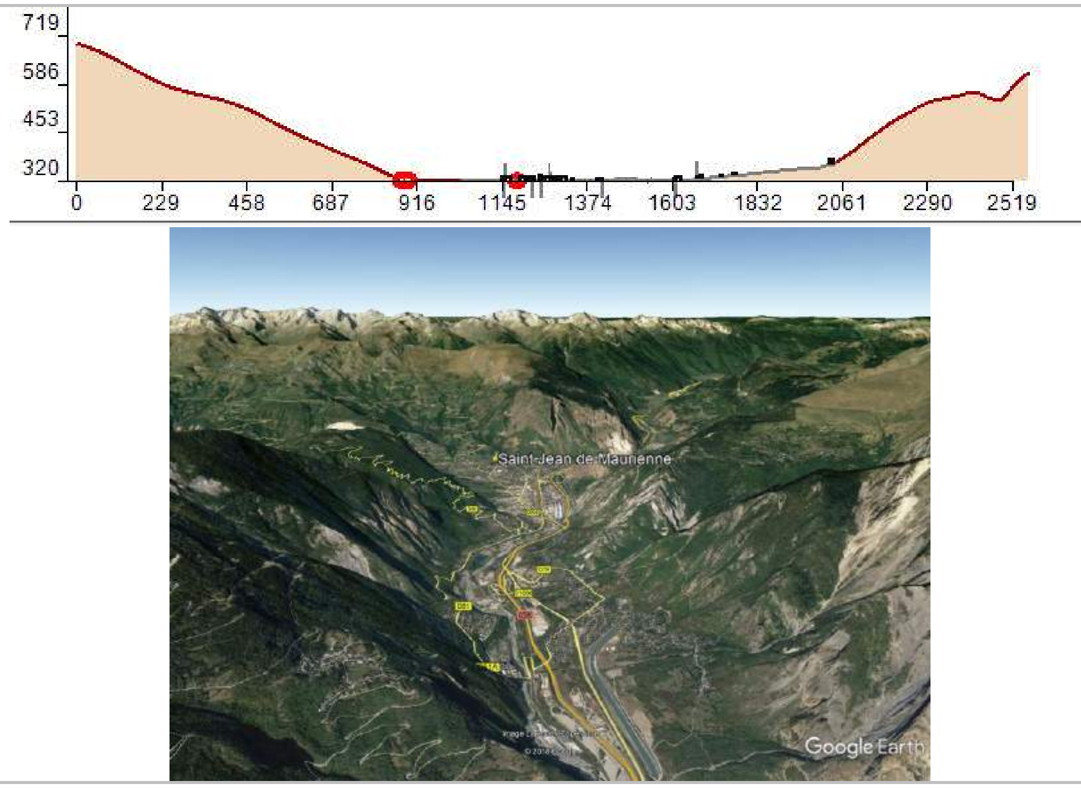


Illustration 32: A43 Aiton – St-Jean de Maurienne. Typical cross-profile on this section. Red dots mark the location of road infrastructure modelled as acoustic sources. Horizontal and vertical scales in meters and aerial photograph (GoogleEarth) close to Saint-Jean-de-Maurienne.

Illustration 33: A43 Aiton – St-Jean de Maurienne. Typical cross-profile on this section. Red dots mark the location of road infrastructure modelled as acoustic sources. Horizontal and vertical scales in meters and aerial photograph (GoogleEarth) of the area around St-Jean-de-Marienne/Modane.

The illustrations above show the classic typology of a V-shaped glacial valley, marked by a strong embankment characteristic of the Maurienne. Urbanization is low and scattered around infrastructures, with the human footprint situatedmostlyon the valley floor.

- ***Noise related external costs***

Section / Route	Terrain Mountain/Plain	External cost of noise (All Vehicles)	Approximate population density (inhab/km²)	Cost/Pers./yr	NCV (1999/62/CE) ct€/veh.km
L'Epine / A41-A43	Plain	592 504 €	1156	93 €	1,95
A41-A43 / Aiton	Plain	2 887 087 €	920	98 €	2,45
Aiton / St-Jean-M	Mountain	269 030 €	129	56 €	0,49
St-Jean-M / Fréjus	Mountain	307 003 €	217	57 €	0,93
L'Epine/Frejus	Mixed	4 055 624 €	461	88 €	1,72

The contrasts in terms of traffic, topography and urbanisation highlighted in the previous paragraphs for these four subsections are also reflected in the estimation of external costs. Around the first two subsections, between L'Epine and Aiton, this more densely populated area indicates noise related external costs within the upper limit rangesuggested by the Directive (between 1.95 et 2.45 €ct/veh.km). At the heart of the Maurienne Valley, the exposed population density is divided by a factor of 5 to 10, but the contribution of HGVs remains significant. This explains the decrease in the NCV indicator: it ranges between 0.49 and 0.93 €ct/veh.km in mountainous sections.

The external cost/km on this route is estimated at approximately 44.5 k€/km/yr.

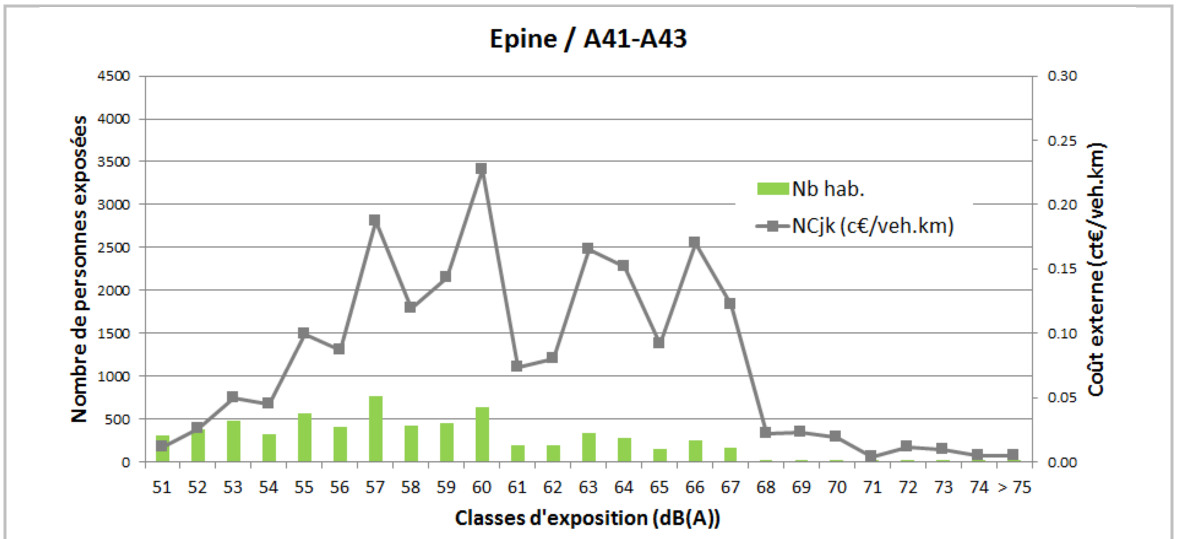


Illustration 34: A43 L'Epine – A41-A43: Population exposed per noise level class (LDEN (dB(A)) and associated external costs per HGV and per noise level class.

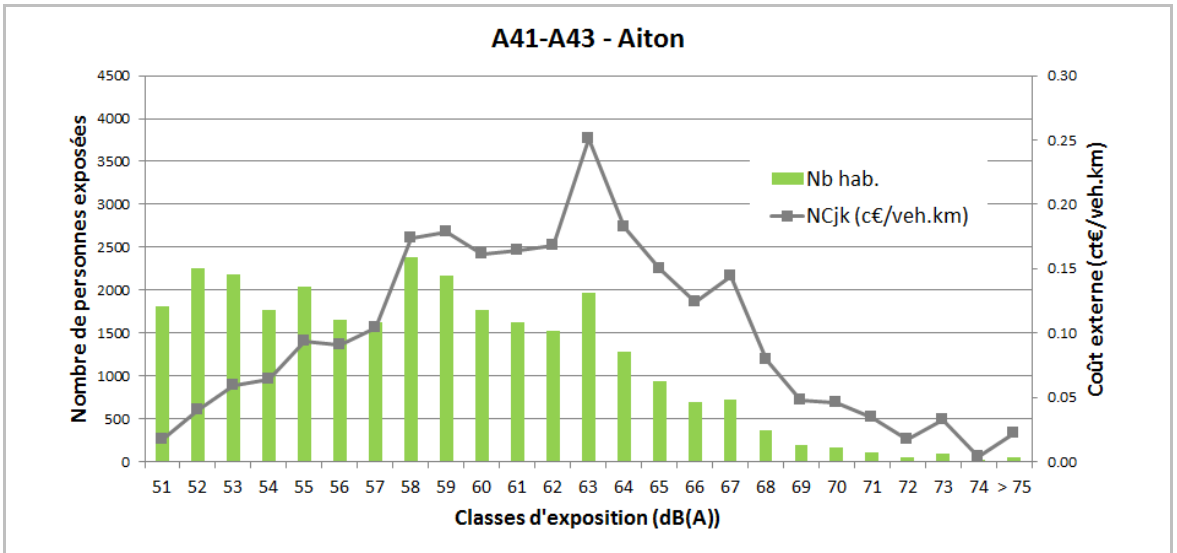


Illustration 35: A43 A41-A43 - Aiton: Population exposed per noise level class (LDEN (dB(A)) and associated external costs per HGV and per noise level class.

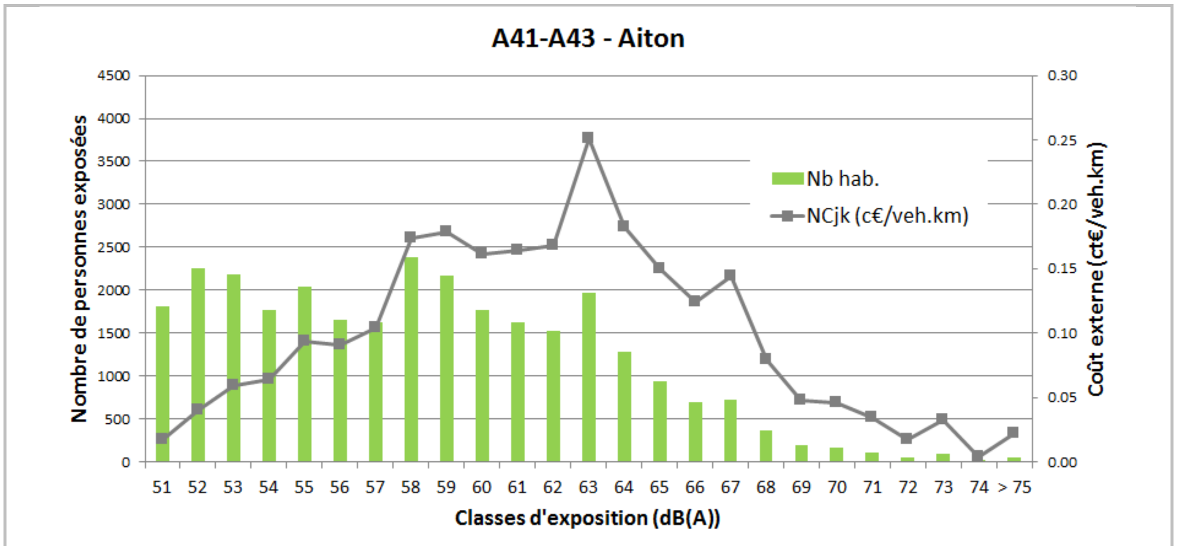


Illustration 36: A43 Aiton – St Jean de Maurienne: Population exposed per noise level class (LDEN (dB(A)) and associated external costs per HGV and per noise level class.

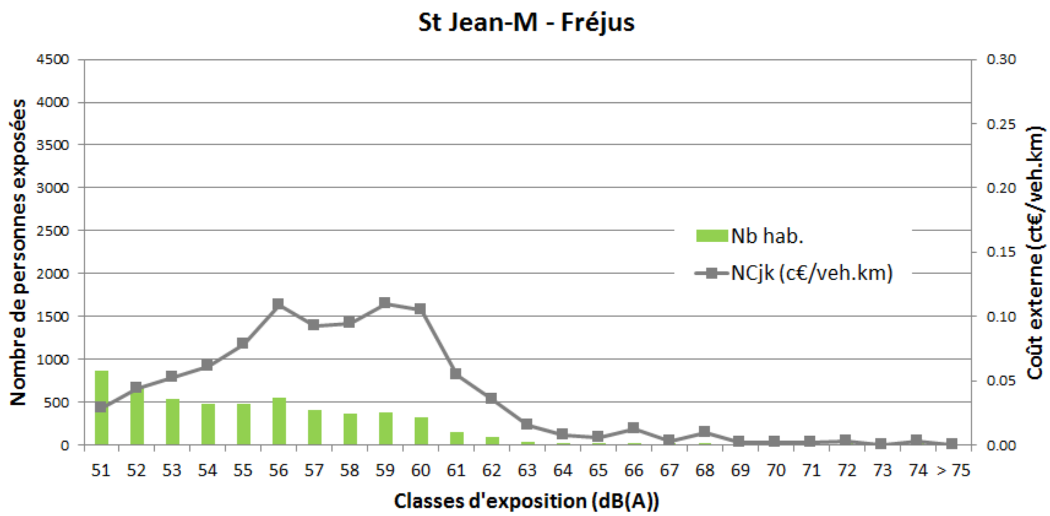


Illustration 37: A43 St-Jean de Maurienne – Fréjus Tunnel: Population exposed per noise level class (LDEN (dB(A)) and associated external costs per HGV and per noise level class.

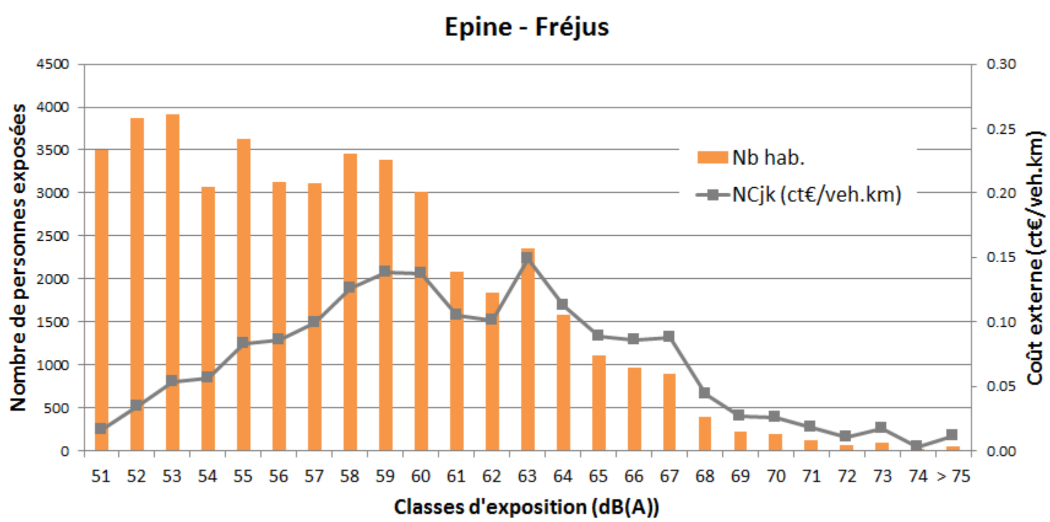


Illustration 38: A43 L'Epine – Fréjus Tunnel: Population exposed per noise level class (LDEN (dB(A)) and associated external costs per HGV and per noise level class.

Analysis by exposure class along the L'Epine-Fréjus Tunnel section shows that population exposure corresponds mainly to levels below 65 dB(A) on building facades and for many, below 60 dB(A). This is particularly the case in the narrowest part of the Maurienne Valley.It should be noted that the motorway was commissioned from Aiton in 1996 and the connection with the Fréjus Tunnel was completed in the early 2000s.The infrastructure thus benefited from the most recent acoustic regulations including the preventive treatment of the most exposed buildings (facade insulation or acoustic screens). Some of the noise related costs have therefore been internalised.

The 2013-2018 Environmental Noise Prevention Plan for Savoie (http://www.savoie.gouv.fr) identified only two remaining Noise Black Points (buildings) in the La Motte Servolex area.

6 - Route A7 the Rhône Valley: Lyon - Valence

The A7 motorway is part of the European routes network (E15 between Lyon and Orange) extending northwards towards Paris via the A6; and southwards linking Lyon to Marseille. The sectionunder study crosses the departments of Isère and Drôme and constitutes a historic corridor connecting the north and south of France. The A7 runs along the Rhône River in a wide valley with limited urban density, with the exception of the cities and conurbations it traverses, i.e. Lyon, Vienne, Valence for the sectionunder study. The A7 motorway is one of the busiest trunk roads in France.

For the purposes of this study, the chosen route has beenlimited to its portion between Lyon and Valence and broken down into four subsections as follows: Chasse-sur-Rhône – Reventin – St Rambert d'Albon – Tain l'Hermitage – Valence Sud.

- ***Traffic characteristics***

Subsections / Route	Terrain Mountain/Plain	AADT (Veh./d)	%HGV	Length (km)	Maximum regulatory speed (HGV//LV) (km/h)
Chasse/Reventin	Plain	109 005	15,41 %	15,6	80/90//110/130
Reventin/St Rambert d'Albon	Plain	70 141	18,26 %	20,6	90//130
St Rambert d'Albon / Tain l'Hermitage	Plain	65 315	17,97 %	29,2	90//130
Tain l'Hermitage/Valence Sud	Plain	62 233	18,11 %	18,4	80/90//110/130
Chasse/Valence Sud	Plain	73 960	17,36 %	83,8	130/110/90

The first section of the itinerary, southbound out of Lyon and its metropolitan area, is the one that carries the most traffic, with nearly 110,000 vehicles per day,of which 15% are heavy goods vehicles (nearly 16,000 HGVs/d). This overall volume decreases as traffic proceedssouth, but the proportion of HGVs increases significantly. Regulatory speeds matchthose of the French motorway network except in the vicinity of major cities or conurbations.

- ***Topographic profiles***

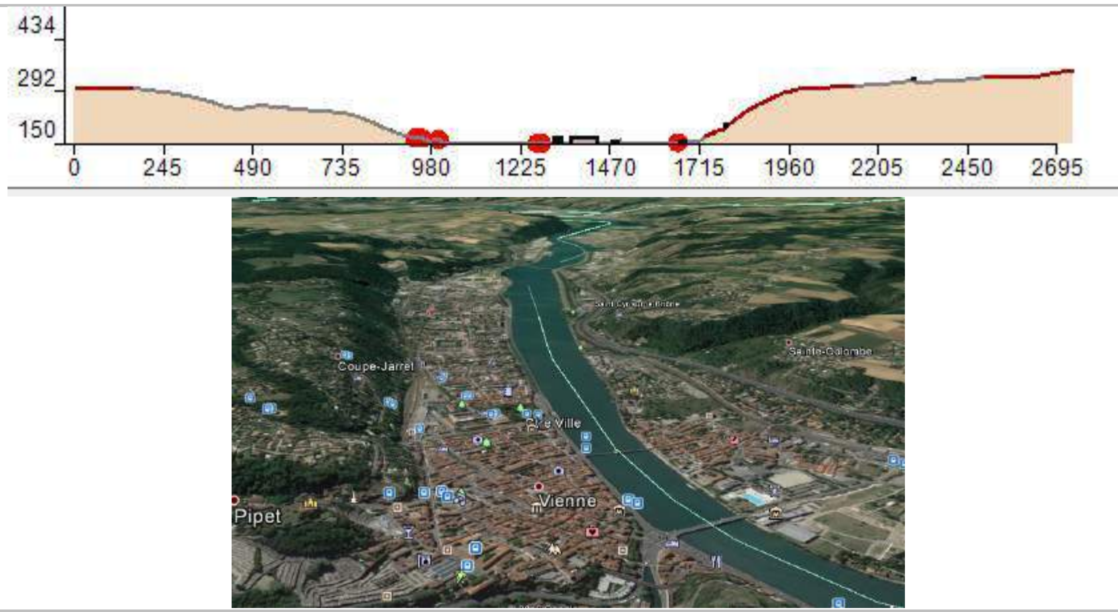


Illustration 39: A7 Chasse – Reventin. Typical cross-profile on this section. Red dots mark the location of road infrastructure modelled as acoustic sources. Horizontal and vertical scales in meters and aerial view (GoogleEarth) of the area close to Vienne.

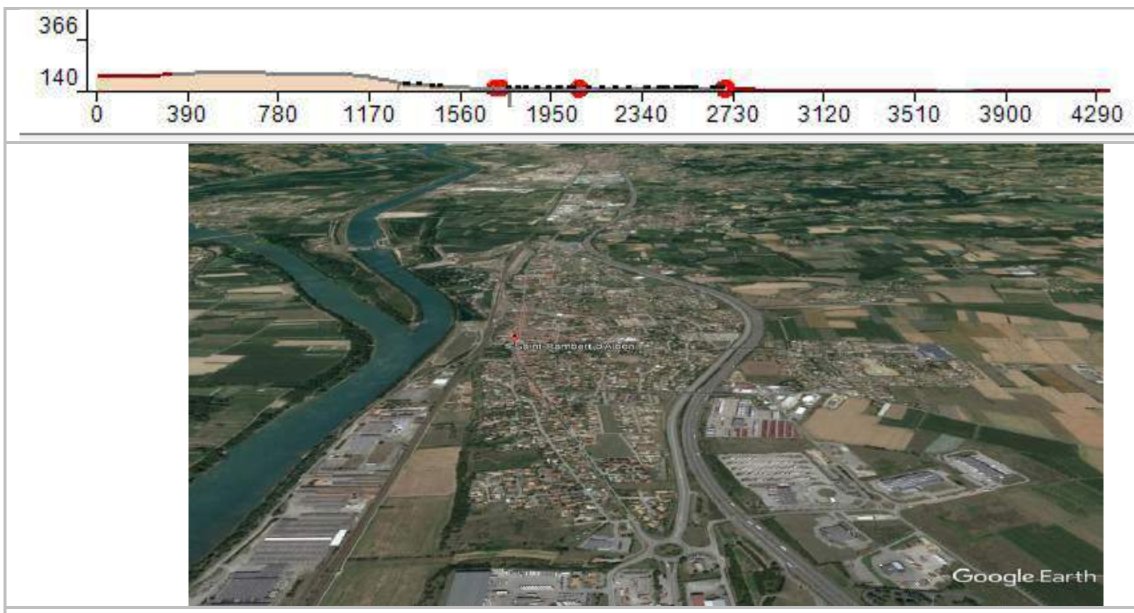
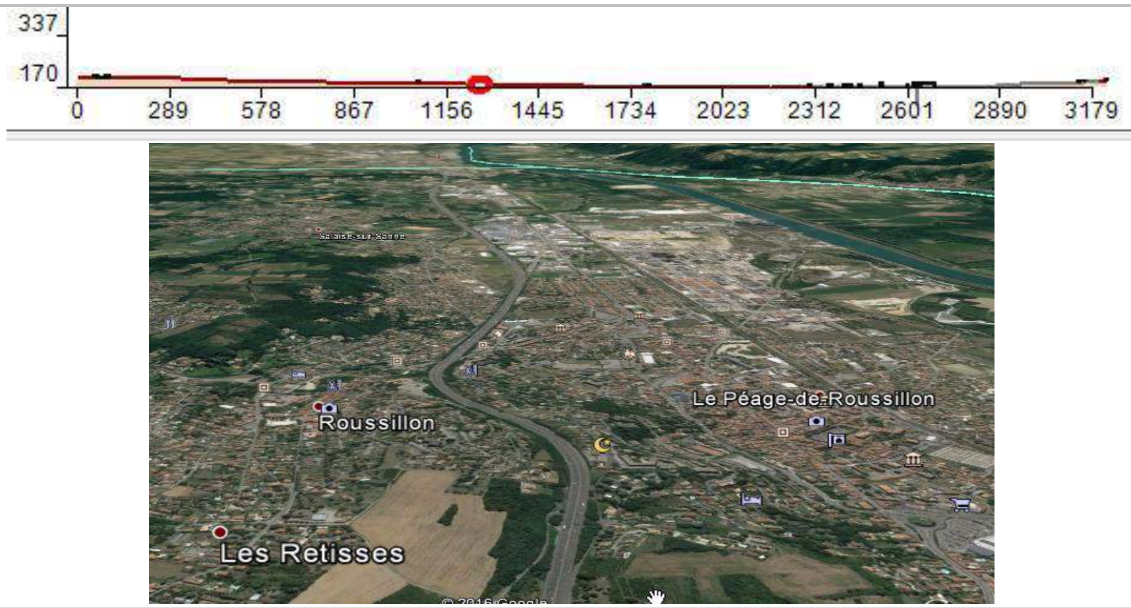


Illustration 40: A7 Reventin – St-Rambert d'Albon. Typical cross-profile on this section. Red dots mark the location of road infrastructure modelled as acoustic sources. Horizontal and vertical scales in meters and aerial view (GoogleEarth) of the area close to St-Rambert d'Albon.



llustration 41: A7 St-Rambert d'Albon – Tain l'Hermitage. Typical cross-profile on this section. Red dots mark the location of road infrastructure modelled as acoustic sources. Horizontal and vertical scales in meters and aerial view (GooglEarth) close to Roussillon.

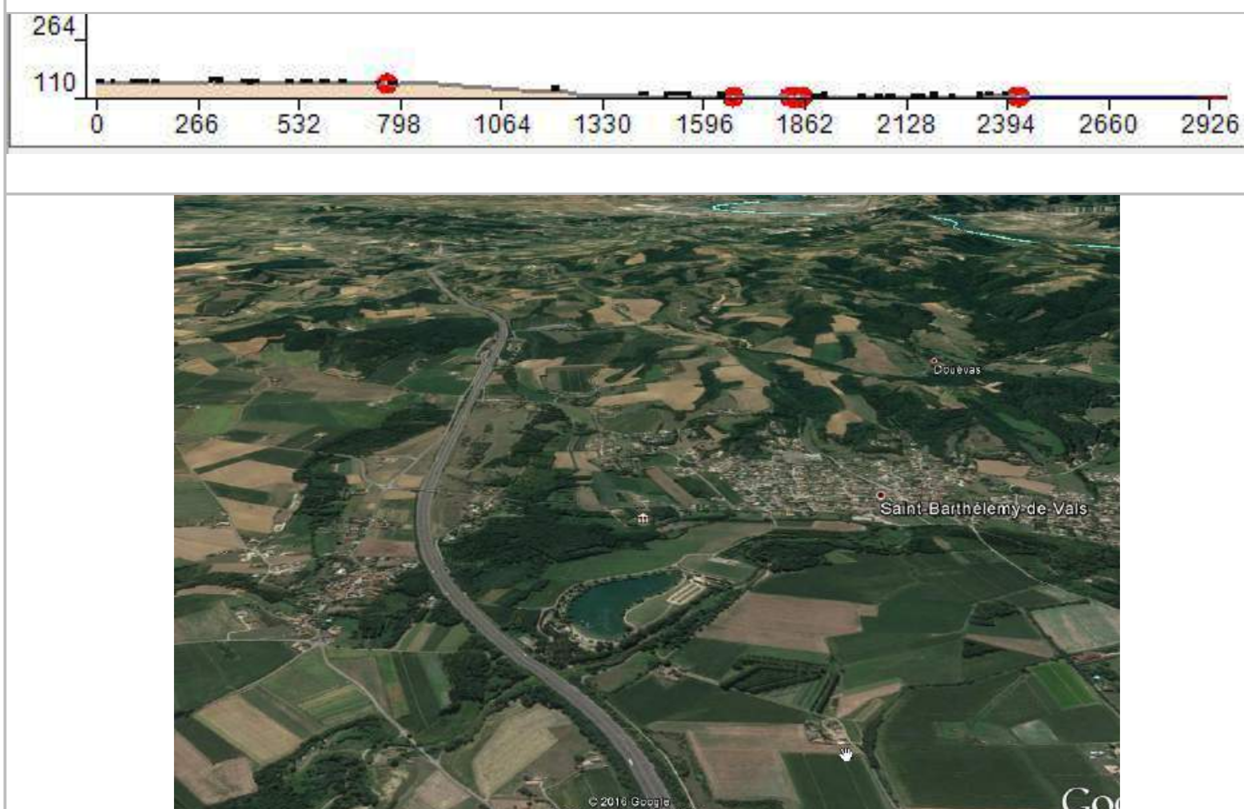


Illustration 42: A7 Tain l'Hermitage – Valence Sud. Typical cross-profile on this section. Red dots mark the location of road infrastructure modelled as acoustic sources. Horizontal and vertical scales in meters and aerial view (GoogleEarth) of the area close to St-Barthélémy de Vals.

Illustration 43: A7 Tain l'Hermitage – Valence Sud. Aerial view (GoogleEarth) of the area close to Valence.

Along thisentire route, the topography is characteristic of plain areas and the first slopesare located several kilometres away from the motorway.

- ***Noise related external costs***

Subsection / Route	Terrain Mountain/Plain	External cost of noise (All Vehicles)	Approximate population density (inhab/km²)	Cost/Pers./yr	NCV (1999/62/CE) €ct/veh.km
Chasse/Reventin	Plain	3 137 845 €	1311	153 €	1,48
Reventin/St Rambert d'Albon	Plain	2 247 634 €	870	125 €	1,17
St Rambert d'Albon / Tain l'Hermitage	Plain	1 466 670 €	311	161 €	0,58
Tain l'Hermitage/Valence Sud	Plain	2 886 984 €	1350	116 €	1,91
Chasse/Valence Sud	Plain	9 739 133 €	862	135 €	1,21

The most important estimated external costs have obviously been identified in subsections crossing the densest urban areas. The calculated NCV values are within the range proposed by the Eurovignette Directive, with the exception of the St Rambert d'Albon/Tain l'Hermitage section (NCV=0.58 €ct/veh.km), which hasthe lowest value due to the particularly low population density exposed to the A7 in this sector.
It should be noted that the external costs over this entire route are the highest of all the routes under study, i.e. approximately 116 k€/km/year. However, the associated NCV values remain "moderate" due to the distribution of costs between a higher number of HGVs.

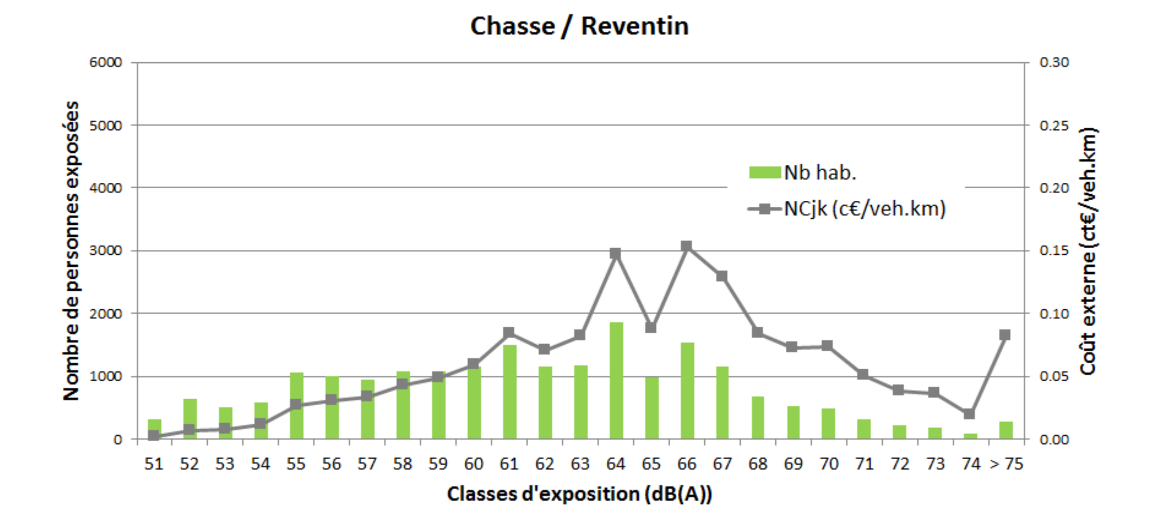


Illustration 44: A7 Chasse – Reventin: Population exposed per noise level class (LDEN (dB(A)) and associated external cost per HGV and per noise level class.

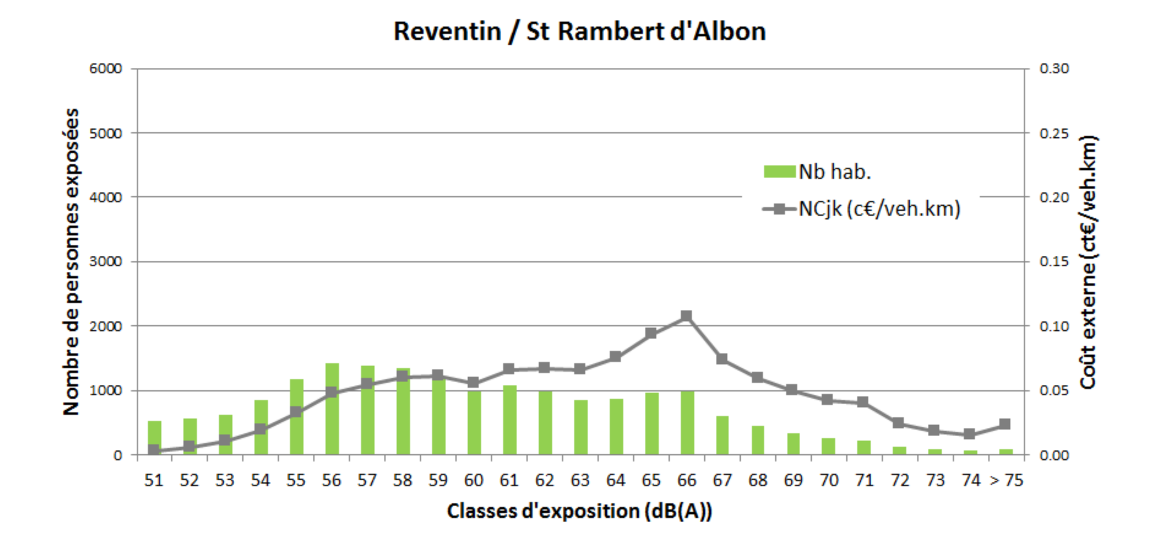


Illustration 45: A7 Reventin – St-Rambert d'Albon: Population exposed per noise level class (LDEN (dB(A)) and associated external cost per HGV and per noise level class.

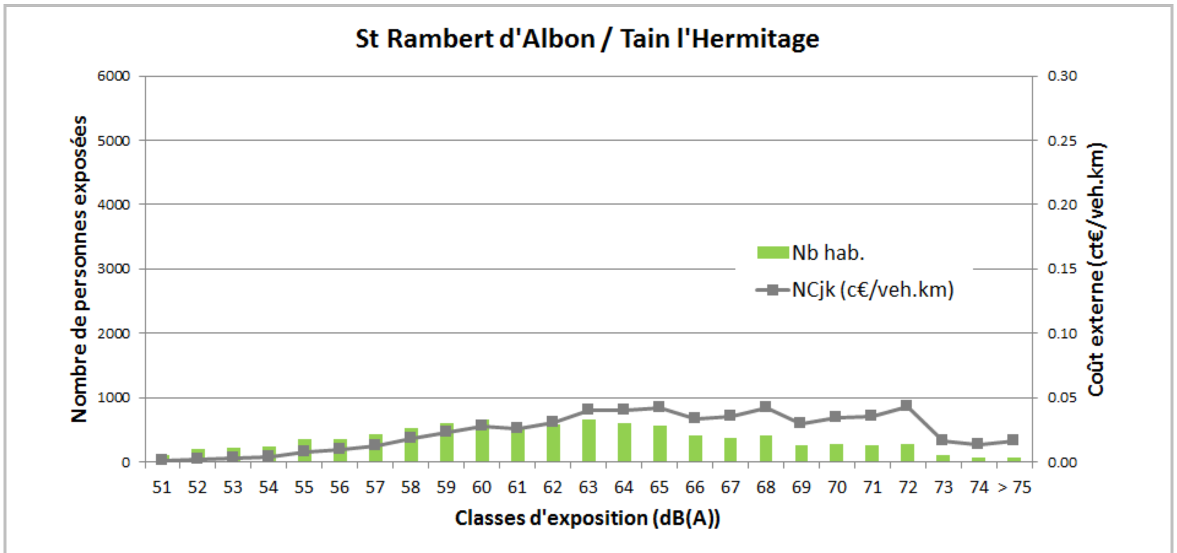


Illustration 46: A7 St-Rambert d'Albon – Tain l'Hermitage: Population exposed per noise level class (LDEN (dB(A)) and associated external cost per HGV and per noise level class.

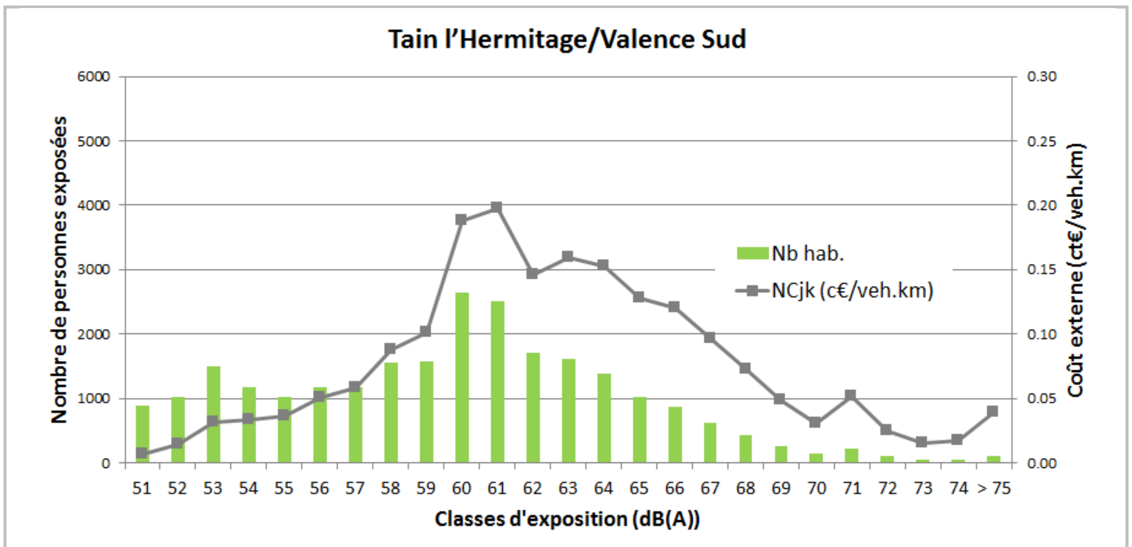


Illustration 47: A7 Tain l'Hermitage – Valence Sud: Population exposed per noise level class (LDEN (dB(A)) and associated external cost per HGV and per noise level class.

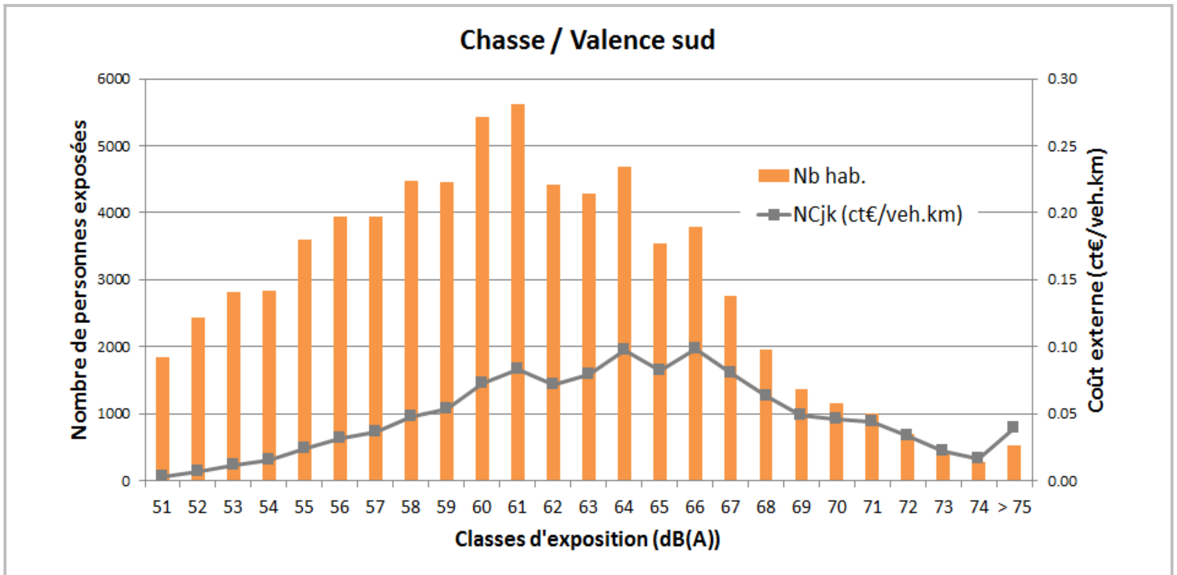


Illustration 48: A7 Chasse-sur-Rhône – Valence Sud: Population exposed per noise level class (LDEN (dB(A)) and associated external cost per HGV and per noise level class.

The external costs are mostly due to population exposures to noise levels below 68 dB(A), but the proportion of the population still exposed to above 68 dB(A) levels remains significant.

As on the other routes, the noise control policies implemented for several decades have made it possible to identify and reduce some of the Noise Black Spots around this trunk road, with the erection of vertical protection or facade insulation.Please note that the assessment of external costs includes the presence of these vertical protections but not the facade insulation works carried out (noise levels calculated on the exterior facade of buildings). us in the department of Isère, the State Environmental Noise Prevention Plan covering the period 2013-2018 (http://www.isere.gouv.fr/)reportsno residual Noise Black Spot around the A7.They have absorbed by facade insulation or by the erection of acoustic screens. The same applies to the Drôme Department (see PPBE 2015-2018, http://www.drome.gouv.fr).

7 - Comparative analysis of external costs per route and conclusions

The following table summarizes all the results for the routes studied, and the breakdown by sub-section. A graphical representation of this table can be found in Illustration 50.

	Subsections	**Mountain/Flat**	**Length (km)**	**AADT Annual average daily traffic (veh/day)**	**% HDV (Heavy Duty Vehicles)**	**Exposed population density (inh,/km²)**	**Noise cost NCVj (ct€/veh,km)**	***NCVj/1000 Pers/km (ct€/veh,/pers)***
E21-E25 European route	Pont d'Ain / Tunnel Vuache	Mix Flat/Mountain	11,8	20 307	14,1%	654	1,65	*2,52*
	Tunnel Vuache / Scientrier	Mix Flat/Mountain	38,7	29 061	8,6%	418	1,39	*2,67*
	Scientrier / Cluses	Mix Flat/Mountain	23,6	26 396	8,8%	983	3,04	*3,09*
	Cluses / Le Fayet	**Mountain**	21,1	17 216	11,2%	665	**2,5**	***3,76***
	Le Fayet / Chamonix	**Mountain**	35,6	13 876	15,3%	149	**0,59**	***3,92***
E70 European route	St Priest N346/ A43-A48 Coiranne	Flat	26,2	73 170	10,5%	1 204	1,75	*1,45*
	A43-A48 Coiranne/ L'Epine	Flat	12,6	71 874	13,1%	820	0,73	*0,89*
	L'Epine / A41-A43	Flat	5,5	47 387	12,7%	1 156	1,95	*1,68*
	A41-A43 / Aiton	Mix Flat/Mountain	32	32 040	12,0%	920	2,45	*2,66*
	Aiton / St-Jean-M	**Mountain**	37,4	10 229	22,0%	129	**0,49**	***3,8***
	St-Jean-M / Fréjus	**Mountain**	25	7 220	36,0%	217	**0,93**	***4,28***
E15 European route	Chasse/Reventin	Flat	15,6	109 005	15,4%	1 311	1,48	*1,13*
	Reventin/St Rambert d'Albon	Flat	20,6	70 141	18,3%	870	1,17	*1,34*
	St Rambert d'Albon / Tain l'Hermitage	Flat	29,2	65 315	18,0%	311	0,58	*1,87*
	Tain l'Hermitage/Valence Sud	Flat	18,4	62 233	18,1%	1 350	1,98	*1,41*
						Average (std. dev.)	**1.51 (*0,78*)**	***2.43 (1,13)***
						Average « Flat »	**1,26**	***1,39***
						Average « Mix Flat/Mountain »	**2,13**	***2,74***
						Average « Mountain »	**1,13**	***3,92***
						Ratio « Mountain/Flat »		***2.83***

Illustration 49: Summary results for the 3 routes and associated sub-sections. NCV and NCV/1000hab./km averages as well as standard deviations are also presented for all sub-sections and by showing the difference between flat areas and mountainous areas.

The table above make the following possible:
- highlighting the actual stated disturbances taking account of the exposed population in the three valleys under study (last column of table 49).
- assessing, regardless of the population, a mountain/plain ratio (last column of table 49).

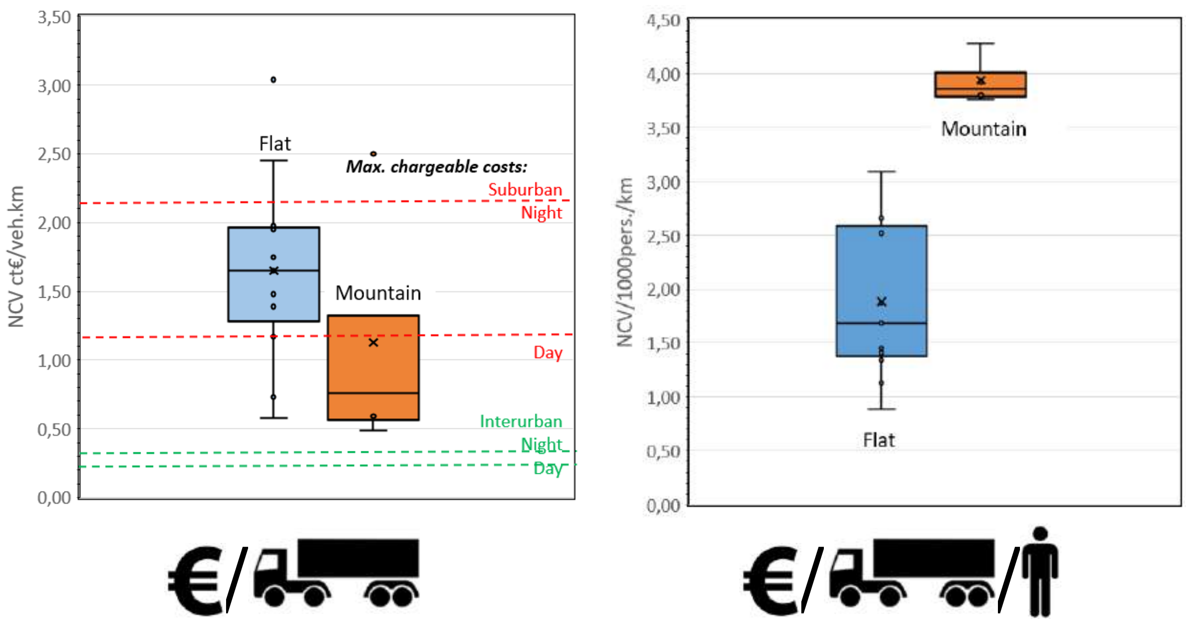


Illustration 50: distribution of results for flat subsections (blue) and mountain subsections (orange). On the left NCVj per HGV, on the right NCV/1000pers./km. Red dotted lines, respectively green, are the suburban, respectively urban, night and day limits of chargeable costs (Eurovignette Directive).

a) Indicator inclusive of population

External costs assessed on the seven flat plain sections vary, according to the NCVj indicator, between 0.58 and 1.98 €ct/veh.km with an average value of1.26 €ct/veh.km. Please note the significant standard deviation: it represents almost 50% of the stated average value.

The estimates calculated for the four mountain sections range from 0.49 to 2.5 €ct/veh.km with an average of1.13 €ct/veh.km. The maximum value is obtained on the Cluses/Le Fayet section, where the highest density of exposed populations is found (665 hab./km²).

b) Indicator exclusive of population

The external costs assessed for the seven plain sections vary according to indicatorNCVj/1,000pers-km,ranging from 0.89 to 1.87 €ct/veh-km/pers with an average value of1.39 €ct/veh-km/pers. We noted a moderate standard deviation.

External costs assessed for the four mountain sections vary according to indicator NCVj/1000pers-km, ranging from 3.76 to 4.28 with an average value of 3.92 NCVj/1000pers-km. We noted a small standard deviation.

The mountain/plain ratio is estimated at**2.8**

c) Benchmarking against the Eurovignette Directive

Appendix III of the Directive authorizes surcharges on the whole European network, for noise disturbances generated by HGVs, based on two criteria:

- the suburban or interurban nature of the section;
- day or night traffic.

It also authorizes applying a factor 2 to theses disturbances in mountainous areas.

Since mountain sections can be considered as suburban axes, the authorized costs of 1.1€ct/veh-km apply for day time, and 2€ct/veh-km for night time.

The results of this study, i.e. 1.39€ct/veh-km, an average for day and night in plains, show the same reference bracket as quoted by the Directive.

However, the mountain/plain ratio estimated in this study is in the order of**2,8**(independently of the population density factor).

d) Comments

Precautionary measures must be taken when interpreting costs calculated with the method we described. Noise levels associated with exposed populations are calculated off facades of residential buildings (external).

The quality of building envelopes, and notably their acoustic insulation, was not factored into the calculation of exposure. However, environmental noise abatement works, supported by public policies and conducted by State agencies and infrastructure managers give rise in part to the reinforcement of the acoustic insulation of buildings.

These actions do not modify external noise levels and therefore external costs as they are calculated, but they limit the exposure of people in their homes. Taking account of the numerous Noise Black Spot Mitigation Operations that have been conducted over the past few years, the calculated external costs are therefore partially overestimated.

Reversely, the cost of such works (acoustic insulation, noise screens etc.) and of their maintenance should be included in the calculation of external costs insofar as they are mainly induced by noise disturbances generated by HGV traffic.

8 - Specificities of the issue of noise in mountainous areas: understanding the Eurovignette case

Among the factors identified as specific to mountainous areas and which could have a negative impact on noise relatedexternal costs, the Eurovignette Directive identifies: slopes, topography and meteorology. The contribution of each of these parameters is discussed below.

8.1 - Contribution of slopes

Road noise emissions are traditionally broken down into two components: engine noise (mechanical operation of the vehicle); and rolling noise (tyre-to-pavement contact). The relative weight of each component in the total emission is related to vehicle speed and traffic dynamics or speed. We can differentiate between the following speeds: stabilized, acceleration, and deceleration. Rolling noise is also dependent on the type of pavement and its condition.

At low speed, engine noise outweighs rolling noise. For LVs, rolling noise will outweigh engine noise above approximately 50 km/h in stabilized speed conditions. For HGVs the limit is slightly higher, at around 70 km/h.
Consequently, rolling noise will always be considered to be predominanton the motorways we studied.

Road gradients affect engine noise, but not rolling noise. Without being completely negligible, a slope will therefore have a limited influence on noise emissions. NMPB08 provides an estimation of the over-emission of noise in descent or ascent for HGVs. It varies between 0 dB(A) (downward slope <2%) and 8 dB(A) (upward slopeat 6%). Combined with the rolling noise, the over-emission for HGVs will be at most around 2 dB(A).
With regard to LVs, it is accepted that any excess acoustic emissions are negligible for gradients below 6%.

The slope factor has been incorporated into the modelling of noise map used to quantify population exposure and therefore external costs.

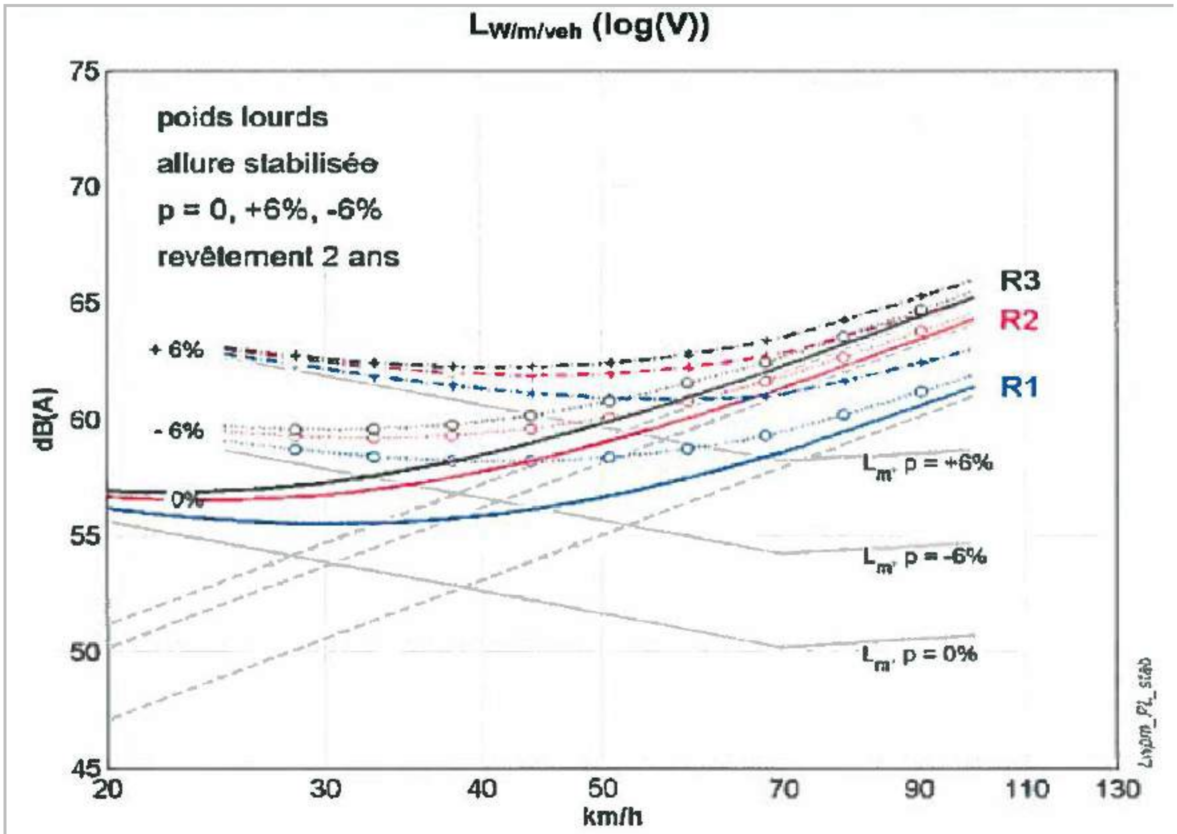


Illustration 51: Emission chart (power level per meter and per vehicle) for HGVs as a function of speed, slope and pavement category (R1, R2, R3), for a recently built pavement (Source: Road noise forecast, Volume 1: Calculation of road traffic noise emissions - Sétra 2009).

8.2 - The amphitheatre effect

The so-called amphitheatre effect is associated in acoustics, with the propagation of sound waves between a source located below a receiver (dominant situation). Such exposure is typical for buildings erected on the slopes of a valley, on the floor of which land transportation infrastructure is found. The relative source-receptor position can minimize the mitigation effect of the sound wave when it reflects during its propagation, on a more or less absorbent ground, or when it encounters other obstacles (natural and artificial). This effect increases with source-receptor distance.
Compared with an exposure in a plain situation, this effect will tend to increase sound levels on dominant receptors located at a few hundred metres;these sound levels are generally moderate due to the distance from the source (natural geometric divergence).
The modelling carried out in this study takes this effect into account through the three-dimensional description of the environment and the absorbent properties of soils.

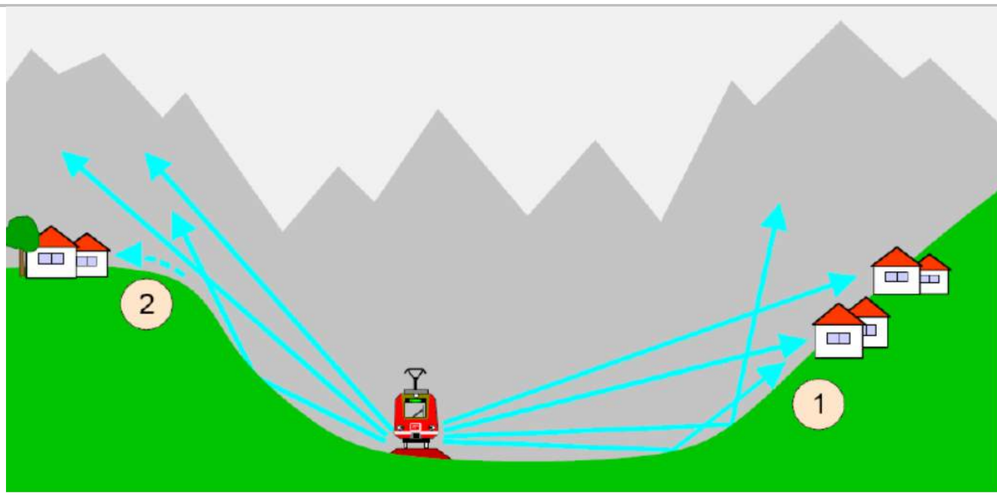


Illustration 52: Illustration of the amphitheatre effect [7]

Along the routes we studied, a number of houses have an amphitheatre-type exposure configuration. However, on the one hand, these houses are relatively few in number compared to "level" exposure situations, and on the other, the buildings involved are generally located farenough to limit noise levels and therefore external costs.

8.3 - The role of reverberation

Mountain zones are easily associated with the phenomenon of acoustic echo or reverberation, resulting from overlapping "echoes" converging towards receivers. The notion of reverberation comes from construction acoustics and is reflected in the persistence of sound over time. This induces an increase in sound level, unlike wider open spaces in which acoustic energy barely returns to the receiver,if at all. Environments of enclosed, semi-open valleys can be where acoustic reflection phenomena similar to the reverberation phenomenon occur, without however going so far as to produce a diffuse, homogeneous field.

Very few scientific studies have been carried out to date to support and quantify the impact of reverberation in mountainous areas.

Between 2009 and 2010, as part of a research and development project carried out for RFF (Réseau Ferré de France, now SNCF-Réseau), the CETE de Lyon (now Cerema Centre-Est) conducted experiments and modelling in order to clarify the tangible influence of reverberation [7]. The site chosen for this study was located in the city of Montvernier, where the Maurienne valley narrows down significantly and becomes very steep-sided (see Illustration 53).

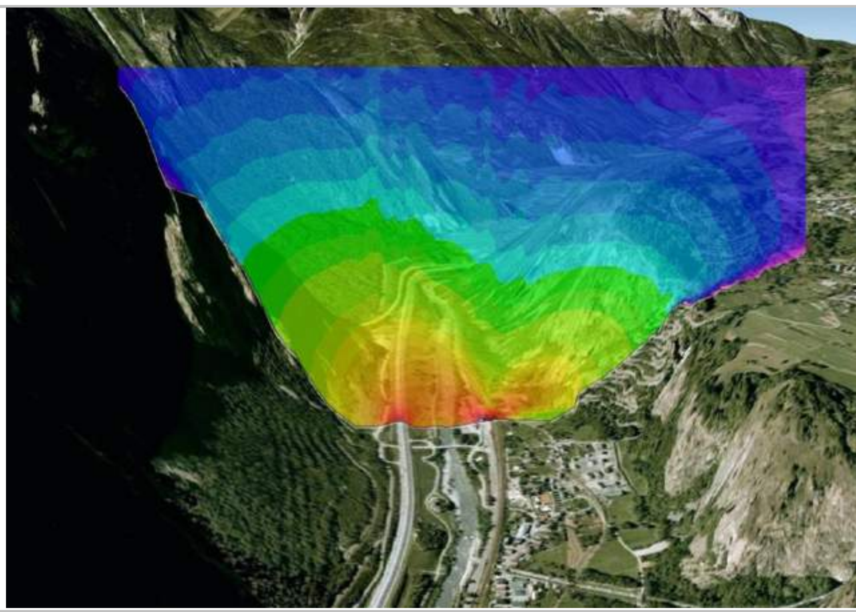


Illustration 53: Modelling of acoustic atmosphere in Montvernier (Savoie), in the heart of the Maurienne valley. The modelling presented here integrates dominant road and rail sources.

Metricsrecorded on the slopes of the Montvernier bends made it possible to isolate the share of acoustic field reverberates by the cliffs. A detailed analysis of these measurementsdisclosed a number of results. It was corroborated by detailed modelling using room acoustics software (Catt-Acoustics) which took into account the phenomena of reflection and diffusion by the walls:

- In narrow valleys with reflective and diffusing walls, the reverberation phenomenon modifies the acoustic atmosphere in certain areas;
- The reverberated field becomes comparable to the quasi-direct field (having undergone only a few reflections: direct, reflection on the ground) when one moves far enough away from the sources, i.e., in this case, on the slopes overhanging the bottom of the valley;
- In the direct vicinity of transport infrastructures, up to a few hundred metres away, the reverberation phenomenon is negligible (direct field predominates);

• The reverberated field consists of sound “rays” that have travelled several hundred metres before reaching receivers. During these “journeys”, acoustic energy has significantly decreased;
• However, as we move away from the sources, the direct field decreases (geometric divergence and sound absorption), and the portion of reverberated field can match the direct field.
• In the case of this valley, considered to be very steep-sided, the contribution of the reverberant field remains negligible in built-up areas on the valley floor (close to infrastructures) and therefore of no consequence on population exposure. However, it affects outdoor spaces.
• The effect of reverberation should be taken into account if sensitive buildings (including homes) werelocated on the slopes in a distant but dominant position with respect to the noise sources considered. This was not the case in the Maurienne Valley.

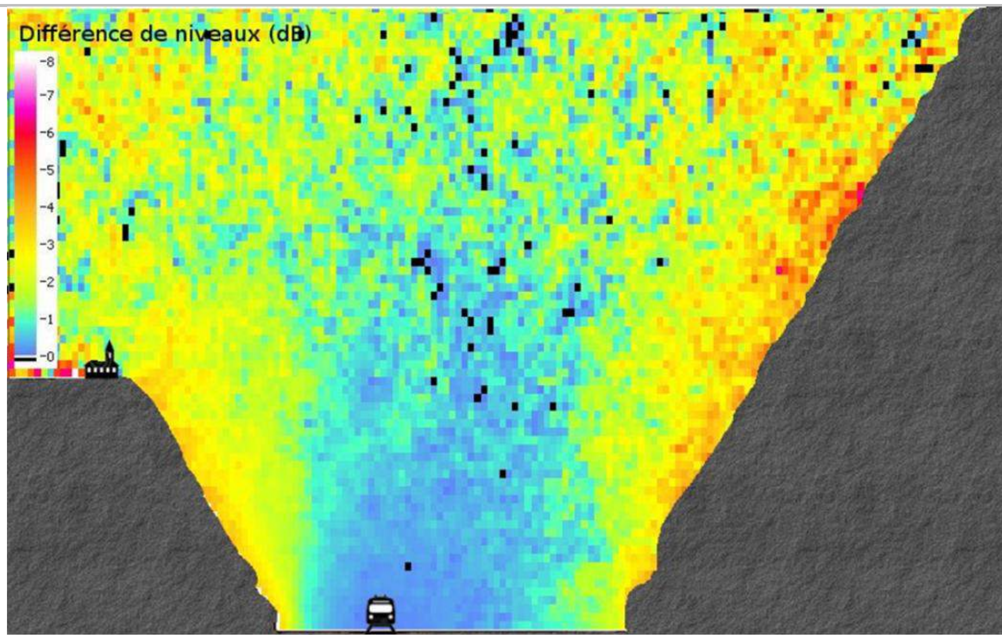


Illustration 54: Highlighting the areas of influence of reverberation in the Maurienne Valley. This influence is more pronounced on the slopes and increases when the distance from the source does.

In a majority of valley situations crossed by major transit routes, built-up areas are located on the valley floor near these routes. Reverberation will therefore only play a secondary role in the population's exposure to noise.

This conclusion does not entail that the phenomenon has no impact in mountain environments; however, the calculation of external costs is based on the quantification of people exposed to levels above 50 dB(A) in their homes.Reverberation will therefore generally have an impact on the unbuilt outdoor environment (natural areas, regional parks, hiking trails, etc.), with the result that noise sources located on the floor of the valley are perceived and background noise levels are increased.This impact is not taken into account by current methods when calculating external costs.

8.4 - The role of meteorology

The propagation of acoustic waves is influenced by the state of the atmosphere and in particular the wind or air temperature fields between the source and the receiver. Apart from the phenomena of reflections on obstacles, in a homogeneous atmosphere, an acoustic wave propagates in a "straight line" between the source and the receiver. In the presence of wind and/or temperature gradients, the variation in propagation parameters (velocity) above the ground will have the effect of bending (refraction phenomenon) acoustic rays upwards or downwards. These phenomena of "acoustic mirages", well documented and integrated into sound level standards and forecasting tools, can lead to differences of several decibels between propagation situations in a homogeneous or heterogeneous atmosphere.

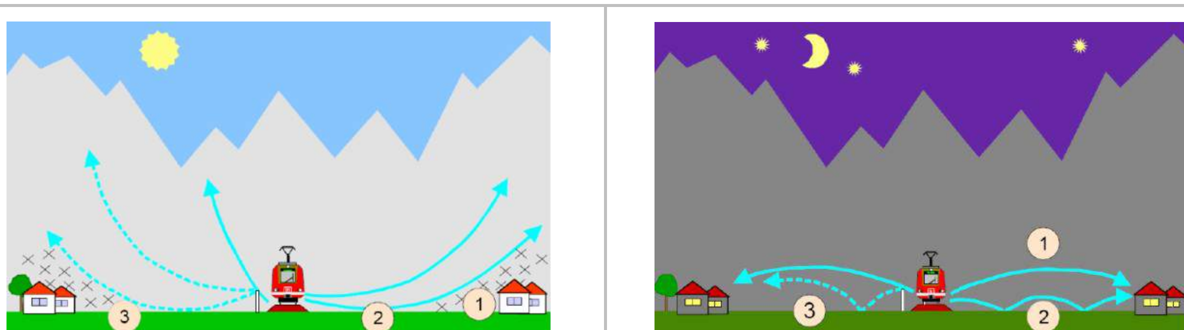


Illustration 55: Influence of meteorology on the trajectory of sound rays: left, upward refraction due to a negative temperature gradient; right, downward refraction due to a positive temperature gradient (temperature inversion) [7]

Weather conditions specific to mountain areas (*foehn*wind effect, corridor winds, temperature inversions) can be conducive to these refraction phenomena of acoustic waves.In the case of upward refraction, the phenomenon generally tends to reduce exposure. On the other hand, downward refraction can result in acoustic waves "down-flowing" onto certain receivers, sometimes even while those are protected by obstacles placed on the propagation path.

The influence of variations in weather conditions is particularly sensitive for receivers located several hundred metres from the source(s), where noise levels are generally already moderate. The consequences on the estimation of external costs therefore remain rather low. The calculation of noise level indicators (LDEN), integrate weather conditions by weighting the periods known as favourable and unfavourable to propagation, thanks to knowledge of the corresponding meteorological occurrences.

9 - Bibliography

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[5] HEATCO, « Developing Harmonised European Approaches for Transport Costing and Project Assessment », FP6‑2002‑SSP‑1/502481, 2006.
[6] Sétra, *Prévision du bruit routier - Tome 1, Calcul des émissions sonores dues au trafic routier*, vol. 1. 2009.
[7] Cete de Lyon, « Etude des impacts acoustiques en Combe de Savoie et vallée de la Maurienne », Réseau Ferré de France, 2010.

10 - Appendix

Appendix A – Reference value in €2010/person exposed /year as a function of the sound exposure level (cost factor) – Sources [4] and [5]

Noise exposure level (dB (A))	Cost in €2010/pers
51	11 €
52	21 €
53	32 €
54	43 €
55	54 €
56	65 €
57	75 €
58	86 €
59	97 €
60	108 €
61	119 €
62	130 €
63	150 €
64	168 €
65	188 €
66	210 €
67	235 €
68	261 €
69	290 €
70	321 €
71	354 €
72	390 €
73	429 €
74	470 €
75	514 €
76	560 €
77	609 €
78	661 €
79	716 €
80	774 €

Appendix B – Modelling maps for the three routes

Acoustic modelling Pont d'Ain to Chamonix

The road noise maps presented below take into account the contributions of all infrastructures carrying more than 5,000 vehicles/day (classified infrastructures). However, the calculation of external costs only includes the acoustic contribution of the motorway.

Noise levels are represented as isophones, per 5 dB(A) classes.Modelling gives the levels on the facades of each building (not visible on the maps). To estimate exposure, the level on the most exposed facade is selected and associated with the population occupying the building.

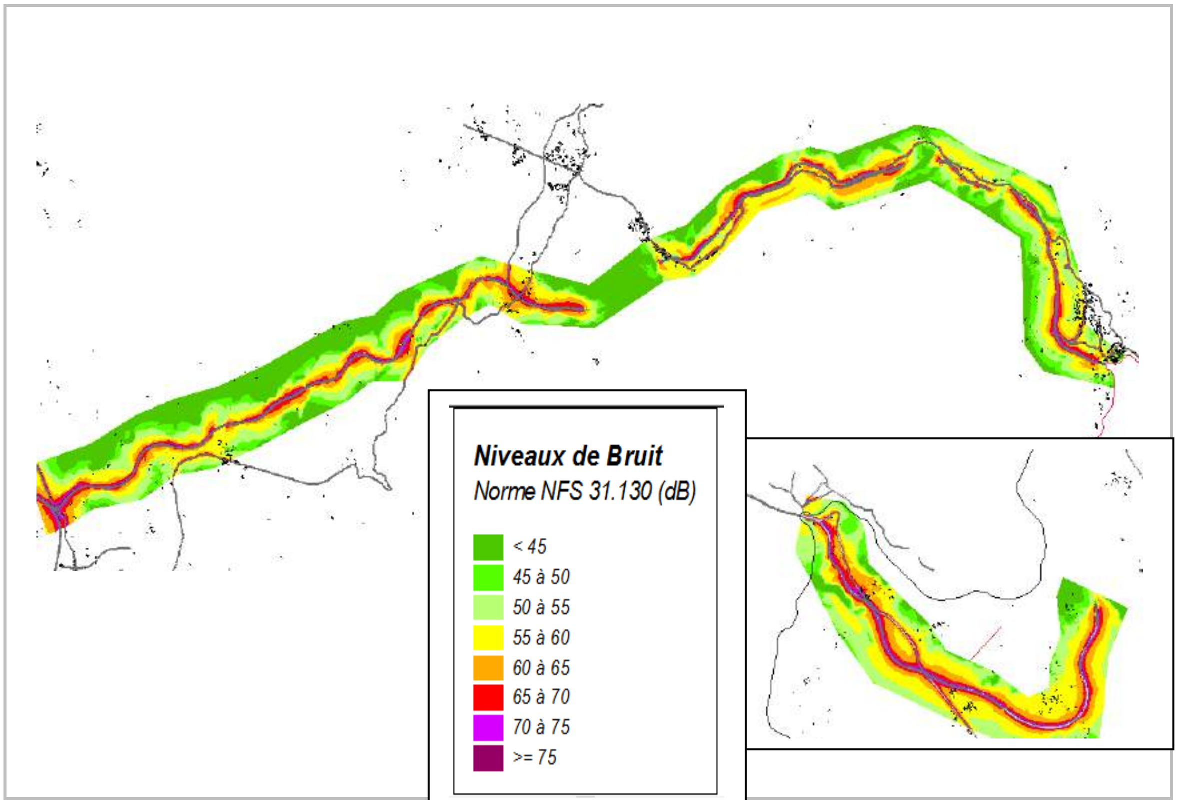

Illustration 56: First sub-section - Pont d'Ain – Vuache Tunnel. Horizontal map of noise levels (LDEN (dB(A)) calculated at 4 meters above ground. For graphic display reasons, the section located after the Vuache Tunne was positioned to the side.l

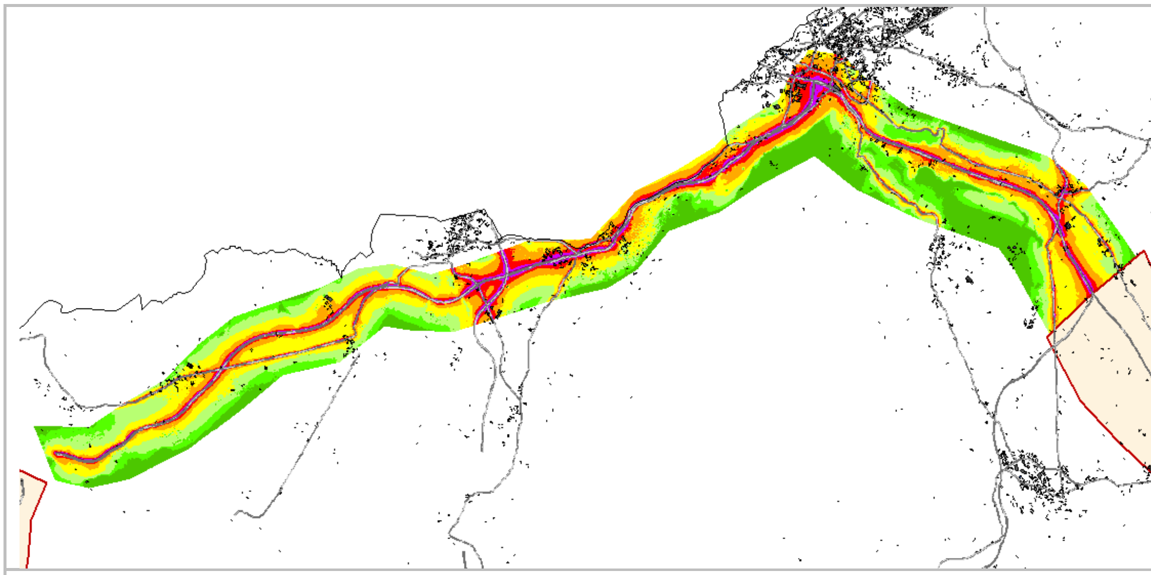

Illustration 57: Second sub-section – Vuache Tunnel – Scientrier. Horizontal mapping of noise levels (LDEN (dB(A)) calculated at 4 meters above ground.

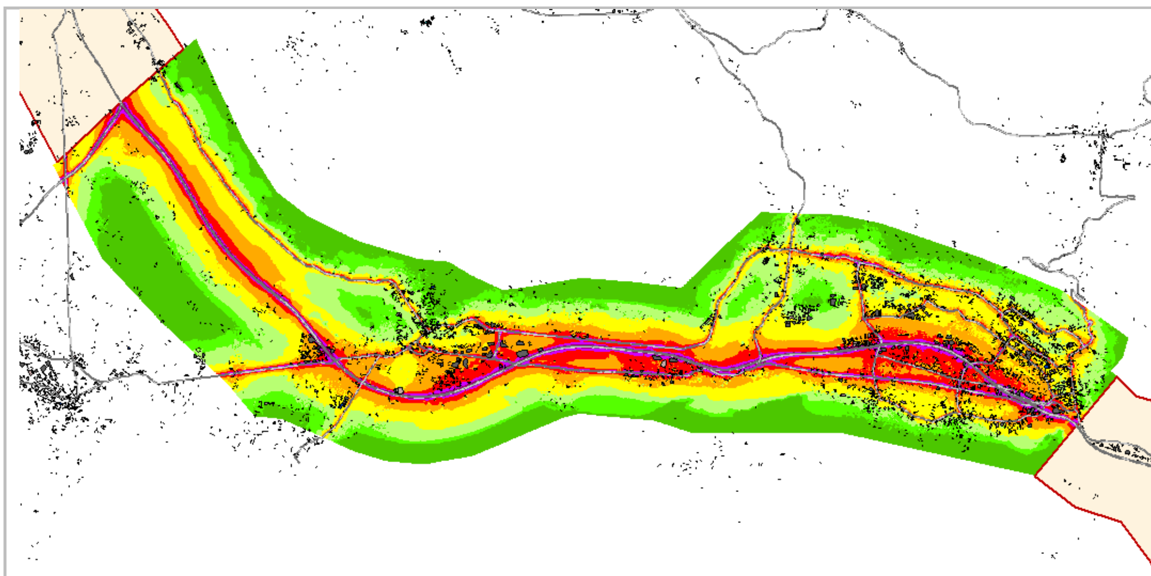

Illustration 58: A40 Scientrier – Cluses. Horizontal mapping of noise levels (LDEN (dB(A)) calculated at 4 meters above ground.

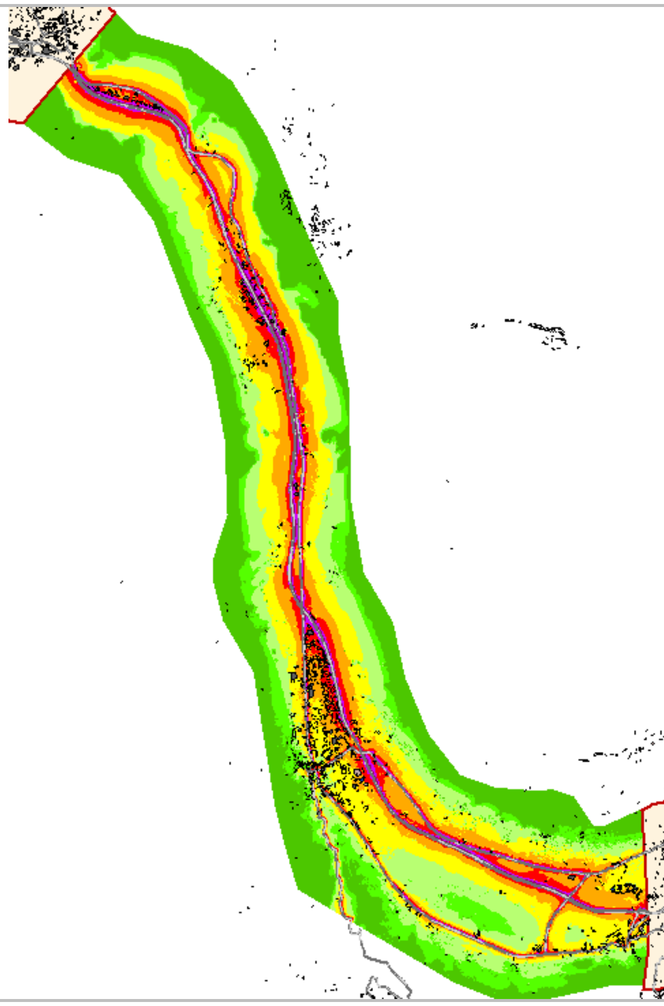

Illustration 59: A40 Cluses – Le Fayet. Horizontal mapping of noise levels (LDEN (dB(A)) calculated at 4 meters above ground.

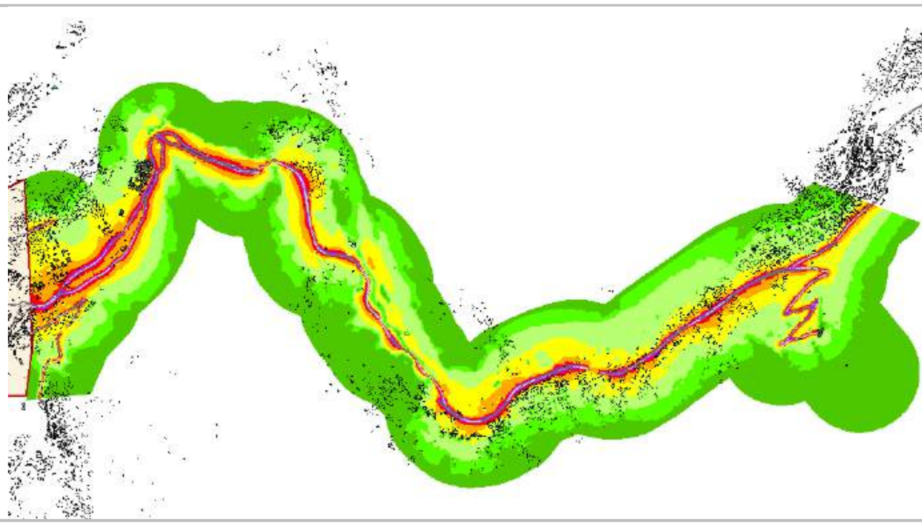

Illustration 60: A40 Le Fayet Chamonix. Horizontal mapping of noise levels (LDEN (dB(A)) calculated at 4 meters above ground.

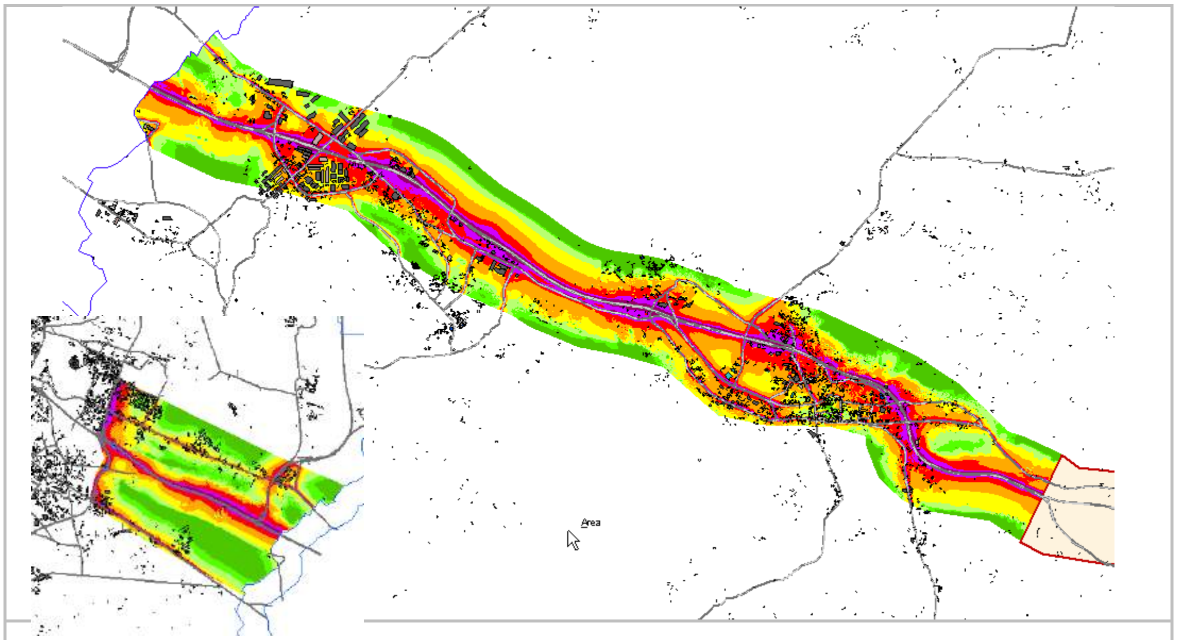

Illustration 61: A43 St Priest – Coiranne. Horizontal mapping of noise levels (LDEN (dB(A)) calculated at 4 meters above ground. For graphic display reasons, the section located at the level of St Priest was positioned below (see box).

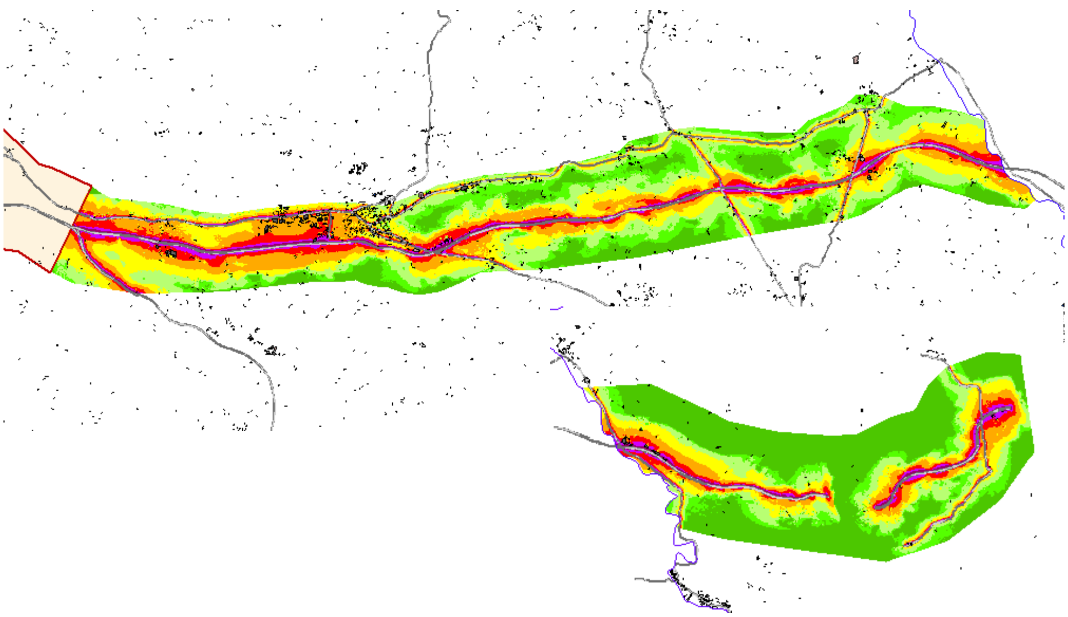

Illustration 62: A43 Coiranne - L'Epine. Horizontal mapping of noise levels (LDEN (dB(A)) calculated at 4 meters above ground. For graphic display reasons, the section located above the L'Epine tunnel was positioned below (see box).

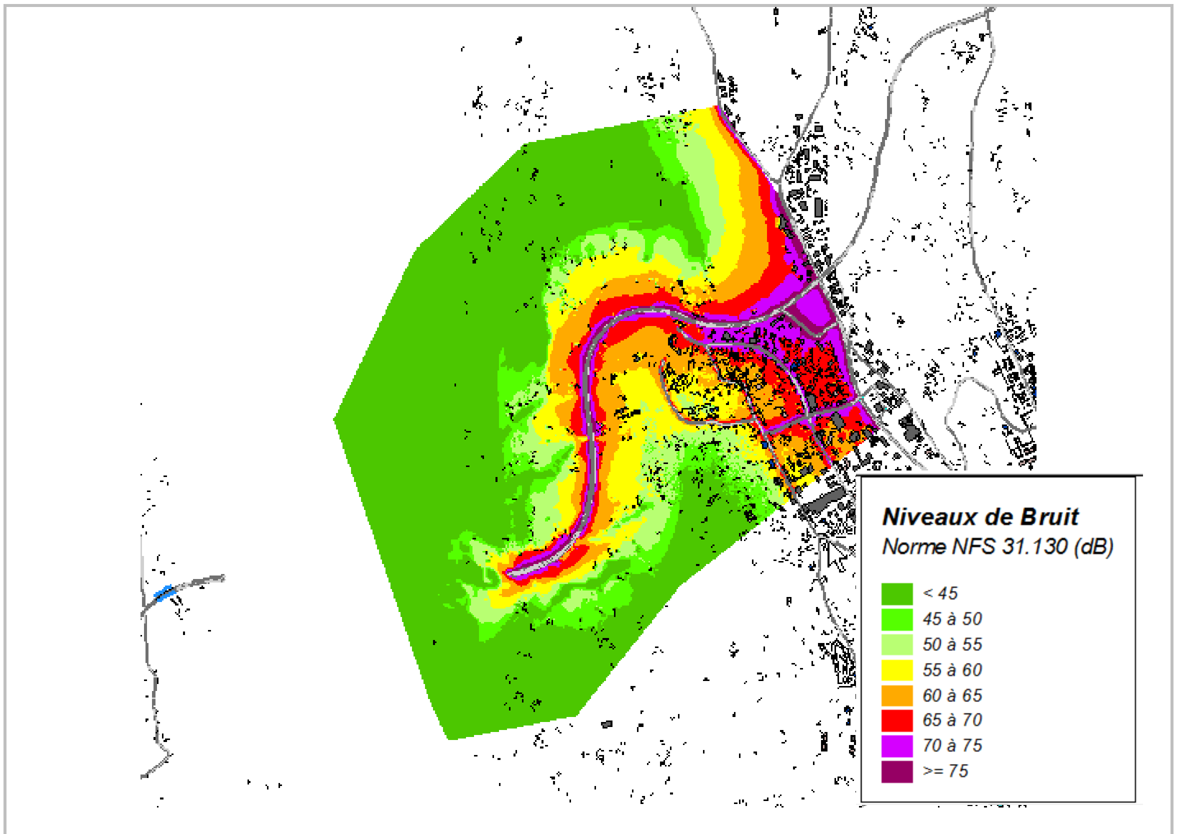

Illustration 63: A43 L'Épine – A41-A43. Horizontal mapping of noise levels (LDEN (dB(A)) calculated at 4 meters above ground.

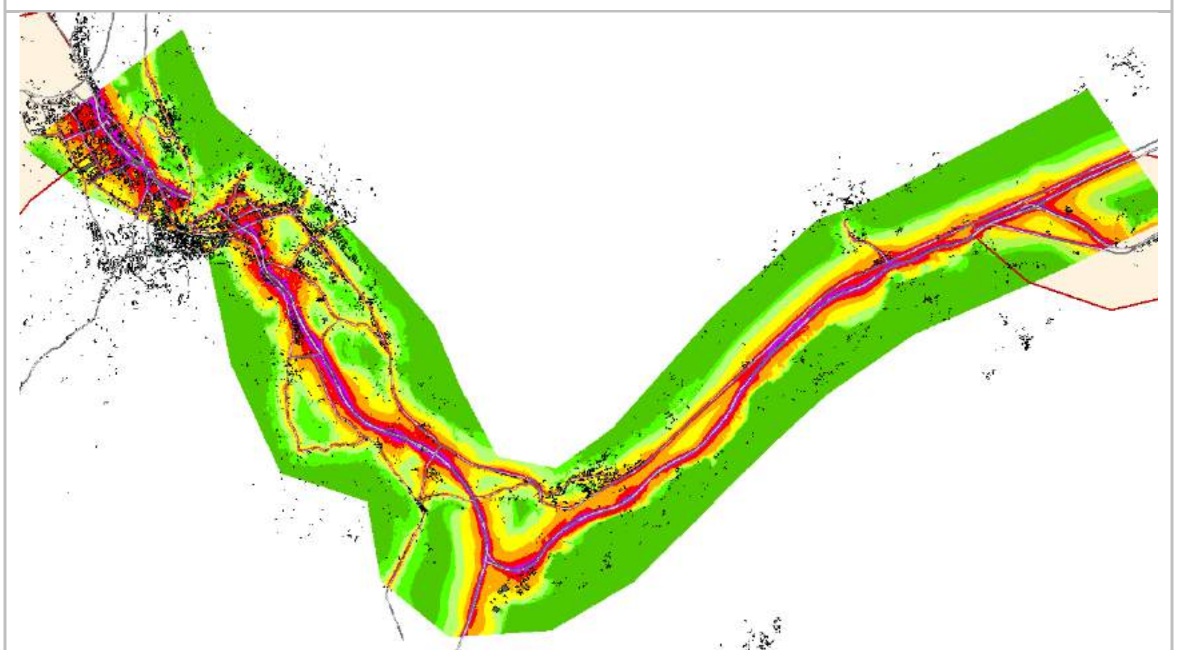

Illustration 64: A43 A41-A43 - Aiton. Horizontal mapping of noise levels (LDEN (dB(A)) calculated at 4 meters above ground.

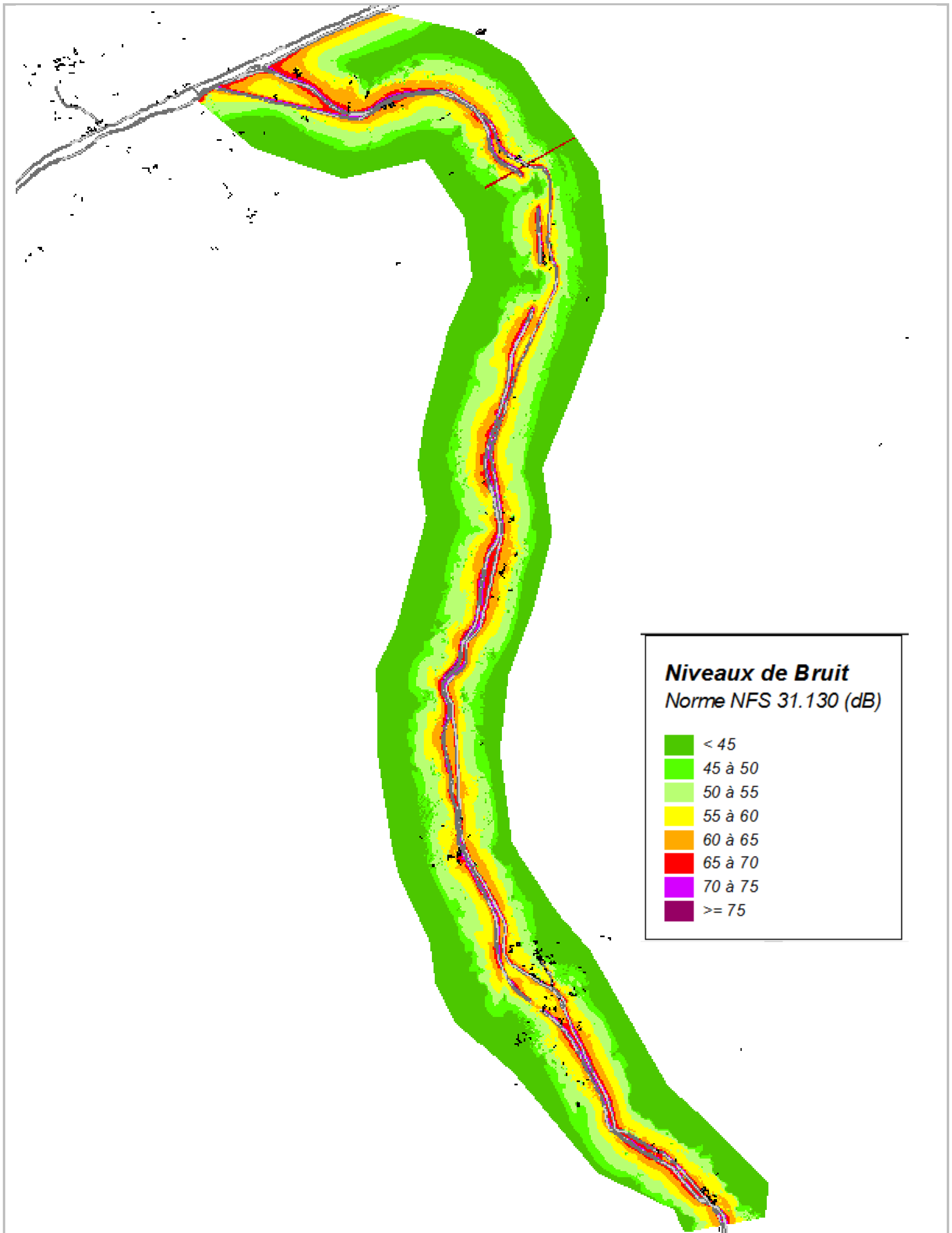

Illustration 65: Aiton – St Jean de Maurienne. Horizontal mapping of noise levels (LDEN (dB(A)) calculated at 4 meters above ground.

Acoustic modelling Chasse-sur-Rhône to Valence Sud

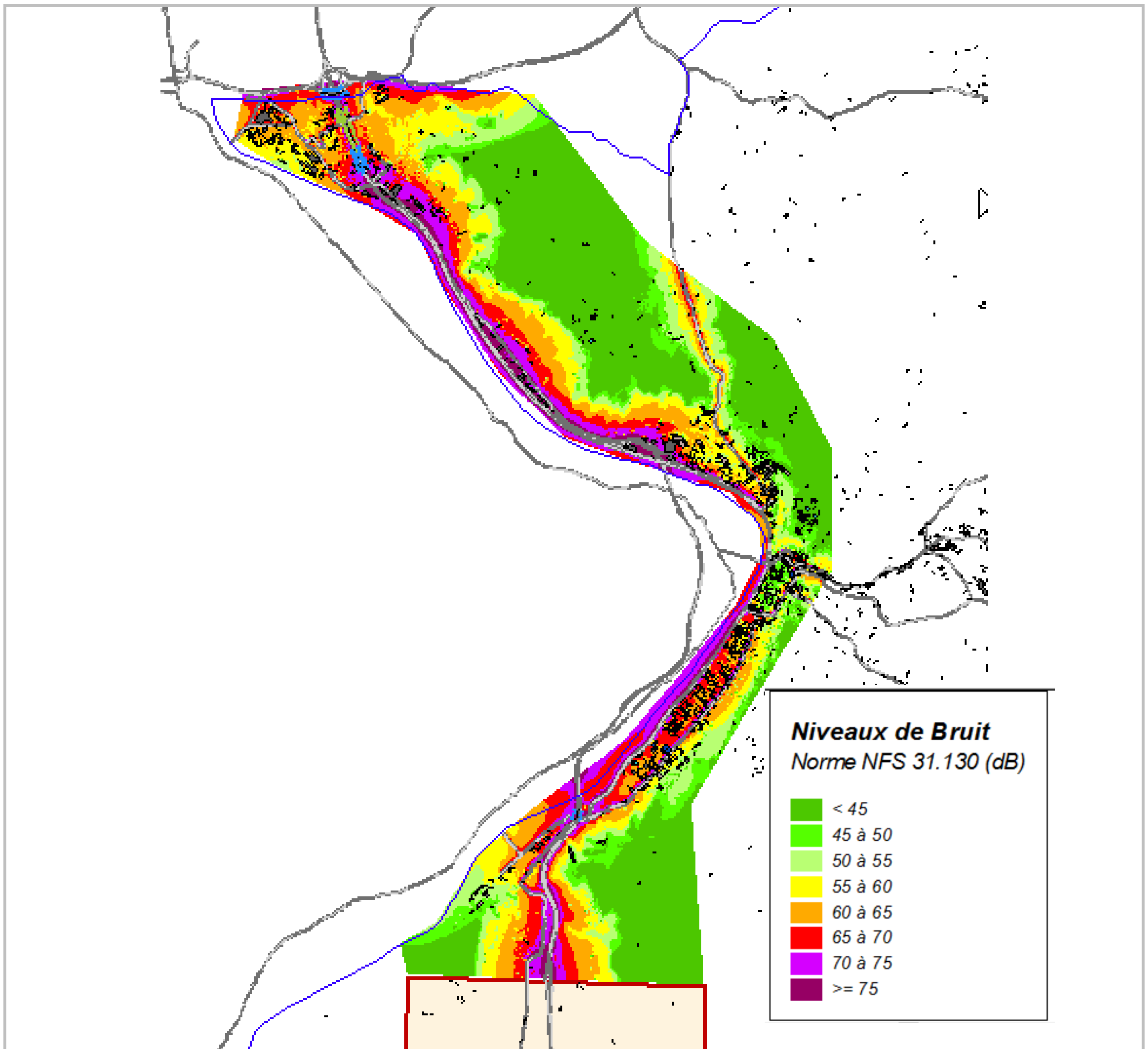

Illustration 66: A7 Chasse – Reventin. Horizontal mapping of noise levels (LDEN (dB(A)) calculated at 4 meters above ground.

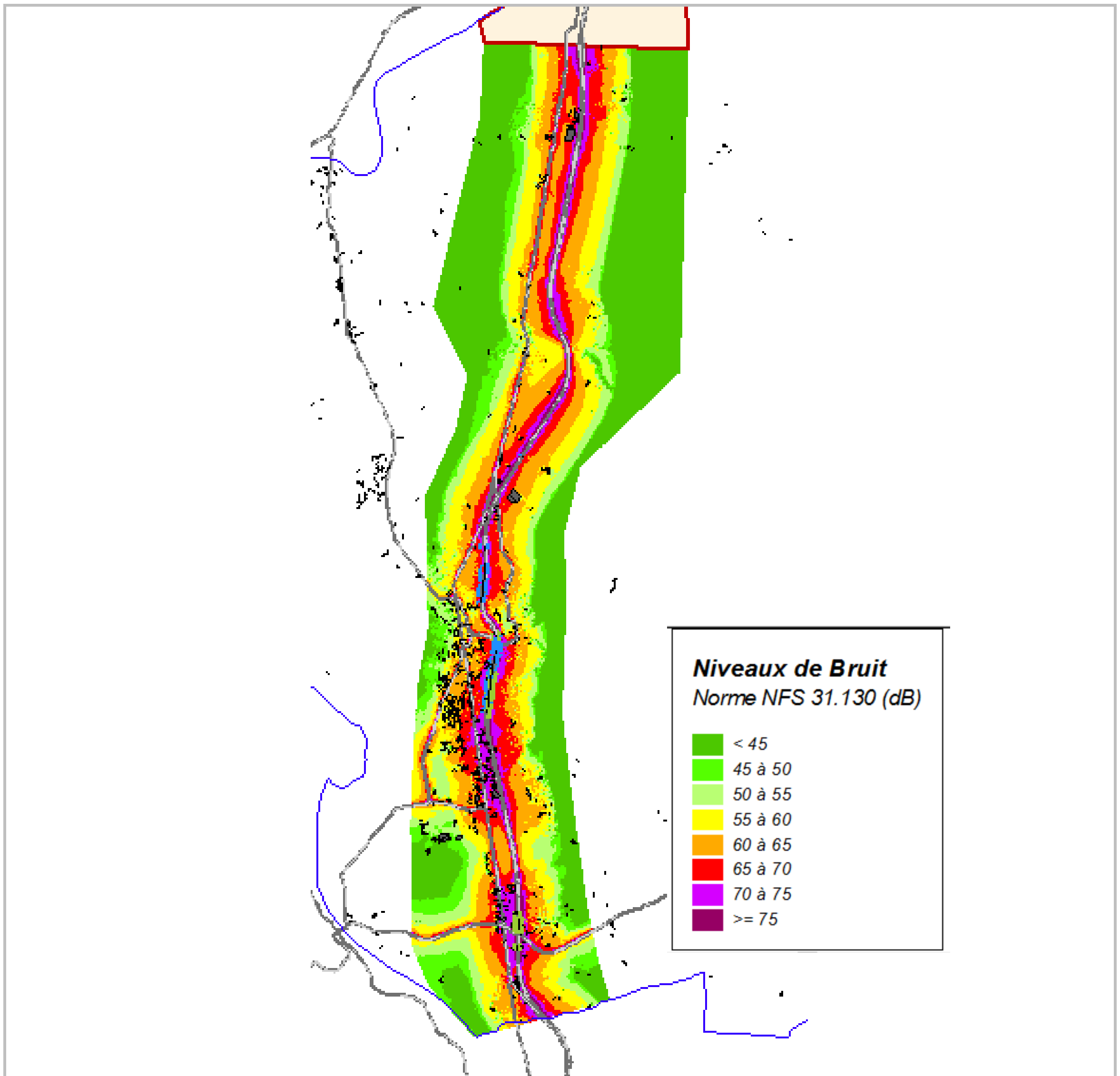

Illustration 67: A7 Reventin – St Rambert d'Albon. Horizontal mapping of noise levels (LDEN (dB(A)) calculated at 4 meters above ground.

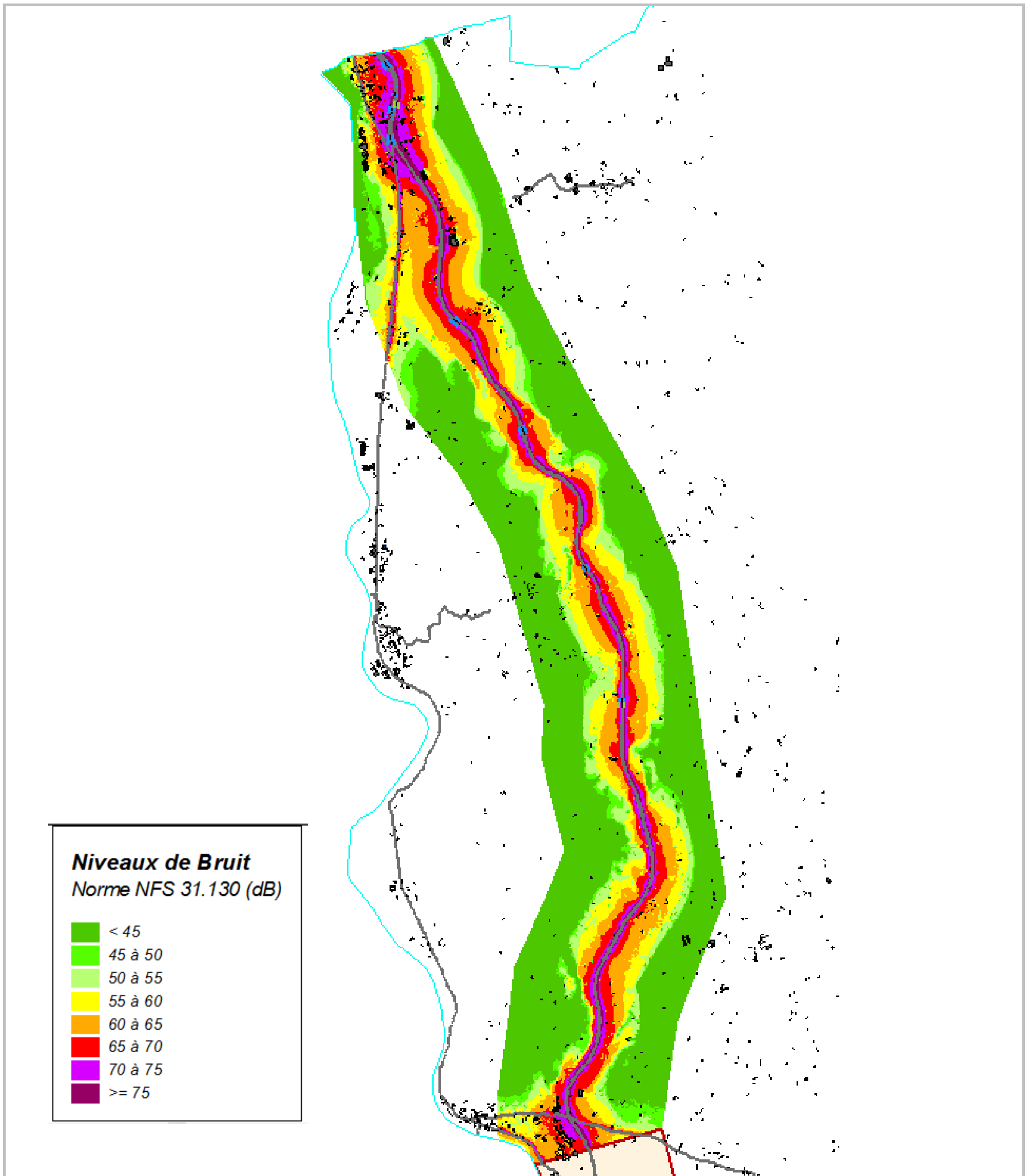

Illustration 68: A7 St Rambert d'Albon – Tain l'Hermitage. Horizontal mapping of noise levels (LDEN (dB(A)) calculated at 4 meters above ground.

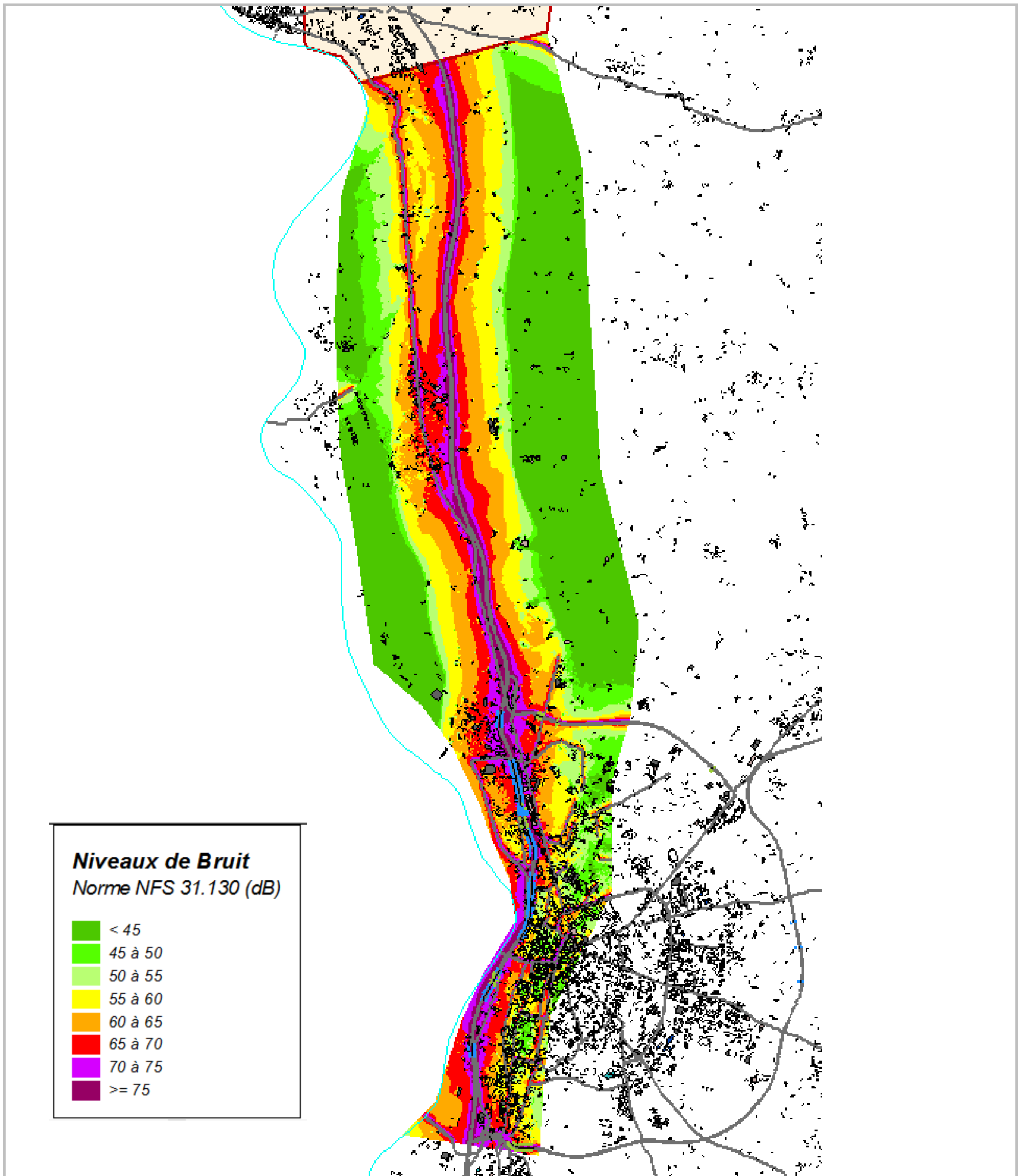

Illustration 69: A7 Tain l'Hermitage – Valence Sud. Horizontal mapping of noise levels (LDEN (dB(A)) calculated at 4 meters above ground.

Appendix C – Additional analysis information per section

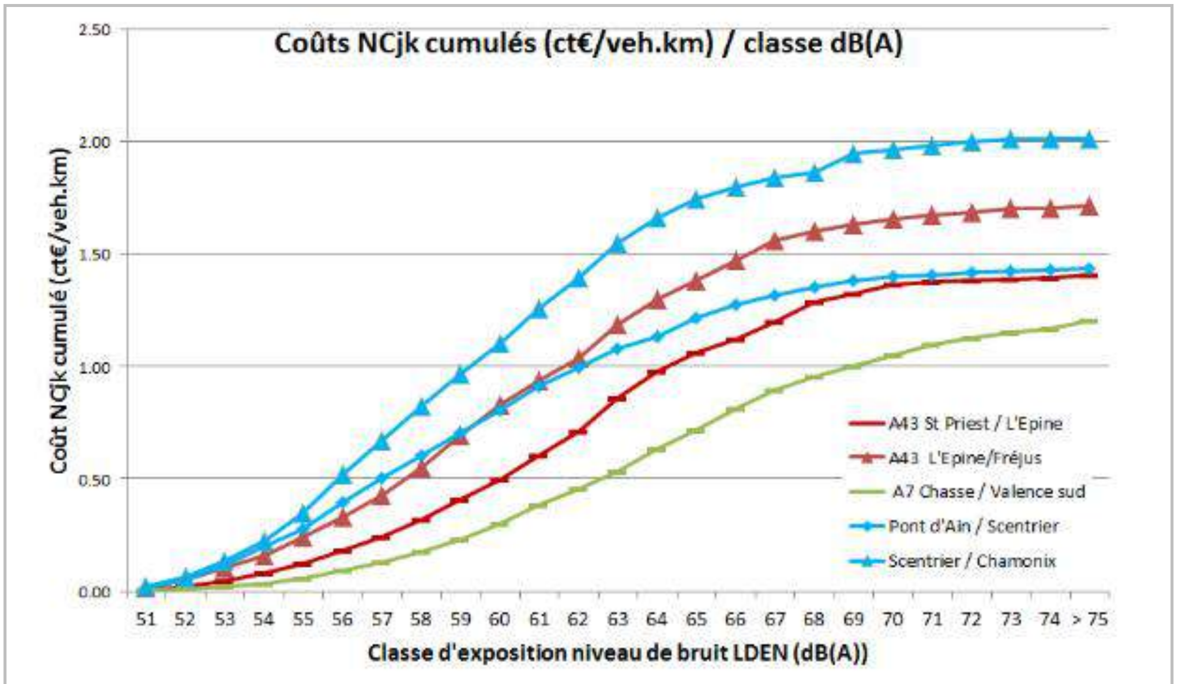

Illustration 70: cumulated NCV by noise level class for the 5 routes analysed.

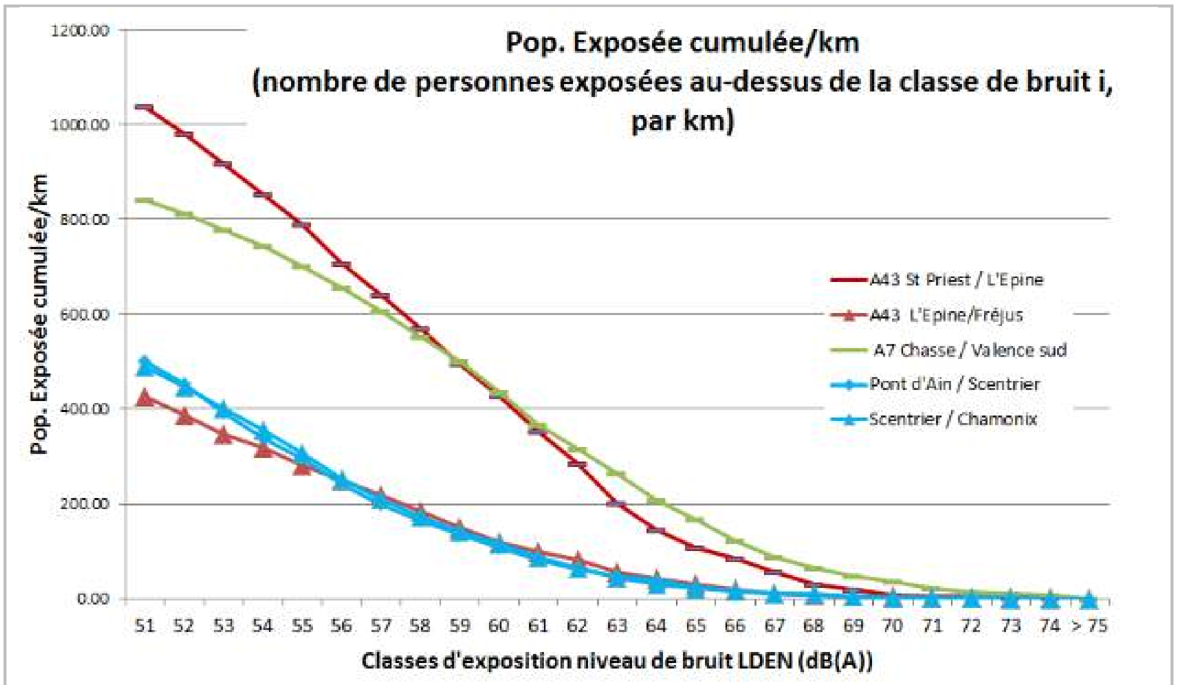

Illustration 71: Population (number of inhabitants) exposed to noise level higher than the one considered for each route.

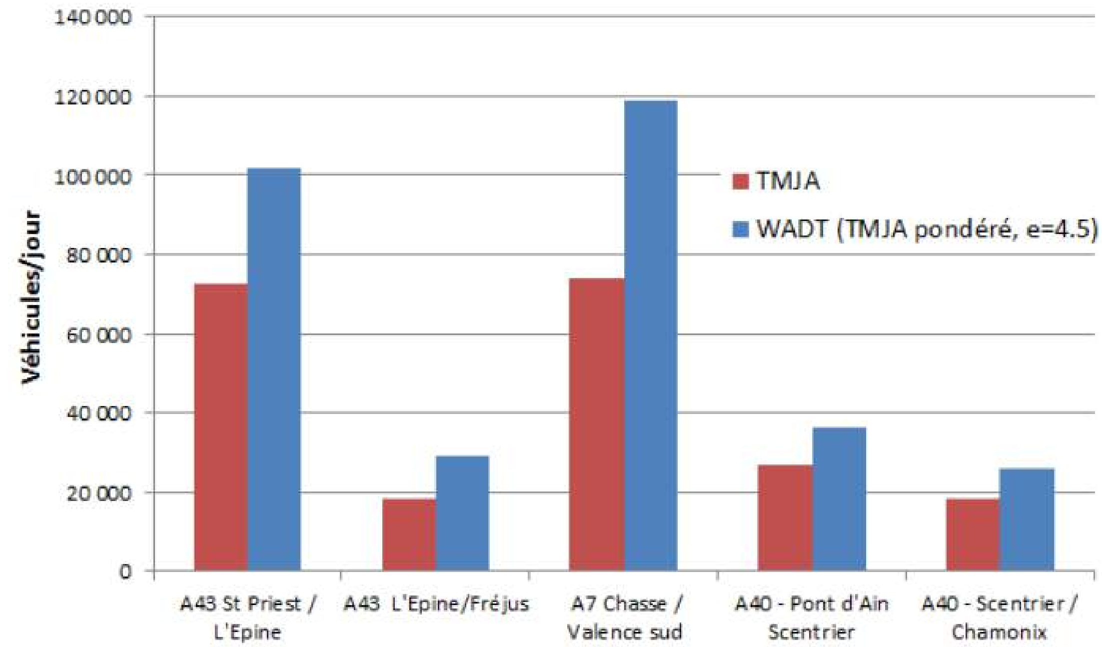

Illustration 72: Summary of AADTs and WADT (with 4.5 equivalent factor) along the routes studied. This graph displays the relative weight of HGV levels for each of the 5 routes.

Deployment of Alternative Fuels Infrastructure Implementing the EU Directive 2014/94/EU on the Alpine territory

An overview from the Working Group Transport of the Alpine Convention

December 2018

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Colophon

The following experts participated in the preparation of the report, under the coordination of the Italian delegation:

- **Austria**: Ernst Lung, Wolfgang Grubert – Federal Ministry for Transport, Innovation and Technology; Christian Rankl – Office of the Vorarlberg State Government;
- **France (Presidency of the WG)**: Jean Pierre Garino, Daniel Chemin, François Lamoise – Ministry of Ecology, Sustainable Development and Energy – France;
- **Germany**: Numerous experts from the German Federal Ministry of Transport and Digital Infrastructure (BMVI); Harry Seybert – Bavarian Ministry of the Interior, for Building and Transport;
- **Italy**: Paolo Angelini – Ministry for the Environment, Land and Sea; Massimo Santori – Advisor of the Italian Ministry of the Environment; Raffaele Vergnani, Federico Cavallaro – Eurac Research;
- **Slovenia**: Zlatko Podgorski – Ministry of Infrastructure and Spatial Planning;
- **Switzerland**: Matthias Rinderknecht – Federal Office of Transport; Ueli Balmer, Franziska Borer Blindenbacher – Federal Office for Spatial Development.

Introduction: the Mandate

During the XIII Alpine Conference held in Torino (21stNovember 2014), the Ministries of the Contracting Parties asked the Working Group Transport (WGT) of the Alpine Convention to carry out a well-defined set of activities aimed at ensuring the movement of intra-Alpine and transalpinetransport by increasing theefficiency of transport systems and promoting environmentally- friendly modes oftransport (objective d).Among them, activities aimed at promoting the modal shift from road to rail have a preeminent – but not exclusive- role. Under the point concerning innovative logistics, a relevant and integrative aspect regards the *"**Analysis of innovative logistics solutions such as rolling highways or solutions for other sustainable long distance alpine crossing, also taking into account the directive on the deployment of alternative fuels infrastructure**"*. The delegated experts of the WGT of the Alpine Convention agreed to start the work in this field, under the coordination of the Italian delegation, by undertaking a general overview in the Alpine countries, and realizing a short introductory report, to be submitted and approved at the XV Alpine Conference at Innsbruck (4th April 2019).

The **aim** of this report is to provide a general overview about the state-of-the-art of the development of alternative fuels in Alpine countries, taking into account implementation reports of EU Member States in this area as well as the latest developments in this field in non-EU Member States.Some selected best practices, projects and initiatives, carried out at European level, have been also highlighted, in order to facilitate an exchange of best practices and ideas, as well as a more coordinated and coherent development. Finally, the report introduces open challenges and next steps for possible further actions to be undertaken at Alpine and national level by decision-makers and private transport operators.

Overview: the European framework

In 2015, **transport** was responsible for 27% of the global energy use and for about 26% of the total European Union (EU) greenhouse gas (GHG) emissions. Compared to 1990, this figure is 23% higher. During this period, international air transport has shown the highest increase in GHG emissions: +105%[1]. Anyway, road transport still generates most of the emissions (ca 73% of total transport emissions). This trend makes road transport responsible for about 20% of all GHG emissions produced in the EU[2]. Moreover, transport is responsible for the emissions of other pollutants that affect directly the human health, such as particulate matters and nitrogen oxides (PM_x and NO_x). In 2018, the EU has formalized an infraction procedure for high concentrations of such pollutants in several critical environmental areas: some of them are located within the Alpine Space. In this framework, the dissemination of more sustainable fuels and renewable energy sources is a crucial factor encouraged by the EU. Nevertheless, transport remains mainly dependent from oil, with oil-derived fuels accounting for 95% of total energy consumption of the field. According to the last data available, the fraction of renewable energy is still low: about 3% of the road transport fuels are biofuels, while electricity (1.3%) plays an even minor role[3].

Alternative mobility solutions improve the availability of fuel supply and at the same time open routes for improving sustainability. **Alternative fuels (AFs)** have prominent advantages for reducing the emissions of GHGs and pollutants. Furthermore, they help alleviating the dependence on fossil fuel consumption in the transport sector. However, the switch from current to AFs requires a fuel infrastructure change, since most of the AFs are not drop-in fuels. It is expected that AFs will play a more prominent role in the next decades in view of the EU objectives of gradually substituting fossil fuels with fuels of renewable origin, growth and jobs, competitiveness, transport decarbonisation and the diversification of the energy sources. However, there is currently a lack of attractiveness of fuel alternatives for users and businesses, and no clear market signals concerning the potential of the different AFs. This is also visible when analyzing the diffusion of AFs. In 2012, alternatively fueled vehicles represented 3.4% of the EU car fleet. In 2015, the share of renewable energy in transport in the EU reached 6.7% and it rose up to7.1% in 2016. These figures are expected to grow in the next years, to achieve the European goal of 10% by 2020. Currently, only Austria, Finland and Sweden have already reached this percentage[4] . On the other hand, the use of AFs in heavy-duty vehicles, maritime and aviation modes is still negligible.

In order to guarantee a further development of AFs, a solid and integrated **policy** framework is required. The most relevant documents produced in last years at the EU level are presented below.

White Paper: Roadmap to a single European transport area - towards a competitive and resource efficient transport system, COM(2011) 144 final

This document, which was published by the European Commission (EC) in March 2011, includes many targets to reduce GHG transport emissions and to develop a resource efficient transport system, e.g. by:

- Halving the use of 'conventionally-fueled' cars in urban transport by 2030, phase them out in cities by 2050; achieve essentially CO_2-free city logistics in urban centers by 2030;
- Shifting 50% of medium distance intercity passenger and freight journeys from road to rail and waterborne transport;

[1] EEA, 2018. Greenhouse gas emissions form transport. Online at: https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-greenhouse-gases/transport-emissions-of-greenhouse-gases-10
[2] EEA, 2017. Monitoring progress of Europe's transport sector towards its environment, health and climate objectives. Online at: https://www.eea.europa.eu/publications/monitoring-progress-of-europe2019s-transport
[3] REN21.Renewables 2018. Online at: http://www.ren21.net/wp-content/uploads/2018/06/17-8652_GSR2018_FullReport_web_-1.pdf
[4] EEA, 2017. Monitoring progress of Europe's transport sector towards its environment, health and climate objectives. Online at: https://www.eea.europa.eu/publications/monitoring-progress-of-europe2019s-transport

- Shifting30% of road freight over 300 km to other modes such as rail or waterborne transport by 2030, and more than 50% by 2050, facilitated by efficient and green freight corridors;
- Establishing the framework for a European multimodal transport information, management and payment system by 2020;
- Moving towards full application of "user pays" and "polluter pays" principles and private sector engagement to eliminate distortions, including harmful subsidies, generate revenues and ensure financing for future transport investments;
- Elaborating a "technology roadmap", including a sustainable AFs strategy and the appropriate infrastructure;
- Setting a regulatory framework for innovative transport;
- Developing a strategy for near-'zero-emission urban logistics' (horizon 2030) under consideration of interdependences with land use planning;
- Establishing multimodal freight corridors for sustainable transport networks and promoting eco-innovation in freight transport.

Comprehensive European Alternative Fuels Strategy, COM (2013)17

This communication of the EC gives an overview about the potential role of AFs. The main conclusions in this document are: "The increasing demand for energy for transport and the need to break transport's dependency on oil can only be met by the comprehensive mix of AFs. The growing interest for natural gas – for maritime and inland-waterways, for long distance road haulage applications, and light duty vehicles - as well as electricity for short distance road transport - indicates that it would be possible, in the short to medium term, to both increase the European supply of energy for transport as well as reduce dependency on imported oil. At the same time, accelerating the development of advanced biofuels – which have potential for all transport modes, but are the only option for aviation - and the progressive build-up of electricity and hydrogen supply networks to provide area wide coverage for road transport are essential for rapid market development. In parallel, research and development of critical components for electric propulsion such as batteries, should deliver significantly improved range, performance, durability and reduced costs for a competitive market offer. This Communication and the accompanying legislative proposal (see directive 2014/94/EU below) catalyze the transformation of Europe's energy supply for transport. With the requirements to establish national policy frameworks for AFs and the build-up of infrastructure with common technical specifications, the EU will complete the policy measures on the development of AFs, from research to market penetration, by ensuring availability of the fuels in the market. No public spending is required for the build-up of AFs infrastructure if the Member States use the wide range of measures available to mobilize private investments cost-efficiently. Union support will be available from TEN-T funds, Cohesion and Structural Funds together with the European Investment Bank lending. A broad basis among industry, policy and civil society should be maintained for the future development of AFs, using the existing European expert groups with participation from industry, civil society, and the Member States. The Commission will continue to support the Member States, review progress and propose any necessary changes and adjustments taking into account technological and market developments."

Fuel / Mode / Range		Road-passenger			Road-freight			Air	Rail	Water		
		short	medium	long	short	medium	long			inland	short-sea	maritime
LPG		■	■	■	■	■	■			■	■	
Natural Gas	LNG	■	■	■	■	■	■		■	■	■	■
	CNG	■	■	■	■	■						
Electricity		■			■				■			
Biofuels (liquid)		■	■	■	■	■	■	■	■	■	■	■
Hydrogen		■	■	■	■	■			■	■		

Table 1: Coverage of transport modes and travel ranges by the main AFs. Source: EU Alternative Fuels Strategy, 2013

Directive 2014/94/EU on the deployment of alternative fuels infrastructure

This Directive (henceforth referred to as "DAFI") was adopted by the European Parliament and the Council on 29th September 2014 following the inter-institutional negotiations. Its objectives are briefly described in the article 1:"This Directive establishes a common framework of measures for the deployment of alternative fuels infrastructure in the Union in order to minimize dependence on oil and to mitigate the environmental impact of transport. This Directive sets out minimum requirements for the building-up of alternative fuels infrastructure, including recharging points for electric vehicles (henceforth, EVs) and refueling points for natural gas (LNG and CNG) and hydrogen, to be implemented by means of Member States' national policy frameworks, as well as common technical specifications for such recharging and refueling points, and user information requirements." Furthermore, the article 3 requires that "each Member State shall adopt a national policy framework (strategy frame) for the development of the market as regards alternative fuels in the transport sector and the deployment of the relevant infrastructure."

In synthesis, the final Directive requires Member States to develop national policy frameworks (NPFs) for the market development of AFs and their infrastructure by November 2016[5], it foresees the use of common technical specifications for recharging and refueling stations and it paves the way for setting up appropriate consumer information on AFs, including a clear and sound methodology to compare prices. Referring to the contents, DAFI "establishes a common framework of measures for the deployment of AFs infrastructure in the EU in order to minimize dependence on oil and to mitigate the environmental impact of transport. This Directive sets out minimum requirements for the building-up of AFs infrastructure, including charging stations for EVs and refueling points for natural gas and hydrogen, to be implemented by means of Member States' national policy frameworks, as well as common technical specifications for such charging and refueling stations, and user information requirements". This Directive shall foster low-emission fuels such as electricity, hydrogen, compressed natural gas (CNG/Bio-CNG) or liquefied natural gas (LNG/Bio-LNG). The required coverage and the timing by which this coverage must be put in place are presented in Table 2.

Action	Coverage	Timings
Electricity in urban/suburban and other densely populated areas	Appropriate number of publically accessible points	By end 2020
CNG in urban/suburban and other densely populated areas	Appropriate number of points	By end 2020
CNG along the TEN-T core network	Appropriate number of points	By end 2025

[5]At the end of 2017, the assessment was carried out by most of the European countries, except for Greece, Malta, Romania and Slovenia (EC, 2017. Detailed Assessment of the National Policy Frameworks. Online at: https://publications.europa.eu/en/publication-detail/-/publication/d80ea8e8-c559-11e7-9b01-01aa75ed71a1)

Electricity at shore-side	Ports of the TEN-T core network	By end 2025
Hydrogen in the Member States who choose to develop it	Appropriate number of points	By end 2025
LNG at maritime ports	Ports of the TEN-T core network	By end 2025
LNG at inland ports	Ports of the TEN-T core network	By end 2030
LNG for heavy-duty vehicles	Appropriate number of points along the TEN-T core network	By end 2025

Table 2: Required coverage and timings of the different AFs

Alternative Fuels Infrastructure Action Plan, COM (2017, 652)

In the course of publishing the second Mobility Package on 8th November 2017, the Commission launched the Alternative Fuels Infrastructure Action Plan, in which it assessed the NPFs that the Member States had to hand in by November 2016 (see previous subsection). From what it had received, the Commission concluded that the planning in the single NPFs is insufficient for the deployment of AFs infrastructures for an interoperable backbone infrastructure on the TEN-T core network and urban nodes. Only eight of the 25 NPFs were considered sufficient. The largest risks were identified with regard to charging infrastructure for EVs, LNG for maritime shipping and road transport as well as for hydrogen. In the communication, the Commission suggests the Member States consolidate their NPFs, integrate stakeholders in the process and foster cross-border cooperation and be more active in the Sustainable Transport Forum. Furthermore, Member States are urged to specify their targets for the deployment of LNG/Bio-LNG infrastructure and to increase efforts with regard to shore side electricity supply for inland and maritime shipping as well as electricity supply to stationary airplanes at airports.

In addition, the Commission increased European funding for AFs infrastructures on the TEN-T core network and urban nodes. The means for 'New technologies and innovation in all transport modes' that are part of the CEF Blending Call were raised from €140 million to €490 million and the deadline for submitting applications was extended until April 2018. In the wake of this increase, European Flagship Projects were launched on four corridors: Atlantic, North Sea Mediterranean, North Sea Baltic and Scandinavian Mediterranean. These were intended to focus on large cross-border projects generating multiplier effects so that they could serve as models for other following projects. Infrastructures for electricity, CNG/LNG and hydrogen were on an equal footing.

European Parliament resolution of 25 October 2018 on deployment of infrastructure for alternative fuels in the EU: time to act! (2018/2023(INI))

On 25thOctober 2018, the European Parliament passed a resolution on the deployment of AFs infrastructure. MEPs demand to globally step up efforts and call on the Commission to bring forward a revision of DAFI, while maintaining the current definition of AFs as listed in Article 2. As part of such a revision, MEPs demand to have the system of NPFs replaced by a more concrete and enforceable framework as the current approach has not yielded satisfactory results, i.e. a comprehensive network of AFs infrastructures across the EU. The paper suggests an annual evaluation of Member States implementation and extends the scope from the TEN-T core network to the TEN-T comprehensive network. Furthermore, the resolution requests that hydrogen infrastructure shall be made mandatory with deployment requirements as for CNG/Bio-CNG, LNG/Bio-LNG and electricity. Lastly, MEPs call on the Commission to provide more of European funding through different instruments at its availability.

The state-of-the-art of the Alpine countries

1) Austria

The Austrian policy framework

In Austria, responsibilities for AFs, energy and infrastructure build-up are spreading across at least three different national-level ministries. There is a variety of relevant transport and energy strategies, as well as key partners at all governance levels.

DAFI build-up driven by companies and supported by public funds is well under way (or in the case of CNG already fulfils DAFI requirements). Hence, the purpose of DAFI implementation in Austria is not to build a policy framework from scratch, but rather to reinvigorate existing initiatives on AFs market development in the transport sector and infrastructure build-up, gaining commitments from national, regional and local policy levels, identifying necessary additional measures as well as placing DAFI implementation into the broader context of decarbonisation.

Austrian-wide on-line consultation on DAFIimplementation and regional workshops

In 2015, AustriaTech on behalf of the Ministry for Transport, Innovation and Technology (BMVIT) implemented a broad participation process on DAFI implementation.The objective of national-level infrastructures and regional workshops as well as the online consultation was three-fold:

- to establish a common understanding that the core of DAFI focuses on decarbonisation with measures in Austria consequently aiming at mitigating the environmental impact of transport – a perspective that goes well beyond the build-up of AFI;
- to state clearly that the Austrian NPF for the development of the market as regards AFs in the transport sector and the deployment of the relevant infrastructure will build on existing national, regional and local strategies;
- to clarify that the NPF will summarize the results of thorough stakeholder consultation as well as planning at different governance levels;
- to establish and confirm a common understanding of necessary policy and administrative measures needed to further clean transport and especially clean vehicles, a process which is on-going at the time of writing.

Embedding DAFI implementation in general transport policy is crucial when decarbonisation of transport is seen as the underlying objective of DAFI. The Transport Ministry considered including the planning procedures of municipalities and regions essential for a successful Austrian implementation. Therefore, the implementation process took care to involve these governance levels many months before the beginning of the actual legislative process.

The Austrian process of DAFI implementation started with an online consultation titled "Clean Power for Transport"[6] conducted by AustriaTech together with the Austrian Association of Cities and Towns from March until May 2015. AustriaTech used an online survey tool, accompanied by a policy brief[7] on the directive, as well as an accompanying document with all questions (in order to allow a consolidated reply per city, region, company, association) and asked regions, cities, associations, companies and citizens to give their views on nine questions, three of which asked to rate measures to support the market development of AFs in transport.

[6] SmartMobility Austriatech. Online at: http://www.smart-mobility.at/energieeffizienter-verkehr-2015/
[7] Bmvit – Austriatech, 2015. Online at: http://www.bmvit.gv.at/verkehr/elektromobilitaet/downloads/policybrief_austriatech.pdf

Information on refueling stations for AFs and loading infrastructure for EVs

In general, in Austria a lot of information about refueling stations for AFs and loading infrastructure for electric mobility is available. On the website of the Austrian Automobile and Touring Club (ÖAMTC), a tool to find all refueling stations for AFs and loading stations is available[8]. The website presents information on ethanol, bio-diesel, CNG, Liquefied Petroleum Gas (LPG), and hydrogen. On this website, in cooperation with e-tankstellen-finder.at, information about loading stations for EVs is provided. Furthermore, a lot of information on loading stations for electro-mobility is provided at several other websites. The main issues are related to the reliability of such information, due to the lack of standardization, as well as the adoption of different definitions (related for example to "public access" of loading stations). Hence, an important step to implement the DAFI is to establish standardized information (see article 3, point 8). In the following sections, more detailed information about each AF is provided.

- <u>CNG and LNG</u>

CNG has already a high availability in Austria with approx. 160refueling stations for public use and in addition company owned fueling stations for their vehicles[9].At national level, there are 3,611vehicles: 2,433 passenger cars, 999 duty vehicles and 171 busses. In addition, 3,584 bivalent cars (gasoline/CNG) circulate in Austria, thereof 807 duty vehicles (data on 31st December 2017)[10]. These figures are significantly higher compared to 2008, when there were 1,414 CNG and LGP vehicles all over Austria. Moreover, the number of stations is particularly high compared to the size of the country and it is well above the European average[11].

LNG is in an early pilot phase. The first LNG refueling station has been opened in late 2017 in Ennshafen, under the management of the RAG Oil Company, which manages also two CNG stations located in Kremsmünster and Gampern. The company plans to enlarge its network of LNG infrastructures, opening in the next future other refueling points along the major transport routes in Tyrol, Upper Austria, Styria and the Vienna area[12].Overall, further 8 LNG fueling stations are planned in the whole Austria.[13]

In a stakeholder-workshop during the DAFI implementation process, the experts agreed that LNG has ecological advantages, but under current conditions the introduction of a dense supply chain seems not be enough economically efficient in Austria. Some energy companies (RAG, Snam, Engie) are investing to build small-scale facilities to minimize costs of supply-chain for LNG and Bio-LNG.Some experts for inland waterway navigation are rather optimistic for LNG supply for ships and elaborated a "Masterplan for LNG on Rhine-Main-Danube Axis"[14].

In Austria, some groups promote the advantages of LNG, e.g. the group energy initiative Austria (http://www.eaustria2020.com). Moreover, contributions from universities were taken into account[15].

- <u>LPG</u>

In Austria, only 212 LPG vehicles were circulating at the end of 2017, while 52 refueling stations are available all over the country in 2018. The biggest share of vehicles is constituted by urban busses in Vienna (191), but the public transport company Wiener Linien started replacing the LPG buses by Euro VI diesel buses. Some years ago, there were some initiatives to convert taxis or light duty vehicles to LPG, but now hybrid an battery electric vehicles (BEVs) have replaced these initiatives. As follow up to this version of the report, reasons for declining of LPG use should be clarified.

[8] ÖAMTC. Online at: http://www.oeamtc.at/portal/tanken+2500++1004854+11027
[9] ERDGAS. Online at: https://www.erdgasautos.at/tanken/tanken-in-oesterreich/
[10] BUNDESANSTALT STATISTIK ÖSTERREICH, Direktion Raumwirtschaft, Kraftfahrzeuge, Gerda Fischer
[11] IEA-AMF. Advanced Motor Fuels. Online at: http://iea-amf.org/content/publications/country_reports/austria
[12] IEA-AMF. Advanced Motor Fuels. Online at: http://iea-amf.org/content/publications/country_reports/austria
[13] ERDGAS: https://www.erdgasautos.at/tanken/kraftstoff-erdgas/
[14] proDANUBE International. Online at: http://www.prodanube.eu/activities?id=49
[15] http://www.tugraz.at/fileadmin/user_upload/Events/Eninnov2014/files/lf/LF_Simmer.pdf.

- Hydrogen

Four hydrogen refueling stations with public access are in service, some others have limited public access[16]. 21 hydrogen driven vehicles are registered in Austria (August 2018). Also for railways hydrogen and fuel cells are an alternative to diesel propulsion. The Zillertalbahn [17] is realizing the implementation of trains driven by hydrogen in fuel cells and the Austrian federal company (ÖBB) is also interested in this technology and joins research programs.

In the road map of A3PS Austrian Association for Advanced Propulsion Systems[18] to fuel cell and hydrogen, it is written that"Fuel cells (FC) have great savings potential for pollutants and CO_2 emissions – implying the usage of renewable generated hydrogen. In addition, local hydrogen production (without importing energy) is possible. A big chance for the introduction of fuel cell vehicles are synergies between the production of fuel cell vehicles and hybrid electric vehicles (e.g. between Toyota's fuel cell vehicle Mirai and Toyota's hybrid electric vehicles).The market introduction of fuel cell vehicles by OEMs (e.g. OMV) started in selected regions in 2014. Austrian companies, research institutions and universities are engaged in the fields of technologies."

Moreover, a Fuel Cell & Hydrogen Cluster Austria was founded to carry out projects on fuel cells and hydrogen. As follow-up of this report, some of the projects developed within this cluster can be presented. An obstacle for a faster dissemination of hydrogen on the market can be the high costs of refueling infrastructure, the Austria fuel supplier OMV calculated for the stakeholder-workshop on hydrogen in the DAFI consultation process an economic benefit after 10 – 15 years. Therefore, public support is necessary.

Action Package to promote electromobility with renewable energy

Based on their successful e-mobility initiatives of the Climate and Energy Fund, the Klimaaktiv mobile program, the former Austrian Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW, now Federal Ministry for Sustainability and Tourism) together with the BMVIT, joined forces and started the package on 1st March 2017. Auto-importers and two-wheeler importers, as well as sports retailers, are partners in funding e-vehicles. The aim is to accelerate the market launch of electro mobility significantly and, in particular, to expand the promotional offerings from the corporate and municipal sector to private individuals. In total,€72 million of funding were available in 2017 and 2018. Additionally, some Austrian Federal States ("Länder") joined in with extra funding.The package focused on funding e-vehicles, such as e-bikes, e-scooters, e-cars and light duty vehicles, as well as busses. Furthermore, charging infrastructures and investments in e-mobility management, e-fleets and e-logistics were funded. Regulatory framework conditions were set, procurement by the public sector was extended to EVs and research and development was encouraged. Established funding institutions of both ministries were used for administering the action package. As a result of the action package, the number of newly registered e-cars (BEVs) has increased significantly passing from about 4,000 in 2015 to 18,000 in August 2018[19]. Together with the Netherlands, Austria is leader in the EU about the share of e-cars among all newly registered cars.

A new Action Package to promote electro-mobility(*mission 2030 E-Mobilitätsoffensive*)has been established for the years 2019 and 2020, with a support of €93 million: €25 million will be provided by the Federal Ministry for Sustainability and Tourism, €40.5 million by the Federal Ministry for Transport, Infrastructure and Technology and €27.5 million by automobile and two-wheel importers, togetherwith sports retailers[20]. Individuals can obtain attractive funding for e-cars and charging infrastructures: up to €3.000 flat-rates per e-car and up to €1.000 per e-scooter. Business, municipalities, administrations are furthermore supported when investing in e-vehicles or infrastructures: €3,000 per e-car, €60,000 per e-bus and up to €500 per e-cargo bike. Charging stations are supported up from €200 to public accessible fast loading stations (more than 43 KW) to €10.000. In addition to

[16] Mein H2.LIVE. Online at: https://h2.live/
[17] Zillertalbahn. Zug – bus – dampf. Online at: www.zillertalbahn.at
[18] A3PS, 2015. Eco-Mobility 2025plus Roadmap. Online at:https://www.a3ps.at/sites/default/files/images/downloadfiles/a3ps_roadmap_eco_mobility_2025plus_0.pdf
[19] Bmvit, 2018. ELEKTROMOBILITÄT IN ÖSTERREICHZAHLEN & DATEN. Online at: https://www.BMVIT.gv.at/verkehr/elektromobilitaet/downloads/oesterreich2018_de_3q.PDF
[20]More information are available at https://www.bmvit.gv.at/verkehr/elektromobilitaet/downloads/emoboffensive.pdf

BEVs, plug-in hybrid electric vehicles (PHEVs) are also funded. Financial support is related to electricity (or hydrogen) based on 100% renewable energy sources.

2) France

Background

The French public policy on transport uses energy transition as a strategic focus, in particular via the framework set out in the Act on Energy Transition for Green Growth (AETGG).Its art. 40 provides a definition of the strategy for the development of clean mobility, attached to the French Multiannual Programme for Energy (PPE - Strategic orientation document applied to Energy).

The strategy for the development of clean mobility includes improving energy efficacy of the vehicular fleet, modal shift, developing collaborative modes of transport, increasing road-haulage loading rates, developing low emission vehicles and deploying the related fueling infrastructure.

Regarding AFs, the State wishes to encourage diversity in the transport energy mix on a short to medium term regardless of mode and, in particular, by promoting electro-mobility, NGV (as a transitional solution allowing for the development of bio-NGV) and bio-NGV. On the longer term, research and development should generate additional solutions such as third generation biofuels and hydrogen-powered mobility.

On 15thDecember 2016, a first draft of the strategy for the development of clean mobility was presented to stakeholders. Its review is part of the MPE consultation process, launched by the end of that year. This first draft presents elements drawn from a situational analysis of the development of AFs. It offers a number of scenarios consistent with the objectives set by the AETGG, on AF demand (provisional at this stage).It recaps on the on-going efforts and suggests new actions. All of these features, discussed in this paper, will serve to draw up the national action framework called for by European Directive 2014/94/EC.

Information on refueling stations for AFs and loading infrastructure for EVs

- LPG

All over the French territory, an amount of ca 1,900 refueling stations of LPG are available[21].

- Hydrogen

19 hydrogen-refueling stations exist in France, 5 of which located in the area of Paris. Eight of them are not public accessible[22].

- Electromobility

On 31stDecember 2014, there were close to 10,000 publicly accessible charging points. The Government has set itself the target of nearly 20,000 additional publicly accessible charging points by the end of 2016.The AETGG provides for at least 7 million charging points to be installed on parking spaces by 2030.

Under the national strategy for the development of electromobility, the French State appraised and approved two projects for the national deployment of charging points for EVs and PHEVs. Working through ADEME, the French Environment and Energy Management Agency, the State financed €50M in projects initiated by local and regional governments, for the construction of charging infrastructure. Under the 'Investment for the Future' programme, the State will also support manufacturers by co-financing projects of national scope.

The Green Paper – a reference guide for local governments and economic players has been updated and its technical section supplemented. It lists recommendations on how to simplify charging point access, streamline their use and form, register each charging point on a national website and generalize interoperability. This new

[21] MyLPG.eu. Online at: https://www.mylpg.eu/stations/france/
[22] TÜV SUD. Online at: https://www.netinform.net/H2/H2Stations/H2Stations.aspx?Continent=EU&StationID=453

technical guide for the design and lay-out of charging point infrastructure for EVs and PHEVs, updated in January 2015, provides recommendations on standards for mains sockets (slow speed, high speed), their design, maintenance, electronic payment and roaming.

- CNG and LNG

In France, the use of LNG as marine fuel has already been enshrined in a National Orientation Scheme, pursuant to the commitments made by the Minister of Ecology, Sustainable Development and Energy.

As for road infrastructure, France offers close to 300 NGV stations, mostly private (245 private stations, 40 multi-stakeholder stations publicly accessible, 2 stations dedicated specifically to public access).The French geography of refueling stations is evolving and a number of projects are being implemented. They target the deployment of LNG (around 15 stations already in operation) and CNG fueling stations, dedicated mostly to road-haulage professionals who see NGV as the most promising alternative to diesel fuel. Marseille VOS is an important dedicated port hub for supply, storage and distribution of LNG for transport.

Scenarios on the demand for AFs

Two contrasting scenarios about the evolution of energy needs in the transport sector are proposed: a lower-end and a higher-end scenario on the trend in energy needs. Both are based on the following criteria:

- Technical and economic uncertainties;
- Requirements for secure procurement, in particular, instant balance between electricity offer and demand;
- Objectives set looking to 2020 and 2030;
- Environmental impacts.

Each of these two scenarios includes a different trend in electric and gas consumption by road-haulage professionals.

Actions for the development of AFs and the deployment of related infrastructures

The draft strategy for the development of clean mobility recaps on on-going actions for the development of AFs. It also presents new proposals.

On-going actions:

- B8 diesel fuel sale authorization and market offer since 1st January 2015 in France;
- Publication of a decree setting the lists of conventional and of advanced bio-fuels as well as the rules applicable to double-counting;
- With a view to future generalization, use of the results from the experimentation in the Rhône-Alpes Region on infrastructure installation to boost the use of gas as fuel;
- Publication of a National Orientation Scheme for the deployment of LNG as marine fuel;
- Publication in 2016 of the development plan for the storage of renewable energies via carbon-free hydrogen;
- Support of pilot operations to install electric mains at port berths for vessels.

New actions (some of which call for prior validation of the strategy):

- Authorization for ED95 fuel which contains 95% of ethanol of agricultural origin, to be used for heavy duty vehicles of captive fleets, starting in January 2016;

- SP95-E10 petrol to be taxed less in order to encourage use of fuel with a high bio-fuel content of agricultural origin;

In 2016, the drafting of the national action framework under the Directive on the deployment of AFs infrastructure to be submitted to the EC before 18 November 2016 (see below) included:

- In the light of the national action framework on AFs, and of the appraisal of previous programs, to define proposals for re-launching a program to support local authorities in their electrical charging network projects;
- To study financing conditions for infrastructures required by carbon-free vehicles;
- To encourage deployment of B10 diesel market fuel providing the corresponding European standard is adopted in 2016.

Link between the strategy for the development of clean mobility and the national action framework required under DAFI

The strategy for the development of clean mobility provides the basis, particularly in terms of demand, that will enable the future action framework for the development of a market for AFs and the deployment of corresponding infrastructure, as set out in DAFI.

This framework was drafted in 2016 with stakeholders and particularly with local and regional governments. It will involve defining territories and priority networks for recharging or refueling infrastructure. The following parameters will be taken into account:

- feedback on existing infrastructure, whether for NGV (i.e. on-going experience in the Rhône-Alpes Region) or for hydrogen as in Germany;
- individual and collective needs in AFs;
- investment costs;
- the types of fuels (electric; LNG; CNG; Biomethane; LPG; hydrogen) for which network connection constraints vary.

3) Germany

The German road transport sector is currently still dominated by oil-based fossil fuels. Biofuels and LPG are established alternatives. In 2017, the share of AFs based on renewable energy sources was 5.2%, remaining constant compared to 2016.[23]

Information on refueling stations for AFs and loading infrastructure for EVs

- Electromobility

So far, EVs are being charged predominantly at home. In mid-2018, 13,500 recharging points were publicly accessible in Germany[24]. The Ordinance on Charging Infrastructure, which entered into force on 17th March 2016, contains minimum requirements regarding the deployment and operation of publicly accessible electric vehicle recharging points plus clear and binding rules governing charging plug standards, thus transposing the provisions of Directive 2014/94/EU. The German Federal Ministry of Transport and Digital Infrastructure (BMVI) has launched a funding guideline on charging infrastructure that seeks to increase the number of

[23] Umwelt Bundesamt - UBA. Online at: https://www.umweltbundesamt.de/themen/klima-energie/erneuerbare-energien/erneuerbare-energien-in-zahlen?sprungmarke=verkehr#verkehr
[24] BDEW- Bundesverband der Energie- und Wasserwirtschaft e.V.

publicly accessible normal charging points to 36,000 and the number of fast charging points to 7,000 until 2020. The volume of this funding guideline amounts to €300 million, of which roughly €70 million had been approved for funding charging infrastructure as of the first two calls that were launched on 15th February 2017 and 14th September 2017, respectively. In addition to the federal program, the Bavarian state government has set up its own state support program in order to promote the development of a Bavarian-wide charging infrastructure.

- CNG and LNG for road transport

As far as CNG is concerned, the existing infrastructure of roughly 880 CNG stations in 2018 already provides coverage that complies with the Directive. Therefore, no further infrastructure build-up had been planned in the NPF. With regard to LNG for road transport, the NPF establishes the goal to cover the TEN-T core network for use of LNG-powered vehicles, i.e. less than ten stations will be needed. The first LNG refueling point for heavy road haulage vehicles have commenced operation at the end of 2016.

In order to support heavy road vehicles powered by AFs, the German parliament approved the removal of tolls applied to AFs trucks (first country in Europe). The planed regulation will enter into force on the first of January 2019. In addition, new public incentives fostering the purchase of LNG trucks are in force (€12,000 for each LNG truck).

Ships are supplied with LNG in seaports and inland ports by means of "truck-to-ship" bunkering. There are currently no LNG terminals in German ports but facilities for refueling with LNG are currently in place in the waterborne transport sector, including at the ports of Mannheim, Brunsbüttel, Bremerhaven, Hamburg and Rostock, although the ships are still bunkered from a truck. An LNG terminal has not yet been installed in Germany. Nonetheless, a funding guideline equipping and/or converting conventionally-fueled maritime ships with LNG propulsions has been launched on 17th August 2017 as part of the Mobility and Fuel Strategy. The latter aimstoprovideinformationandorientationonthecurrentstatus,opportunities and challenges of AF options and innovative drives by funding pilot projects in this sector[25]. In the area of LNG for shipping, the approach consists of increasing demand for the fuel and subsequently scaling up infrastructure deployment.

- Hydrogen

The infrastructure for hydrogen is currently being deployed. In November 2018, 53 refueling points had been completed and were in operation. An initial network of around 100 refueling points will be established in Germany by 2020 regardless of the number of fuel cell electric vehicles (FCEVs) on German roads. The NPF states the target of 400 refueling stations until 2025. However, this number will depend on the uptake of FCEVs.

4) Italy

Background

The Ministry of Transport and Infrastructure (MIT) - in consultation with the Ministry of Economic Development (MISE) - had the formal responsibility of preparing a legislative decree of "transposing" the DAFI, which defines the Italian National Strategic Plan for the development of the AFs infrastructure. The National Plan should provide clear indications about the following actions:

- develop a legislative framework and proposals for updating;
- define the objectives to be pursued about environmental standards the security of supplies;
- identify the most suitable financing solutions to the Italian national context;
- determine the most appropriate approach for the development of hydrogen mobility;

[25] BMVBS (2013), p. 6

- analyze the costs and benefits for the country system;
- be consistent with the guidelines for the development of European TEN-T corridors and with the priorities identified by the Fuel Cells Hydrogen Joint Undertaking (FCH JU).

As envisaged by such Directive, the Plan covers the supply infrastructure, storage, distribution and supply of LNG, CNG, hydrogen and the electricity recharging systems for electric vehicles. The final version of the plan ("Quadro Strategico Nazionale") has been approved through the Legislative Decree Decreto Legislativo 16 dicembre 2016, n° 257. It specifies where, how and when carrying out an adequate number of refueling infrastructures for road (cars, buses and trucks), rail (tram and trains) and water transport (ferries) will be implemented.

Furthermore, the last National Energy Strategy (*strategia energetica nazionale*, SEN) has been approved, giving the priority for LNG mobility for trucks and ships, Bio-methane and electric mobility for buses and vans in towns and metropolitan areas. In accordance, MIT is supporting the purchase of new trucks powered by AFs with significant incentives. Finally, in March 2018, a new inter-ministerial decree boosting the implementation of bio-methane has been approved[26].

Information on refueling stations for AFs and loading infrastructure for electric vehicles

- LNG and CNG

Italy is the country whit the stronger CNG network in Europe, more than 1,000 public facilities.

Referring to the LNG, a Strategic National Plan was approved in 2015, forecasting around 35 LNG refueling stations for trucks within 2020, starting from the current facilities already in operation in 29 locations, above all in the Center-Northern Italy. New LNG hubs are scheduled in the harbors of Livorno and Ravenna. The public gas-company SNAM scheduled to build 8 new small-scale facilities as specialized hub to generate bio-CNG and bio-LNG for road transport. At the alpine level, the bio-LNG refueling station of Gera Lario has been opened in Valtellina; the refueling station of Sadobre along the Brenner corridor has been opened in October 2018 and the refueling station of Bainasco (Turin) has been opened in November 2018. In terms of vehicles, more than 1,000 LNG trucks are registered. This data is influenced by the high growth of this sector in thefirst part of 2018: +105% in terms of new registered LNG trucks compared to the previous year (504 new units in 2018 compared to 280 in 2017).LNG trucks now represent ca 5.4% of the total Italian HGV fleet (compared to 3% in 2017) and are expected to reach 1,000 units by early 2019.[27] To this aim, MISE is implementing a special public fund to boost the startup of the LNG infrastructure network. In last years, the Italian Government supported the purchase of new LNG and CNG trucks with dedicated incentives (€20.000 per each LNG truck – €8.000 per each CNG truck). Incentives are also in force for CNG vans in 3 regions of the Alpine Space (Lombardy, Piedmont and Veneto).

- LPG

The Italian government has traditionally promoted the use of LPG through fiscal incentives, initially to provide an outlet for surplus volumes of LPG from the large domestic refining industry, though Italy has since become an importer of LPG. In this respect, currently there are about 4,600 LPG stations all over Italy.[28] In recent years, environmental concerns have been the main driving force behind LPG policies. The Italian government and local authorities encourage LPG use through a mixture of policies, including favorable fuel taxes, incentives for clean vehicles and traffic regulations. LPG currently enjoys a substantial excise tax advantage. The Italian government also encouraged LPG and other clean fuels through vehicle incentives. Grant schemes for the conversion of an existing vehicle or the purchase of an OEM LPG vehicle have been in place for several years. In May 2014, grants were reintroduced for the purchase of LPG and other AF vehicles on condition their CO_2

[26] Decreto interministeriale 2 marzo 2018 - Promozione dell'uso del biometano nel settore dei trasporti
[27] Federmetano 70. Online at: https://www.federmetano.it/2018/07/11/mezzi-pesanti-alimentati-a-metano-liquido-e-la-mappa-distributori-lng/
[28] MyLPG.eu. Online at: https://www.mylpg.eu/stations/italy/

emissions do not exceed 120 grams per km for businesses and 95 g/km for private motorists. Many LPG vehicles also benefit from a lower annual vehicle road tax, which depends on engine power and CO_2 emissions[29].

- Electromobility

The National Plan for electric vehicles charging infrastructures was signed on 29thJuly 2014. The plan develops the charging network to get to over 130,000 public charging stations by 2020, and has been framed in cooperation with the major sector stakeholders, including manufacturers, grid operators, utilities, fleets, local authorities, and industrial associations. The following incentives were introduced:

- Electric vehicles are exempt from the annual circulation tax (ownership tax) for a period of five years from the date of their first registration. After this five-year period, they benefit from a 75% reduction of the tax rate applied to equivalent petrol vehicles in many regions.
- Non-financial policy measures: free parking, access to restricted areas (such as city centers)
- Financial support at purchase (once-only support): total funds €120 Mio.

As a partial result of this plan, in 2018 about 2,800 normal power and 600 high power charging infrastructures are public available all over the country (2.35% of the entire EU), while other ca 7,000 existing charging points are private.

Fourregions of the Alpine Space (Lombardy, Piedmont, Trentino-Alto Adige and Veneto) support the purchase of Full-Electric and Hybrid vehicles with dedicated incentives. For instance, the Autonomous Province of Bolzano supports both private citizens and companies in purchasing EVs offering facilities up to €4,000. A similar approach has been adopted by the Autonomous Province of Trento in 2017, investing€20 million in facilities for the purchase of e-vehicles in the next 5 years.

- Hydrogen

For the Italian institutional stakeholders, the hydrogen for mobility will be relevant referring to a long-term horizon, above all for urban mobility. In the field of city logistics and passenger LPT, the hydro-CNG technology can show positive development perspectives, in the mid-long term.

The initiative "Mobilità Idrogeno Italia” brings together key stakeholders in the field of mobility in hydrogen and fuel cells within H2IT, the Italian Association of hydrogen and fuel cells. The strategic Committee of such initiative aims to assist the public competent authorities in establishing a national plan for the development of hydrogen refueling infrastructure for transport by 2025. Currently, two refueling stations for hydrogen are active in Italy, in Bolzano and Milan. Further fueling stations for hydrogen vehicles are planned in Trento, Verona and Carpi (along the A22 highway), as well as in Taggia (Liguria) close to the IT-FR border.[30]

5) Slovenia

The Slovenian Ministry of Infrastructure strongly supports the use of electric vehicles. Slovenia is one of the first countries in the EU, which has covered the motorway network with high-speed bottling plant for electric vehicles. Precisely, 26 fast charging stations were set up in 2015 along Slovenian highways by the company SODO, thanks to the project “Central European Green Corridors”.[31]

In the context of network interoperability, it is ensured and enabled hosting system. Fast bottlers have a high standard of technology, which ensures the compatibility with most electric vehicles on the market. On the universal charging stations can be all the batteries of electric cars for mass sale recharged to 80 percent capacity in under half an hour.

[29] WLPGA (2014), Autogas Incentive Policies.
[30] TÜV – SUD. Online at: https://www.netinform.net/H2/H2Stations/H2Stations.aspx?Continent=EU&StationID=453
[31] SODO – Electricity distribution system operator. Online at: https://en.sodo.si/fast-charging-stations/about-cegc-project

In Slovenia, transport consumes about 40% of the energy, while it is almost exclusively on imported petroleum products. With the use of AFs, especially electricity and natural gas, it can be possible to improve safety and reduce the negative effects on the environment and health, as well as to increase the quality of life in urban centers.

Transport development strategy until 2030 and with a view to 2050 in addition to the development goals of transport infrastructure also includes the implementation of the vision of sustainable mobility of the population and the care economy. It provides for the electrification of transport, which is aimed at the greening of transport and the transition to a carbon-free society and to reduce dependence on fossil fuels. The introduction of alternative low-carbon fuels with a focus on electric mobility is a priority in the guidelines for the preparation of long-term development strategy in the field of energy - energy concept Slovenia.

- Electromobility

Regardless of the plans and needs of Slovenia and its capital, the number of electric vehicles (EVs) on the streets and parking lots in Ljubljana will gradually increase. Besides global reduction in GHG emissions, electromobility also brings important local benefits such as the reduction of road noise and air pollution. The Ljubljana municipality administration is aware of both advantages of electromobility and risks of a passive approach to massive introduction of electric vehicles.

Therefore, the City of Ljubljana decided to elaborate and adopt a "Sustainable Electromobility Plan" (SEP) which explains the advantages of electromobility, highlights the links between EVs and the supporting infrastructure, and puts forward strategic starting points and proposals for fast, safe and organized adoption of electromobility in Ljubljana. In addition, several workshops were organized and promotional materials were distributed among the citizens in order to promote electromobility and raise public awareness of its advantages. SEP has been elaborated and discussed at a workshop in July 2012, which has been organized with the goal to collect public responses to SEP and in general to the municipal plans related to electromobility. In May 2013, the Plan has been accepted by the City Council and hereby, electromobility became a part of the strategy for a better quality of life in the city. The measures have also been presented to representatives of other major Slovenian cities in order to encourage them to introduce similar actions in their cities.

SEP provides a framework for sustainable development of electromobility in Ljubljana by introducing strategic electromobility measures and enhancing synergies between them. A single point of contact will provide a direct interface between citizens, businesses and public services, thus accelerating a balanced evolution of electromobility in the city. The dissemination activities will raise public awareness of the advantages of electromobility, stimulate the use of environmentally friendly vehicles and eliminate the barriers currently discouraging citizens to use new technologies in personal transport. The successfully implemented measures will result in an increased share of electric vehicles on the streets of Ljubljana and consequently in reduced negative impacts of transport on the citizens' quality of life. A successful implementation will also contribute, on a local level, to tackle the global climate change.

- LNG

In 2017-18, 4 new LNG refueling stations for trucks were launched between Ljubljana and Maribor. The Ljubljana facility was officially launched with the presence of the European Commissioner for Transport, Violeta Bulc. The LNG infrastructures in Slovenia can be very relevant to support the growing freight traffic East-West, allowing the development of AFs for the transport of goods by road.

- Hydrogen

Among AFs, hydrogen still plays an ancillary role: a refueling station for hydrogen was opened in Lesce, in Upper Carniola, in 2013. However, it was then closed and currently it is not operative. Nevertheless, a new station is now planned to be located in Lower Styria, in the city of Velenje in order to encourage the use of this AF.[32]

6) Switzerland

As a non-EU-Member State, Switzerland is not bound to DAFI, nevertheless as a central Alpine country and in the perspective of fulfilling the CO_2 emission reduction targets, Switzerland is implementing the so-called energy strategy 2050[33] which includes electromobility and alternative fuels/propulsion systems for the mobility sector[34].

The Swiss Confederation is taking a number of different measures to promote electromobility in Switzerland. As electric vehicles do not need conventional fuels, they are not subject to mineral oil taxes and surcharges. In addition, they are exempt from vehicle duty (4% of the value of the vehicle). Since taxes on vehicles in Switzerland are levied by the cantons, subsidies in this area come under cantonal authority. Almost all the cantons offer either a short-term or a permanent reduction in vehicle tax for particularly fuel-efficient, low-emission vehicles. In some cases, these vehicles are granted full exemption from the vehicle tax. Furthermore, electric vehicles benefit from the current CO_2 emission regulations for cars. Support is also available for research, pilot and demonstration projects, model projects and information as well as advisory services.

In May 2015, the Federal Council issued a report on electromobility, which specifies additional measures for improving the conditions for electric-powered vehicles in Switzerland[35]. As part of the first package of measures for the Energy Strategy 2050, the Council is proposing measures to speed up the market penetration of electric cars, such as a further tightening of the CO_2 regulations for cars to reduce emission levels to 95 g CO_2/km by 2020. An increased cooperation among different stakeholders is essential in order to accelerate the market penetration of electric-powered cars. Therefore, a roundtable on promoting e-mobility was organized on 28th May 2018 by Federal Councilor Doris Leuthard. The stakeholders (automotive sector, energy providers, public authorities, trade associations, etc.) agreed to develop a joint e-mobility roadmap and signed the final roadmap jointly on December 18, 2018: the target of electric-powered cars is 15% market share of newly registered cars by 2022[36].

Information on refueling stations for AFs and loading infrastructure for electric vehicles

- Natural gas/biogas/synthetic CO_2-neutral methane

Switzerland has a nationwide network of around 140 natural gas fuel stations. This network will be extended by the industry to meet demand.

- Electromobility

The Federal Council recently introduced improved guidelines for constructing a fast-charging infrastructure for electric-powered cars along Switzerland's motorways. To achieve this, the Federal Roads Office (FEDRO) has brought together the owners of motorway service areas (cantons), concession holders, associations and other stakeholders from the private sector. However, the development of a fast-charging infrastructure is not a task for the public sector. This is why the Swiss Confederation does not intend to remain involved in the implementation

[32] H2tools. Hydrogen tools. Online at: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=2ahUKEwiXjr203bDeAhUJBiwKHXR7DQAQFjAAegQICBAC&url=https%3A%2F%2Fwww.h2tools.org%2Fsites%2Fdefault%2Ffiles%2Fdata%2Fsource%2FInternational%2520Hydrogen%2520Fueling%2520Stations.xlsx&usg=AOvVaw2qHwTw1dkOIX2E1GNe86k4
[33] http://www.bfe.admin.ch/energiestrategie2050/index.html?lang=en
[34] General information: http://www.bfe.admin.ch/energieeffizienz/07032/07033/index.html?lang=en
[35] Admin.ch, 2015. Bericht in Erfüllung der Motion 12.3652 Elektromobilität. Masterplan für eine sinnvolle Entwicklung. Online at: http://www.news.admin.ch/NSBSubscriber/message/attachments/39400.pdf
[36] Admin.ch. Online at: https://www.admin.ch/gov/de/start/dokumentation/medienmitteilungen.msg-id-70904.html

process (not even in the form of a public-private partnership). Fast charging points are now in operation at 24 out of the 59 motorway service stations in Switzerland (15 more are planned)[37].

In addition, from 1st January 2018 on, fast charging points may be installed and operated at roadside rest areas. FEDRO has started an application process for approximately 100 rest areas in five lots. The cost of providing enough power is financed in advance by FEDRO. The operators pay these investments back from their revenue. Together with the fast charging stations at motorway service stations resulting from private initiatives, Switzerland will have one of the densest fast charging networks for national and transit traffic in the near future.

Until the end of 2019, the Swiss Federal Office of Energy (SFOE) is promoting a dialogue with stakeholders (cantons, cities, municipalities, associations, grid operators, vehicle manufacturers, researchers, etc.) in the charging infrastructure sector in order to resolve issues relating to data, regulation, coordination and planning, and to develop new solutions. The aim is to extend the support for coordinating and for planning to a more wide-ranging charging infrastructure beyond the network of motorways. Follow-up projects have already been launched (e.g. a guideline for e-mobility infrastructure in buildings, national data infrastructure to provide open data on charging infrastructure, a guideline for municipalities).

- Hydrogen

The Swiss Confederation is supporting a wide variety of research and development projects, together with pilot and demonstration projects. For example, from 2011 through 2017, the SFOE funded a pilot project involving fuel cell buses and the first hydrogen fuel station in the Swiss city of Brugg[38]. More fuel stations have been built with federal support, including in particular the first public 700 bar facility[39], while others are in planning. As part of this effort, the industrial production of hydrogen, its distribution to a commercial fuel station, and its use in hydrogen fueled cars and trucks have been demonstrated with SFOE support. A private sector initiative has emerged aiming at rolling out a hydrogen supply chain that includes production plants, a nationwide fuel station network, and commercially available vehicles for freight and passenger transport.[40]. In addition, the Swiss Confederation is promoting a dialogue with stakeholders in this area in order to identify the existing obstacles (safety factors, approval processes, market issues, etc.) and to understand how using this technology could best be backed.

[37] Admin.ch. Online at: https://www.astra.admin.ch/astra/de/home/themen/elektromobilitaet/schnellladenetz-nationalstrassen.html
[38] More info available in the "Desk Research Report for environment-related freight transport issues in the Alpine area" implemented in its final draft by the Working Group on 'Environmental Indicators and the Impacts of Traffic Management Systems and other Measures on the Alpine Environment' (EnvALP), April 2018.
[39] Coop. Die erste öffentliche Wasserstofftankstelle der Schweiz. Online at: https://h2energy.ch/wp-content/uploads/2017/06/Factsheet_Tankstelle_D.pdf
[40] Förderverein H2 Mobilität Schweiz. Online at: https://h2mobilitaet.ch/

Best practices

European initiatives

In the recent years, many projects and initiatives of interest have been carried out, financed by the EU through specific funds coming from different transport-related programs, firstly the CEF (Connecting European Facilities) Programme for Transport. Some of them are still ongoing, or just recently started, but they certainly show the growing interest about topics related the diffusion of AFs across EU and the need of a balanced infrastructure among Member States. A non-exhaustive list of most well-known initiatives is listed here.

- GAINN – Gas Innovation Network

The GAINN (GAs INnovation Network) project participates in the European tender for the granting of funds under the CEF[41]. The main objective is to promote the development of LNG as fuel and related infrastructure in the Mediterranean, through the creation of feasibility studies, design and pilot initiatives. The project involves a consortium of port authorities, ship-owners, gas suppliers and infrastructure providers from Italy, France, Malta, Spain, Portugal, Slovenia, Croatia and Cyprus. The coordinator of the project is the Spanish Port Authority of Valencia; In Italy, the initiative is coordinated by the MIT, in collaboration with the Italian Naval Registry (Registro Italiano NAvale, RINA).

- GasHighway project

The project[42] aims to promote the uptake of gaseous vehicle fuels (biomethane and CNG), by creating a network of refueling stations for biomethane and CNG spanning Europe from the north, Finland and Sweden, to the south, Italy (the "GasHighWay"). This objective is reached by involving refueling stations owners, operators of vehicle fleets, existing and potential biogas producers and municipal and regional authorities. The project activities include:

- promoting the implementation and expansion of distribution systems for gaseous vehicle fuels by e.g. mapping the optimal locations for gas refueling stations and supporting the expansion of networks of gas refueling stations;
- promoting the uptake of gas vehicle fleets by offering information and support to operators of potential gas vehicle fleets - providing information and support to potential and existing biogas producers in order to boost the investment projects;
- creating a roadmap for the European GasHighWay, and - raising the awareness on the use of these AFs.

- Hyfive project

HyFIVE is an EU FP7 project including 15 partners who deploy 110 FCEVs from the five global automotive companies who are leading in their commercialization (BMW, Daimler, Honda, Hyundai and Toyota). Refueling stations configured in viable networks are developed in three distinct clusters by deploying six new stations linked with 12 existing stations. The project's scale and the pan-European breadth allow to tackle all of the final technical and social issues which could prevent the commercial roll-out of hydrogen vehicle and refueling infrastructure across Europe. Research tasks ensure that these issues are analyzed and that the learning is available for the hydrogen community across Europe.

- LNG Blue Corridors

LNG Blue Corridors is an international research and demonstration project that intended to improve the knowledge and awareness of LNG for medium and long-distance transport. 12 LNG Blue Corridors unites/mobilizes the critical mass (expertise of industrial partners and research institutes) in LNG transport and infrastructure technology. It also represents the first phase in the staged roll out of LNG refueling stations and a

[41] European Commission. CEF Transport. Online at: https://ec.europa.eu/inea/connecting-europe-facility/cef-transport
[42] European Commission. Intelligent energy Europe. Online at: https://ec.europa.eu/energy/intelligent/projects/en/projects/gashighway

broad market development for heavy-duty vehicles running with LNG. The project's aim is to establish LNG as a real alternative for medium & long distance transport - first as a complementary fuel and later as an adequate substitute for diesel. To accomplish its objective it has defined a roadmap of LNG refueling stations along four corridors covering the Atlantic area, the Mediterranean region and connecting Europe's South with the North and its West and East. In order to implement a sustainable transport network for Europe, the project has set the goal to build approximately 14 new LNG or L-CNG stations, both permanent and mobile, on critical locations along the Blue Corridors whilst building up a fleet of approximately 100 Heavy Duty Vehicles powered by LNG. The project, whose duration is between 2013 and 2017, is carried out by 27 partners from 12 EU Member States.

- Project "Crossing borders"

The Research & Development project Crossing Borders connects the four e-mobility regions Munich, Salzburg, Vienna and Bratislava and builds on development results of the R&D project EMPORA as well as on the transnational project VIBRATe. The EC TEN-T funded project Central European Green Corridors (CEGC) builds on the knowledge generated in Crossing Borders. The aim of the project is to develop and test intelligent, cross border e-mobility systems and services in the project corridor from Bratislava via Vienna to Munich. The focus of the project lies on the deployment of more than 20 high power recharging stations in the project corridor. These stations will be integrated into cross border roaming and CRM systems. This enables customers to use cross border e-mobility services. The project, whose duration is between July 2013 and June 2016, is carried out by 13 project partners from Austria, Germany, Slovakia and France.

- Project "Central European Green Corridors" (CEGC)

The project creates a multi-modal, cross-border network along TEN-T corridors by demonstrating high power recharging points for EVs to enable long distance driving along the TEN-T network in Austria, Slovenia and Slovakia, including the cross border sections to Germany and Croatia.

CEGC is driven by the emerging need for decarbonisation and electrification of EU road transportation and by the related interoperability and synergy opportunities. The project aimed to deploy infrastructure in Central Europe, making driving of EVs a viable alternative to vehicles with internal combustion engines. CEGC focuses on the roll out of the technologies ready for mass market deployment in the short term (high power charging for EVs) and additionally carry out studies examining the preparation required for the roll-out that will be ready in the mid-term (future customers, clean energy for transport, network planning) thereby opening the market for an even larger customer base in the future.

The project wanted to deploy 115 high power charging stations in Austria, Croatia, Germany, Slovakia, and Slovenia to create a recharging network with country-wide coverage in Austria, Slovenia and Slovakia. A limited number of the high power charging stations will provide connections from this network to major cities in Croatia (Zagreb) and Germany (Munich). At each charging station, service for vehicles with AC/Type 2, DC/Combo 2 as well as DC/CHAdeMO interfaces will be provided, thus being compatible with most EVs with high power charging technology on the market. All charging stations will form one interoperable network. The project, whose duration is until 2015, was carried out by VERBUND AG (in the role of coordinator), Bayern Innovativ, BMW, Municipality Zagreb, Government of Slovenia GreenWay, Nissan, OMV, Schrack, Smatrics, Renault, Volkswagen, ZSE.

- EMILIA – Electric Mobility for Innovative Freight Logistics in Austria[43]

The project focused on innovative freight logistics for urban environments, specifically geared towards the significant use of EVs and has the following objectives:

- To optimize vehicle technologies to increase range and lower costs;
- To develop new logistics concepts and planning methods;

[43] Emilia Electric Mobility, 2015. Online at: https://dts.ait.ac.at/projects/select/wp-content/uploads/sites/11/2015/12/elocot_emilia_boschidarganev.pdf

- To demonstrate the technological feasibility and cost effectiveness of the use of EVs in urban logistics;
- To open innovation to actively involve external stakeholders.

Logistic concepts in the project focus on food delivery, parcel delivery services and pharmaceutical logistics, through the development of sustainable logistics for regional produce (Linz), optimization of delivery runs for e-mobility (Linz, Vienna – inner cities), city Hub near a shopping high street (Vienna), E-Commerce / Home-Delivery in inner city (Vienna) and refrigerated logistics(e.g., for pharmaceuticals in Vienna).

- eMPROVE

The flagship project aims at innovative solutions for the industrialization of electrified vehicles, increasing both energy and cost efficiency and is also supported by the Austrian climate and energy fund[44].

- EVA+ (Electric Vehicles Arteries in Italy and Austria)

The project aims to develop e-mobility in the cross-border territory between Italy and Austria focusing in particular on the four Core Network multimodal corridors. Specifically, it aims to encourage long-distance e-mobility travels in both countries, providing fast charging infrastructures along highways and in main strategical centers.[45]The project is expected to introduce ca 180 new fast charging points in Italy and 20 in Austria. These infrastructures will ensure the compatibility with most types of EVs on the market. Moreover, informative systems will be developed to allow customers searching "for the nearest charging station, and learn about the growing network of charging infrastructures"[46].

In addition to the described activities, further projects related to AFs can be found in the Annexes I, II and III of the report *"Desk Research Report for environment-related freight transport issues in the Alpine area"* implemented by the Working Group on "Environmental Indicators and the Impacts of Traffic Management Systems and other Measures on the Alpine Environment" (EnvALP). They refer either to specific fuels or to the technical development of the vehicles.

Other initiatives

- National Plans and Programs

The Klimaaktiv mobil program of the Austrian Federal Ministry of Environment (see also page 12) is targeting the reduction of GHG emissions. It offers funding and consulting programs, awareness-raising initiatives, partnerships as well as training and certification initiatives to the target groups like companies, public authorities and others. The program supports businesses and municipalities in their transition to e-mobility (e.g. e-cars, range extenders, plug-in hybrids, electric commercial vehicles, e-buses and trolley buses) and alternative vehicles powered by biofuel and biomethane. In particular, e-busses for passenger transport (≤ 5 tons gross vehicle weight) and light duty E-vehicles (≤ 3.5 tons gross vehicle weight) receive a funding rate of €20,000 by using electricity from 100% renewable energy sources. The Klimaaktiv mobil program grants additional financially support for e-charging stations, from €200 up to €10,000 in dependency of the technical specification.

In Germany, "The National Hydrogen and Fuel Cell Technology Innovation Program (NIP)" is continuing to provide financial assistance to R&D projects and to the market activation by means of capital grants for the procurement of vehicles with fuel cells and/or the respective hydrogen refueling infrastructure. The Federal Ministry of Transport and Digital Infrastructure has so far provided around €250 million for the period from 2016 to 2019. For instance, funding calls support the procurement of passenger cars, light duty vehicles and busses using fuel cell systems (40% of additional CAPEX compared with conventional vehicles) and of public hydrogen refueling infrastructure (60% of CAPEX). Also funding of R&D is ongoing. As an example, Deutsche

[44] IESTA. Institute for Advanced Energy Systems & Transport Applications. Online at: http://www.iesta.at/IESTA_Projektreferenzliste.pdf
[45] EVA+ Electric Vehicles Arteries in Italy and Austria. Objectives. Online at: https://www.evaplus.eu/objectives
[46] This text cites the report "Desk Research Report for environment-related freight transport issues in the Alpine area" implemented in its final draft by the Working Group on 'Environmental Indicators and the Impacts of Traffic Management Systems and other Measures on the Alpine Environment' (EnvALP), April 2018.

Post will develop the next generation of their Street Scooter delivery vans with fuel cell system. This will increase their range to 500 km and enable them to operate between conurbations.

Trucks and alternative fuels/propulsion systems

- Iveco Stralis Natural Power - LNG

This truck has been designed by the Italian Engineering Techno-Centers finalized to the road freight transport, distribution and logistics, particularly for medium and long distance in its LNG version[47] (*long haul logistics*). The autonomy of vehicles used for medium and long range operations is around 1600 km (100% by LNG), with double cryogenic LNG tank, assuring the same performance than a similar diesel truck, thanks to engines since to 460 horsepower.

The advantages of this type of vehicles are multiple, both from the point of view of environmental sustainability and profitability for customers. Natural gas is an environmental friendly fuel (-95% consumption of PM_{10}; -75% NO_x compared to diesel). Furthermore, the use of these technologies allows a reduction of CO_2 emissions from 10% up to 100% in case of use of bio-methane. Finally, the reduction of noise by an average of 5 decibels compared to the diesel version makes it a more suitable vehicle for night trips.

- Hyundai Motor Co: fuel cell trucks for Switzerland[48]

Hyundai Motor Co. will build 1,000 commercial fuel cell electric trucks to be operated in Switzerland beginning in 2019, to be completed by 2023 operated by Coop Cooperative which is also part of “H2 Mobility Switzerland Association”. Hyundai will work with Swiss hydrogen company H2 Energy to build an infrastructure that will support hydrogen refueling stations across the country.

- Scania: trucks with several alternative drives[49]

Scania has begun a comprehensive launch of a full range of products with AFs and powertrains for Euro 6. Scania developed a hybrid truck for urban distribution combining electric and biodiesel operation. The hybrid solution, developed by Scania itself, allows an 18-ton distribution truck to operate solely on electric power for up to two kilometers.

- Hybrid, electric and natural gas trucks in use by Meyer Logistics[50]

For several years, Meyer Logistic has been using natural gas trucks with low particle and noise emissions for daily operation in Berlin. In 2011, the first hybrid vehicle was going into operation for the customer of the supermarket chain REWE in Cologne. In Berlin two 18-tons trucks with full-electric drive (E-Force-One) are used for the daily operation. The trucks are in use for contribution logistics in inner cities and conurbations.

- Electric truck BMW & Scherm Group

BMW and Scherm Group developed an experimental 40-ton-electric-truck for material transport on public road traffic. The BMW Group is the first automobile manufacturer in the EU who uses a 40-ton-electric-truck.

Refueling stations

- Refueling Station in Piacenza (Italy)

ENI inaugurated in April 2014 in Piacenza its first plant in Italy that delivers LNG for refueling heavy trucks. The refueling station in Piacenza is the first one of a series that ENI will carry out over the next four years, along the main national road networks. ENI actively participates with other partners coming from different countries

[47] 400 hp with the same performance of diesel version.
[48] https://www.trucks.com/2018/09/21/hyundai-fuel-cell-electric-trucks-switzerland/
[49] Scania Deutschland. Online at: http://www.scania.de/about-scania/media/press-releases/2015/q4/nachhaltige_transportloesungen.aspx (downloaded on 14.12.15)
[50] Meyer Logistik. Online at: http://www.meyer-logistik.com/#fuhrpark (downloaded on 14.12.15)

to the European project "LNG Blue Corridors", which has among its objectives the development of refueling stations equipped with fuels producing lower environmental impacts along four major trade routes crossing Europe, from North to South.

- Hydrogen refueling station in Bolzano (Italy)

It is the first refueling station installed in Italy, located in the Bolzano South station along the Modena - Brenner motorway (A22) for the production and distribution of hydrogen from renewable energy, therefore producing clean fuel for busses and cars. The hydrogen production facility is able to replace 525,000 liters of gasoline or 440,000 liters of diesel per year, with an annual reduction of about 1,200,000 kg of CO_2 emissions per year.

Recommendations

The Alpine area is a strategic region that can help ensuring continuity and interoperability of AFs infrastructure among Member States located in the Alps and beyond. However, as this report shows, the Alpine countries seem to follow different strategies and have focused their attention more on a specific range of fuels, rather than implementing a more comprehensive strategy. The deployment of AFs infrastructure is at very different stages in European Member States as well, and the national and/or regional structures vary considerably. This is also a consequence of the fact that the Alpine countries have also different "starting points" and technological/industrial expertise, which certainly play a relevant role in deciding overall transport strategies.

The implementation of the Directive 2014/94/EU is improving the standardization of the national policies finalized to boost the development of the AFs infrastructures and refueling stations, increasing the presence of the AFs vehicles in the road network (above all, LNG for trucks and electric/hybrid and CNG for cars, vans and buses).So far, most of efforts have been addressed to passenger transport, despite a few business-cases exceptions referred to freight transport (e.g., innovation on trucks).

Despite these general considerations, it is clear that alternative energy sources require dedicated investments and infrastructures, as necessary conditions to unleash their potential and prove their advantages over conventional fuels both in terms of consumptions and environmental impacts. More targeted interventions at policy level, as well as more coordinated public and private initiatives are needed. The following lines summarize some recommendations in order to implement the AFs for transport in the Alpine Space, due to their expected positive impact in the reduction of PM_{10},/$PM_{2,5}$ NO_x and CO_2 emissions.

- **To ensure the implementation of harmonized standards for the main alternative fuels, as set out by the Directive 2014/94/EU "Alternative Fuels Infrastructure " (DAFI);**
- **To establish an EU-wide (including CH and FL)minimum coverage of refueling infrastructure for the main AFs which are technologically viable and with market potential to facilitate economies of scale for market introduction, above all CNG facilities and electric charges in urban areas and LNG infrastructures along the TEN-T Network;**
- **To individuate carefully the location of recharging and refueling points to best accommodate the initially small vehicle or vessel numbers and to create maximum impact in early stages of deployment. To this end, coordinated roll-out of vehicles and infrastructure will be necessary;**
- **To differentiate road tolls according to the polluter-pays principle, by granting lower values to alternatively fueled vehicles (e.g. LNG, CNG, Electric and Hydrogen), especially but not only along the transalpine road axes;**
- **To envisage a transit priority to alternatively fueled vehicles along the transalpine road axes where traffic dosing systems or similar measures are in operation;**
- **To encourage investors and operators of refueling stations to offer AFs (Bio-CNG and Bio-LNG included, synthetic fuels), apart from fossil based petrol and diesel, on the basis of an analysis of market-demand and/or the technical (including safety) and financial implications involved;**
- **To organize promotional campaigns to encourage citizens and operators to switch to more eco-friendly vehicles;**
- **To promote actions to improve the public perception of safety of AFs as fuels for transport and ensure that differences are explained properly;**
- **To ensure appropriate access to information by the consumer on the location of refueling possibilities for different fuels.**

alpenkonvention · convention alpine
convenzione delle alpi · alpska konvencija

Bundesministerium
Verkehr, Innovation
und Technologie

Innovation in Rail Freight

an important contribution to more competitiveness of rail transport

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Karl Zöchmeister

Content:

1. Introduction: Acting now is necessary to preserve competitiveness of rail freight

In the German Masterplan for Rail Freight Transport (Masterplan Schienengüterverkehr) [1] economic problems for rail freight operators are described. While the average price for diesel has decreased in the last years in Germany, the price for traction electric energy for trains increased. Also the fees for using the rail infrastructure climbed up in Germany.

A further problem for rail freight is, that road transport will be more efficient, based on a degree of automatization, which can be expected based on a fast technological development already in few years Therefore competitiveness of rail is be confronted with a big challenge.

On the other hand, rail freight is clean transport, e.g. in Austria from the electric traction-energy for trains comes to 90,2 % from hydro-power and 2,3 % from other renewable sources, only 7,5 % are produced with natural gas. [2] The average CO_2 emission of all trucks in Austria is 71,1 g / ton-kilometer but only 5,3 g /ton-kilometer for freight trains. [3]

Truck platooning to increase efficiency of road transport

6 European truck producers (Daimler, MAN, Scania, Volvo, DAF and Iveco) work intensively on the development of technologies for truck platooning. In the actual phase the lead truck and the trailing truck still have a driver, in the next phase the drivers of trailing trucks can rest and do administrative works. The next phase will be driverless trailing trucks and finally autonomous convoys.

Figure 1:
The European Automobile Manufacturers Association (ACEA) road-map for truck platooning

Source: https://www.acea.be/uploads/publications/Platooning_roadmap.pdf

It is expected that after 2025 it will already be possible that drivers from the trailing cars can rest and the next step will be full autonomous trucks.

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[1] Masterplan Schienengüterverkehr (Masterplan for Rail Freight Transport) published by the German Federal Ministry for Transport and Digital Infrastructure (BMVI) in June 2017, elaborated together by BMVI, Allianz pro Schiene, BDI, DB AG, DSLV, DVF, kombiverkehr, NEE, SGKV, Wirtschaftsvereinigung Stahl, VDB, VDV and VPI and representatives of science

[2] Source: https://blog.oebb.at/gruener-strom-fuer-die-bahn/

[3] Source : http://www.umweltbundesamt.at/fileadmin/site/umweltthemen/verkehr/1_verkehrsmittel/EKZ_Pkm_Tkm_Verkehrsmittel_01.pdf

Truck platooning means the following advantages[4]:

- It lowers fuel consumption and CO2 emissions. Trucks can drive closer together (on motorways in a distance of only 15 meters instead of 50 meters with individual drivers) , therefore the air-drag friction is reduced significantly.
- Platooning can reduce CO2 emissions by up to 16% from the trailing vehicles and by up to 8% from the lead vehicle (according to the ITS4CV study by Ertico).
- Truck platooning helps to improve safety. Braking is automatic and immediate; the trucks following the lead vehicle only need one-fifth of the time a human would need to react.
- Platooning optimizes transport by using roads more effectively (less space demand).
- The driving range of trucks can also be extended in certain situations. Up from phase 3 it allows drivers to undertake other tasks, such as administrative work or making calls.

The electricity concern Siemens and the truck producer Scania work together to develop electric powered trucks, which get their propulsion energy from wires like trolley busses, see https://www.siemens.com/press/en/feature/2015/mobility/2015-06-ehighway.php

Photo 1: Trolley trucks (Siemens –Scania project)

Source: https://www.siemens.com/press/en/presspicture/?press=/en/presspicture/2014/infrastructure-cities/mobility-logistics/soicmol201428/soicmol201428-10.htm&content[]=ICMOL&content[]=MO

Already this short overview on the development of truck technology shows that also further innovations in rail freight transport are necessary to stay competitive.

Moreover, in the Alps high investments of public finances were made and are still under way or planned to improve the rail infrastructure, especially for base tunnels (Mt. Cenis, Lötschberg, Gotthard, Brenner, Semmering, Koralm..). The capacities of the new and upgraded railway lines should be used efficiently.

[4] Source : http://www.acea.be/uploads/publications/Platooning_roadmap.pdf

2. Benefits of digitization in rail freight

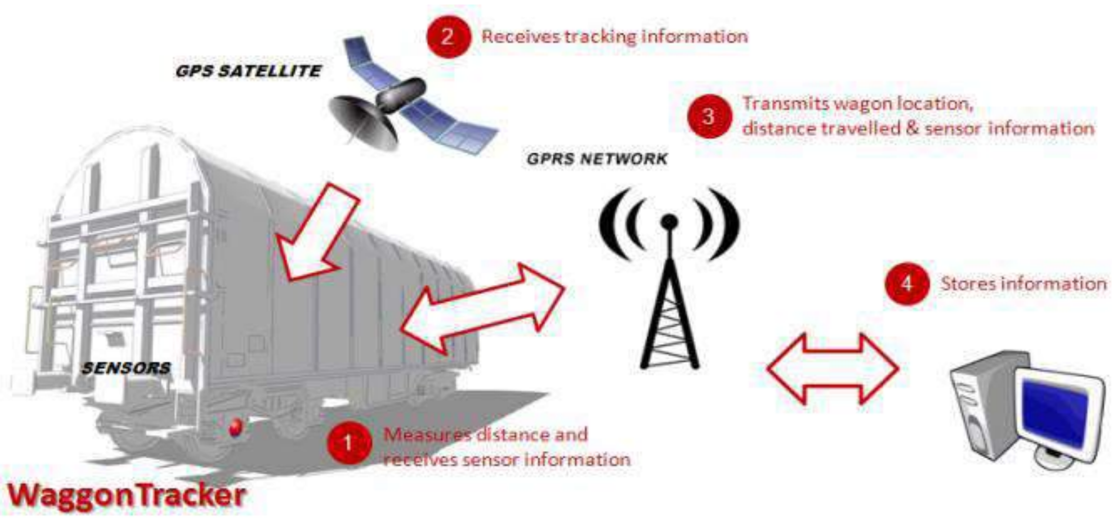
As in almost all branches, also in rail freight digitization is a main field of innovation and contributes to make rail transport more efficient, safe and environmentally sustainable. But for the improvement of competitiveness of rail freight more fields of technological innovation are relevant, like innovative freight wagons, propulsion systems independent from electricity wires, especially for the “last mile”, low-noise brakes for less loud trains. Driverless trains are already reality in metro systems and many tests are under way for other rails. Finally innovations in transshipment for combined transport increase the efficiency for freight transport on rail [5]

2.1 Digital equipment for the rolling stock

IT- applications can improve efficiency, safety and security of rail freight:

- Location of freight (-wagons) by GPS , periodic messages to sender and the addressees of freight-shipments
- Measurement of temperature and humidity and alarm-message if not suitable,
- Controlling of loading (distribution of weight on axis) and alarm signal if not suitable
- Alarm in case of tried theft of loading units
- Technical control of wagons (e.g. running hot brakes)
- The wagons should have an independent electricity supply for these IT- applications. In the shown case of the Wagon Tracker the independent energy supply is provided by a generator which is integrated in the bearing cap of the bogie.

Figure 2: Example of digital equipment of freight wagon



Source: www.waggontracker.com , (Company JPM; Graz)

[5] See e.g.: Synthesis document - Analysis of innovative logistics solutions such as rolling highways or solutions for other sustainable modes of long-distance Alpine crossing transport, elaborated by the German colleagues in the working group transport of the Alpine Convention

With the digitization, status data of locomotives and freight wagons are collected during operating time of the vehicles and evaluated in real time. It is possible to locate the vehicles precisely and to recognize technical weaknesses at an early stage, the reliability and safety in the railway operation can be improved. Some complex manual processes of technical control can be replaced of facilitated by digital solutions and cost savings are achieved.

Very helpful is equipment for automatic brake tests. It saves time due to computer-based technology (e.g. RFID-chips). Therefore, the distances which a shunter has to walk will be reduced resulting in a shorter shunting process. Wagons are available more quickly. A permanent control of the brake function is possible even the train is moving. This simplifies also service and maintenance can avoid accidents. On each freight vehicle of the train, an on-board unit needs to be mounted. Sensors are measuring the pressure in the main brake pipe, between the brake cylinder and the control valve. Results of the measurements are displayed on a screen in the locomotive, where the driver can check whether the brakes are well functioning. The automatic brake control was developed in a research project of the German Ministry for Economics and Technology. [6]

2.2 Expected benefits of ETCS (European Train Control System)

The European Train Control System (ETCS) is an example for the benefits of digitization of rail - operation, in the German Masterplan Rail Freight Transport [7] the following advantages are highlighted:

- An expansion of network-capacity by the reduction of the time between trains on the existing infrastructure,
- a reduction of the maintenance costs for signals on the tracks (after a full change to ETCS),
- increase the productivity of the railway system.

On the other hand the costs for the ETCS equipment of locomotives are between 300.000 and 700.000 €, depending on the number of locomotives to be equipped. The costs are to be paid by the railway operators now, but the benefits will come step by step according the equipment of railway–lines with ETCS equipment. In the German Masterplan Rail Freight Transport (page 18), therefore financial support by public authorities is recommended based on the argument of reduced costs for additional rail infrastructure.

2.3 Digitization of processes in rail freight

In the German Masterplan Rail Freight (pages 19 and 20) some benefits of digitization of business processes are described:

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[6] Project SWIFTLY GREEN (Sweden- Italy Freight Transport and Logistics Green Corridor), TENT-T Programme Activity 4 report "Railway Innovations for the Greening of Transport" https://www.swiftlygreen.eu/en pages 27 and 28, see also http://www.diloc.de/diloc-brake/

[7] Masterplan Schienengüterverkehr (Masterplan for Rail Freight Transport) published by the German Federal Ministry for Transport and Digital Infrastructure (BMVI) in June 2017

- In general digital exchange of data improves the transparency of transport processes and contributes to the optimization of rail-bound logistics.
- Locomotive drivers and other operating personnel can react based on digital transmission of timetables and regulatory documents in an early stage to deviations.
- Digital interfaces between infrastructure operators and train operators the preparation of train journeys and the calculation of the infrastructure using fee - can be facilitated considerably.
- For rail freight transport, short-term and flexible allocation of railway capacity – to get suitable slots for freight trains - is becoming increasingly important. The flexible demand of freight customers can be often not represented in annual timetables. The use of digital technology facilitates the flexible and demand-oriented allocation of slots for freight trains.
- Through digital provision of train- and customer data for operating staff (e.g. electronic wagon list for train drivers, digitized data acquisition and forwarding in the car inspection) can the subsequent processes for planning, scheduling and maintenance systematically connected and accelerated.
- The development and use of a continuous digital process chain in the maintenance of rail vehicles contribute to increased efficiency and availability in railway operations.

In Germany an umbrella project “Simple Railway” (“Einfachbahn”) is under way. The main objective is to facilitate operating with the system rail by the implementation of user-friendly IT-tools.

Figure 3: Already used applications or “Einfachbahn” (“Simple Railway”)

Source: http://www1.deutschebahn.com/einfachbahn-de/projekte/projekte_tools/14337350/ueberblick_projekte.html?start=0 www.strecken.info shows based on maps restrictions on the rail network (e.g. construction works, closing times of some lines and short time disturbances).

“Trassenfinder” optimizes the route planning under consideration of several criteria and facilitates also ordering slots for freight trains.

GretA (Grenzlast-Anzeiger) helps to identify weight-limits for rail-freight and to order calculations for specific cases.

IKAs is an information and communication system for information to equipment failures and to support solving these technical problems.

AnDi is a planning and disposition tool for railway-operators including a customer version, which allows them to ask for free capacities and to look for their wagons on the rail-network.

Railway.Tools (https://railway.tools/) gives based on interactive maps an overview to the access points for combined and conventional transport on rail, like terminals, railway-sidings. Moreover, railway-diesel filling stations are shown.

I-Trace is a platform for the development of the rail-infrastructure based on the demand on the market. Also suggestions of clients to improve the rail-infrastructure are considered. The platform includes also tools for a first evaluation of the technical feasibility of the proposed infrastructure measure, costs, benefits, duration of implementation and suitable financing instruments.

3. Innovations in rolling stock to improve efficiency and to reduce negative impacts on the environment

3.1 Modular construction of wagons: different loading units on standard chassis

At first a standardized construction of wagon chassis can save production- and maintenance-costs by economics of scale. Moreover, many categories of freight have summits of demand while in the meantime only low transport demand exists. Therefore conventional wagons without the possibility to separate the loading-units (“super-structure elements”) from the chassis have in the low-demand- phases inefficient breaks, their capacity is not used. In the case of modular wagons with an easy possibility to separate the chassis from the loading unit, the chassis with the bogies can be used for other loading units.

Loading units can be removed by crane or reach-stacker, stapled and stored for the next use. Especially interesting are foldable superstructures that can be stapled space-saving.[8]

[8] Project SWIFTLY GREEN (Sweden- Italy Freight Transport and Logistics Green Corridor), TENT-T Programme Activity 4 report “Railway Innovations for the Greening of Transport” https://www.swiftlygreen.eu/en

By the construction of the chassis, using innovative bogies with radial steering technology, disc brakes or low-noise brake – pads maintenance cost of wheels and rails can be reduced. In the report of the project “Swiftly Green” 2 German and 1 Slovakian type of innovative bogies are described.[9]

Figure 4: Separation of chassis and loading unit, example Rail Cargo Group Austria

(Source: presentation by Karl Zöchmeister, meeting of the WG Transport, 5.5. 2017)

3.2 Low noise brakes and bogie skirts on wagons to reduce noise

In the report “Railway Noise in Europe”[10], reducing the wheel roughness by replacing cast iron brake blocks – which cause rough wheels – by K- or LL blocks or using disk brakes is regarded as most important option to reduce rail noise

In a “whisper” brake, also called "K-sole", the brake pad (block) is made of composite materials which are more elastic than older, metallic gray cast iron brake pads. In the composite metal fibers, rubber and resin compounds and additional materials are usually processed, therefore these brake blocks are also called "composite brake sole". Compound brake pads can cause a reduction of rolling noise of 8-10 dB (A) on smooth track surfaces, which is perceived by the human ear as a halving of the noise. The disadvantage of the K-blocks is that composite wears

[9] See note 8 to the report “Railway Innovations for the Greening of Transport”, project “Swiftly Green” p. 55

[10] “Railway Noise in Europe” , published by the UIC (Union International des Chemins de fer) in March 2016, page 28

faster and causes higher maintenance costs for the railway companies. A further development are the so-called LL soles ("low noise, low friction" - low noise, little abrasion).

However, retrofitting a freight car originally equipped with gray cast iron brake blocks is laborious. The entire braking system of the vehicle must be rebuilt for this purpose and re-approved depending on the type of wagon. For example the Deutsche Bahn estimates the costs of converting one freight wagon to low-noise ("whispering") brake between 5.000 and 7.000 €.

Significantly reduced costs result from the conversion to the LL sole, which has been approved since June 2013. Because the coefficient of friction of this quiet sole is comparable to that of the conventional gray cast iron sole, the old gray cast iron soles of standard freight wagons can be replaced 1: 1 with the new composite brake sole without further modification. The costs are about 1.700 euros per car about two-thirds lower than when using the K-sole. [11]

In addition to the whisper brake with composite brake pads, disc brakes are increasingly being used in rail freight transport - a technique that has always been used to brake lighter passenger trains. With disc brakes, the rolling noise of freight trains can be reduced even more than with whisper brakes.[12] The investment costs for disc brakes per new wagon are about 9.000 € higher compared to a block brake and the lifetime is estimated to 10 years. Disc brakes have an economic advantage in comparison to block brakes by avoiding the wear out of the wheel during the brake operation of the train. Considering a new acquisition of a freight vehicle, the advantage can become apparent with a yearly mileage of 60.000 km. The costs for the modification of existing freight vehicles are high and the process is seen as uneconomical.[13]

Example Germany

In Germany since December 2012 for trains that do not yet have noise-reducing technology (whisper brakes) a higher infrastructure use fee compared to quiet trains is to pay by rail operators. This concerns above all the goods traffic. The aim of the noise depending infrastructure use fee ("lärmabhängiges Trassenpreissystem", short LaTPS) is to accelerate the noise reduction in rail traffic.

A federal funding program worth up to 152 million € was introduced by the German government for converting noisy freight wagons to low-noise braking technology until the 2020/2021 timetable change. From the end of 2020, the operation of noisy freight wagons in Germany will be prohibited by law. [14] Therefor a fleet of more than 60.000 freight wagons of DB Cargo have to be upgraded, also further 60.000 wagons of private wagons owners. Since 2001 new freight wagons of DB-Cargo are equipped with low-noise brakes, at first with K-pads and since

[11] Source: https://www.allianz-pro-schiene.de/glossar/fluesterbremse/

[12] See number 7 above: Masterplan Schienengüterverkehr (Masterplan for Rail Freight Transport)

[13] Project SWIFTLY GREEN (Sweden- Italy Freight Transport and Logistics Green Corridor), TENT-T Programme Activity 4 report "Railway Innovations for the Greening of Transport" https://www.swiftlygreen.eu/en, page 30

[14] Source: https://www.allianz-pro-schiene.de/glossar/trassenpreise/

2013.with the cheaper LL pads. In January 2019 63 % of the rolling stock for rail transport in Germany was equipped with “whisper brakes”.[15]

Photo 2: LL brake pad

Source: DB, Pablo Castagnola, downloaded from https://www.allianz-pro-schiene.de/glossar/fluesterbremse/

Example Austria

On the initiative of the Federal Ministry for Transport, Innovation and Technology the conversion to so-called “whisper brakes” is rewarded with a noise bonus for rail tolls. The proposal for the "noise-related railway use fee" has already been approved by the European Commission. The new regulation will be implemented by the Austrian Federal Railways (ÖBB) infrastructure from December 2017. Trains equipped with whisper brakes will be rewarded with a toll credit. The bonus is one cent per wagon axle and kilometer up to a maximum of 1.700 € per wagon. This equates to the cost of retrofitting to new composite brake pads and motivates rail transport companies to transition. [16]

At the Austrian Rail Cargo Group, 40 percent of the more than 21.000 freight wagons[17] used in Austria are already quiet. By the end of 2020/2021, more than 90 percent of freight wagons our vehicles, which are mainly used in Austria, will be retrofitted. [18]

Critical remarks

Experience in Sweden and Finland shows: In nordic winter weather conditions, trains carrying wagons with composite brake pads - type C810 - could pose serious safety-related problems. Checks shows, that the brakes with the composite soles are blocked by a layer of snow and ice. In trains consisting exclusively of wagons with whisper brakes, in at least one case even "no braking effect" has occurred. Similar incidents were reported from Finland. The Swedish

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[15] Source : Information by the German Ministry for Transport and digital Infrastructure (BMVI) department railway research on 29th January 2019

[16] Source: https://infothek.bmvit.gv.at/gueterverkehr-fluesterbremsen-bremssohlen/

[17] Source : Karl Zöchmeister, presentation in the WG transport 5.5.2017 in Vienna

[18] Source: http://www.railcargo.com/de/News/News/2017/Q4/Leiser_Gueterverkehr/index.jsp

transport authority "Trafikverket" has reported this problem in a safety alert to the European Railway Agency.[19] In contrast to reports submitted by Sweden, other European railways have already extensive experience with composite brake blocks without any similar incidents. DB Cargo for instance has so far 41,000 wagons retrofitted to the LL blocks. These have now covered by mid-November 2018 a total of more than 1.5 billion wagon kilometers without any incidents reported corresponding to the Swedish incidents.[20] , also in Austria no dramatic incidents with low noise brakes are known with low-noise brakes.
Owners of freight wagons complain that "whisper–brakes" causes higher maintenance costs than cast-iron brakes. While investments in new wagons and for up-grading old wagons are supported e.g. by federal funding programs the higher maintenance cost remain for the wagon-owners. [21]

European Solution for low- noise brakes

The European Commission plans a regulation for low-noise brakes after 2024 and is criticized e.g. by the German government that this is very late for countries that have already implemented noise differentiated track access charges.

Bogie skirts on wagons to reduce noise

A further possibility to reduce the noise of rolling trains is to use bogie skirts on wagons. This equipment can reduce the noise up to 10dB (on wagons with cast iron brakes), especially in combination with low noise protection wall on the track near the rails.

On the other hand the maintenance of bogies and wheelsets with noise protection skirts is slightly more difficult than without because the skirts have to be removed during the maintenance. Also the periodical inspection all parts of the bogie by wagon masters at shunting yards can become more difficult. This disadvantage can be solved if sensor technologies (e.g. Cargo CBM) would be used on the freight wagons to simplify the train making process. Further, in winter additional icing hazard of the bogie could occur when using skirts. [22]

Photo 3: Bogie skirts for noise protection

Source: The Influence of Surface Impedances on Sound Radiation Properties of a Shroud-Barrier-Combination, Dissertation Kai Johannsen (taken from source 22)

[19] http://www.taz.de/!5450408/

[20] Information by the German Ministry for Transport and digital Infrastructure (BMVI). Rail research department .

[21] https://www.allianz-pro-schiene.de/presse/pressemitteilungen/2014-017-plattform-leise-bahnen-schienenlaerm/

[22] Project SWIFTLY GREEN (Sweden- Italy Freight Transport and Logistics Green Corridor), TENT-T Programme Activity 4 report "Railway Innovations for the Greening of Transport" https://www.swiftlygreen.eu/en, page 33

3.3 Bimodal locomotives with energy accumulator or diesel engines for the "last mile"

For safety reasons (high tension electricity) and to operate without obstacles with cranes the loading rails in combined transport terminals as well in other rail-freight stations are not electrified. Therefore it`s often necessary for the full rail transport chain to provide in addition to the electric long-distance locomotive a diesel shunting locomotive. If the capacity of such shunting locomotives is not used in a sufficient size, the cost-structure of the rail-transport becomes inefficient.

A possible solution is to use bimodal locomotives, suitable to pull a freight train over long distance with electric power and also for shunting-services in freight not electrified freight terminals. A research in the internet shows, that locomotives with this performance are already available on the rolling-stock market.

Long distance locomotives with "last mile package" for not electrified tracks

An example for electric locomotive with "a last mile package" is the type 187 (German class number), which is built by Bombardier in Kassel. This locomotive is equipped for 15 kilovolt 16.7 Hertz and 25 kilovolt 50 Hertz alternating voltage. Moreover, a 180 kilowatt diesel auxiliary motor is available to serve sections without overhead wires ("Last Mile"). In diesel mode, all four traction motors are working, the starting tractive force is just as high as during electrical operation. A class 187 locomotive with its diesel engine can reach a top speed of 60 km / h and a train with 2.000 tons can still be accelerated to 40 km / h. The diesel auxiliary engine has a capacity of 7,150 cubic centimeters and complies with the Stage IIIB emission standard. The tank capacity of 400 liters is sufficient for up to 8 hours of diesel-operation, short distances can also be covered only with the built-in battery. The transition from electric traction to diesel traction can be done while driving. A radio remote control is available for shunting operations.[23]

Also the newest generation of electric locomotives produced by Siemens – called Vectron – offers as upgrade option an optional shunting module available for the models Vectron AC and DC. It includes an auxiliary diesel engine with a power of 180 kW (exhaust emissions according to EU standard IIIb) with which is possible to drive on not electrified tracks in shunting services.[24]

[23] Sources: https://de.wikipedia.org/wiki/Bombardier_Traxx#Baureihe_187 and Nahtloser Übergang – die Last Mile Lokomotive. In: Eisenbahntechnische Rundschau 9/2014, S. 174–176.

[24] Source: https://de.wikipedia.org/wiki/Siemens_Vectron based on Siemens: Hintergrundpapier Modulerweiterungen

Photos 4, 5 and 6 : Examples of locomotives with last mile diesel motors

Traxx categorie 187

Source : www.railpool.eu

Siemens Vectron in Hanko, Finland

Source: http://junalauta.net

Eurodual from Stadler Spain

Source: http://www.railwaygazette.com/news/traction-rolling-stock/single-view/view/stadler-seeks-most-powerful-loco-family-as-eurodual-trials-begin.html

The train producer company Stadler Spain developed heavy 6 axle - dual mode locomotive – called Eurodual - which is capable hauling main line trains at up to 160 km/h in either diesel or electric mode, the prototype is rated at 7 Megawatt (MW) when under 25 kV 50 Hz electrification or 4 MW from a 1·5 kV DC supply. Its Stage IIIB-compliant Caterpillar C175-16 diesel engine is rated at 3 MW. [25] The first customer is the Havelländische Eisenbahn Aktiengesellschaft (HVLE), which ordered 10 Eurodual-locomotives. Compared with last mile conceptions these dual mode locomotives (electric or diesel electric traction) provide more flexibility in a network with some not-electrified lines. A disadvantage might be the weight of the strong diesel engine and the big diesel tank.

The ÖBB (Austrian Federal Railways) start in 2019 test with a 3 –piece railcar (type City Jet, from the Desiro main line family with 4 accumulators [26] . The range without catenary should be appr. 80 kilometers, the performance appr. 1.300 KW (half of service under catenary) and the maximum speed 140 km/h

Bimodal shunting locomotives

Fuel cells and lithium-ion batteries or super capacitors in Austrian electric shunting locomotives as solution for the last mile:

[25] Source: http://www.stadlerrail.com/de/produkte/detail/eurodual/

[26] Source: https://futurezone.at/b2b/14-tonnen-akku-statt-diesel-oebb-testen-oeko-zug-ab-2019/400114013

The project was started by ÖBB (Austrian Federal Railways) and is part of a research contract of the Austrian Research Promotion Agency (FFG) and the Federal Ministry for Transport, Innovation and Technology (bmvit).

One experimental vehicle is based on the use of batteries and supercapacitors, while the second experimental vehicle relies on the use of four 600 V lithium-ion batteries and one fuel cell. Two battery packs supply the traction motors with 1,200 V voltage. The supply of the battery packs takes place either directly from the AC overhead line or self-sufficient from the fuel cell, which is powered by hydrogen. The test vehicle is initially equipped with a fuel cell with 30 kW power, which will soon be changed to a more powerful fuel-cell. A positive feature of this technology is that it provides a much longer range or service life than a conventional battery solution. Test services are under way. [27]

Photo 7: Fuel cell shunting test locomotive

Photo: SN/ HET/Inderst,

Photo 8: Battery pack on the roof of City Jet Eco

Photo: Harald ÖBB [28]

Fuel cell locomotives and trains

For the regional passenger traffic since March 2017 in Lower Saxony (Niedersachsen) a completely by fuel-cell powered low-floor train unit is on rail in the test phase:
“Alstom has successfully completed its first test drive on the company's own test track in Salzgitter (Lower Saxony) with the world's only fuel-cell-operated passenger train Coradia iLint at 80 km / h. In the coming months, an extensive test campaign will follow in Germany and the Czech Republic, before the Coradia iLint will go into trial operation with passengers at the beginning of 2018 on the Buxtehude-Bremervörde-Bremerhaven-Cuxhaven route.

This completely emission-free train is quiet and only emits water vapor and condensation. The Coradia iLint features a number of different innovations: clean energy conversion, flexible energy storage in batteries, and smart management of power and available energy.

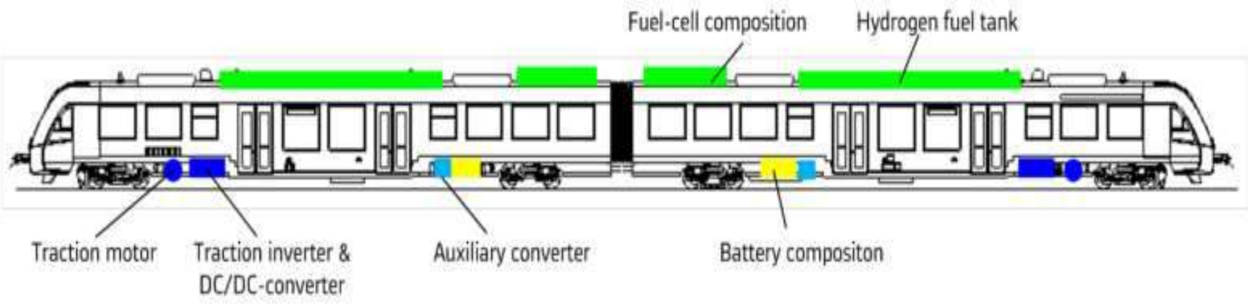
[27] Source: https://www.eb-info.eu/aktuell/forschung-und-entwicklung/11-10-2017-oebb-hybridlok-mit-brennstoffzelle-versuchslokomotive-mit-alternativem-antriebskonzept-getestet/

[28] Downloaded from http://forum-mobil.at/innotrans2018/

The hydrogen used for the test drives is the by-product of an industrial process and is usefully recycled. In the long term, the producer Alstom supports the generation of hydrogen from wind power.

This project of a fuel cell driven train benefits from the support of the Federal Ministry for Transport and Digital Infrastructure. Alstom has already signed declarations of intent for 60 trains with the federal states of Lower Saxony, North Rhine-Westphalia, Baden-Württemberg and the Hessian Rhein-Main-Verkehrsverbund" [29].

Figure 5: Construction of the fuel-cell powered iLint



Source: http://www.greencarcongress.com/2017/11/20171109-alstom.html

It can be expected that success of fuel cells for passenger trains –powered by hydrogen soon will lead to the construction of more powerful fuel cells also for rail-freight.

Alternative freight train conceptions

Successful ways to low-emission traction also on not electrified lines can contribute to the success of alternative freight train conceptions, like the Aron RCS rail cargo system[30]

Such systems, also the cargo-sprinter of the Deutsche Bahn[31] have the advantage to be more suitable for smaller freight-shipments and for spontaneous and fast transports as locomotives and wagons which must be often shunted. But recently such innovative rail freight conceptions had the disadvantage of diesel traction, also on electrified lines. The vehicles were equipped with diesel engines – emitting greenhouse gases and NOx - to be flexible for the use not electrified lines and railway sidings.

Dual low emission traction (e.g. electric energy from overhead wires or from fuel cells or batteries) makes such vehicles more attractive from the environment impacts point of view. In the Hungarian Aron RCS rail cargo system the following ways for energy supply are considered:

[29] Source: http://www.alstom.com/de/press-centre/2017/03/erfolgreiche-erste-testfahrt-von-alstoms-wasserstoffzug-coradia-ilint-bei-80-kmh/

[30] http://www.aron-rcs.com/solutions

[31] https://en.wikipedia.org/wiki/CargoSprinter

- Electric traction with overhead collection – for electrified networks, with an optional "last mile" function to extend reach to non-electrified sidings and decrease exposure to infrastructure disturbances;
- Battery powered electric traction for operation without local emissions on non-electrified network sections and sidings.
- Electric traction from diesel power pack for non-electrified networks: A diesel power section incorporates several motors in view of efficient operation with low breakdown susceptibility.

The Aron RCS is developed for containers but it could be used also for standardized changing loading units as described above. The twin loading device “riding” the train is an essential part of the ARON-RCS system. Presently no such mobile device operates that loads and unloads standard containers, swaps bodies, and even non-cranable road semitrailers. The required device must speedily crane swap containers on-site as well as being carried on-board, descend from the train and remount, without requiring any particular infrastructure elements. The loading devices can be powered diesel-hydraulic or electric.

Figure 6: Aron RCS twin loading devices

Source: http://www.aron-rcs.com/downloads/ARON-RCS_prospect_En.pdf

4. Automatic coupling systems

Automatic coupling is regarded by many experts as key to improve the efficiency of rail freight. Conventional screw coupling is a heavy and often dangerous work. Moreover, it needs a lot of staff. In the U.S.A. or in Russia automatic coupling is usual, advantages are higher safety for the railway staff , the possibility to pull heavier and longer trains, with some systems also a remote decoupling is possible (e.g. Scharfenberg-coupler, often used for passenger train units in shuttle service). Automatic coupling is a condition to automate shunting procedures.

Conceptions to replace conventional coupling by automatic coupling in one step (e.g. during a long weekend) failed, therefore automatic coupling systems should be compatible with conventional screw coupling (“Schraubenkupplung” in German, sometimes also called chain coupler). Exceptions could be special trains, e.g. block-trains, which need no compatibility with conventional coupled wagons.

The C-AKv coupler (Compact - Automatische Kupplung vereinfacht) as possible solution

The C-AKv coupler was developed by SAB WABCO, now Faiveley Transport Witten GmbH. Unlike the former UIC automatic coupler, it is compatible with the existing chain coupler, which would allow for a longer transition period.[32] Since the year 2002, the C-AKv has been on tests on the German railway network.
It is used on heavy coal block trains between the opencast mines at Profen and the Schkopau power plant.

The advantages of the C-AKv coupler are:

- The C-AKv coupler automates the wagon coupling and decoupling procedures and therefore speeds up the entire transport process. This results in a significantly higher system speed and a shorter wagon turnaround time.
- The automatic coupler enables greater drawing and buffing forces to be used for heavier and therefore longer freight trains, making a doubling of current train lengths possible.
- The C-AKv coupler also enables the automatic coupling of the brake pipe and the electrical lines (including data transmission cables).
- The C-AKv coupler is compatible with existing screw coupling systems and the Russian SA-3 coupler and thus guarantees a transition period during which all freight wagons can undergo conversion.
- Once the transition period is over and all side buffers have been removed, the C-AKv coupler will also offer greater derailing protection at higher running speeds.

Large volume production of the automatic central buffer coupler should mean that the cost of retrofitting an older freight wagon is substantially less than €8000, while the cost of equipping a new wagon is estimated to be less than € 5000. [33]

The C-AKv coupler enables the double load compared to screw couplers (tensile load 1.000 kN of C-AKv). This make possible to pull heavy and long trains (up to 1.400 meter length). An example are 6.000 ton iron ore trains from Rotterdam to the steel works at Dillingen in the Saarland. For this purpose 18 DB class 189 electric locomotives were equipped C-AKv coupler and pull the iron trains in double traction.[34]

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[32] Source : https://en.wikipedia.org/wiki/C-AKv_coupler

[33] Source: Bernhard Sünderhauf: The Automatic Centre Buffer Coupler (ACBC) - Cost-Benefit Analysis, Köln; Altaplan Leasing GmbH, 2009; downloaded from http://www.automatische-mittelpufferkupplung.de/dl-counter/download/automatische_mittelpufferkupplung.pdf

[34] https://en.wikipedia.org/wiki/C-AKv_coupler

Figure 7: Main components of the C-AKv (automatic central buffer coupler system)

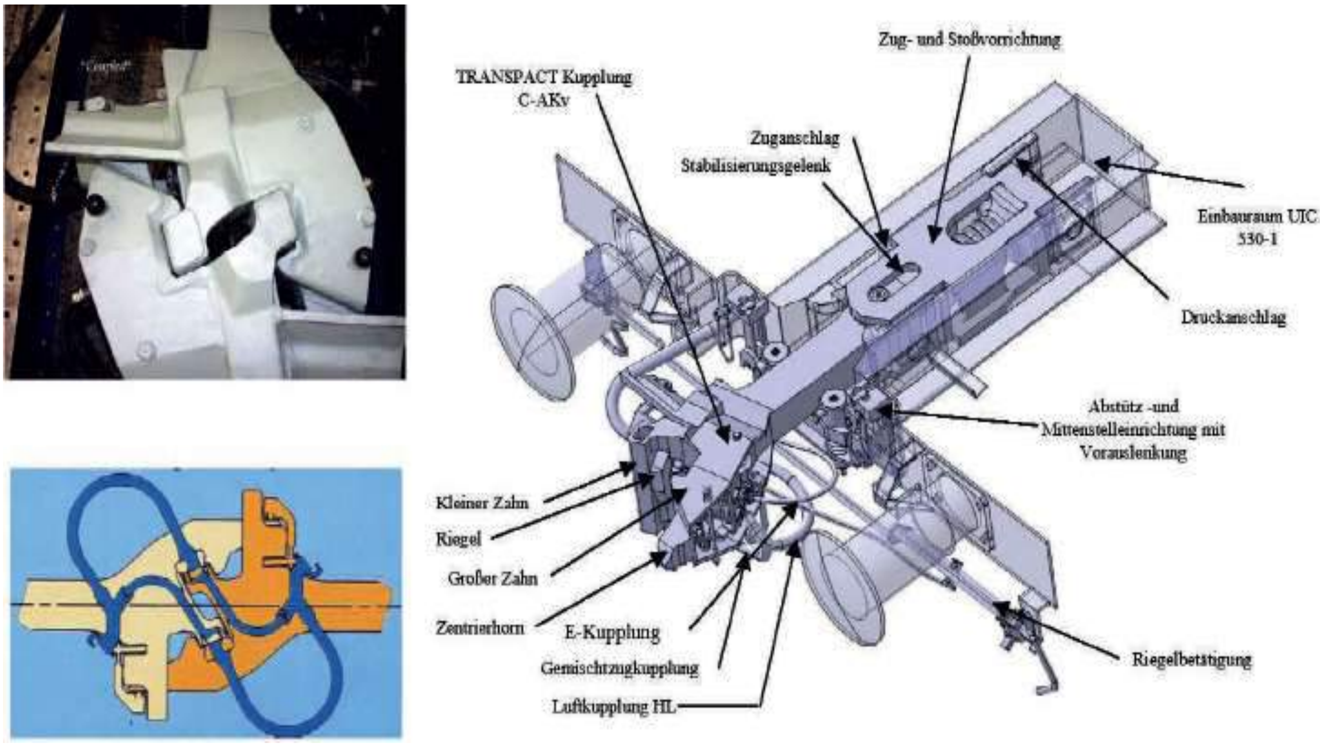
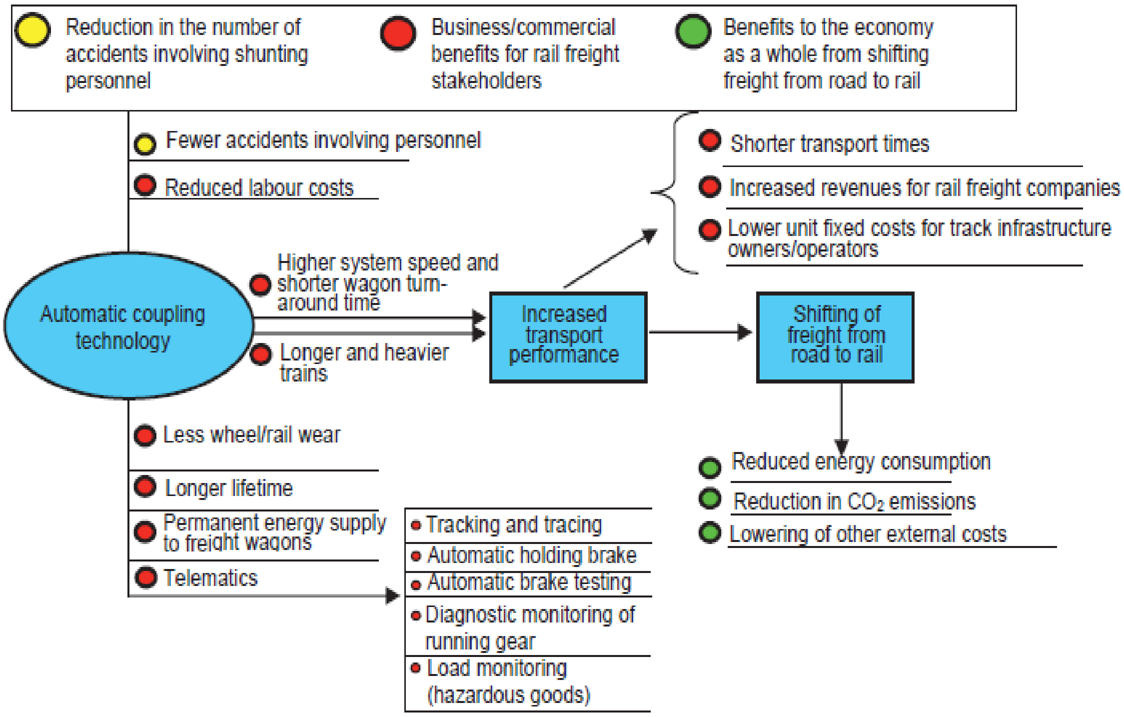


Figure 8: Overview of the most important business/commercial benefits and broader economic benefits



Sources of figure 7 and 8 see next page

Source of figures 7 and 8: Bernhard Sünderhauf: The Automatic Centre Buffer Coupler (ACBC) - Cost-Benefit Analysis, Köln 2009, downloaded from www.automatische-mittelpufferkupplung.de/dl-counter/download/automatische_mittelpufferkupplung.pdf , source of the pictures in figure Source of the pictures: Faiveley Transport

Summed up, automatic coupling can be regarded as condition for automatization an improved competitiveness of rail-freight.[35]

Regarding to the German Masterplan for Rail Freight Transport a blueprint for the Federal Government programme entitled "The Future of Rail Freight" was developed in September 2018. It shows the need for a digital automatic coupling (DAC). In the same direction the Technical Innovation Circle for Rail Freight Transport (TIS) published a position paper in October 2018. [36] The industry wants to develop a DAC type 4 in 2019.

Photo 9 Locomotive with C-AKv coupler

Photo 10:Coupling with conventional screw-coupler

Source photo left: www.fotocommunity.de/photo/189-031-8-martin-morkowsky/20557477
Source photo right: Bernhard Sünderhauf , Faiveley Transport

[35] An excellent overview to more rail coupler systems in German language is provided at http://www.innovative-freight-wagon.de/wp-content/uploads/TIS-uebersicht-Kupplungssysteme.pdf , written by Stefan Hagenlocher, hwh Gesellschaft für Transport-und Unternehmensberatung mbH, Karlruhe 2015 (client SBB-Cargo)

[36] http://www.innovative-freight-wagon.de/wp-content/uploads/EN_TIS-position-paper.pdf

5. Partly and fully automatic shunting

Shunting, especially coupling with conventional screw couplers needs many employees and is a dangerous work. Automatic couplers, which are described above facilitate shunting and avoid the most dangerous works. For the improvement of the competitiveness of rail-freight compared with road transport, a further step is to automate the traction processes for shunting.[37]

In the German Masterplan for Rail Freight Transport[38] the following measures to automate shunting are mentioned:

- Automation of train formation towards real-time control entire marshaling yard
- development and use of automation options (e.g. decoupling robot) to support and discharge the operating personnel and to increase work-safety,
- fully automatic shunting locomotive,
- automatic check of the wagon-sequence,
- (semi-) automatic coupling and decoupling,
- automated wagon examinations with video analytics,
- automated brake tests,
- real-time monitoring of all shunting processes and the infrastructure
- software for optimal real-time control,
- support of research projects for future work in digitized and automated systems.

Automatic coupling systems are regarded as key-technology for further measures to improve efficiency of rail freight transport.

A pilot project was implemented in the wagon repair and maintenance shop in Paderborn[39] . The working processes there need many shunting procedures. With the pilot project, DB -Systel wants to prove that the systems and technologies already in use make it possible to implement quickly innovative ideas such as automated shunting. Many current rail vehicles are already prepared for automated driving. The pilot project in Paderborn shows that innovations can build up on an existing base.

The two-way shunting -vehicles in Paderborn use technology such as radio receivers and sensors, which are already for other applications elsewhere. A key step was the development of the interface to the two-way vehicle. These powered vehicles can now interact with the DB technology, addressed via radio from a central control system installed on a notebook - whereas it was previously controlled manually by remote control.

The aim is that the dispatcher enters into an IT system, which vehicles should be provided on which working position, so that the automatic two-way vehicle then can provide the wagons

[37] Considerations to the impacts on the labor-market see chapter 8 Conclusions

[38] Masterplan Schienengüterverkehr (Masterplan for Rail Freight Transport) published by the German Federal Ministry for Transport and Digital Infrastructure (BMVI) in June 2017, page 22.

[39] Source: http://digitalspirit.dbsystel.de/die-zukunft-des-rangierens

on the right place controlled by the IT- system. The test in Paderborn, which was finished at the end of 2016 was successful, further steps of implementation are planned.

Photo 11: Small automatic two-way shunting robot in the wagon repair shop in Paderborn

Source: DB Systel GmbH (David Just)

Magna factory in Albersdorf (Styria)

It`s almost surprising that an example for automatic shunting is operating since the year 2001 in a plant for automobile technics (e.g. gears) Albersdorf (approximately 30 km in the East of Graz).

The fully autonomous operating shunting-locomotives (robots) were constructed by the regional rail-company „Steiermärkische- Landesbahnen“ (since 2018 called Steiermarkbahn) together with soft-ware partners. The robots are used in a factory area of Magna in Albersdorf (Styria) to provide wagons for loading scrap metal and to shunt them (at first to weigh the loaded wagons).

For steering the shunting robots are used induction loops, photo-cells (light- barriers), also conventional radio remote control is possible. The robots receive electricity from loading wires and from batteries in wireless sections. Also all relevant data to wagons and loads are transferred automatically. Railway -switches and conveyor belts are controlled automatically. In the factory site the automatic shunting-coupler RK 900 is used, before rolling on the network the coupler are fixed by shunting staff. [40]

[40] Information by Stefan Greiner, technical leader of Steiermarkbahn, Graz (e-mail 2. November 2016)

Photo 12: Shunting robots work in the Magna factory

Source: http://www.steiermarkbahn.at/leistungspalette/verladung

6. Freight trains without driver

Metros are already operating without drivers. Examples are Paris, the Dockland Railway in London, or the metro in Nürnberg. In Wien the new metro-line 5 is under construction and it is planned that the trains will operate without driver. Also the shown examples for shunting in chapter 5 prove, that the technology for automatic driving are available, but experts underline that automatic trains on lines with mixed train categories (fast trains, regional trains with many stops, freight trains and railway crossings with streets on the same level) need a more complex technology than limited systems like metros or shunting services in the local area of a shunting yard. Nevertheless tests are under way in many countries.

For example, the DB (German Railway) in 2016 started a test on a disused 30-kilometer long railway in the Erzgebirge. The test railcar is equipped with state-of-the-art camera and sensor technology. In the project technologies for detecting obstacles from a longer distance, automatically coupling trains and also for digital communication with road users should be tested and improved.[41]

Also in Austria a test environment for automatically operating trains on the open track is developed. In the "Open.Rail.Lab", companies and research institutes are testing new railway technology, such as locomotives, which automatically detect railroad crossings or obstacles on the rails. The test track between Friedberg in Styria and Oberwart in Burgenland is over 25 kilometers long. In the "Open.Rail.Lab" the entire development of the technology for automatically operating trains can be performed - from the first simulations on the computer to tests in normal railway operations.

The Federal Ministry for Transport, Innovation and Technology invests together with the state of Burgenland and the industry 11 million € in the upgrading of the track. In addition, the ministry will provide around five million euros annually for research projects related to automated rail operating. The test line will be opened in June 2018. It is expected that the

[41] Source: Deutschlandfunk 18.8.2016, Eisenbahn 4.0

settlement of research institutes and branches of railway equipment producers leads to positive impacts on the regional economic development.[42]

Smaller tests for sensors on railcars and locomotives to avoid collisions were already performed successfully in the year 2013 on the Traunsee Railway in Upper Austria (cooperation of the Austrian Institute of Technology, Siemens and the regional train company Stern&Hafferl). In fog, heavy snowfall or at night, the sensors achieve a better detection performance than the human eye, which promises to increase the safety of rail traffic [43]

The digital association Bitkom has checked the German trust in the autonomous rail traffic. After that, every second person aged 14 or over in this country can imagine using a train that is not controlled by one person and is self-driving. This is the result of the representative survey.[44] This is maybe an argument to introduce at first automatically operating freight trains.

Photo 13: Old test train for new sensors on the Traunseebahn

Source: 38, Science Apa, dossier.

7. Efficient and environmentally sustainable strategies to collect and distribute rail freight on the "last mile"

The automatization of coupling and shunting can reduce the costs for the distribution and collection of smaller loading-units to/from decentral destinations. Moreover, clean technologies for the "last mile" on rail, especially locomotives with electric energy storage for operation without catenary facilitate services on rail sidings. These facts support measures to come with freight trains into the cities and shorten the transport on trucks. Therefore the delivery and collection of goods is obvious.

[42] Source: https://infothek.bmvit.gv.at/europas-1-teststrecke-fuer-selbstfahrende-zuege/

[43] Source: https://science.apa.at/dossier/Automatischer_Zug_macht_Regionalbahnen_attraktiver/SCI_20130322_SCI45791818612021142

[44] Source: https://www.bitkom.org/Presse/Presseinformation/Jeder-Zweite-wuerde-selbstfahrende-Zuege-nutzen.html

An Austrian consultant, who is specialized on transport logistics and spatial development, has precisely analyzed the current situation of urban logistics. Based on his studies he shows 2 projects of urban logistics in Paris, which could be a sustainable solution for the future of urban logistics based on new technologies[45]:

A strong trend of city and location development is to be seen, relocating the transshipment points between long-distance and distribution traffic to the hinterland of the core cities, but abandoning the inner-city rail freight facilities so that they can be used for the lucrative real estate exploitation. The price of this spatial development is increasingly the "city of long freight routes", because the performance and payload capacities in distribution traffic within the core city and in the city region, as shown by CEP (courier, express and parcel services), are increasing. The previously decentralized freight handling seemed to have finally disappeared. But there are tentative signs of a trend reversal where space is still available. Projects that mark this paradigm shift are currently being realized in Paris in co-operation of state railway, logistics terminal operators and the city administration.
Intelligent logistics, vehicle and transport technologies are opening new opportunities to transport goods into the cities in an environmentally friendly way and to integrate space-saving transfer facilities into urban development projects, if the relevant players are willing to accept these solutions.

The deconsolidation in the course of cross-docking (steps to arrange the consignments for the delivery to the receiver) can certainly take place in the central logistic centers, which are located in the wider surrounding area of the cities. The transport into the cities can be bundled - with already final-consigned and destination-loaded consignments to the individual reception locations - in rail shuttle traffic to city-center transfer points (PoUT). From there the shipments in standardized containers are handled largely automated in city-compatible emission-free distribution vehicles. The integration of city-center transfer points (PoUT) into a multifunctional urban development project is the second special feature to emphasize, underscoring the importance of multi-agency space management.

Examples of city center transfer points in Paris

ZAC Clichy-Batignolles:

This urban development as a zone d'aménagement concertée (ZAC) takes place on former railway facilities and is part of the urban restructuring program for the northern districts of the core city of Paris, which are among the densely populated and highly polluted areas. Measures are for example, the creation of a green motor vehicle-free axis, the expansion of public transport (fully automated metro line 14, construction of tram line 3b) and consideration of rail-bound supply and disposal logistics were key subprojects. The city-center transfer point (PoUT) can be approached by trains from a main line. It provides 4.8 ha

[45] Heinz Dörr, Viktoria Marsch, Yvonne Toifl: Smart City Supply – Verkehrstechnologien, Güterversorgung und Stadtentwicklung auf dem Weg ins 4.0-Zeitalter (Smart City Supply – Transporttechnologies, goods-supply and urban development on the way into the 4.0-age), contribution to the conference REAL-CORP 2017 in Vienna, downloaded from http://programm.corp.at/cdrom2017/papers2017/CORP2017_111.pdf

(48.000 square meters) of total floor space on 4 floors for the handling of 60,000 t of goods per year. [46]

Chapelle International:

The residential quarter as the core use of the new urban development area on a former freight yard will accommodate 900 flats including civic amenities and open spaces, as well as a freight delivery station (city-center transfer point), which will be operated in a multimodal transport chain. Chapelle International will work together with a logistic center in the suburbs, situated on the river Oise (so inland waterway transport is considered). Shuttle trains transport the goods to Chapelle International. Electric utility vehicles distribute the goods in the arrondissements of Paris). Chapelle International is the first logistic station of a new type (Hôtel de Logistique) on the Parisian metropolitan area since the closing of the last freight yard at the end of the 1990s. It provides 4 ha with 390 m track length for indoor cargo handling on 4 levels. In autumn 2017 it starts operation and should save 2.6 million truck kilometers per year. The landowner SNCF, the city of Paris and the logistics terminal operator SOGARIS have jointly developed the project.[47]

Figure 9 : Hotel de Logistique , Paris, La Chapelle (model)

Source: Girus Eng.http://girus.fr/2012/10/17/hotel-logistique-chapelle-international-paris-18eme/

Cargo Cap: an innovative underground solution for the last mile in cities

Goods are transported in tunnels with a diameter of only 2.80 meters. The transport vehicles, called caps, are loaded with 2 to 3 pallets or small containers in standard dimensions. The caps operate autonomous, electric and fully automatic. Innovative switches make possible short distances between the caps. The cargo is immediately made available to the receiver at Cargo Cap stations or distributed via a connection logistics facility in the vicinity of the station which is also electrically powered. The Cargo Cap only at these stations is there a connection to the surface. Cargo Cap stations can be set up in the middle of city centers as

[46] Heinz Dörr at all from Mairie de Paris 2015, see also https://www.paris.fr/services-et-infos-pratiques/urbanisme-et-architecture/projets-urbains-et-architecturaux/clichy-batignolles-17e-2379

[47] Heinz Dörr at all, see also http://www.chapelleinternational.sncf.com/

well as on the assembly line of a factory. The advantage of Cargo Cap is an efficient operation, an obstacle could be high investment costs for the tunnels.[48]

Figure 10: Principle of Cargo Cap

Figure 11: Cargo Cap loading station

8. Developments in rail freight since 2017 and dissemination of the working group transport report on “ Innovation in Rail Freight “

8.1 Logistic dialog on 17th October 2018 in Altdorf

The logistics dialogue in Altdorf, Switzerland on 17 October 2018 started with a rather political discussion. The share of rail freight on transalpine transport is 67% in Switzerland and only 33% in Austria.

Two contributions were also interesting for innovation in rail freight:

Logistic solutions of the Coop company

The logistic concept of the Swiss super market company Coop, was presented by Georg Weinhofer, the head of the Coop logistic unit. The Coop company is a pioneer in using green trucks. From the year 2008 until 2017 the greenhouse gas emissions of Coop trucks could be reduce by approx. 25 %. From 2010 the share of biodiesel (e.g. gained from biogenic waste) increased from 5 % in 2010 to 40% in the year 2017. Coop is also using hydrogen powered fuel cell trucks and battery electric duty vehicles. The innovation according rail is that Coop has founded a daughter- company , called Rail Care for transports. 3 trains with together 90 container waggons transport goods from , see also https://www.taten-statt-worte.ch/content/dam/act/TatenstattWorte_Relaunch/Cross-Teaser/cross-teaser-links/coop-si-green-railcare_de.pdf

[48] Source: http://www.cargocap.de/content/das-cargocap-system

Photos 14 and 15: Battery driven and hydrogen truck of Coop (source contribution of Georg Weinhofer, Logistik Dialog 2018, 17. October in Altdorf Switzerland)

Verein Netzwerk Logistik (VNL, association network logistics)

Prof. Herbert Ruile presented the Swiss network logistics, see also . http://www.vnl.ch/de-de/der-verein/mitglieder . He underlined that logistics innovation will heavily contribute to improve competitiveness and sustainability of economies. VNL supports knowledge transfer between research and industry in the field of logistics. The network also facilitates collaborative projects to innovate in logistics in industry, trade and service sectors. Moreover, the Swiss Logistics Faculty, a cooperation of 14 universities with multiple disciplines, more than 100 researchers and a R&D budget of 100 Mio. CHF works on innovation in logistics, see also http://www.vnl.ch/de-de/logistics-faculty . In the Kanton Uri "Detranz" is an innovation center for a transport-efficient economy, also for solutions to decouple transport demand from economic growth, see http://www.detranz-uri.ch/index.php/ueber-uns

Finally Dr. Ivan Beltramba , a railway expert who joined the Logistic Dialog in Altdorf sent me some interesting information to automatic coupling of trains. He underlines the advantages of automatic train coupling compared with screw coupling for the safety of railway-workers and to increase the weight of freight trains (more than 2 times higher, e.g. on the Brener railway from 1.600 tons up to 3.500 tons). He mentioned that beside the C-AKv coupler (Compact - Automatische Kupplung vereinfacht) which was developed by Bernhard Sünderhauf, see page 17 ff. other proven technologies are available. He showed as example the Janney Coupler which is used in Great Britain and in a other version also in Belgium.

Photo 16: Janney Automatic Coupling in Great Britain in a swiveling version which can be compatible with the screw coupler. (Source: Ivan Beltramba)

The SA-3 AK coupler (also called Willison) is used in the former USSR and also in Norway and Sweden for the Kiruna- Narvik iron-ore trains.

In the working group i-Monitraf the reduction of long distance traffic in the Alps by regional consumption and general by changing consumer - behaviour were discussed. Some participants suggested to consider also future transport systems like Cargo Sous-terrain http://www.cargosousterrain.ch/de/ and the Pipe Net automatic transport system in tubes, developed in the technical university of Perugia. Moreover, the impacts of automatic diving and platooning of trucks on the Alpine freight transport should be analysed. Many participants of the working group agreed that innovation in rail freight needs more support than on roads, with a bigger market for the industry.

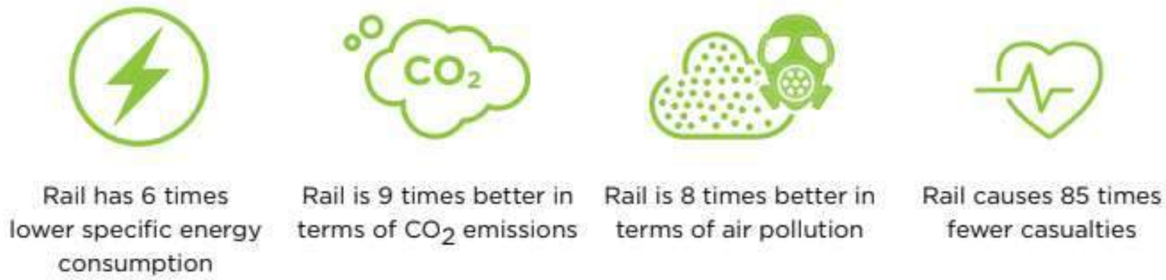
8.2 Rail Freight Day on 6th December 2018 in Vienna

The conference on rail freight with appr.300 participants offered the possibility to distribute the document „Innovation in Rail Freight“ which was elaborated in our working group. The interest for this document was big and I promised to send the updated version to colleagues who did not get a hand-out during the conference.

Main topics of the conference were the development of the European rail-infrastructure to win capacities for rail freight .e.g. by 740 m long freight trains and the improvement of the cooperation of rail companies with other partner on the logistic market and their clients.

Environmental advantages of rail freight were underlined, based on studies of the Rail Freight Forward Coalition:

Figure 12: Environmental advantages of rail freight compared with road transport



Rail transport causes 12 times less external costs to the society than road transport.

Source: https://railfreightforward.eu/ , brochure 30 BY 2030: TOWARDS A BETTER TRANSPORT MIX FOR EUROPE'S FUTURE

All figures in this brochure are taken from various European studies: CEBR analysis, CE Delft 2012, EEA, eRRac, EU Commission, Eurostat, Fraunhofer IIS, INFRas, INRIX, OANDA, OECD, and UNFCCC

Based on these facts the Rail Freight Forward Coalition recommends to increase the market share of rail transport in Europe from today 18 % to 30 % until the year 2030. (Austria has still a rail-share of appr. 30 % on freight transport in ton-kilometers.)

Therefore railway undertakings have to offer superior innovative products for the benefit of the customer. They can achieve this by:

- continuing restructuring and modernisation to achieve a competitive cost base;
- intensifying their work on quality, flexibility and ease of use by offering integrated multimodal solutions;
- driving automation, continuing to develop telematics and building more user-friendly interfaces;
- implementing their contingency management.

Infrastructure managers have to provide and manage interoperable and sufficient infrastructure which is "as easy to use as European roads" by:

- offering standardised, highly available and high-capacity infrastructure for freight without bottlenecks;
- providing easy access to the entire European rail network;
- ensuring easy, reliable and fast planning of train paths throughout Europe;
- running easy train operations with real-time ETA and dynamic traffic management in the case of congestion.

Policymakers and authorities have to ensure a stable regulatory framework and a level playing field for rail and all other modalities to nudge customers towards rail. They can do so by:

- ensuring a higher level of internalisation of external costs through road charges or carbon taxation, which in turn can be used to stimulate the use of transport modes with the lowest external cost.
- reducing the Track Access Charges;
- avoiding additional administrative costs;
- sharing the burden on safety costs between authorities, infrastructure managers and railway undertakings;
- taking into account all societal benefits when planning infrastructure investments;
- stimulating and maintaining best last-mile infrastructure;
- supporting innovation.

Source: Brochure : 30 BY 2030: TOWARDS A BETTER TRANSPORT MIX FOR EUROPE'S FUTURE at https://railfreightforward.eu

Although the focus of the rail freight day was transport policy and also the improvement of processes to increase efficiency of rail freight and services for customers some technical innovation were discussed:

Thomas Spiegel from the Austrian Transport ministry (BMVIT) mentioned the Austrian program to support railway sidings for clients with a higher amount of freight. New technologies can improve the efficiency of the operation with single waggons from railway sidings.

Carlo Borghini (representative of the research programme Shift2 Rail underlined the importance of automatization, digitation, automatic coupling and on-time information (e.g. where the transported goods are and when they will arrive). He underlined that rail operations can learn something from air-traffic, e.g. IT-translation tools with high reliability facilitate the communication between operating persons with different mother-languages.

Many delegates regard a fast implementation of the European Rail Traffic Management System (ERMTS) on the TEN-T network as important to facilitate cross-border rail service.

Also transparency of processes and a reliable exchange of data are considered as important step to improve rail freight services. Ad Toet presented the project ELETA:

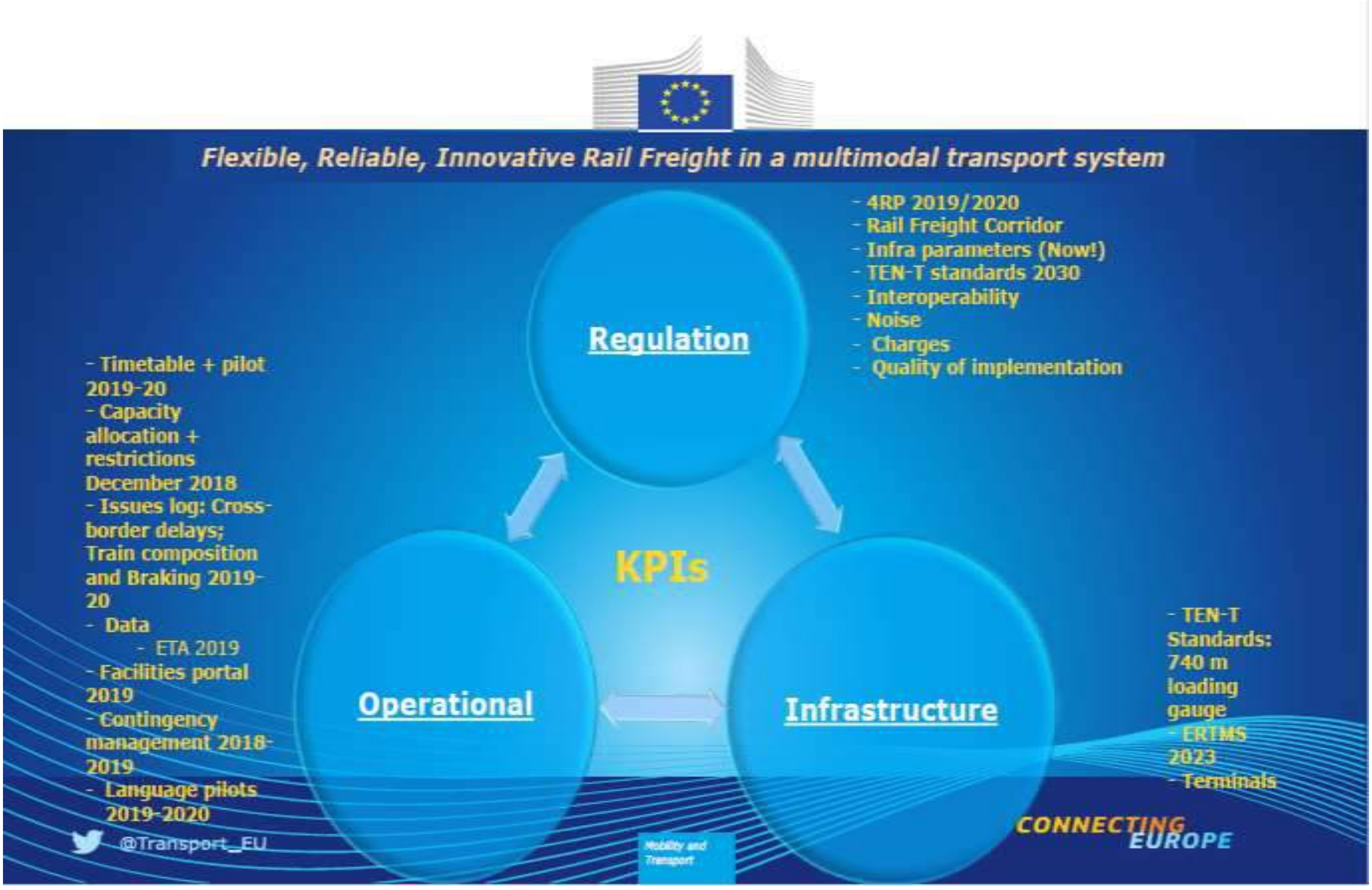
ELETA is a co-financed project under Connecting Europe Facility (CEF), launched in September 2017, which aims to demonstrate the advantages of exchanging the Estimated Time of Arrival (ETA) data within the whole rail supply chain management.

ELETA, which is the acronym for "Electronic Exchange of ETA information" scopes 12 selected intermodal transport relations, which are operated by the Combined Transport operators CEMAT (Italy), Hupac (Netherlands), Inter Ferry Boat (Belgium), Kombiverkehr (Germany) and Rail Cargo Operator (Austria).

The project is the result of an agreement of the rail sector to provide information on Estimated Time of Arrival (ETA) to their contract partners, including terminals and intermodal operators under the protection of confidentiality clauses.

Further information at: http://www.uirr.com/projects/ongoing/item/21-electronic-exchange-of-eta-information/34-ongoing.html
The final slide gives an overview to the complex framework of rail freight in Europe:

Figure 13: “Environment” for innovative rail freight



Source: Contribution of Elisabeth Werner, DG Move, director for land transport on Rail Freight Day 6th December 2018 in Vienna

As summary of the Rail Freight Day 2018 also a Vienna Declaration – Progress on boosting rail freight was agreed, this attached declaration is a follow up of the Rotterdam Ministerial Declaration - Rail Freight Corridors to boost international rail freight , see http://www.cer.be/sites/default/files/publication/160621_Ministerial_Declaration_RFC.pdf

8.3 AlpInnoCT

Many thanks to Zlatko Podgorski from Slovenia, he sent for the update of our report “Innovation in Rail Freight” the “Analysis report of projects, policies, strategies and support measures in the field of CT relevant for the Alpine Space”. This report was elaborated in 2017 by EURAC Research in Bolzano/Bozen in the framework of the project “AlpInnoCT” in the Alpine Space Program. Although AlpInnoCT is focussed on combined transport, in the report also some information on innovation is available.

At first the ***Appendix 3- Intermodal terminals*** - Transport supply, starting at page 101 of the report is a very precise overview to the combined transport (CT) –terminals in the Alpine Space. In this overview information to the location, infrastructures, total area (m²), available modes , terminal operators, provides services and main markets of the described terminals is provided.

Also the ***Appendix 10: CT Projects*** starting at page 155 of the AlpInnoCT –report from EURAC is very helpful. In this appendix the results of many studies to freight transport in the Alps are presented in useful summaries, including studies on technical innovation in rail freight. An example is the study

SWIFTLY Green - Sweden-Italy Freight Transport and Logistics Green Corridor:

The main result of the project was the drafting of about 130 analysed measures that can all be called up in the Green Corridor Portal and filtered according to certain criteria, and the Green Corridor Development Plan. This document is addressed mainly to the Coordinators and decision-making institutions of the other Corridors and includes recommendations as to how the results of the SWIFTLY Green project can be applied to other projects.

The project partners defined greening (goals) as follows: reduction of noise, energy consumption and greenhouse gas emissions, modal shift , improvement of traffic flows, reduction of air pollution and increased efficiency within individual transport modes and the various measures are mainly evaluated on the basis of these criteria. Subsequently, marketability was evaluated, verifying whether a prototype of a certain technology exists, if it is ready for serial production and whether it is relevant for the corridor as such, whether it can be applied only in a certain region or in the entire Corridor. With a search tool queries can be input and some measures are identified. The measures cover many different sectors of infrastructure, logistics, transport technologies and guidelines or directives. The Green Corridor Portal includes all the measures analysed as part of the project but the overall goal is for stakeholders to upload their own measures to create a portal that can be used over the long term.

Moreover, the AlpInnoCT report provides information on statistics to Alpine Transport and to operators of combined transport terminals.

**"*Heavy Goods Traffic Management Systems in the Alpine Area"*
*Review on combined/multi-modal/rail transport***

This report by the Zurich - Working Group , which was also submitted by the Slovenian delegation of the transport group of the Alpine Convention provides also a good overview to combined transport, but the report from the AlpInnoCT project is newer and more detailed.

8.4 Project Smartlogi (Interreg, Italy - Austria)

In the project, which is focused on combined transport, also innovative solutions, which are helpful for rail freight in general are described. Thanks to Federico Cavallaro from the Italian delegation in the Transport Group for sending to me the deliverable D.3.3.1 “Analysis of the best methods to give incentives and to benefit by implementing ICT instruments”, see also http://www.smartlogi.eu/ . In this document (published in September 2018 interesting, innovative solutions for rail freight are presented (pages 18 following), for instance

ERTMS (European Rail Transport Management System)

ERTMS is a Pan-European standardized system for message, control and automatic train protection. ERTMS is articulated in two main elements: The Train Control System (ETCS), and a mobile radio system for the spoken communication and the data communication in rail operation.

Improvements by ERTMS are:

- planning of network capacity and the selection of the route before the ride,
- the disposition of locomotives and staff,
- reduction of travel times,
- the disposition in case of unforeseen events,
- increase of infrastructure capacity,
- more efficient driving (optimal speed) based on information to situation on the line ahead In Switzerland the ADL system (adaptive train steering) should also improve the efficiency of train operation, see. https://www.sbbrcs.ch/en/family/rcs-adl/

ERTMS is already implemented or planned on TEN-T corridors. Further information at https://ec.europa.eu/transport/modes/rail/ertms_en

Automatic Train Operation (ATO)

The French train equipment producer Alstom has signed an agreement with the Dutch infrastructure operator Prorail and Rotterdam Rail Feeding (RRF) to carry out automated train operations (ATO) tests in 2018. The ATO system automates the driver's work, allowing him to focus on surveillance tasks.

These tests will be carried out at automation ERTMS level 2 on the Betuwe route equipped, a 150 km long double-track freight line connecting Rotterdam with Germany and belonging to the European freight corridor A between Genova and Rotterdam. The test drive on the Betuwe route will focus on the ATO application in freight transport. The purpose of the tests is to perform a live demonstration with a locomotive in automatic mode from the port of Rotterdam to the container handling center (CUP) Valburg in the eastern part of the Netherlands. The locomotive provided by RRF will travel approximately 100 km without any driver intervention on sections of track equipped with two different ERTMS steps (1 and 2).

Automated shunting is also tested on Valburg Container Handling Terminal. Read more at: http://www.alstom.com/press-centre/2018/01/alstom-to-perform-automatic-train-operation-test-drive-with-prorail-and-rrf-on-the-betuweroute-in-the-netherlands

Automatic inspection of freight trains

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The system ensures the high-precision automatic inspection and identification of freight trains through video, high-resolution photos and a 2D scanner system. It allows faster inspection of freight cars and saves time and money. It can also capture and archive identification codes of goods as well as images of the freight car and goods. More information at http://www.kleintech.net/traininspect.html

Further innovative solutions described in the Smartlogi project

In the mentioned deliverable of the Smartlogi project also some complex IT solutions to facilitate the administration of freight transport are presented, including also a block chain approach.

Interesting – in competition to rail freight - are also 2 projects with electric propulsion for trucks: the project on the Stockholm airport e-road Arlanda with electricity rails to support trucks (like many urban metros use) and a project in Italy on the Motorway A35 Brebemi (Lombardy) were on 6 km long section in a height of 5,5 m a catenary for hybrid trucks (with an additional diesel motor) should be installed. See also: https://eroadarlanda.com/, http://www.brebemi.it/site/?p=8396 and the introduction to this report.

8.5 Mobility of the Future – Research Program of the Austrian Ministry for Transport, Innovation and technology

In the 11th call of this program "System Rail, Vehicle Technologies and Transport Infrastructure" were main topic. The tasks "System Rail" focus on rail, vehicle technologies on all modes and infrastructures in this call more on the road network. Rail research topics are

- Automated train formation and separation
- Automated railway operation on branch lines
- Automatized train control
- Intelligent measuring technology for infrastructure and rolling stock in the railway system
- Condition-based maintenance in the rail system

Further topics to vehicle technologies are

- Fuel cell and hydrogen technologies for road, rail vehicles and ships
- Temperature management for road, rail vehicles and ships
- Car electronics for road, rail vehicles and ships

Project applications had to be delivered until the end of September 2018, the project selection was done in December 2018.

9. Conclusions

The analysis shows that, based on technological innovation, a lot of measures to improve the efficiency of rail freight transport are available to implement. Negative environmental impacts and the energy consumption of rail operation can be reduced and safety and security in rail operation increased.

In addition to the examples in this report the French overview-document “L'innovation dans le transport ferroviaire de fret en France - Rapport d’étape” [49] shows, innovations in rail freight transport go in the same direction. In addition to the examples shown in the chapters before the French report includes more recommendation to improve the rail-infrastructure to make it fit for very long and heavy trains up to a length of 1.500 meters and to increase capacity. Low noise brakes, digitization and automatically controlled trains are also topics in the French report.

Not only the technology for rail freight transport can be improved and contribute to increase efficiency and reduce negative environmental impacts, also administrative processes and the legal framework can be updated and facilitate the implementation of successful rail freight services. In the French report « L'innovation dans le transport ferroviaire de fret en France » a lot of recommandations is presented.

The Swiss “Regulation on the transport of goods by rail and shipping companies” (Verordnung über den Gütertransport durch Bahn- und Schifffahrtsunternehmen, Gütertransportverordnung, GüTV) provides a basic legal framework for many aspects of rail freight:

- the financial support for the transport of goods and accompanied motor vehicles by rail;
- the provision of financial aid for the construction, extension and renewal of combined transport terminals and sidings;
- the planning, construction , the operation and maintenance of railway-sidings,

In chapter 4 of the regulation the conditions for the support of the implementation of new technologies for rail freight transport are specified. [50]

A main question, which should be discussed from different points of view, concerns societal impacts of innovation in rail freight. New technologies replace manual – often dangerous – works, like shunting and coupling with screw couplers, but also some cases also other jobs like train drivers. Technological Innovation should not lead to unemployment. Therefore policies and strategies must be developed and implemented to solve the problem. In the rail freight sector in some cases more staff to advice existing and potential clients to suitable freight logistic solutions would be helpful.

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[49] MINISTÈRE DE L’ENVIRONNEMENT, DE L’ÉNERGIE ET DE LA MER , L'innovation dans le transport ferroviaire de fret en France - Rapport d’étape (Rapport n° 010477-01) établi par Hervé de TRÉGLODÉ, Septembre 2 0 1 6

[50] Source : https://www.admin.ch/opc/de/classified-compilation/20160958/index.html#id-4 (Web-Portal of the Swiss Government

But not only in the field of rail freight policy-solutions are necessary, e.g. a step-by-step reduction of the weekly working time, a discharge of work from taxes by environmental taxes and taxes on profits.

In the transport sector a fair competition between the different modes is a main target. The social standards have to be harmonized, e.g. limits for driving times of truck and train drivers and mandatory rest breaks. Of course efficient control is necessary that the regulations are followed. Moreover, it`s indispensable to fight against social dumping. Fair and efficient prices in transport are an objective of Transport Protocol of the Alpine Convention (article 14).

Finally, we have to discuss what we as members of the working group transport of the Alpine Convention can do, that rail freight transport remains competitive and the objectives of the Transport Protocol can be successfully.achieved

A main contribution of us can be widespread information of decision makers and the public about innovation in rail technologies and their contributions to an efficient, safe and environmentally sustainable transport in the Alps.

The present report should be regarded as a begin, together with the excellent German report on Combined Transport as an overview to available, innovative technology for rail freight transport. A next step could be to collect further information on innovation in rail freight and to elaborate an interesting publication of the Transport Group of the Alpine Convention. In any case, action from all responsible stakeholders is necessary to make rail freight in the near future more efficient and to use the capacities of existing rail-infrastructure and new lines under construction efficiently.