ALPENKONVENTION
CONVENTION ALPINE
ALPSKA KONVENCIJA
CONVENZIONE DELLE ALPI

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

**TOP / POJ / ODG / TDR**

**XVII**

**A3**

**EN**

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06-10-2022

# ANNEX

## 8 Activity Report of the Transport Working Group for the period 2021-2022 (EN)

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# ACTIVITY REPORT OF THE
# TRANSPORT WORKING GROUP
## FOR THE PERIOD 2021-2022
## (BETWEEN THE XVI AND XVII MEETINGS OF THE ALPINE CONFERENCE)

## 1. Overview of the mandate given by the XVI Alpine Conference

| Summary of the objectives according to the 2021-2022 mandate or work programme |
|---|
| The objectives of the Transport Working Group during Swiss presidency were as follows:<br>1. Continue the work on the external costs of transport in the Alpine area (Transport Protocol, Art. 14) with a synthesis report on the progress since the last status report and an overview about the evolution of transalpine freight transport flows , based on documents of the Transport Observatory of the CH-EU Land Transport Agreement<br>2. Contribute to the topic relating to policies and measures/instruments for sustainable mobility in the Alpine Area.<br>3. Finish assessing the potential of technologies for the promotion of sustainable passenger transport in the Alpine region (under German leadership), develop recommendations for implementation.<br>4. Give advice for improving the accessibility of remote mountain destinations with integrated transport systems or multimodal mobility, including passenger transport by rail, road (e.g. by low emission buses, minibuses and taxis), cable cars and shipping as well as active mobility like walking and cycling, and combining individual private mobility means, by identifying best practices, contributing to the development of new concepts and connecting the last mile.<br>5. Analyse the effects of the evolution of commuters' behaviours in the Alpine area concerning home-office mobility as well as everyday activities triggered by the recent sanitary crisis. Based on available reports in the member states of the Alpine Convention and on the results of the 2020 study report on possibilities for the reduction of transport demand through transport-saving spatial structures, new working or coworking solutions, pooling of shipments, regional and local distribution chains, changed mobility and behavioural patterns, recommendations for the implementation of measures in order to enhance quality of life will be elaborated.<br>6. Contribute to elaborate and complete a digital map on a relevant topic and to be published on the Alpine Convention WebGIS/Atlas, either by collecting the necessary data provided by other bodies and organizations or by relying on existing international sources. The specific content of such map will be agreed upon by the Group based on relevance and data availability. The map will be elaborated in cooperation with the PSAC. |

## 2. Meetings

| Summary of the meetings held (date, place, main topics and milestones) |
|---|
| • 4 March 2021 (online meeting): distribution of the tasks foreseen in the mandate;<br>• 1 June 2021 (online): update on the status and content as well as common discussion of the different tasks;<br>• 28 September 2021 (online): update on the status and content as well as common discussion of the different tasks;<br>• 20 January 2022 (online): update on the status and content as well as common discussion of the different tasks;<br>• 21 and 22 April 2022 in Landquart, Switzerland: discussion and (principal) approval of the four reports issued by the Group, discussion of the next mandate;<br>• 23 June 2022 (online): final approval of the reports before communication to the PC |

## 3. Activities carried out

| Synthetic description of further activities carried out (including outreach and communication activities) |
|---|
| • Regular meetings and bilateral exchanges<br>• Chairman's participation to the PC<br>• Chairman's participation on behalf of the Group to the MAP task force (kick-off meeting on 29 April 2021, roadmap 14 September 2021 in Chambéry, etc)<br>• Chairman's participation to chairs' meetings organized by the PSAC (17 June 2021 and 25 January 2022)<br>• Chairman's participation to two meetings of the Alpine climate board (15 December 2020 and 4 November 2021) |

## 4. Outputs and results

| Description of the main outputs and results achieved |
|---|
| • Four reports:<br>o *Report on the Eurovignette Directive - Synthesis and status report on the application of the Eurovignette Directive 1999/62/EC as modified by 2011/76/EU (Swiss leadership),*<br>o *Climate neutral Alpine mobility, Report on policies for sustainable mobility in the Alps (Austrian-Italian leadership),* |

- *Potential analysis of existing and new technologies for the promotion of a sustainable passenger transport in the Alpine region (German leadership),*
- *Daily mobility in the Alps after Covid crisis recovery (French leadership).*

- *Conversely, the 5th and 6th objectives couldn't be fulfilled on time and could be taken up again in a next mandate.*

## 5. Cooperation

| Description of cooperation developed with other Alpine Convention bodies and further relevant partners and processes, and of the resulting benefits |
|---|
| • PC, MAP task force, ACWB chairs' meetings: participation to its meetings<br>• Alpine climate board: participation to two meetings<br>• Zurich process: Former EnvAlp chairman (Matthias Rinderknecht) is Swiss delegate at the WG; representatives of Slovenia (Zlatko Podgorski), Liechtenstein (Henrik Caduff) and France (Guy Poirier) are also at the same time Steering committee members of the Zurich process and WGT members.<br>• EUSALP, Interreg Alpine space programme, CIPRA, iMONITRAF!: observers at the WG |

## 6. Attachments

| List of the documents attached to this report, such as papers proposed for approval by the XVII Alpine Conference (thematic reports, guidelines, statements etc.) and supporting documents (workshop proceedings, survey reports, communication materials etc.). *Please kindly provide a PDF file of each attachment. Do not include the minutes of regular meetings!* |
|---|
| 1. *Report on the Eurovignettte - Synthesis report based on an updated Questionnaire on the application of the Eurovignette Directive 1999/62/EC as modified by 2011/76/EU*<br>2. *Report on policies for sustainable mobility in the Alps - Climate neutral Alpine mobility*<br>3. *Report on technologies - Potential analysis of existing and new technologies for the promotion of a sustainable passenger transport in the Alpine region*<br>4. *Report on behaviours - Daily mobility in the Alps after Covid crisis recovery*<br>NB: These four reports have been sent to the PSAC by 25 April 2022 in a quasi-final version and finalized at the WG 23 June 2022 online meeting. |

# REPORT ON THE APPLICATION OF THE EUROVIGNETTE DIRECTIVE

***Synthesis and status report on the application of the Eurovignette Directive 1999/62/EC as modified by 2011/76/EU***

**Transport Working Group of the Alpine Convention**

*Mandate 2021-2022*

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## IMPRINT

This report is the result of the Transport Working Group, chaired by France.

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**National delegates**:

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- **Switzerland**: Matthias Rinderknecht, Franziska Borer Blindenbacher (*Eidgenössisches Department für Umwelt, Verkehr, Energie und Kommunikation UVEK* – Federal ministry of environment, transport, energy and communication).

**Observers**:

- Hélène Denis and Veronika Schultz (*Club Arc alpin*)
- Jakob Dietachmair and Stefan Tischler (CIPRA)
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Permanent Secretariat of the Alpine Convention, 2022

**Cover picture**: ©Daniele Fossali

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# 1. BACKGROUND AND PURPOSE

The actual mandate 2021/2022 of the Working Group on Transport (WGT) of the Alpine Convention[1] also deals with article 14 of the Transport Protocol[2] and the implementation of the polluters pay principle in road freight transport in Alpine countries. It continues the work on the external costs of transport in the Alpine area.

In this context, Switzerland (CH) has taken over the task to write a short report on the progress since the last status report in 2016[3]. Another aspect of the mandate is to analyse, to which extent the Eurovignette Directive[4] is in line with the provisions of article 14.

In order to be able to proceed to this analysis, Member States were asked to indicate their experiences made with respect to the implementation of the Eurovignette Directive 2011/76/EU. For this purpose, the questionnaire in the Annex 2, elaborated initially by Austria (AUT) in 2013, was refined and updated by Switzerland and sent to the Member States in July of 2021 to be filled out during the summer months.

This task had to be finalised until the XVII Alpine Conference on 26-27 October 2022, in Brig, Switzerland, under Swiss Presidency of the Alpine Convention.

# 2. STATUS ON IMPLEMENTATION OF EUROVIGNETTE 2011/76/EU DIRECTIVE

## 2.1. Result of the updated survey 2021

### 2.1.1. Scope

In application of article 14 of the Transport Protocol of the Alpine Convention, the WGT is – after 2016 - again updating the synthesis on the present application of the Eurovignette Directive and similar tolling systems and, in more general terms, the implementation of real costs, including external costs, in the Alpine countries.

The scope of the Swiss survey and questionnaire is the gathering of information about

- tolling modalities,
- level of tolls,
- differentiation by emission classes or other categories,
- tolling network,
- mark ups, and
- the use and earmarking of toll revenues.

The information sent back to Switzerland by all Member States provided answers to the sixteen questions of the survey. The following main points emerged from the survey, listed more detailed in Annex 1.

[1] Transport_WG_Mandate_2021-22_en.pdf (alpconv.org)

[2] Protocol_Transport_EN.pdf (alpconv.org)

[3] See here: Annex_1_Synthesis Eurovignette_with_questionnaires-AT-CH-DE-FR (alpconv.org)

[4] Consolidated version of Directive 2011/76/EU of the European Parliament and of the Council of 27 September 2011 on the charging of heavy good vehicles for the use of certain infrastructures EUR-Lex - 32011L0076 - EN - EUR-Lex (europa.eu)

### 2.1.2. Implementation at legal level

The implementation of legal principles/rules is various, be it through the Constitution, federal laws, regulations or road acts. In most of the countries, implementation of tolling rules is regulated by national laws and regulations. In Switzerland, the principle of tolling is even based on the Federal Constitution (art. 36 quarter).

### 2.1.3. Tolling network

The survey displays that in all countries except Switzerland, the perimeter of application concerns the national tolling network such as the highways and trunk roads. As for CH, the entire road network is at hand.

In **Germany**, an important extension of the tolled network was operated to other trunk roads/Bundesfernstrassen in July 2018 (approx. 52,000 km tolling network).

The level of toll for a Euro 6 vehicle varies between 0.2 €/km and 0.42 €/km regarding the four+ axles. More precisely, the toll is of 18.3 cts/km in Germany, involving the infrastructure costs (16.9), air pollution costs (1.2) and the noise costs (0.2); of 27.6 cts/km on average in France, taking into consideration the infrastructure costs only; of 41.702 cts/km during the day in Austria, involving the infrastructure (40.299), air pollution (1.2) and the noise (0.203) costs; of 42.8356 cts/km in SLO, including an adjustment factor of 0.6 and finally of 2.28 cts/tkm in CH/FL including the overall costs, namely infrastructure and external costs.

In **Italy**[5], the toll variation is between 0.15 €/km and 0.20 €/km (for different vehicle categories based on number of axles), without any differentiation of Euro classes. Only few sections of the Italian highway network apply a fixed lump sum on so-called “open systems” on highway stretches like A8 Milan–Laghi or A12 Rome–Civitavecchia, where the customer does not need to take a ticket, but just has to pay a pre-established distance-amount applying a lump sum approved by the awarding body (ANAS). The majority of the network is operated in a "closed system", where the customer takes a ticket on entering the highway and returns it on exiting, paying toll on the basis of the route covered[6].

In **France**, a similar system is operated by concessionary companies applying on the majority of the network also a closed system, where users take a ticket entering the highway stretch and pay at the exit. As in Italy, an electronic tolling system based on On Board Units (OBU) and automatic registration units at toll stations allow also digital recording and payment instead of manual ticketing and payment. Few highway stretches are also operated as open systems with lump sum payment for each vehicle category. Two motorway concessions, Atlandes (104 km) and Albea (17.8 km) vary toll rates according to EURO emission classes. The concessions ARCOS (24 km) and ALIAE (88 km), which will respectively open in 2021 and 2022, will also vary toll rates according to EURO emission classes. One concession, CEVM – operating the famous bridge “Viaduc de Millau’ (2.5 kilometers long), varies toll rates depending on the season (summer / not summer). Two concessions (Cofiroute- A86 duplex and SANEF on motorway A1) vary toll rates depending on the time of day. One concession (Cofiroute-

[5] Home - Autostrade per l'Italia

[6] Network map: Italy toll roads map - Italy highway map (Southern Europe - Europe) (maps-italy.com)

A86duplex) varies toll rates depending on the type of day (Saturday, Sunday, holyday and day before a holyday, business day in august).

All concession contracts allow the use of different tolls according to the time of day should the state allow or demand it.

#### 2.1.4. Level of toll and differentiation

For **Switzerland**, including the **Principality of Liechtenstein**, the specificity to distinguish the tolling level compared to the other Alpine countries is the fact that the toll rate is calculated by vkm and tons (maximum allowed weight of the vehicle according to registration document), not only by vkm. The Swiss heavy vehicle fee is registered and collected by an OBU, which is compulsory for Swiss vehicles, allowing automatic distance registration and payment. Foreign vehicles must be registered when they first enter in Switzerland. At registration, an "ID CARD" is provided to the driver, containing all information on the vehicle. The card should be kept with the driver for all future journeys to Switzerland. Declaration of distance performed by the registered vehicle (weight, emission class) at the exit of Switzerland is operated by mean of this ID-Card at specific terminals. Hauliers, which often run through Switzerland, may install the Swiss OBU for easier automatic distance declaration and payment.

The specific performance related HGV fee (distance, max. allowed total weight, emission class) is calculated, as an example, for the 300 km trip through Switzerland, in comparison to the German toll system, for a 40 ton Euro 6 vehicle generates the following toll costs:

**Switzerland**: 300 (km) x 2.28 cts x 40 (t) = 273.6 CHF = 260.5 € [by exchange rate of 1.05]

**Germany**: 300 (km) x 18.3 €cts = 57.29 CHF = 54.9 €

Compared to other Alpine crossings like the French-Italian crossing by Mont Blanc or Fréjus, the usual toll rates as well as the tunnel fees representing only infrastructure maintenance costs need to be taken into account.

The following comparison of Alpine Crossing sections linking France – Italy, transit through Switzerland and Germany-Austria-Italy shows the different level of tolls (incl. highway tolls, tunnel tolls, special tolling sections ("Sondermautstrecken")):

**Toll-level comparison 2014 / 2021 for a 40t HGV (emission category 5 for 2014 and 6 for 2021)**

**France – Italy by Fréjus: Lyon-Santhia (350 km)**

| Toll / fee | 2014 € without VAT | 2021 € without VAT | sources |
|---|---|---|---|
| Tunnelfee Fréjus (F->It) | 194.40 | 222.58 | 2014: http://www.tunneldufrejus.com/doc/commerciales/tariftun2014.pdf (Half of the return-ticket at reduced price which is the most favorite-one,minus 20% VAT France) 2021: https://www.sftrf.fr/InfoliveDocuments/tarifs/tarifs_tunnel_au_1er_janvier_2021.pdf |
| Highway toll (A43 France) | 65.60 | 71.58 | http://www.autoroutes.fr/fr/itineraires.htm (Lyon-Valfréjus; abzügl. 20% MWST Frankeich) |
| Highway toll (A32 and A4 Italy) | 39.10 | 46.97 | https://www.autostrade.it/autostrade-gis/ricercaPercorso.do?tipo=P&equivalenzaClassi=5&dscDa=bardonecchia&dtxpDa=11118&dscA=santhia&dtxpA=21125 (Bardonecchia-Santhia; abzügl. 22% MWST Italien) |
| **TOTAL 2014** | **299.10** | | **vKM (length ~350 km): 0.85 €/km** |
| **TOTAL 2021** | | **341.13** | **0.97 €/km** |

**Transit through Switzerland: Basel-Chiasso (300 km)**

| Toll / fee | 2014 € without VAT | 2021 € without VAT | sources |
|---|---|---|---|
| HGV fee per km and per ton of max. authorized weight of vehicle, Euro 5 in 2014 and Euro 6 in 2021 | | | HGVF in CHF: 0.0228CHFx40 [t] x 300[km]= 273.60 CHF (without VAT) HVC - General / Rates (admin.ch) |
| **TOTAL 2014** | **228** | | 2014 average exchange rate: 1€ = 1.20 CHF) **vKM (length ~300 km): 0.76 €/km** |
| **TOTAL 2021** | | **251.33** | Same level of fee for Euro 6 vehicle in 2021 as for Euro 5 vehicle in 2014 2021 average exchange rate: 1€ = 1.08 **0.84€/km** |

**Transit through Austria until northern Italy Verona: Kufstein-Verona (341 km)**

| Toll / fee | 2014 € without VAT | 2021 € without VAT | sources |
|---|---|---|---|
| Highway toll (A12, A13 Austria | 92.34 | 83.90 | http://services.asfinag.at/mautkalkulator-light (A12 Kufstein to A13 national border line Brennerpass; incl. Sondermaut - section; minus. 20% VAT Austria); day-time tariff, see also note[1] [https://mautkalkulator-light.go-maut.at/de/, average day / night tarif] |
| Highway toll( A22 Italy) | 30.96 | 32.95 | https://www.autostrade.it/autostrade-gis/ricercaPercorso.do?tipo=P&equivalenzaClassi=5&dscDa=Brennero&dtxpDa=305&dscA=Verona&dtxpA=15030 (A22 Brennero-Modena - Verona-Nord; minus. 22% VAT Italy) |
| **TOTAL 2014** | **123.30** | | **vkm (length ~341 km): 0.36 €/km** |
| **TOTAL 2021** | | **116.85** | **0.34 €/km** |

[1] In 2014 the infrastructure charge in AT was differentiated according to the EURO emission class in a revenue neutral way. While the differentiation factor for EURO IV and V in 2014 was 1,05, it was 0,92 for EURO VI. In 2021 for EURO VI vehicles a factor of 0,985 on the infrastructure charge was applied (= toll bonus of 1,5% compared to all other EURO emission classes). In 2016 the toll rates on the A 13 Brenner Autobahn had to be adjusted.

Concerning the current toll rates, the survey shows that some of the countries (DE, CH) do not include VAT in their stated rates. Austria has five separate toll rate networks in terms of infrastructure charges. Furthermore, Austria has an external cost charge for air pollution, and external cost charge for noise pollution. Germany has a similar approach. The toll rate calculation takes into account the air pollution, noise pollution, and the infrastructure costs. Switzerland presents overall rates, which include infrastructure costs and external costs, differentiated in three categories according to the emission classes, Slovenia defines also different emission classes. The toll rates in France include the VAT and vary from one motorway concession to another. In Italy the Highway Concessionary companies apply toll rates for three categories of heavy vehicles (Class III: Vehicles with three axles; Class IV: Vehicles with four axles; Class V: Vehicles with five and more axle) according to the specific stretches and VAT of 22%.

Regarding the topic of charged vehicle categories and the tariffs applied, the survey unveils that the differences of principles of charging by axles, by total weight and by emission class between countries remain mostly the same as in the former activity report.

Most of the countries declare that charges vary according to factors such the emission, time and season. However, France underlines that only a small fraction of the network makes a differentiation regarding the emission classes. In Italy, no differentiation between Euro emission classes is made. Concerning the implemented differentiation, the countries proceed as follows. CH grounds its differentiation on the Euro emission classes, so does Slovenia while adding a distance adjustment factor. Germany implements differentiation based on emission as well as weight. In France, the differentiation varies from one concession to the other. In Austria, the differentiation varies with the number of axles, the Euro emission classes and the

time of the day. Furthermore, except Slovenia and Italy, a monitoring is implemented. The tools in order to do so vary from one country to the other.

#### 2.1.5. Mark ups and use of revenues

Austria and Slovenia report having a mark-up for financing specific projects of high interest for Europe. Austria does so in order to cross-finance parts of the Brenner Base tunnel and Slovenia in order to finance the rail section Divaca-Koper.

In Italy, where highway concessionary companies are levying specific infrastructure tolls, only on the highway section of A22 between Modena and Brenner a mountain rate (”tariffa di montagna”) is operated.

Concerning monitoring measures, in France, impacts are being monitored in the two concessions, which use differentiation of Euro emission classes (Atlandes and Albea) following the rules of the articles 25 of those contracts:

https://www.ecologie.gouv.fr/sites/default/files/Atlandes%20Cahier%20des%20charges%20vf.pdf
https://www.ecologie.gouv.fr/sites/default/files/ALBEA_contrat_consolid_vf.pdf

They will also be monitored in the two future concessions ARCOS and ALIAE following the rules of the articles 25 of those contracts: https://www.ecologie.gouv.fr/sites/default/files/ARCOS_contrat_consolide_vf.pdf
https://www.autoroute-a79.fr/le-concessionnaire/

The impact of these toll differentiations provide no additional income for the motorway concession. Vehicles may pay up to 10% more or less according to their Euro classes on air pollution.

On the subject of the impact on interurban road network, only Germany and Switzerland observe an impact. France does not, whereas Austria and Slovenia have no view on the subject.

Concerning the charging revenue earmarked for transport sector and its extension, the surveys displays that it concerns for France, Germany, Slovenia and Switzerland some of it, whereas for Austria it concerns all of it.

#### 2.1.6. Modal shift effects

Germany, and Switzerland report observing a shift from road to rail. Germany reports that the influence on modal shift is minor, but that it has positive effect on emission classes, use of capacities and diminution of empty trips. Switzerland observes an emission reduction, a HGV traffic reduction in numbers, and an incentive on vehicle technology renewal. Whereas France does not and Slovenia has no view upon the question. As positive effects, Austria mentions that toll measures like charging external costs and applying a mark-up could build incentives, which help to achieve the objectives of art. 14 by contributing to encourage the use of more environmentally friendly vehicles and a modal shift from road to rail.

Most of the countries with the exception of Slovenia and Italy plan additional measures. AUT recently has raised the bonus on the infrastructure charge from 50% to 75% for E/H2-vehicles since 1 September 2021 and may implement further measures depending on the provisions of a new Eurovignette Directive. FR plans new regulations allowing local authorities to implement

toll on non-tolled motorways. CH is looking further into a new system of a so-called mobility pricing (charging road and rail passenger as well as freight transport), planning pilot projects for 2027 as well as a further development of HGV fee, which will eventually include $CO_2$ emissions and alternatives to fuels and propulsion systems.

In Italy, the highway concessionary companies keep concessions based on provisions dated a long time ago with long duration. The concessionary companies will therefore have to implement new provisions of the Eurovignette Directive only following the renewal of the existing concession, which implies an average deadline in the next 15-20 years.

Finally, Austria, Germany, and Switzerland plan to or already charge external costs in their tolling schemes. For further details, see 13.b.

## 3. EU PROGRESS SINCE LAST STATUS OF 2016

### 3.1. Progress concerning principles of charging, tolling network, vehicle categories

Regarding the topic of charged vehicle categories and the tariffs applied, the survey unveils that the differences of principles of charging by axles, by total weight and by emission class between countries remain mostly the same as in the former activity report.

Germany:

An important progress concerning the tolled network is stated in Germany since July 2018, where the tolled network was extended to other trunk roads (Bundesfernstrassen), total length of the tolled network 52,000 km.

Since October 2015, the tolled vehicle categories were changed: the limit of vehicle weight of tolling was lowered from 12 tons to 7.5 tons, which extended considerably the number of tolled vehicles.

Switzerland:

In Switzerland, the three categories containing the different vehicle emission classes are regularly updated. Currently, the categories, emission classes, and tariffs are as follows, presenting the specificity that the second category remains empty as no newer emission category than Euro 6 could be added:

| Category | Euro emission class | Tariff |
|---|---|---|
| I | Euro 0 to 5 | 3.10 Rp./tkm |
| II | - | 2.69 Rp./tkm |
| III | Euro 6 | 2.28 Rp./tkm |

The Swiss system of categories containing the different emission classes and the tariffs, decided by the government, needs the approval of the European Commission in the framework of the Joint Committee of the Landtransport Agreement EU-CH.

Italy:

The concessionary system for the main highway network covers most of the regions of the country.

### 3.2. Progress concerning distinction of various external cost factors in tolling rate

A most important element since the last review concerning implementation of the polluter pays principle and true costs is the fact that several countries introduced explicitly external cost factors in the overall toll rates.

In Austria for instance, a vehicle with four or more axles is tolled according to the following factors in comparison to a vehicle with two axles: infrastructure: 2.1; air: 1.6; noise: 2.9. In terms of the external cost charge for traffic-based air pollution distinctions are also made between the Euro emission classes. The external cost charge for traffic-based noise pollution distinguishes between day- and nighttime.

Also in Germany, the overall toll rate includes since 2017 explicitly beside the infrastructure use a factor for air pollution and noise.

The general overview looks as follows for a 40t Euro 6 emission vehicle:

Toll: infrastructure /+ external costs :

- DE: infra + air poll + noise -> 16.94 + 1.2 + 0.2 = 18.3 cts/vkm (since Oct 2021)
- FR: 27.6 cts/vkm (average) only infrastructure (concessionary companies)
- AT: infra + air poll.+ noise -> 40.299 + 1.2 + 0.203 = 41.702 cts/vkm (daytime)
- (mark up sections +25% / no ext. cost elements)
- SI: 42.8356 cts/vkm with adjustment factor 0.6 = 25.7 cts/vkm
- IT: only infrastructure : average 0.20 €/vkm (concessionary companies)
- CH/FL: 2.28 cts(CHF)/tkm (overall cost: infra + external costs)

### 3.3. Progress concerning use of revenues and earmarking

Since the last status report, in some countries an evolution concerning the use of revenues and earmarking took place.

While in the former period in almost all countries except Switzerland the revenues were affected specifically to road infrastructure investments only, the scope was widened in France and parts of the road tolling revenues from the concession companies are affected to the infrastructure financing Agency for all modes of transport,

Also in Slovenia, mark ups from tolling are used for the rail network extension (second rail Divaca–Koper).

In Italy, revenues from tolling generated by HGV are used by Highway Concessionary companies beside maintenance for safety and sustainability measures of road infrastructure (bridges, tunnels etc). Moreover, on the access highway to the Brenner A22, a mountain tariff is applied.

The reimbursement system for hauliers in Italy will be changed: reimbursement of tolls to the Haulage Companies will be differentiated on the basis of Euro classes of commercial vehicles (no reimbursement for < euro IV trucks – maximum reimbursement for Euro VI / alternative fuels trucks).

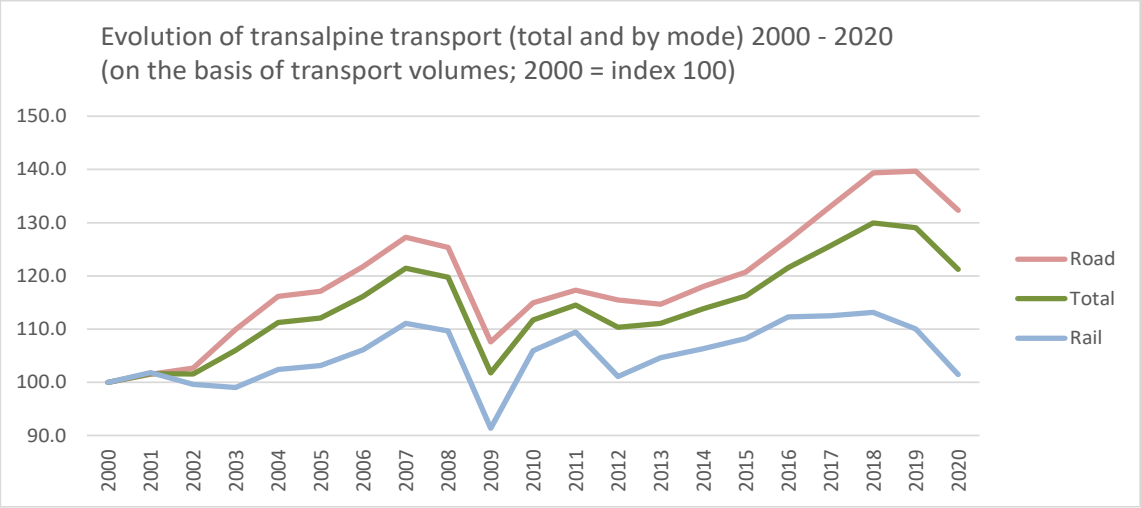
In Germany, revenues are not only reinvested in road infrastructure, but also in programs for employment, qualification, environment, security and safety of the road haulage transport branch as well as for EETS.

In Switzerland, the former "FinöV-infrastructure Fund" (reinvestment in projects of NEAT/alptransit, rail links to high-speed network, rail noise emission protection measures) was transformed 2016 into a general rail infrastructure fund (BIF) for new projects as well as for maintenance; 2/3 of HGV revenues are contributing to this fund, 1/3 is feeding cantonal budgets.

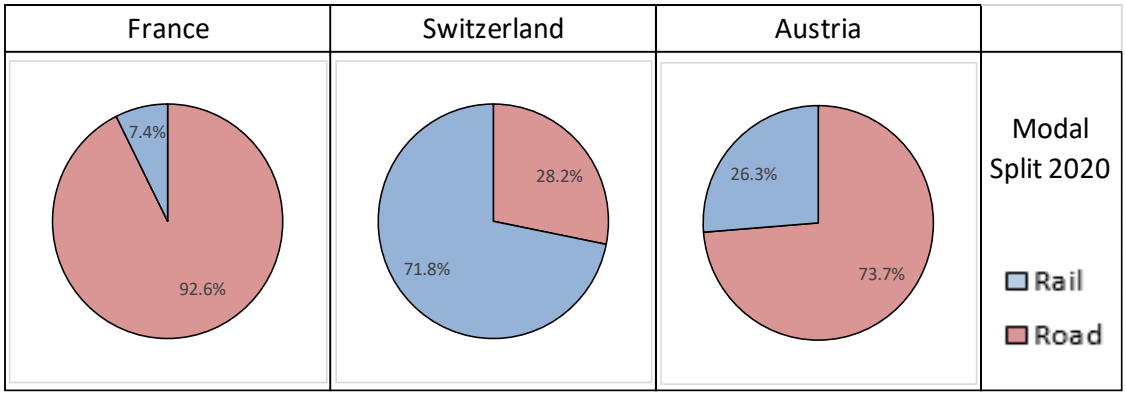
### 3.4. Overview of transalpine freight transportation (road and rail)

The analysis and results from the transalpine freight traffic Observatory Switzerland – EU provide an overview about the development over the last 20 years (up to 2020, an update concerning the figures from 2021 will be operated further on).

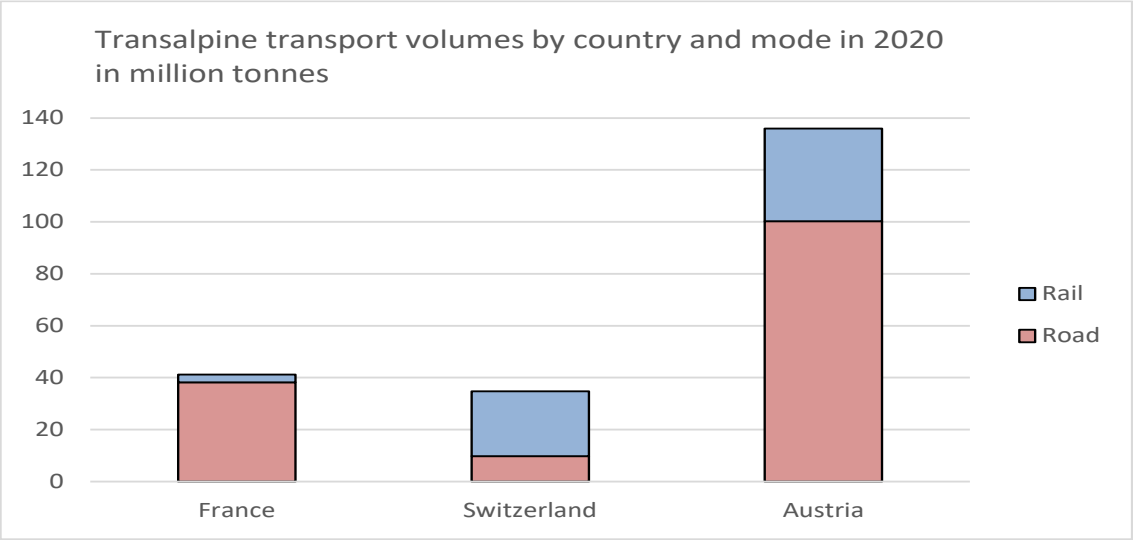
Evolution 2000 - 2020 of transalpine transport (basis index 100 in 2000):




Modal split figures for transalpine goods transportation:

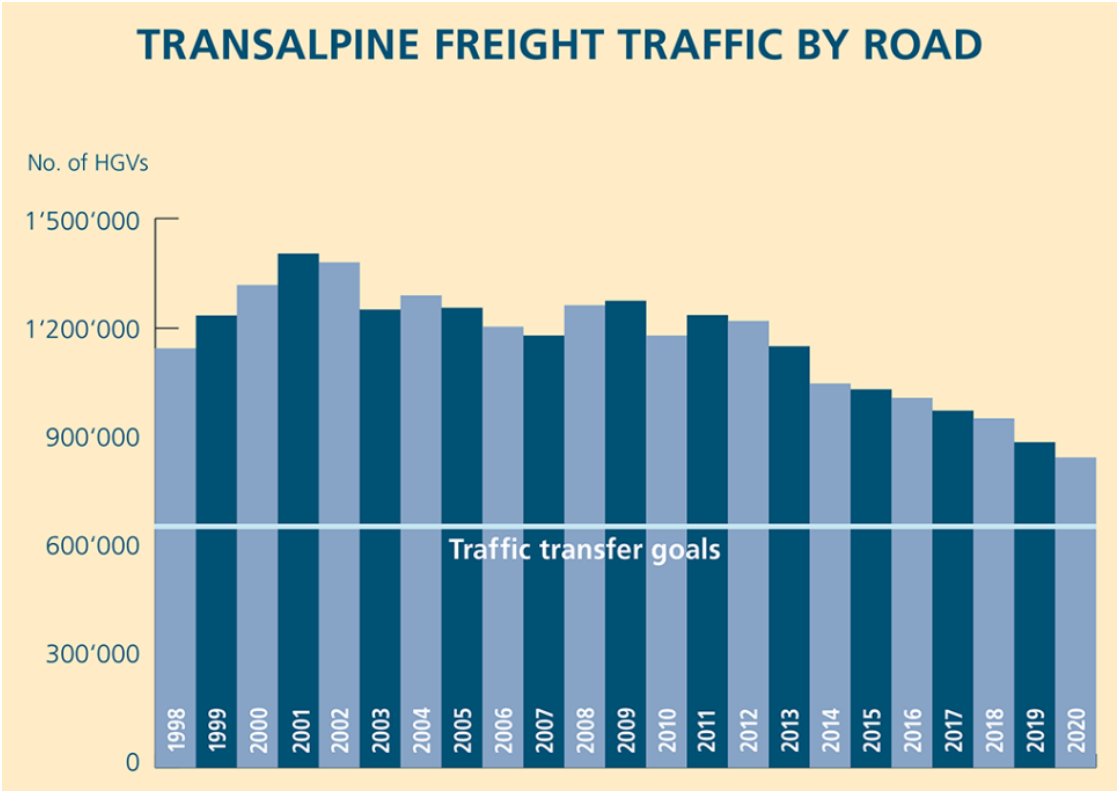


Transalpine transport volumes by country and mode:

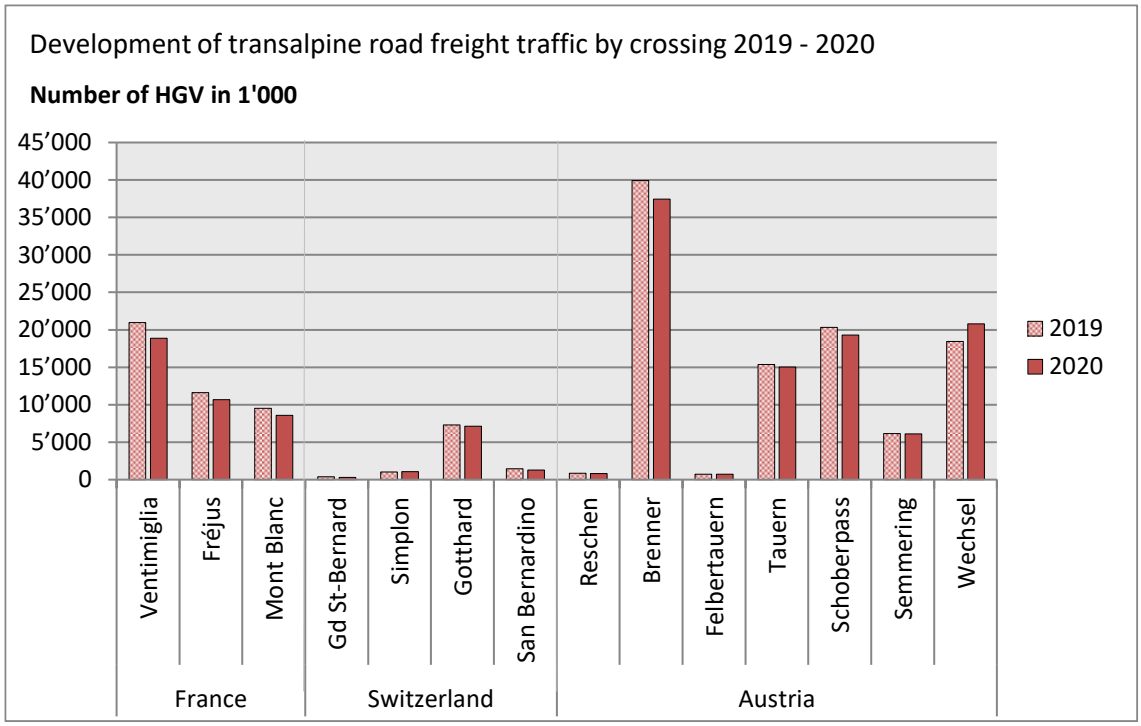



The specific case of transalpine transport through Switzerland shows the modal shift effect of a bundle of measures implemented over the last 20 years (HGV fee, railway reform, new important railway infrastructure in form of the three rail base tunnels Loetschberg, Gotthard and Ceneri, promotion of rail freight measures by different instruments and flanking measures):

The transfer goal for heavy goods vehicles is the number of 650,000 vehicles/year, not yet achieved, but on the way to reach it in a near future

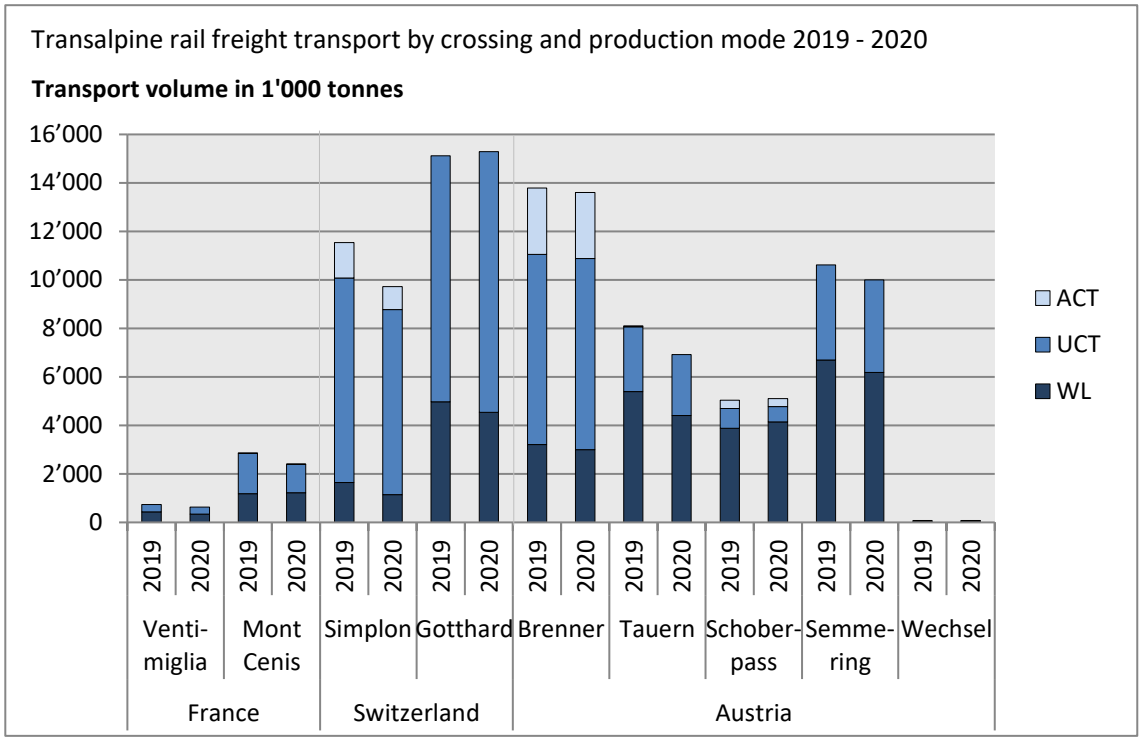


Road transport 2019 - 2020 by crossing:




Rail transport 2019 - 2020 by crossing and production mode (ACT, UCT, WL):

(Accompanied Combined Transport, Unaccompanied Combined Transport, Waggon Load)



Transalpine Road freight transport: Euro-emission classes of vehicles / shares by country[7]

France – Italy (Fréjus / Mont Blanc) :

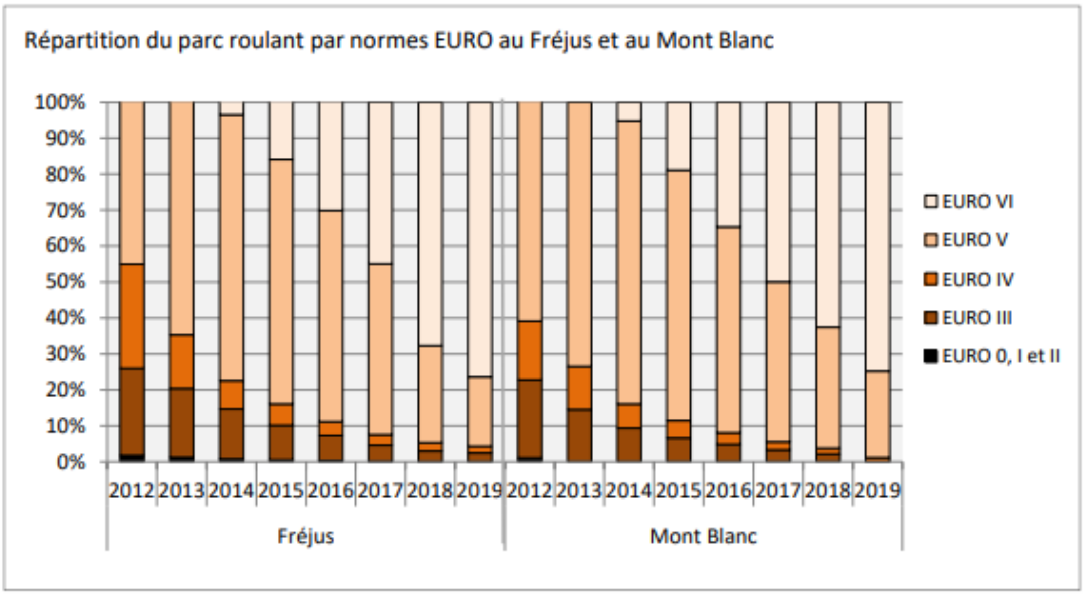



Figure 20: Répartition du parc roulant par normes EURO aux passages du Fréjus et du Mont Blanc

Switzerland :

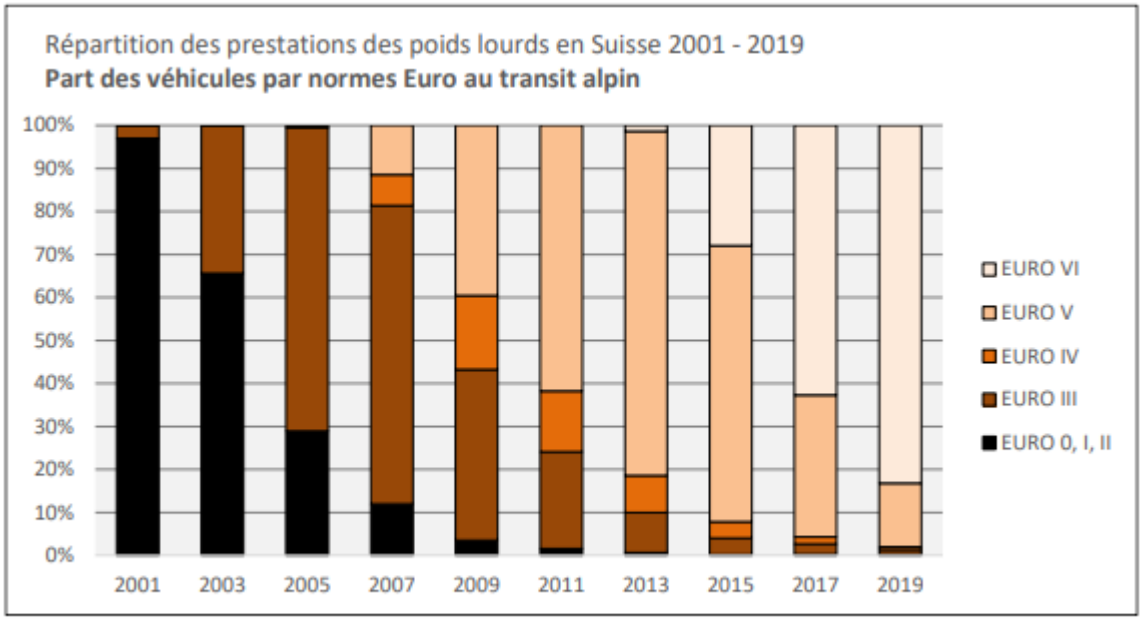



Figure 21: Répartition des poids lourds en trafic transalpin suisse selon normes EURO 2001 - 2019

[7] Figures from 2019 in Annual report Observatory CH-EU: https://www.bav.admin.ch/dam/bav/de/dokumente/themen/verlagerung/alpenobservatorium-2019.pdf.download.pdf/RA_2019_V5_0.pdf

Austria, 2011-2019, distribution on the different axis:

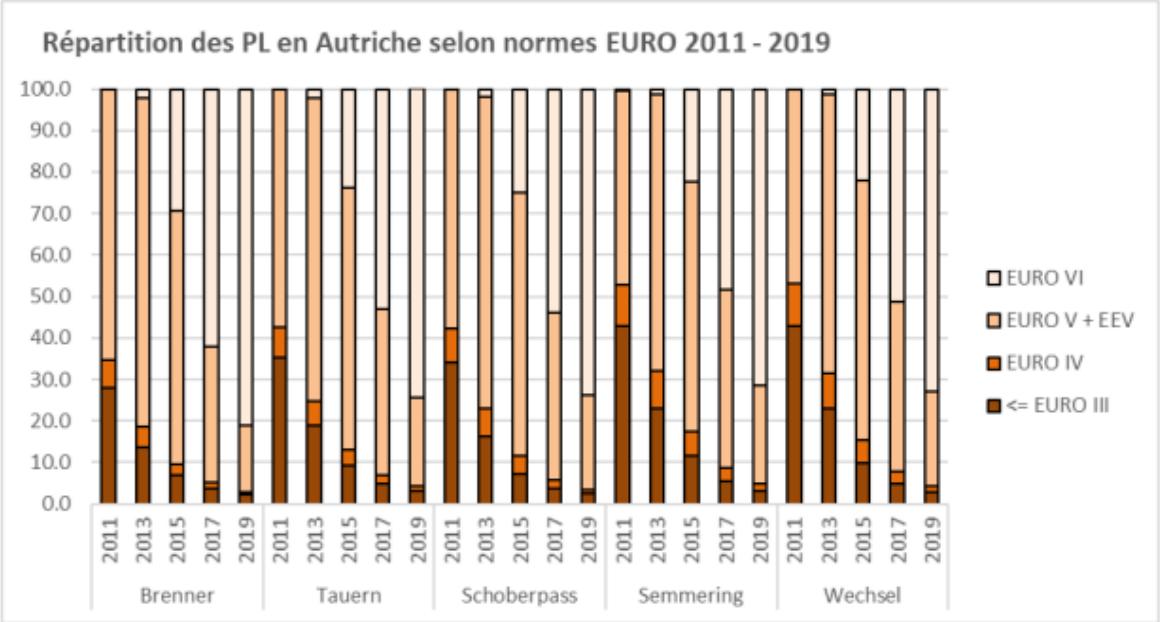
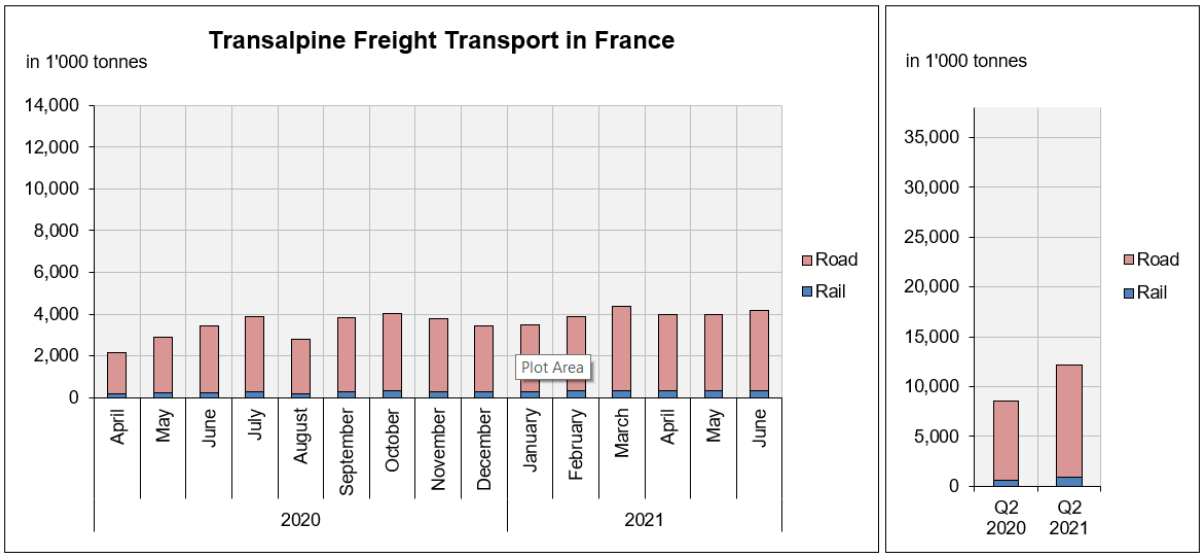


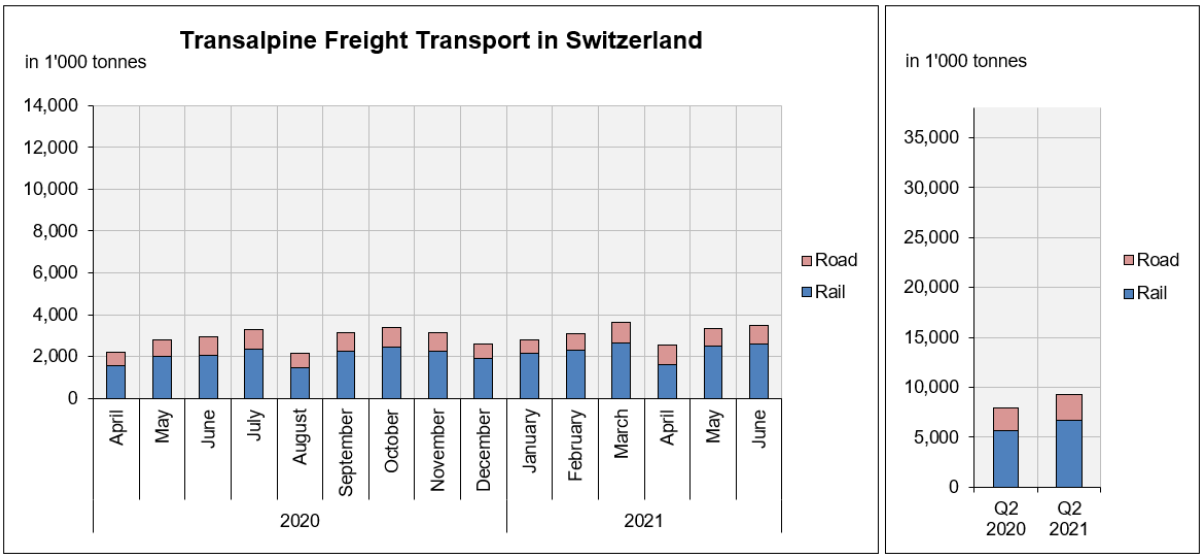

Figure 22: Répartition des poids lourds en Autriche selon normes EURO 2011 - 2019

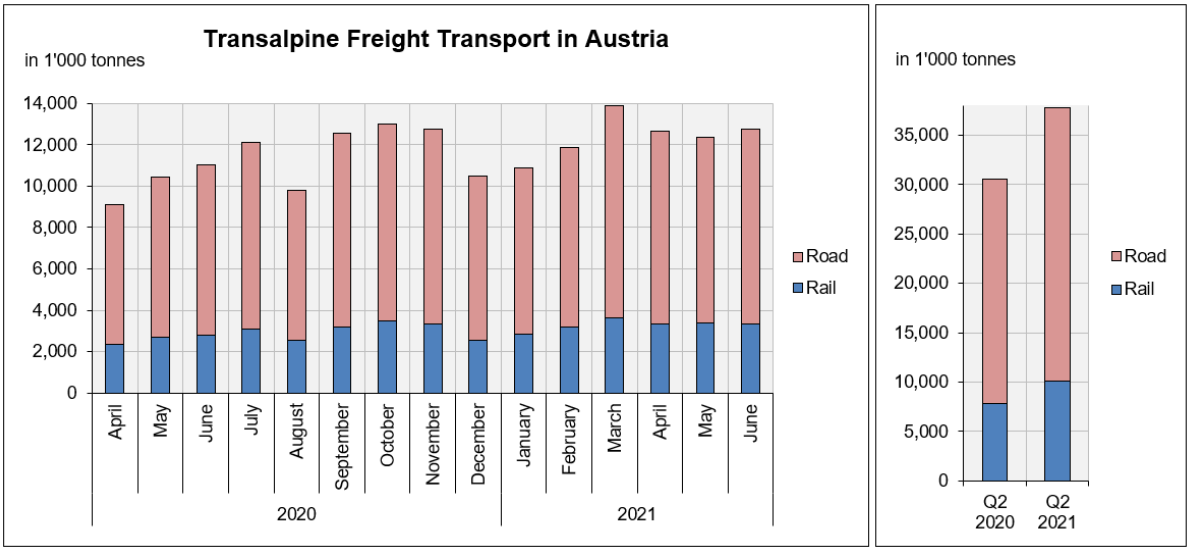
On all important crossings, where long distance international freight transport is performed, the share of Euro 6 vehicles achieves in 2019 already about ~80%, Euro 5 between 10 and 15 % and only very few lower Euro categories

### 3.5 Overview concerning 2021

The latest developments in transalpine freight transport (road+rail) show variations due to the Covid-19 crisis:






## 4. STATE OF THE ART ON EXTERNAL COSTS

In our last two mandates, we produced and looked at studies

- of France: “Assessment of external costs induced by noise in mountainous areas” (CEREMA, 2018) AlpineConvention_TransportWG_ExternalCostsNoise_112018_web (alpconv.org)
- and of the EUSALP working group 4: Study on External Costs in Mountain Areas | EUSALP (alpine-region.eu) (EUSALP, 2017)

for relevant mountain factors regarding internalisation of external costs for heavy goods traffic.

The findings (see table 19 of EUSALP study, 2017, below) show a necessity of taking into account the specific needs of the sensitive Alpine environment and of the trans-Alpine transport networks. The Alpine regions are particularly sensitive to the negative impacts of freight and passenger transport. This is due to very high shares of heavy goods vehicles (HGV), specific topographical features, limited spatial resources and highly vulnerable ecosystems.

Table 19: Mountain factors for external costs of transport

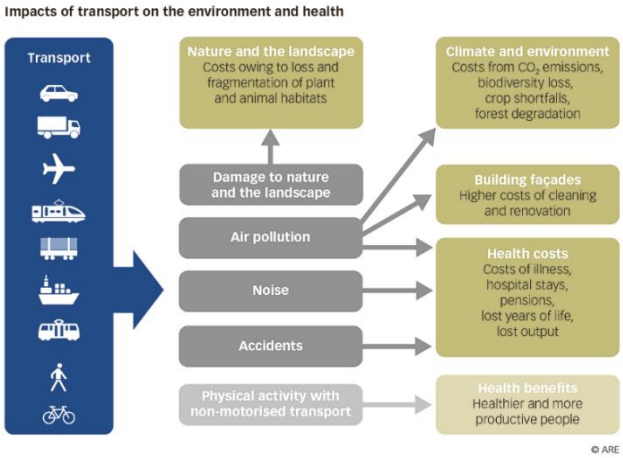
| | Present EUSALP study | | GRACE study (2006) | |
|---|---|---|---|---|
| Cost category | Road transport | Rail transport | Road transport | Rail transport |
| Air pollution | **4.2** (1.3 – 14.2) | **2.6** (0.9 – 6.6) | 5.25 (2.4 – 19.8) | 3.5 (2.1 – 5.2) |
| Noise | **4.1** (1.3 – 14.7) | **3.0** (1.0 – 11.25) | 5.0 (2.3 – 19.8) | 4.15 (2.1 – 10.4) |
| Nature & landscape | **1.3** (1.0 – 1.6) | **1.4** (0.8 – 2.0) | n.a.* | n.a.* |
| Accidents | **3.9** | n.a. | n.a. | n.a. |

**Switzerland**

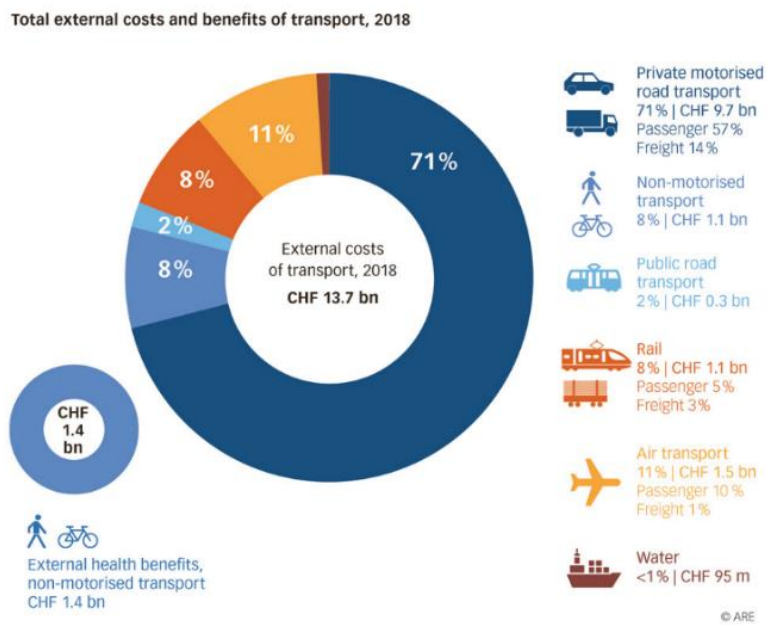
In the meantime, Switzerland has updated the external environmental, accident, and health-related effects of transport in Switzerland with results for the year 2018: External costs and benefits of transport (admin.ch).

Costs and benefits for the following areas were calculated: air pollution-related damage to health, damage to buildings, crop shortfalls, forest degradation, loss of biodiversity, noise, the climate, nature and the landscape, soil degradation, upstream and downstream processes, accidents, additional costs in urban areas, and the benefits to health of non-motorised transport. Congestion costs were estimated in a separate study.

External cost calculations in Switzerland include life-cycle emissions for vehicles and fuels, take into account a well-to-wheel analysis and all relevant processes producing emissions ahead of the operational phase, and are based on an electricity mix of electricity produced in Switzerland as well as imported electricity with the relevant CO2-emissions.




The total external costs of transport in Switzerland amount to 13.7 billion Swiss Francs (CHF) in 2018 and congestion costs to 1.4 billion Swiss Francs in 2017).




For optimum resource allocation within an economy, external costs and benefits should be internalised. In other words, they must be charged or credited to those who produce them. In Switzerland, these costs – total external and congestion costs – are also accounted for in the Swiss Heavy Vehicle Fee, successfully applied since 2001 on the entire Swiss network.

There are no mountain factors applied in the system of the Swiss Heavy Vehicle Fee (Heavy vehicle charges (performance-related and lump-sum) (admin.ch)).

The Heavy Vehicle Fee applied in Switzerland reflects an overall amount for a full cost calculation including the different external cost factors covering the entire country, meaning flatland, hills, and mountainous areas. It was designed in the 90ies and introduced in national legislation in 2001 as well as in the Landtransport Agreement CH-EU entering into force in June of 2002. In the Landtransport Agreement, the level of the fee covering the entire territory is explicitely mentioned in article 4. A splitting in a “normal” and a “mountainous” level of the fee would be difficult to apply. Nevertheless, the level of the fee, calculated in vehicle-kilometres and tons, is already reflecting an average of the external costs in the flatland, hills, and the mountainous area.

**European Union**

In 2008, the European Commission commissioned the first Handbook on External Costs of Transport (as part of the IMPACT study, Infras, CE Delft, ISI & University of Gdansk, 2008). In 2014, the Handbook was updated and broadened with new developments in research and policy (Ricardo-AEA, TRT, DIW Econ & CAU, 2014). The Handbook of 2019 (Handbook on the external costs of transport - Publications Office of the EU (europa.eu)) is an update of the 2008 and 2014 version, taking into account any new evidence that has become available on the methods and input values (e.g. emission factors) for estimating external costs of transport in research and policy since 2014.

This newest version of the Handbook does not only consider marginal external costs, as was the main focus of the previous Handbooks, but also total and average external costs of transport in all EU-countries, Switzerland and Norway. Furthermore, external cost figures for some non-European countries were produced to compare them with the European figures.

This updated Handbook on external costs of transport has been developed in the study 'Sustainable Transport Infrastructure Charging and Internalisation of Transport Externalities' commissioned by the European Commission DG MOVE, by a consortium led by CE Delft.

The full list of deliverables of this study are:

- **Handbook on external costs** – version 2019.
    - This report provides an overview of the methodologies and input values that can be used to provide state-of-the-art estimates for all main external costs of transport. Furthermore, the report and corresponding excel file present the total, average and marginal external costs for all relevant countries.
- **Overview of transport infrastructure expenditures and costs**.
    - This report provides an overview of the infrastructure costs of all transport modes in all relevant countries.
- **Transport taxes and charges in Europe** - An overview study of economic internalisation measures applied in Europe:
    - This study provides an overview of the structure and level of transport taxes and charges applied for the various transport modes in the EU28 Member States and other relevant countries like Switzerland. Furthermore, this study presents the total revenues from transport taxes and charges for the various transport modes and countries.
- **Summary report**.
    - Providing an overview of the main findings of the other four deliverables.
- **The state of play of internalisation in the European transport sector (EC, May 2019)**: Sustainable transport infrastructure charging and internalisation of transport externalities - Publications Office of the EU (europa.eu)
    - This report shows the extent to which external and infrastructure costs are internalised by current taxes and charges for all countries and transport modes. It also investigates recommended options for further internalisation.

This report (EC, May 2019) is a good source for more information on external costs and their internalisation in the European Union (EU 28) and for comparing, as far as possible, to our findings in the Alpine Area. See for example the report's results in the following three tables:

**Table 2 - External costs in the EU28 in 2016 (all figures are PPS adjusted)**

| Vehicle category | Total external costs | Average external costs |
|---|---|---|
| **Passenger transport modes** | **Billion €** | **€-cent/pkm** |
| Passenger car | 565 | 12.0 |
| Bus/coach | 19 | 3.6 |
| Motorcycle | 41 | 24.5 |
| High speed train | 1 | 1.3 |
| Electric passenger train | 11 | 2.6 |
| Diesel passenger train | | 3.9 |
| Aircraft | 48[a] | 3.4 |
| **Light commercial vehicles** | **Billion €** | **€-cent/vkm** |
| Light Commercial vehicle | 118 | 24.7 |
| **Freight transport modes** | **Billion €** | **€-cent/tkm** |
| Heavy Goods Vehicle | 78 | 4.2 |
| Electric freight train | 5 | 1.1 |
| Diesel freight train | | 1.8 |
| IWT vessel | 3 | 1.9 |
| Maritime vessel | 98[a] | 0.7 |

[a] Rough estimations. For more details, see CE Delft et al. (2019c).

Table 3 - Tax/charge revenues in the EU28 in 2016 (all figures are PPS adjusted)

| Vehicle category | Total tax/charge revenues | Average tax/charge revenues |
|---|---|---|
| **Passenger transport modes** | **Billion €** | **€-cent/pkm** |
| Passenger car | 267 | 5.4 |
| Bus/Coach | 7 | 1.2 |
| Motorcycle | 9 | 5.0 |
| High speed train | 4 | 3.0 |
| Electric passenger train | 8 | 2.6 |
| Diesel passenger train | 5 | 6.8 |
| Aircraft[a] | 14 | 1.5 |
| **Light commercial vehicles** | **Billion €** | **€-cent/vkm** |
| Light Commercial vehicle | 35 | 7.3 |
| **Freight transport modes** | **Billion €** | **€-cent/tkm** |
| Heavy Goods Vehicle | 33 | 1.5 |
| Electric freight train | 2 | 0.5 |
| Diesel freight train | 1 | 1.3 |
| IWT vessel | 0.4 | 0.3 |
| Maritime vessel[ab] | 2 | n/a |

[a] The figures for aviation and maritime transport refer to the 33/34 selected EU28 (air)ports.

[b] Due to a lack of data, no average tax/charge revenues (in €-cent/tkm) for maritime transport could be calculated.

Table 5 - Overview cost coverage ratios for the average cost perspective

| | Overall cost coverage | Overall cost coverage excluding fixed infra costs | Variable infrastructure and external cost coverage | Total infrastructure cost coverage | Variable infrastructure cost coverage |
|---|---|---|---|---|---|
| **Passenger transport** | | | | | |
| Passenger car | 51% | 63% | 48% | 27% | 417% |
| Bus | 17% | 24% | 21% | 3% | 6% |
| Coach | 18% | 26% | 23% | 3% | 6% |
| Motorcycle | 19% | 20% | 15% | 35% | 576% |
| High speed train | 26% | 145% | 208% | 28% | 394% |
| Electric pax train | 16% | 61% | 70% | 19% | 160% |
| Diesel pax train | 22% | 91% | 101% | 16% | 122% |
| Aircraft | 34% | 45% | 46% | 82% | 247% |
| **Freight transport** | | | | | |
| LCV | 43% | 53% | 48% | 11% | 153% |
| HGV | 26% | 37% | 33% | 14% | 44% |
| Elec. freight train | 12% | 30% | 35% | 16% | 86% |
| Diesel freight train | 26% | 55% | 61% | 25% | 138% |
| IWT vessel | 6% | 12% | 13% | 12% | 176% |
| Maritime vessel | 4% | 4% | 4% | 127% | 4,571%[a] |

[a] This very high cost coverage ratio can be explained by the fact that the variable share of port infrastructure costs is assumed to be low. Combined with the fact that port charges are often set to cover (most of the) total infrastructure costs, this results in very high variable infrastructure cost coverage ratios.

The report also investigates **recommended options for further internalisation** (EC, May 2019, p. 12):

"The assessment of the state-of-play of internalisation shows that there is room for improvement with respect to the internalisation of external and infrastructure costs of transport in the EU28. For that reason, a scoping analysis of potential further internalisation options has been carried out. The main results of this analysis are:

- Wider use of distance-based road charges differentiated to vehicle characteristics, location and/or time may improve the extent of internalisation for road transport. For urban areas, the use of specific urban road charging schemes may be considered to address the relatively high external costs of urban transport.

- Wider application of noise differentiations in rail access charges may be an option to further internalise the noise costs of rail transport. Mark-ups on these access charges may be used in case a larger share of the fixed infrastructure costs should be covered.
- Introducing fairway dues or higher port charges may be options to internalise a larger share of the external and infrastructure costs of IWT. Applying differentiations to air pollutant emissions in these instruments may help to address the relatively high air pollutant costs of this transport mode. Current legislation does, however, prohibit the introduction of fairway dues on the Rhine and its tributaries (the most important inland waterway(s) of the EU).
- Environmentally differentiated port charges or fairway dues may be options to further internalise the air pollution cost of maritime transport. With respect to GHG emissions of maritime transport, the EU already works with global partners in the International Maritime Organisation (IMO) on further policy instruments.
- Further policies in the field of GHG emissions from aviation are being developed in cooperation with global partners in the International Civil Aviation Organisation (ICAO). Furthermore, environmentally differentiated airport charges or aviation taxes may be options to further internalise externalities of aviation."

## 5. PERSPECTIVES WITH EU GREEN DEAL

The European Green Deal - with the goal of being the first climate-neutral continent by 2050 - may well support and strengthen the above mentioned recommended options for further internalisation and prove helpful for the Alpine Area as well.

In the summer of 2021, The European Commission adopted a set of proposals to make the EU's climate, energy, transport, and taxation policies **fit for reducing net greenhouse gas emissions by at least 55% by 2030 (fit for 55)**, compared to 1990 levels: A European Green Deal | European Commission (europa.eu)

"With transport contributing around 5% to EU GDP and employing more than 10 million people in Europe, **the transport system is critical to European businesses and global supply chains.** At the same time, transport is not without costs to our society: greenhouse gas and pollutant emissions, noise, road crashes and congestion.

Today, transport emissions represent around 25% of the EU's total greenhouse gas emissions, and these emissions have increased over recent years. Our goal of being the first climate-neutral continent by 2050 requires **ambitious changes in transport.** A clear path is needed to achieve **a 90% reduction in transport-related greenhouse gas emissions by 2050**.

The Green Deal for Transport is supposed to "providing efficient, safe and environmentally friendly transport by pursuing three objectives: sustainable, smart, and resilient mobility": Transport and the Green Deal | European Commission (europa.eu).

## 6. CONCLUSION AND RECOMMENDATION

While concluding this report, the news reaches the authors that the European Parliament adopted new rules on road charging in a final vote on 17 February 2022 Greening road transport: EU adopts new road charging rules (europa.eu): the new system will contribute to the aims of the European Green Deal and its Sustainable and Smart Mobility Strategy. The Commission tabled its proposal for the revised Eurovignette Directive in 2017. The revised Directive was signed on 4th March 2022 and published in the Official Journal of the EU, entering into force on the 20th day after publication. Member States will now have two years to enact the new rules in their national law.

The new system will improve incentives for more efficient and sustainable road transport. It will phase out time-based vignettes for heavy-duty vehicles on the core Trans-European Network by 2030, in favour of distance-based. It will also **introduce EU-wide rules to vary charges for heavy-duty vehicles based on their $CO_2$ emissions**. Moreover, after a 4-year transition period, **external cost charging for air pollution will become mandatory for heavy-duty vehicles**, except where it would create unintended traffic diversion.

While the existing rules cover only lorries over 3.5 tonnes with the option to exempt lorries under 12 tonnes, they will be extended to all heavy and light vehicles, making sure charges are proportionate to their use and environmental performance depending on type of vehicle. Tolling systems will also have to include the option of daily vignettes and avoid discriminating against foreign drivers. Member States will also have a new **option to apply an additional congestion charge on any section of their road network, which is affected by congestion**, with the revenues of these additional charges to be allocated to the development of sustainable transport alternatives. Road charging exemptions are included for special cases such as sparsely populated areas or disabled persons.

While the new Eurovignette Directive makes an initial contribution, there is still scope for further improvement. For instance, while the Sustainable and Smart Mobility Strategy of the European Commission points out that the costs of GHG emissions, air, noise and water pollution, accidents and road crashes, congestion and biodiversity loss affect our health and well-being, the new Eurovignette Directive (EU) 2022/362 still does not allow for internalising the traffic-based costs of water pollution, accidents and biodiversity loss.

## 7. ANNEXES

ANNEX 1:

Overview of national results

(separate document attached)

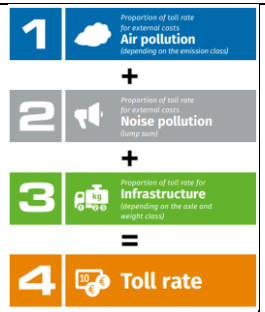
ANNEX 2:

Questionnaire sent to Member States

(separate document attached)

## Annex 1: Overview of national results

| ***Countries answering / Questions*** | **Austria**<br>Maximilian Koch | **France**<br>Christophe Mascitti | **Germany**<br>Maximilian Joshua Klebe | **Italy**<br>Massimo Santori | **Slovenia**<br>Simon Novak | **Switzerland /FL**<br>Thomas Supersaxo |
|---|---|---|---|---|---|---|
| **1. Legal principals/ rules**<br><br>**Vehicles charged** | Federal Road Tolls Act 2002<br>Toll Rate Ordinance 2020<br>Tolling Regulations<br>Toll Section Exemption Ordinance 2010<br>ASFINAG Act<br><br>• > 3.5t | Vehicles charged > 3.5t<br>Toll modulation according emission class<br><br>➢ 3.5t | Federal Trunk Road Toll Act<br>HGV Toll Regulation<br>various other regulations<br><br>➢ 7.5t (since Oct 2015) | act L.285/92: the transport of things on behalf of third parties is business activity for the provision of transport services for a specific fee<br><br>➢ 3.5t | Tolling act, various regulations<br><br>➢ 3.5t | Federal Constitution art. 85<br>Federal law on performance-related HGV-fee and Regulation<br><br>➢ 3.5t |
| **2. Charging: Map of application perimeter** | Map with national tolling networks | Map with national tolling network | Map with national tolling network | Map with national tolling network | Map with national tolling network | Entire road network |
| **3. Current toll rates, including VAT or not?** | VAT added to following net rates.<br>41.702 cts/km (4+ axles, EURO VI) during the daytime in Austria, involving the infrastructure (40.299), air | Toll rates incl. VAT<br>Toll rates vary from one motorway concession to another | Toll rates not subject to VAT<br>general scheme of toll rate calculation: | Highway concessionary companies<br>Min euro 0.15 / Max euro 0.20 per Km for HDV with 4/5 and more axles | VAT added to following net rates<br>R2 – R4 (axles)<br>▪ R2: 0.185346 € | Without VAT<br><u>Cat 1:</u><br>Euro 0-5: 3.10 cts/tkm<br><u>Cat 2:</u> -<br><u>Cat 3:</u> |

| | | | | | | |
|---|---|---|---|---|---|---|
| | pollution (1.2) and the noise (0.203) costs<br>five separate toll rate networks, each with<br>different toll rates consisting of:<br>▪ infrastructure charge<br>▪ external cost charge for air pollution<br>▪ external cost charge for noise pollution<br>See also Annex | |  | No difference according the Euro classes<br>VAT of 22% | ▪ R3: 0.205940 €<br>▪ R4: 0.428356 € | Euro 6:<br>2.28 cts/tkm |
| **4. Charged vehicle categories and tariffs > 4 axles** | In annexes of AT questionnaire | Vehicle categories:<br>▪ Class 3: 2 axles<br>▪ Class 4: 3 axles + more<br>Average:<br>▪ Class 3: 0.206€/km<br>▪ Class 4: 0.276€/km | See above,<br>18.7cts/km [Euro6]-26.1cts /km [Euro0/1] | 0.15 – 0.20 €/km | R4: 0.428356 € | See under 3, differentiated toll according to Euro class and weight, toll is calculated per tkm! |

| | | | | | | |
|---|---|---|---|---|---|---|
| **5.a Variation of charges (Emission, time, season)** | Yes | Only small fraction of network making differentiation of emission classes | Yes, emission, weight | No | Yes | Yes |
| **5.b Implemented differentiation** | two axles (factor: 1)<br>three axles (factors: infrastructure and air: 1.4; noise: 2.3)<br>four or more axles (factors: infrastructure: 2.1; air: 1.6; noise: 2.9)<br>**Infrastructure charge** is varied by EURO emission classes and drive type E/H2 (purely electric drive and hydrogen fuel cell drives):<br>• EURO 0 to V and EEV<br>• EURO VI (1.5%-bonus)<br>• E/H2 (currently 50%-bonus; 75%-bonus planned by | Yes.<br>Motorway concessions Atlantes and Albea vary according emission classes, in a near future also ARCOS and ALIAE also.<br>CEVM/Viaduc de Millau varies depending on seasons<br>Cofiroute A86 duplex and SANEF A1 | Emission + weight differentiation, see table in annex<br>▪ 7.5-11.99t<br>▪ 12-18t<br>▪ >18t to 3 axles<br>▪ >18t from 4 axles<br><u>Euro classes:</u><br>▪ Euro 0 and 1,<br>▪ Euro 2<br>▪ PRC1, Euro 2+, Euro 3<br>▪ PRC2, Euro 3+, Euro 4<br>▪ EEV, Euro 5<br>▪ Euro 6 | No | R2-R4, Euro emission class<br>Distance<br>Adjustment factors<br>▪ Euro IV:0.8<br>▪ Euro V: 0.7<br>▪ EEV and higher:0.6 | Euro classes |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 1st September 2021)<br>**External cost charge for air pollution** is varied by EURO emission classes (no charges for E/H2):<br>• EURO 0 to III<br>• EURO IV<br>• EURO V and EEV<br>• EURO VI<br>**External cost charge for noise pollution** and on the A 13 Brenner motorway the infrastructure charge for vehicles with four or more axles is varied by time of day:<br>• daytime (05:00 - 22:00)<br>• nighttime (22:00 - 05:00)<br>Tolls are not varied according to type of day or season | vary on time of day<br>Cofiroute A86 duplex varies on type of day.<br>Differentiation of 10% in the Euro Classes for more or less air pollution | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **5.c Monitoring** | Yes | Yes | Yes | No | No | Yes |
| **5.d Tools for Monitoring** | In terms of revenue neutrality the differentiation according to EURO emission classes<br>between 2010 and 2016 was monitored by ASFINAG and BMVIT (predecessor of BMK)<br>and had been adapted in 2012, 2014 and 2015, taking into account the development of the share of the different EURO emission classes and the necessary revenue neutrality.<br>Since 2017, external cost charges are applied. | Monitoring in two concessions with differentiation (Atlandes, Albea) and in future concessions ARCOS and ALIAE | Kilometer performance and Euro classes statistically evaluated<br>▪ Emission<br>▪ Driving performance by km<br>▪ Emission class | No, No implementation of Eurovignette Directive, each highway concessionary company will have to implement it following the renewal of the concession (average deadline in the next 15-20 years) | - | Statistics of customs administration for tkm per emission class, environmental Monitoring of flanking measures |
| **6.a Mark-up planned for financing of specific projects of** | Yes | - | No | Mountain tariff on Highway track A22 Modena – Brenner | Yes, +15% Koper-Ljubljana, | No |

| | | | | | | |
|---|---|---|---|---|---|---|
| **high European interest?** | | | | | +5% Ljubljana-Sentrupert | |
| **6.b If yes, what for?** | A mark-up of 25% in addition to the infrastructure charge is applied<br>• on the A 12 Inntal motorway on the Lower Inn Valley route (between the border at Kufstein and the Innsbruck-Amras intersection) and<br>• on the whole A 13 Brenner motorway.<br>The revenues from the mark-up are used for cross-financing the Brenner Base Tunnel.<br>Due to the provisions of the Eurovignette directive, which currently do not allow for applying a mark-up and external cost charges | - | _ | | Rail Divaca-Koper | - |

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| | cumulatively on the same road section, no external cost charges are applied on these road sections subject to a mark-up.<br>See also Annex | | | | | |
| **7. Development of traffic by vehicle categories** | See Tables | Data available only for Atlantes and Albea (1% of network)<br>General increase of HGV traffic (vkm) between 2011 and 2019: 19.1% | Statistics, appendix | Not identified | Not available | General Statistics, by emission class |
| **8. Impact on interurban road network** | No view | No | Yes, special reports, Marktbeobachtung BAG | No view | No view | Yes<br>Less empty runs<br>Slightly higher loading |
| **9. Charging revenue earmarked for** | All of it | Some of it | Some of it | See above mark up | partly | Yes, some of it |

| | | | | | | |
|---|---|---|---|---|---|---|
| **transport sector and how much** | | | | | | |
| **10. Details of earmarking policy** | Revenues from the infrastructure charge are used by ASFINAG for planning, construction, maintenance and refinancing of the federal road network (high- and express-ways) | Certain taxes of motorway concession companies fund/contribute to the French infrastructure financing agency (AFITF) for all transport modes | System costs, road infrastructure financing, programs for employment, qualification, environment, security and safety of the road haulage transport branch, EETS | The Highway Company have to improve security/safety and sustainability of network, bridges and tunnels<br>Specific project to realize rail infrastructures | Mark up for cofinancing 2nd rail Divaca-Koper | Revenues feeding the Rail Infrastructure Fund in the past for<br>NEAT/alptransit, Rail links to highspeed network, noise emission protection measures<br>Currently new Fund BIF for rail infrastructure projects 2/ 3of HGV fee revenues, 1/3 to Cantons |
| **11.a Shift from road to rail happening (2011/76 EU)?** | Yes | No | Yes | No view | No view | Yes |
| **11.b If yes, what are positive effects?** | The application of external cost charges, where the | - | Minor influence on modals split, but positive | - | - | Emission reduction |

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| | charge for air pollution is differentiated according to EURO emission classes and thus more environmentally-friendly vehicles pay lower charges, can encourage the use of more environmentally-friendly vehicles and therefore can contribute to achieve the objectives of Art. 14 a).<br><br>Since vehicles with purely electric drive and hydrogen fuel cell drives (E/H2) get a bonus on the infrastructure charge of 50% (75% planned by 1st September 2021), this measure can encourage the use of the most | | effects on emission classes, use of capacities, less empty trips | | | HGV traffic reduction in numbers<br><br>Incentive of vehicle Technology Renewal |

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| | environmentally-friendly vehicles and thus can contribute to achieve the objectives of Art. 14 a).<br><br>The mark-up of 25%, which is applied on the Brenner corridor, can contribute to incentivising a modal-shift from road to rail and can therefore contribute to encourage the use of the most environmentally-friendly modes and means of transport and to achieve a more balanced use of transport infrastructure on the Brenner corridor.<br><br>Therefore, this measure can contribute to achieve | | | | | |

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| | the objectives of Art. 14 a) and b). | | | | | |
| **12.a Plans for additional measures** | Yes | Yes | Yes | No | No | Yes |
| **12.b If yes, which ones and timing** | By 1st September 2021 the bonus for E/H2-vehicles (purely electric drive and hydrogen fuel cell drives) on the infrastructure charge will be raised from currently 50% to 75%.<br>Further measures depend on the provisions of a new Eurovignette directive. | New regulations allowing local authorities to implement toll on non-tolled motorways, no time schedule | Revision Eurovignette Dir. Including external cost charge for CO2 or/and a variation of the infrastructure cost charg.es based on CO2 | - | - | Plans for mobility pricing (road/rail), pilot projects for the future (2027)<br>Further development of HGV fee / LSVA including CO2 emission, alternative fuels / propulsion |
| **13.a Plans for integrating external costs** | Yes | - | Yes | - | No view | Yes, already integrated |
| **13.b Detailed information of planned measures** | External cost charges for traffic-based air and noise pollution based on the maximal values | - | See point 4 | The structure of highway tolls in Italy is anomalous in the European overview, due to the management of the | - | Integration of external cost factors in pricing already implemented |

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| | according to Annex IIIb of the current Eurovignette directive are already applied on all parts of the high- and expressway network except for the Brenner corridor, where due to the provisions of the Eurovignette directive, applying a mark-up and external cost charges cumulatively on the same road section is not allowed.<br>The Eurovignette Directive 2011/76/EU does not allow for applying additional external cost charges addressing climate change or costs due to CO2-Emissions. | | | network by numerous private highway cconcessionary companies, which follow different policies | | since introduction of HGV fee / LSVA in 2001.<br>Switzerland as a model and pioneer in this regard |

| | | | | | | |
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| **14. Additional Comments** | - | - | - | Road haulage companies are entitled to an annual reimbursement of the costs of fuel excise duties and tolls | - | EU Green Deal as leverage to this strategic target net zero by 2050, user pays principle and fair+efficient pricing |
| ***Countries answering / Questions*** | **Austria**<br>Maximilian Koch | **France**<br>Christophe Mascitti | **Germany**<br>Maximilian Joshua Klebe | **Italy**<br>Massimo Santori | **Slovenia**<br>Simon Novak | **Switzerland /FL**<br>Thomas Supersaxo |
| **2. Legal principals/ rules**<br><br>**Vehicles charged** | Federal Road Tolls Act 2002<br>Toll Rate Ordinance 2020<br>Tolling Regulations<br>Toll Section Exemption Ordinance 2010<br>ASFINAG Act<br><br>• > 3.5t | Vehicles charged > 3.5t<br>Toll modulation according emission class<br><br>➢ 3.5t | Federal Trunk Road Toll Act<br>HGV Toll Regulation<br>various other regulations<br><br>➢ 7.5t (since Oct 2015) | act L.285/92: the transport of things on behalf of third parties is business activity for the provision of transport services for a specific fee<br><br>➢ 3.5t | Tolling act, various regulations<br><br>➢ 3.5t | Federal Constitution art. 85<br>Federal law on performance-related HGV-fee and Regulation<br><br>➢ 3.5t |
| **2. Charging: Map of application perimeter** | Map with national tolling networks | Map with national tolling network | Map with national tolling network | Map with national tolling network | Map with national tolling network | Entire road network |

| | | | | | | |
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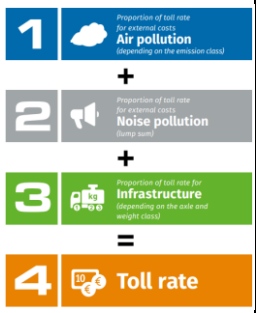
| **3. Current toll rates, including VAT or not?** | VAT added to following net rates.<br>41.702 cts/km (4+ axles, EURO VI) during the daytime in Austria, involving the infrastructure (40.299), air pollution (1.2) and the noise (0.203) costs<br>five separate toll rate networks, each with<br>different toll rates consisting of:<br>▪ infrastructure charge<br>▪ external cost charge for air pollution<br>▪ external cost charge for noise pollution<br>See also Annex | Toll rates incl. VAT<br>Toll rates vary from one motorway concession to another | Toll rates not subject to VAT<br>general scheme of toll rate calculation:<br>  | Highway concessionary companies<br>Min euro 0.15 / Max euro 0.20 per Km for HDV with 4/5 and more axles<br>No difference according the Euro classes<br>VAT of 22% | VAT added to following net rates<br>R2 – R4 (axles)<br>▪ R2: 0.185346 €<br>▪ R3: 0.205940 €<br>▪ R4: 0.428356 € | Without VAT<br><u>Cat 1:</u><br>Euro 0-5: 3.10 cts/tkm<br><u>Cat 2:</u> -<br><u>Cat 3:</u><br>Euro 6:<br>2.28 cts/tkm |
| **4. Charged vehicle categories and tariffs > 4 axles** | In annexes of AT questionnaire | Vehicle categories:<br>▪ Class 3: 2 axles | See above, | 0.15 – 0.20 €/km | R4: 0.428356 € | See under 3, differentiated toll according to Euro class and weight, |

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|---|---|---|---|---|---|---|
| | | ▪ Class 4: 3 axles + more<br>Average:<br>▪ Class 3: 0.206€/km<br>▪ Class 4: 0.276€/km | 18,7cts/km [Euro6]-26,1cts /km [Euro0/1] | | | toll is calculated per tkm! |
| **5.a Variation of charges (Emission, time, season)** | Yes | Only small fraction of network making differentiation of emission classes | Yes, emission, weight | No | Yes | Yes |
| **5.b Implemented differentiation** | two axles (factor: 1)<br>three axles (factors: infrastructure and air: 1.4; noise: 2.3)<br>four or more axles (factors: infrastructure: 2.1; air: 1.6; noise: 2.9)<br>**Infrastructure charge** is varied by EURO emission classes and drive type E/H2 (purely | Yes.<br>Motorway concessions Atlantes and Albea vary according emission classes, in a near future also ARCOS and ALIAE also.<br>CEVM/Viaduc de Millau | Emission + weight differentiation, see table in annex<br>▪ 7.5-11.99t<br>▪ 12-18t<br>▪ >18t to 3 axles<br>▪ >18t from 4 axles<br><u>Euro classes:</u><br>▪ Euro 0 and 1,<br>▪ Euro 2<br>▪ PRC1, Euro 2+, Euro 3<br>▪ PRC2, Euro 3+, Euro 4 | No | R2-R4, Euro emission class<br>Distance<br>Adjustment factors<br>▪ Euro IV:0.8<br>▪ Euro V: 0.7<br>▪ EEV and higher:0.6 | Euro classes |

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| | electric drive and hydrogen fuel cell drives):<br>• EURO 0 to V and EEV<br>• EURO VI (1.5%-bonus)<br>• E/H2 (currently 50%-bonus; 75%-bonus planned by 1st September 2021)<br>**External cost charge for air pollution** is varied by EURO emission classes (no charges for E/H2):<br>• EURO 0 to III<br>• EURO IV<br>• EURO V and EEV<br>• EURO VI<br>**External cost charge for noise pollution** and on the A 13 Brenner motorway the infrastructure charge for vehicles with four or more axles is | varies depending on seasons<br>Cofiroute A86 duplex and SANEF A1 vary on time of day<br>Cofiroute A86 duplex varies on type of day.<br>Differentiation of 10% in the Euro Classes for more or less air pollution | ▪ EEV, Euro 5<br>▪ Euro 6 | | | |

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| | varied by time of day:<br>• daytime (05:00 - 22:00)<br>• nighttime (22:00 - 05:00)<br>Tolls are not varied according to type of day or season | | | | | |
| **5.c Monitoring** | Yes | Yes | Yes | No | No | Yes |
| **5.d Tools for Monitoring** | In terms of revenue neutrality the differentiation according to EURO emission classes<br>between 2010 and 2016 was monitored by ASFINAG and BMVIT (predecessor of BMK)<br>and had been adapted in 2012, 2014 and 2015, taking into account the development of the share of the different EURO emission classes | Monitoring in two concessions with differentiation (Atlandes, Albea) and in future concessions ARCOS and ALIAE | Kilometer performance and Euro classes statistically evaluated<br>▪ Emission<br>▪ Driving performance by km<br>▪ Emission class | No, No implementation of Eurovignette Directive, each highway concessionary company will have to implement it following the renewal of the concession (average deadline in the next 15-20 years) | - | Statistics of customs administration for tkm per emission class, environmental Monitoring of flanking measures |

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| | and the necessary revenue neutrality.<br>Since 2017, external cost charges are applied. | | | | | |
| **6.a Mark-up planned for financing of specific projects of high European interest?** | Yes | - | No | Mountain tariff on Highway track A22 Modena – Brenner | Yes, +15% Koper-Ljubljana, +5% Ljubljana-Sentrupert | No |
| **6.b If yes, what for?** | A mark-up of 25% in addition to the infrastructure charge is applied<br>• on the A 12 Inntal motorway on the Lower Inn Valley route (between the border at Kufstein and the Innsbruck-Amras intersection) and<br>• on the whole A 13 Brenner motorway. The revenues from the mark-up are used for cross-financing the Brenner Base Tunnel. | - | _ | | Rail Divaca-Koper | - |

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|---|---|---|---|---|---|---|
| | Due to the provisions of the Eurovignette directive, which currently do not allow for applying a mark-up and external cost charges cumulatively on the same road section, no external cost charges are applied on these road sections subject to a mark-up.<br>See also Annex | | | | | |
| **7. Development of traffic by vehicle categories** | See Tables | Data available only for Atlantes and Albea (1% of network)<br>General increase of HGV traffic (vkm) between 2011 and 2019: 19,1% | Statistics, appendix | Not identified | Not available | General Statistics, by emission class |

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| **8. Impact on interurban road network** | No view | No | Yes, special reports, Marktbeobachtung BAG | No view | No view | Yes<br>Less empty runs<br>Slightly higher loading |
| **9. Charging revenue earmarked for transport sector and how much** | All of it | Some of it | Some of it | See above mark up | partly | Yes, some of it |
| **10. Details of earmarking policy** | Revenues from the infrastructure charge are used by ASFINAG for planning, construction, maintenance and refinancing of the federal road network (high- and express-ways) | Certain taxes of motorway concession companies fund/contribute to the French infrastructure financing agency (AFITF) for all transport modes | System costs, road infrastructure financing, programs for employment, qualification, environment, security and safety of the road haulage transport branch, EETS | The Highway Company have to improve security/safety and sustainability of network, bridges and tunnels<br>Specific project to realize rail infrastructures | Mark up for cofinancing 2nd rail Divaca-Koper | Revenues feeding the Rail Infrastructure Fund in the past for<br>NEAT/alptransit, Rail links to highspeed network, noise emission protection measures<br>Currently new Fund BIF for rail infrastructure projects 2/ 3of HGV fee |

| | | | | | | |
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| | | | | | | revenues, 1/3 to Cantons |
| **11.a Shift from road to rail happening (2011/76 EU)?** | Yes | No | Yes | No view | No view | Yes |
| **11.b If yes, what are positive effects?** | The application of external cost charges, where the charge for air pollution is differentiated according to EURO emission classes and thus more environmentally-friendly vehicles pay lower charges, can encourage the use of more environmentally-friendly vehicles and therefore can contribute to achieve the objectives of Art. 14 a).<br>Since vehicles with purely electric drive and hydrogen fuel | - | Minor influence on modals split, but positive effects on emission classes, use of capacities, less empty trips | - | - | Emission reduction<br>HGV traffic reduction in numbers<br>Incentive of vehicle Technology Renewal |

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|---|---|---|---|---|---|---|
| | cell drives (E/H2) get a bonus on the infrastructure charge of 50% (75% planned by 1st September 2021), this measure can encourage the use of the most environmentally-friendly vehicles and thus can contribute to achieve the objectives of Art. 14 a).<br><br>The mark-up of 25%, which is applied on the Brenner corridor, can contribute to incentivising a modal-shift from road to rail and can therefore contribute to encourage the use of the most environmentally-friendly modes and means of transport | | | | | |

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| | and to achieve a more balanced use of transport infrastructure on the Brenner corridor.<br>Therefore, this measure can contribute to achieve the objectives of Art. 14 a) and b). | | | | | |
| **12.a Plans for additional measures** | Yes | Yes | Yes | No | No | Yes |
| **12.b If yes, which ones and timing** | By 1st September 2021 the bonus for E/H2-vehicles (purely electric drive and hydrogen fuel cell drives) on the infrastructure charge will be raised from currently 50% to 75%.<br>Further measures depend on the provisions of a new Eurovignette directive. | New regulations allowing local authorities to implement toll on non-tolled motorways, no time schedule | Revision Eurovignette Dir. Including external cost charge for CO2 or/and a variation of the infrastructure cost charg.es based on CO2 | - | - | Plans for mobility pricing (road/rail), pilot projects for the future (2027)<br>Further development of HGV fee / LSVA including CO2 emission, alternative fuels / propulsion |

| | | | | | | |
|---|---|---|---|---|---|---|
| **13.a Plans for integrating external costs** | Yes | - | Yes | - | No view | Yes, already integrated |
| **13.b Detailed information of planned measures** | External cost charges for traffic-based air and noise pollution based on the maximal values according to Annex IIIb of the current Eurovignette directive are already applied on all parts of the high- and expressway network except for the Brenner corridor, where due to the provisions of the Eurovignette directive, applying a mark-up and external cost charges cumulatively on the same road section is not allowed. | - | See point 4 | The structure of highway tolls in Italy is anomalous in the European overview, due to the management of the network by numerous private highway cconcessionary companies, which follow different policies | - | Integration of external cost factors in pricing already implemented since introduction of HGV fee / LSVA in 2001.<br>Switzerland as a model and pioneer in this regard |

| | | | | | | |
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| | The Eurovignette Directive 2011/76/EU does not allow for applying additional external cost charges addressing climate change or costs due to CO2-Emissions. | | | | | |
| **14. Additional Comments** | - | - | - | Road haulage companies are entitled to an annual reimbursement of the costs of fuel excise duties and tolls | - | EU Green Deal as leverage to this strategic target net zero by 2050, user pays principle and fair+efficient pricing |

## Annex 2: Questionnaire sent to Member States

# National survey on the application of the Eurovignette Directive 1999/62/EC as modified by 2011/76/EU

### Background and purpose

The actual mandate 2021/2022 of the Working Group on Transport (WGT) of the Alpine Convention also deals with article 14 of the transport protocol and the implementation of the polluters pay principle in road freight transport in Alpine countries. It continues the work on the external costs of transport in the Alpine area.

In this context, Switzerland has taken over the task to write a short report on the progress since the last status report in 2016, see here: Annex_1_Synthesis Eurovignette_with_questionnaires-AT-CH-DE-FR (alpconv.org).

This task should be finalised until the XVII$^{th}$ Alpine Conference in October 2022 in Brig, Switzerland.

Another aspect of the mandate is to analyse to which extent the Eurovignette Directive is in line with the provisions of article 14. In order to be able to proceed to this analysis, Member States are asked to indicate their experiences made with respect to the implementation of the Eurovignette Directive 2011/76/EU. The following questionnaire was elaborated in 2013 by Austria and updated by Switzerland in 2021.

Please, give all relevant information as short and concise as possible. It will be used to get an overview on the national challenges, special circumstances, benefits, difficulties and obstacles with respect to the implementation of the EU-Directive. If you consider it useful, you may also indicate relevant web-links.

Please send the completed survey to Matthias.Rinderknecht@bav.admin.ch and Franziska.BorerBlindenbacher@are.admin.ch by **13$^{th}$ of August 2021 at the latest.**

The consolidated version of Directive 2011/76/EU of the European Parliament and of the Council of 27 September 2011 on the charging of heavy good vehicles for the use of certain infrastructures can be downloaded here EUR-Lex - 32011L0076 - EN - EUR-Lex (europa.eu).

### Contact details

| | |
|---|---|
| **Name of person responsible for completing the questionnaire** | |
| **Name of Authority** | |
| **E-Mail** | |
| **Telephone** | |

### Questionnaire

| | |
|---|---|
| 1. | Please provide the most relevant national legal principles and rules for vehicles weighing more than 3.5 tonnes maximum permissible laden weight (MPW) in your country. |
| | |

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| 2. | Please attach a map (e.g. a pdf-document) showing where tolls and user charges are collected/applied in your country. |
| | |

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| 3. | One of the main benefits of this survey should be to identify and compare the current toll rates and/or levels of user charges for vehicles weighing more than 3.5 tonnes maximum permissible laden weight (MPW).<br>Therefore, please indicate the current toll rates and/or user charges for vehicles weighing more than 3.5 tonnes maximum permissible laden weight (MPW) applied in your country.<br>Please indicate also, if toll rates and/or user charges are subject to the value added tax (VAT) in your country and if yes, if the VAT is included in the listed rates. |
| | |

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| 4. | In order to be able to compare toll rates and/or user charges for the different categories of vehicles, please indicate the toll rates and user charges for vehicles weighing more than 3.5 tonnes maximum permissible laden weight (MPW) with more than 4 axles, EURO III, V and VI. |
| | |

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| 5.a | Does your country vary toll rates according to EURO emission classes and/or the time of day, type of day or season? |
| | ☐ Yes ☐ No |
| 5.b | If yes to 5.a, please provide information about how this differentiation is implemented in your country. |
| | |
| 5.c | Are the impacts of the differentiation of infrastructure charges according to EURO classes on air pollution being monitored? |
| | ☐ Yes ☐ No |
| 5.d | If yes to 5.c, please specify how they are being/will be monitored and whether you are able to provide us with link to related documents. |
| | |

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| 6.a | Toll rates may in exceptional cases be subject to a mark-up for the financing of specific projects of high European interest. If your country does not already apply this exception, does it have any plans to do so? |
| | ☐ Yes ☐ No |
| 6.b | If yes to 6.a, please provide information, on how this exception will be applied in your country (respective project, planned timetable for implementation and level of toll rates for each vehicle category). |
| | |

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| 7. | Please provide information on the development of traffic by vehicle categories on the tolled/charged road network and, if available, the development of the shares of EURO classes of HGV´s on this network since getting into force of the EU-Directive 2011/76/EU. |
| | |

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| 8. | Are you able to provide information about whether infrastructure charging has had an impact on freight traffic on the interurban road network (e.g. traffic performance, degree of loading or empty runs)? |
| | ☐ Yes ☐ No ☐ Don't know / No view |
| | |

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| 9. | Is revenue from infrastructure charging earmarked for reinvestment in the transport sector in your Member State? |
| | ☐ All of it ☐ Some of it ☐ None of it ☐ Don't know |

| | |
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| 10. | Please provide details about your country's policy (and practice) in terms of earmarking infrastructure charging revenue. |
| | |

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| 11.a | One of the main strategic objectives of the transport protocol of the Alpine Convention is shifting freight from road to rail.<br>Did the implementation of the EU-Directive 2011/76/EU or of similar measures contribute to achieve the objectives of a, b and c of Article 14 of the Transport Protocol? |
| | ☐ Yes ☐ No ☐ Don't know / No view |
| 11.b | If yes to 11.a, please provide a short summary of these positive effects. |
| | |

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|---|---|
| 12.a | Are there any plans in your country to implement additional measures in the field of tolls and/or user charges? |
| | ☐ Yes ☐ No ☐ Don't know / No view |
| 12.b | If yes to 12.a, please provide information which measures are planned and the schedule for their implementation. |
| | |

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|---|---|
| 13.a | Is your country planning to implement the relevant provisions of the latest Eurovignette Directive 2011/76/EU for better reflecting the external costs of traffic-based air and noise pollution and climate change? |
| | ☐ Yes ☐ No ☐ Don't know / No view |
| 13.b | If yes to 13.a, please provide information, which measures are planned and the schedule for their implementation. |
| | |

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|---|---|
| 14. | Do you have any additional comments? |
| | |

## Thank you for your time and support!

# CLIMATE NEUTRAL ALPINE MOBILITY

***REPORT ON POLICIES FOR SUSTAINABLE MOBILITY IN THE ALPS***

**Transport Working Group of the Alpine Convention**

*Mandate 2021-2022*

ALPENKONVENTION
CONVENTION ALPINE
ALPSKA KONVENCIJA
CONVENZIONE DELLE ALPI

## IMPRINT

This report is the result of the Transport Working Group, chaired by France.

The members of the Working Group are:

**President**: Michel Rostagnat (*Ministère de la transition écologique, France* – French Ministry for Ecological Transition)

**National delegates**:

- **Austria**: Wolfgang Grubert (Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie – Federal ministry for climate action, environment, energy, mobility, innovation and technology), Patrick Skoniezki (Amt der Tiroler Landesregierung – Tyrolean regional administration).
- **France**: Isabelle Paillet, Guy Poirier, François Lamoise (*Ministère de la transition écologique, DAEI* – Ministry for ecological transition).
- **Germany**: Lisa Maria Arnold, Leonie Pantzke (*Bundesministerium für Digitales und Verkehr*– Federal Ministry for Digital and Transport), Harry Seybert (*Bayerisches Staatsministerium des Innern* – Bavarian home office).
- **Italy**: Paolo Angelini, Massimo Santori (*Ministerio della Transizione Ecologica* – Ministry of ecological transition).
- **Liechtenstein**: Henrik Caduff (Office of Construction and Infrastructure).
- **Monaco**: Astrid Claudel-Rusin (*Gouvernement Princier de Monaco, Direction de l'environnement* – Monaco Prince's government, directorate of environment).
- **Slovenia**: Zlatko Podgorski (Ministrstvo za infrastrukturo – Ministry of infrastructures).
- **Switzerland**: Matthias Rinderknecht, Franziska Borer Blindenbacher (*Eidgenössisches Department für Umwelt, Verkehr, Energie und Kommunikation UVEK* – Federal ministry of environment, transport, energy and communication).

**Observers**:

- Hélène Denis and Veronika Schultz (*Club Arc alpin*)
- Jakob Dietachmair and Stefan Tischler (CIPRA)
- Anne-Séverine Lay and Jana Habjan (Interreg Alpine Space)
- Patrick Skoniezki (EUSALP)

**Permanent Secretariat of the Alpine Convention**: Aureliano Piva

**Cover picture**: Rhätische Bahn, PSAC

Permanent Secretariat of the Alpine Convention, 2022

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# 1. MANDATE GIVEN BY THE ALPINE CONFERENCE

Based on the mandate of the Working Group on Transport for the period 2021-2022 until the XVII Alpine Conference, the Working Group was entrusted to elaborate policy recommendations based on its previous work in promoting more sustainable transport means to support decarbonization in transport and acknowledging the changing social and economic needs of the Alpine area.

With the rapidly changing traffic and mobility behaviours, in conjunction with the opportunities offered by new transport technologies, there is also a growing need to analyse and forecast the future challenges in this field as well as to conceive and promote appropriate responses. At the same time, there is an urgent need to reduce the environmental impact of different modes of transport.

**Objective No. 2 of the mandate** calls for the Working Group to address the topic relating to policies and measures/instruments for sustainable mobility in the Alpine Area.

## I. Challenges under the aspect of climate change and environmental impact

Transport is a strategic sector for the socio-economic development of our societies. It connects people, cities, countries and economies, fostering growth and employment. Nevertheless, transport remains a major source of environmental pressures in the Alpine region, accounting for more than 1/5 of greenhouse gas emissions and 1/4 of pollutants, most of which are generated by road transport.

Individual and freight traffic as well as air traffic have a negative impact on the climate due to the high levels of pollutant emissions and result in environmental and health damage. Additionally, the noise generated by traffic burdens people and animal species.

Transport infrastructure also takes up significant amounts of land, thus exacerbating land consumption, landscape fragmentation and soil sealing. With its share of an average of 20% on overall greenhouse gas emissions, the transport sector is to be considered as a significant source for climate change. With the critical consequences of climate change, air pollution and the loss of biodiversity, the pressure on all actors to make transport sustainable is increasing.

## II. Specific vulnerability of the Alpine Region

The Alps are at the crossroads of European transport systems and are a highly sensitive area. The geographical and topographical conditions of the Alps are the reason for its diverse ecosystems. At the same time, these circumstances are also the reason for the specific vulnerability of the Alpine space. Climate change is progressing faster in the Alps than in the lowlands.[1] The mountain and valley landscapes make the available space a limited resource. Noise can spread further through the funnel-like valleys or echo-effects, and pollutant loads concentrate in the valleys due to the weather conditions, like inversion. This results in an even more urgent need for action than in other regions.[2]

[1] Cf. Alpine Convention (2017) Climate Change – How it affects the Alps and what we can do; Climate-neutral and Climate resilient Alps 2050 – Declaration of Innsbruck (2019).

[2] Landschaften und Lebensräume der Alpen: Zwischen Wertschöpfung und Wertschätzung, Leitungsgruppe des NFP 48 (Hrsg.), Zürich: vdf Hochschulverlag, 2007 (PDF); Paesaggi e habitat nell'arco alpino: Tra creazione e percezione di valore, Comitato direttivo del PNR 48 (ed.), Zurigo 2007 (PDF).

## III. Targets for climate-neutral mobility with different time horizons[3]

The urgency of the need for action in the transport sector is also highlighted by the fact that there are numerous targets and measures specific to transport at international, European and national level, but they relate to different time periods. The Alpine Climate Target System 2050 contains four targets for transport. The corresponding pathways, including concrete implementation steps in a period from 2020 to 2035, are contained in the Climate Action Plan 2.0. The European Green Deal[4] includes clear reduction targets for greenhouse gas emissions in the transport sector for the years 2030, 2035 and 2050 and the Mobility Strategy provides for various measures to achieve these goals.

In view of the partly much shorter implementation horizons, the question of achieving a climate-neutral transport sector before the year 2050 is pressing. The Austrian Mobility Master Plan 2030 (see Annex I) for example, supports the goal of achieving climate neutrality in 2040[5]. Germany, in a similar way, recently adopted its climate protection law and aims for climate neutrality by 2045. [6] The Italian Interministerial Committee on the Ecologic Transition ("*Comitato Interministeriale per la Transizione Ecologica*") proposed the interdiction to sell cars with traditional internal combustion engines within 2035 (2040 for light duty vehicles), only allowing full electric, hydrogen and biofuels technologies.


*RhB (Rhaetian Railways) Container Terminal in Samedan (Source: Stephan Tischler, CIPRA Austria)*

[3] See 3.4.1. and 3.4.2.

[4] European Commission - Mobility Strategy and Action Plan.

[5] https://www.bmk.gv.at/dam/jcr:eaf9808b-b7f9-43d0-9faf-df28c202ce31/BMK_Mobilitaetsmasterplan2030_EN_UA.pdf

[6] www.bundesregierung.de/breg-de/themen/klimaschutz/klimaschutzgesetz-2021-1913672 (20.09.2021).

# 2. INTERNATIONAL AND NATIONAL FRAMEWORKS

## I. European Green Deal

To overcome the challenges of environmental degradation and climate changes as a threat to Europe and the world, the European Green Deal was initiated by the European Commission.

The **overarching goals** of the European green deal include the following targets for the transport sector:

- 90% reduction of greenhouse gas emissions by 2050;
- 55% reduction of emissions from cars by 2030;
- 50% reduction of emissions from vans by 2030;
- Zero emissions from new cars by 2035.

Milestones for a smart and sustainable future[7]:

**By 2030:**

- at least 30 million zero-emission cars will be in operation on European roads;
- 100 European cities will be climate neutral;
- high-speed rail traffic will double across Europe;
- scheduled collective travel for journeys under 500 km should be carbon neutral;
- automated mobility will be deployed at large scale;
- zero-emission marine vessels will be market-ready.

**By 2035:**

- zero-emission large aircraft will be market-ready.

**By 2050:**

- nearly all newly registered cars, vans, buses as well as new heavy-duty vehicles will be zero-emission;
- rail freight traffic will double;
- a fully operational, multimodal Trans-European Transport Network (TEN-T) for sustainable and smart transport with high speed connectivity.

Additionally, the **Sustainable & Smart Mobility Strategy** of the European Commission contains ten Flagship measures which are divided into three chapters[8]:

- Sustainable Mobility - an irreversible shift to Zero-Emission[9] Mobility;
- Smart Mobility - Achieving seamless, safe and efficient connectivity;
- Resilient Mobility - A more resilient single European transport area: For Inclusive Connectivity.

[7] European Commission, Mobility Strategy and Action Plan: https://transport.ec.europa.eu/transport-themes/mobility-strategy_en

[8] https://data.consilium.europa.eu/doc/document/ST-14012-2020-INIT/en/pdf

[9] Note that a zero-emission heavy-duty vehicle is a vehicle without an internal combustion engine, or with an internal combustion engine that emits less than 1g $CO_2$/km. Pure battery electric and hydrogen-powered vehicles are ZEV.

## II. Fit for 55

A further step of the planning picture for the Green New Deal and sustainability in Europe has been defined by the "Fit for 55" Package"[10], a broad legislative package to align existing EU policy with the new emissions reduction goal of 55%, by 2030.

The "Fit for 55" Package" sets a framework within which national policies and measures for the sustainable mobility will be developed.

"Fit for 55 Package" is based on the following key facts:

1. **Key targets for 2030**
    1. Carbon emissions reduction by 55%;
    2. Renewable Energy target: 40%.
2. **Emission Trading System**
    1. The cap reduces by 4.2% each year (previously 2.2%);
    2. Extended to buildings, transport, maritime sectors.
3. **Carbon Border Adjustment Mechanism**
    1. Sectors: electricity, cement, fertilizers, aluminium, iron and steel;
    2. Importers have to buy CBAM certificates to cover the embedded emissions. Certificate prices are based on the average prices of carbon allowance auctions.
4. **Mobility sector:**
    1. Revised Alternative Fuels Infrastructure Regulation (AFIR);
    2. Stronger CO2 emissions standards for cars and vans (tailpipe).

## III. Alpine Convention - Transport Protocol

The Transport Protocol is the binding basis for sustainable transport in the Alps. Its preamble states that the contracting parties are "*aware that transport is not without an environmental impact and that the environmental damage it causes produces increasing negative effects on and risks to the ecology, health and safety, which need to be tackled through a common approach".*

Article 1 of the Transport Protocol breaks down the following objectives:

- Reduce the effects of and risks posed by intra-Alpine and trans-Alpine traffic to a level which is not harmful to people, flora and fauna and their environments and habitats;
- Shift traffic to the railways, especially freight traffic, by means of suitable infrastructures and market-based incentives;
- Increase the effectiveness and efficiency of transport systems;
- Promote environmentally friendly and resource-conserving modes of transport at economically viable costs;
- Ensure fair competitive conditions among the individual modes of transport.

Regarding the current mandate objective No. 2 of the Transport WG, Articles 3 and 7 of the Transport Protocol contain relevant provisions on strategies and measures for sustainable mobility in the Alps.

[10] https://ec.europa.eu/commission/presscorner/detail/en/ip_21_3541

**According to Article 3**, the Contracting Parties shall limit transport-related burdens and risks and take account of environmental, social and economic concerns by means of a coordinated environmental and transport policy. A mandate for a joint strategy for the sustainable development of transport and mobility in the Alpine region can be derived from this.

As a specific measure**, Article 7 lays the foundation for a general transport policy strategy** according to which the Contracting Parties shall, in the interest of sustainability, promote a rational and safe transport management in a harmonized cross-border transport network.

Such cross-border transport network has to:

- Ensure coordination between different carriers, modes and types of transport and encourages intermodality;
- Optimize the use of existing transport systems and infrastructures in the Alps, including the use of electronic data transmission and charges external and infrastructure costs to polluters in line with the damage caused;
- Encourage, by means of structural and regional planning measures, the transfer of the carriage of passengers and goods to more environmentally-friendly means of transport and to intermodal transport systems;
- Recognizes and utilizes the opportunities for reducing traffic volume.

The relevant provisions of the Transport Protocol for "policies" are completed by the **technical measures** contained in Chapter II B) of the Transport Protocol. The following is an excerpt of these measures:

**Public transport (Article 9):**

- Promotion and expansion of customer-friendly and environmentally sound public transport systems.

**Rail transport and shipping (Article 10):**

- Improvement of railway infrastructure by constructing and developing the major transalpine railway routes, including connecting routes and suitable terminals.
- Optimisation and modernisation of railway (cross-border).
- Measures to transfer long-distance carriage of goods to rail and harmonization of transport-infrastructure user charges.
- Intermodal transport systems.
- Increased use of rail and shipping.
- User-friendly synergies between long-distance passenger transport, regional transport and local transport.

**Road transport (Article 11):**

- Refrain from constructing any new, large-capacity roads for transalpine transport.
- Large capacity roads for intra-Alpine transport only under certain conditions.

**Air transport (Article 12):**

- Reduction as far as possible of the environmental damage caused by air transport, including aircraft noise.

- Improvement of public transport systems from airports on the fringes of the Alps to the various Alpine regions.
- Restriction as far as possible of the construction of new airports and any major extension of existing airports in the Alps.

**Tourist facilities (Article 13):**

- Evaluation of the transport impact of new tourist facilities.
- If necessary, implementation of precautionary or compensatory measures to fulfil the objectives of this protocol.
- Creation and maintenance of low-traffic and traffic-free areas.
- Measures to encourage tourists to avoid arriving by car or using cars.

**Real costs (Article 14):**

to influence the routing of transport by taking greater account of the reals costs:

- Polluter-pays principle.
- Establishment and use of a system to calculate infrastructure costs and external costs.
- Transport-specific charging systems to cover such real costs in an equitable manner.
- Encouragement of the use of the most environmentally friendly modes and means of transport: a more balanced use of transport infrastructure.
- Incentives to make more use of opportunities for the reduction of environmental and socioeconomic costs by means of structural and regional planning measures which have an impact on transport.

## IV. Further International Policies

### Alpine Climate Target System 2050

The Alpine Climate Target System 2050[11] includes, in addition to the two strategic goals "climate-neutral Alps" and "climate-resilient Alps", ten sectoral targets for different fields of activity. For transport, the Alpine Climate Target System 2050 foresees four targets:

**T_Tr1: Modal shift of Alpine freight transit**

Alpine freight transit transport is shifted to rail wherever possible (ideally for all relations exceeding 300 km), going beyond European modal shift objectives, supported by an ambitious implementation of innovative logistics solutions.

**T_Tr2 Reduced car- dependency (inner-Alpine and transalpine passenger transport)**

Sustainable mobility solutions such as public transport, shared mobility and non-motorized transport are further developed and supported through an improvement in quality and services (multi- modality, integrated timetables and ticketing, comfort and further “smart” innovative services) so that accessibility in remote Alpine areas is improved and there is a significant increase of the share of public transport and non-motorized transport in the modal split for commuter, leisure and holiday mobility.

[11] http://www.alpineclimate2050.org and www.alpconv.org/en/home/news-publications/publications-multimedia/detail/climate-action-plan-20/ (17.11.2021).

**T_Tr3 Reduced transport demand (passenger and freight)**
Transport demand of both freight and passenger transport is reduced through making use of transport saving spatial structures, new working solutions (i.e. telework, taking into account of the economic and public services efficiency), mobility planning integrated in spatial planning procedures to avoid unnecessary transport and lowering the transport demand, pooling of shipments, regional distribution chains and changed mobility and behavioural patterns.

**T_Tr4 Decarbonised transport fleet**
The road transport fleet is CO2-free (heavy goods and light vehicles) through electric mobility and other alternative powertrains (e.g. bio-fuels).

## Alpine Climate Action Plan 2.0 of the Alpine Convention

In the **Climate Action Plan 2.0**[12] adopted by the XVI Alpine Conference in December 2020, there are four transport specific pathways, which propose several implementation steps in a timeframe from 2020 to 2035:

| **Pathway 1: Strategies for decarbonization of Alpine freight transport** | |
|---|---|
| **Preliminary step** | Lobbying for Toll Plus (2020) |
| **Step 1** | Support innovative technologies rail/CT (2021-2022) |
| **Step 2a** | Kick-start regional strategies for regulating further use of ICE vehicles (2022-2025) |
| **Step 2b** | Support for implementing a Toll Plus system (2022-2025) |
| **Step 3** | Alpine Crossing Exchange (2035) |

| **Pathway 2: Developing the Alps into a model-region for reduced working mobility** | |
|---|---|
| **Step 1** | Follow-up of activities of cross-border project and transfer to pilot regions (2022-2025) |
| **Step 2a:** | Set-up of network of regional mobility coordinators (2025) |
| **Step 2b** | Pilot projects for location-flexible work solutions (2025-2030) |
| **Step 3** | Recommendations for Alpine companies on decentralized work & living solutions (2030) |

| **Pathway 3: Developing an alpine-wide approach towards integration and decarbonization of public transport** | |
|---|---|
| **Step 1a** | Extension of Youth Alpine Interrail tickets (2021-2027) |
| **Step 1b** | Completion and addition of Alpine-wide information & ticketing system (2025) |
| **Step 2a** | Integration of information & ticketing system into local and regional mobility plans (2027) |
| **Step 2b** | Support of new mobility tickets - further development of Alpine Interrail (2027) |
| **Step 3** | Coordination of Alpine funding schemes for low-carbon public transport fleet (2030) |

[12] www.alpineclimate2050.org, www.alpconv.org/en/home/news-publications/publications-multimedia/detail/climate-action-plan-20/ (17.11.2021).

| Pathway 4: Developing the Alps into a model region for shared mobility | |
|---|---|
| **Step 1** | Set-up of an Alpine-wide information system to link Apps for shared mobility solutions (2021-2022) |
| **Step 2a** | Develop a label and award for shared mobility solutions in the Alps (2022-2025) |
| **Step 2b** | Support to pilot projects (2025-2030) |
| **Step 3** | Coordination of funding programs for set-up of shared mobility stations (2030) |

## V. National Energy and Climate Plans

The 2030 National Energy and Climate Plans (NECPs) are the framework for EU Member States to outline their climate and energy goals, policies and measures from 2021 to 2030. In the post-Covid recovery package published by the Commission on 27 May 2020, the NECPs recommendations act as eligibility criteria for National "Recovery Plans".

With the presentation of the European Green Deal and the Fit For 55 package Europe´s climate ambition was set in line with the Paris Climate Accord. Current NECP's were developed based on levels of ambition agreed upon before the Paris Climate Summit, which is why NECP´s are susceptible for improvement until 30 June 2023.

Until the measures under European Union law enter into force, the NECPs still represent the current plan for climate and energy targets.

On the website of the European Commission, it is possible to find all details for the NECPs of the EU countries[13]. In Annex I to this report, the national strategies for sustainable mobility of Austria, Italy and Switzerland are provided as an example.

[13] https://ec.europa.eu/info/energy-climate-change-environment/implementation-eu-countries/energy-and-climate-governance-and-reporting/national-energy-and-climate-plans_en

# 3. SUSTAINABLE MOBILITY IN THE ALPINE REGION

## I. The pillars of a sustainable transport policy in the Alpine Space

Requirements and obligations according to Alpine Convention

According to the Transport Protocol, the contracting states of the Alpine Convention are obliged to adopt a **coordinated environmental and transport policy** to limit transport-related impacts and risks. For this purpose, national, regional and local targets, strategies and measures shall be developed, considering the different environmental, economic and socio-cultural data as well as the different needs to reduce the negative environmental impact of transports through a combination of economic instruments, spatial planning and transport planning measures.[14]

Based on the Transport Protocol of the Alpine Convention, the following environmental, social and economic objectives have to be pursued through a coordinated environmental and transport strategy:[15]

| Environment | Population | Economy |
|---|---|---|
| Reduced use of natural resources to a level which does not exceed their natural capacity for regeneration. | Accessibility for persons, labour, goods and services, while effectively preserving the environment, saving energy and space and meeting the essential needs of the population. | Increased profitability of the transport sector and internalised external costs. |
| Reduced harmful emissions to a level which is not detrimental to the absorption capacity of the environments concerned. | Avoid endangering human health and reduce the risks of environmental disasters and the number and severity of accidents. | Optimum use of existing infrastructure. |
| Limited input of substances into the environment to avoid harming environmental structures and natural materials cycles. | | Guaranteed employment in undertakings which are performing well in the various sectors of the economy. |

Article 7 of the Transport Protocol additionally stipulates the **obligation to implement a rational and safe handling of traffic in a cross-border coordinated transport network**. The necessary measures need to ensure the protection of transports routes against natural hazards, the protection of persons and of the environment, particularly in areas negatively affected by transport activities, as well the gradual reduction of pollutants and greenhouse gases emissions and noise by all modes of transport, including through the use of the best technologies available. This includes coordinated modes of transport, zero emission and climate-neutral means of transport and traffic types, favouring intermodality, making the best

[14] Article 3 Paragraph 1, 2 Transport Protocol.

[15] Article 3 Paragraph 1 Transport Protocol.

possible use of transport systems and infrastructures, charging external costs and infrastructure costs to the polluter, shifting traffic to more environmentally friendly means of transport and utilizing traffic reduction potentials. [16]

### Implementation on the national level

The implementation of a coordinated environmental and transport policy requires joint efforts and a common orientation. Many national plans of the Alpine countries, like the Austrian "Mobility Master Plan 2030", published on 16th of July 2021, and the Italian 2019-2023 "Clean Air Dialogue Plan" can be seen as such a policy that meets the requirements of the Transport Protocol and contributes to achieving the Protocol's targets as well as international climate goals (Paris Climate Agreement17, Green Deal18) and those of the Alpine Climate Target System 2050. A coordinated sustainable mobility strategy requires a common understanding of the requirements of such a strategy. Many national plans of the Alpine Countries represent good practice examples for the development of common core messages and ambitious recommendations towards sustainable and climate-neutral mobility in the Alps.

## II. Key messages for sustainable mobility in the Alps

Taking into account the strategies and objectives at international, European and national level, the following key messages addressing the implementation of sustainability in freight and public transport, zero emission and carbon neutral transport on the whole life cycle, tourism and land use are commonly agreed within the Transports Working Group of the Alpine Convention.

**FREIGHT TRANSPORT:**

- Due to its inherent advantages such as mass transport capacity, environmental sustainability, safety, energy efficiency the intermodal freight transport shall be the core component of a sustainable Alpine freight transport system. In addition, capillary transport as the last link in logistics shall rely on a well-functioning intermodal system between rail and road.
- Freight mobility will rely on renewable energy: on rail, further electrification of tracks is key in addition to raise the renewable share of electricity supply
- On the road, it is necessary to renew LDV and HDV fleets by zero emission and climate-neutral powertrains. The efficiency-first principle is of particular importance in this regard, from the environmental and socio-economic sustainability point of view.
- Focus on European value chains and efficient goods exchange within Europe will shift flows of goods to the regions, reducing transport distances.

**PUBLIC TRANSPORT:**

- Cross-border collaboration on planning, organisation and financing of the alpine railway system to introduce new and convenient night and long-distance trains.
- Integrated range of cross-border public transport services (bus, train, sharing cars and/or bikes) has to be offered at an attractive base price. For example,

[16] Article 7 Transport Protocol.

[17] https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement (20.09.2021).

[18] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en (20.09.2021).

The Austrian “Klimaticket” and the Italian “Mobilcard” (SüdTirol – Alto Adige) could be a role model offering all means of transport with a single ticket[19].

- Integrating new services into routing and ticketing making full use of digital possibilities will make it possible to use a single ticket with multiple transport providers – from micro transit to long-distance rail transport.
- Bolstering public transport with extensive micro-transit and new types of carsharing and bike-sharing systems towards fully multimodal integrated mobility solutions, including both traffic management and information services made possible through digital means.
- The mobility behaviour of the population in everyday life and for day trips must change, with more journeys being made by bicycle or on foot. Where this is not possible, zero emission and climate-neutral public transport or shared mobility will be used.

**ZERO EMISSION AND CARBON NEUTRAL TRANSPORT ON THE WHOLE LIFE CYCLE:**

- According to the revised Regulation on Alternative Fuels Infrastructure (AFIR), the necessary infrastructure for carbon neutral alternative fuels and zero-emission operation of all types of vehicles needs to be developed while protecting the environment.
- Higher levels of cooperative, connected and automated mobility need to be deployed in order to integrate transport modes fostering modal shift and to manage the mobility system more effectively. The potential and possibilities in the field of traffic management should be better exploited through the use of various digital tools. The electrification of the various means of transport is fuelled from 100% renewable energy. Where direct electrification is not possible, such as for hard – to-abate sectors shipping, and air traffic climate-neutral fuels are developed and used. The strategy for the transitional period of some Member States includes freight transport

**TOURISM:**

- Make sure that touristic destinations and sights can be reached easily by train, by bus, using flexible mobility services and by bicycle and on foot.
- Increase bicycle tourism by expanding bicycle infrastructure and creating attractive options for taking bicycles on public transport and for hiring bicycles and electric bicycles.
  Overall tourism offers can be provided through mobile application integrating options for sustainable mobility, leisure and sports/cultural offers with reservation of accommodation.

**LAND USE:**

- Given the limited space available in sensitive Alpine regions, the land used by the transport sector is an important environmental indicator. Natural habitats are often cut off by transport infrastructure, destroying them forever. Land-use planning needs to avoid cutting off natural habitats, adjusting routing to the

[19] Cf. www.klimaticket.at/en

landscape when infrastructure is built, promote especially space-saving means of transport and prevent mobility pressures, such as long commutes and distances to shopping opportunities.

- Rather than investing in new infrastructure, the existing infrastructure needs to be managed and used in a more efficient way, making full use of the capabilities and prospects of cooperative, connected and automated mobility through the means of digitalisation.
  Tax incentives for transport need to be eliminated if they are counterproductive in terms of climate and environmental protection.

## III. Recommendations towards implementation

In order to implement the Transport Protocol, its objectives must be taken into account and the measures set out herein must be realised. The recommendations listed below are taken directly from the requirements of the Transport Protocol. In particular, Articles 1, 3 and 7 contain clear objectives for a common coordinated transport policy:

**REDUCE TRAFFIC VOLUME:**

**In accordance with the avoidance principle (cf. Article 1(2) of the Transport Protocol), all possibilities must be explored and utilized to reduce the volume of traffic. In order to achieve this, transport cannot be treated in isolation. Solutions must be sought across all sectors.**

**A concrete example is provided by the Alpine Convention Climate Action Plan 2.0. with its pathway #2 "*Developing the Alps into a model-region for reduced working mobility*".**

**ENCOURAGE INTERMODALITY:**

**The coordination of the different modes, means and types of transport is an essential factor for sustainable mobility. Alpine transit must be considered in the context of the EU transport network. For this reason, intermodality must be improved across borders so that the most environmentally friendly means of transport are available for the respective transport purposes. This requires appropriate investments in infrastructural and spatial planning measures.**

**There is a particular need for action here in freight transport, especially with regard to intermodality between rail and road transport powered by renewable energies.**

**OPTIMIZE THE USE OF EXISTING TRANSPORT SYSTEMS:**

**The existing transport system must be adapted to changing demands. However, this doesn't mean a constant resource-intensive expansion, but an improved cross-state coordination in the Alps, especially through the use of digital solutions.**

**In freight and passenger transport, digitization must offer solutions that enable users to quickly and easily find the most environmentally friendly routes. The co-modality and the combination of different means of transport must also be taken into consideration.**

**IMPLEMENT THE POLLUTER/USER PAYS PRINCIPLE:**

**Optimised use of the existing transport must be supported by the implementation of the polluter/user-pays principle, in which external costs, which put a burden on the general public, and infrastructure costs, which are caused by the users/polluters, are adequately charged to the users/polluters.**

**Given the central position of the Alps in the European transport network, a common transport policy enforcing an increased implementation of the polluter/user pays-principle can be pursued at EU level.**

**Within the framework of the Eurovignette Directive, the Alpine states could explore the possibilities for implementing the polluter-pays principle and introduce corresponding mark-ups for the congested Alpine corridors in order to reduce the burden on the local population and environment.**

**Charging schemes for the means of transport, on the one hand, must adequately reflect the transport-specific real costs (infrastructure and external costs) caused by it and should, on other hand, also incentivise a modal shift (see recommendation 3) (cf. Article 14 Transport Protocol).**

**Measures to limit HDV-transit on Alpine crossings may take into account various emission factors, including $CO_2$-emissions.**

**ENCOURAGE MODAL SHIFT:**

**The modal shift to more environmentally friendly modes of transport (e.g. from road to rail) to achieve a more balanced use of transport infrastructure is closely linked to the intermodality of the transport system. To promote modal shift, appropriate incentives (e.g. through charging according to recommendation 4) and low-threshold access and digital information and management for passenger and freight transport are needed, especially in cross-border transport.**

# 4. CONCLUSIONS AND RECOMMENDATIONS

The Transport Protocol of the Alpine Convention – together with European policies for sustainable mobility and energy transition – contains clear guidelines for a strategy for sustainable mobility in the Alpine region. From today's point of view, these targets have to be considered in the light of the challenges of climate change and pollution. The numerous climate targets at international, EU and national level share the goal of climate neutrality, but the underlying time frame varies from 2040 to 2050.

In order to make transport in the Alpine Space sustainable and climate neutral, a **clearly defined transport policy for the Alpine region is needed**, accompanied by a jointly coordinated strategy for sustainable transport and mobility in the sense of the Transport Protocol. Alpine transit is significantly shaped by European transport policy and the related legal acts of the European Union. Joint efforts are needed to ensure that the specific requirements of the Alpine region and its vulnerability in the European context are sufficiently taken into account.

To this end, the Working Group **recommends developing a joint Alpine-wide strategy for sustainable transport and mobility** that meets the requirements of the Transport Protocol (Article 3 and Article 7). The goals of the Alpine Climate Targets 2050 can serve as a vision for sustainable mobility in the alps and with the Climate Action Plan 2.0, there are already implementation paths that directly address transport and mobility.

## I. Recommendations for action

**FREIGHT TRANSPORT:**

1. **Evaluate existing and needed terminals to increase the intermodality of freight transport.**
2. **Develop sustainable strategies for regional $CO_2$-neutral freight transport.**
3. **Advocate for a coordinated Alpine Toll plus[20] system within the frame of the Eurovignette Directive for transalpine freight traffic on the roads in order to promote a shift to rail.**
4. **Realize infrastructures for recharging and refilling and encourage the renewal of the fleet of light and heavy commercial vehicles promoting zero emission and climate-neutral technologies powered by renewable energy.**

**PUBLIC TRANSPORT:**

5. **Expand and intensify cross-border transport projects for low-threshold access to public transport for short and long distances.**
6. **Link multimodal cross-border traveller information services and potentially ticketing systems for the Alpine region[21].**
7. **Support projects for integrated and shared mobility services, including their digital integration across administrative and regional borders.**
8. **Establish co-working spaces in municipal centres to reduce the daily work commute. Start with first pilot regions in 2023.**

[20] https://www.tirol.gv.at/fileadmin/themen/verkehr/verkehrsplanung/Carole/Dokumente/Toll_Plus_2014.pdf

[21] Based on the approaches defined in the Linking Alps project https://alpine-space.org/projects/linkingalps/en/home

## ZERO EMISSION TRANSPORT:

9. Prioritize the optimization of pedestrian and cycling infrastructure in order to improve the use of active mobility in daily life.
10. Convert private, freight and public transport to 100% renewable green energy. This should be achieved by clear zero emission registration targets beginning with 2030 and depending on the type of vehicle.
11. Adapt and optimise the existing transport infrastructure to the requirements of carbon neutral and zero emission technologies without additional land consumption.
12. Deploy cooperative, connected and automated mobility services throughout the Alpine region towards a fully integrated multimodal transport system.
13. Establish Alpine-wide standards regarding the required infrastructure (e.g. charging stations, filling stations) to guarantee 100 % renewable green energy.

## TOURISM:

14. Create and communicate special offers for tourists travelling by public transport, paying particular attention to the first and the last mile. This also includes improving the possibilities for transporting and travelling with bicycles (communication of existing routes, parking facilities, rental options, etc.), as well as public transport and shared mobility concepts at the tourist destinations facilitated by mobile applications for sustainable tourism.
15. Develop guidelines for climate-neutral touristic destinations, including concepts for active and shared mobility and the promotion of slow-travelling, focusing on relaxation and mindfulness and thus also influencing the choice of transport means.
16. Provide multimodal traveller information services targeted for tourists through digital means in the alpine region.

## LAND USE:

17. Create combined residential and transport development plans to reduce land consumption and individual transport, and producing synergies through development poles.
18. Favour the use of transport infrastructure for the generation of renewable energy (photovoltaics), rather than exploiting untouched nature.
19. Instead of building new infrastructure in the Alpine Region, develop cross-border multimodal traffic management applications, including cooperative, connected and automated mobility services, towards a more efficient use of the existing infrastructure.

## ANNEX I – EXEMPLARY NATIONAL STRATEGIES FOR SUSTAINABLE MOBILITY

# I. AUSTRIAN MOBILITY MASTERPLAN 2030

### Approach and methodology

In this section, the methodology of the Austrian Mobility Masterplan 2030 is described. It represents one of the several examples of national planning aimed at implementing the European policies for sustainable mobility and energy transition as well as the Alpine Transport Protocol.

Common understanding regarding approach, methodology and overall objectives

The three guiding principles of sufficiency (mobility behaviour and well-considered freight transport usage), consistency (shift to more environmentally friendly modes of transport) and efficiency (reduce energy use) define the core of the coordinated policy.

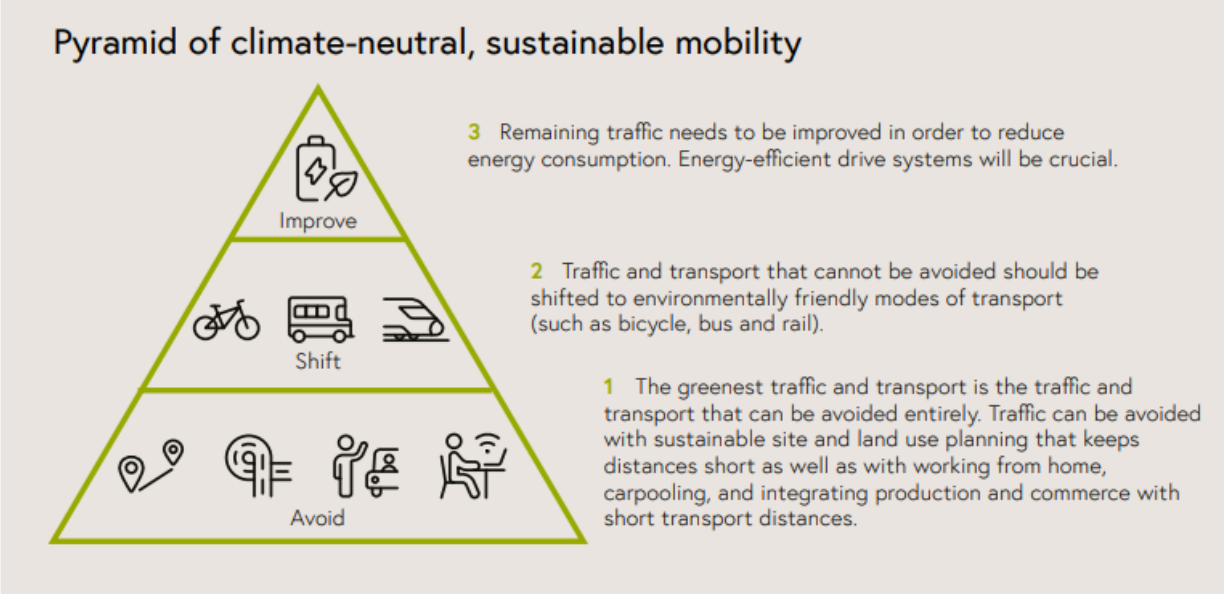
As the most environmentally friendly traffic and transports are the ones that can be avoided, altogether the principle of sufficiency has to be given priority, followed by consistency and efficiency. For the greatest possible impact, as well as the avoidance of secondary effects such as the rebound effect, the joint realization of all three principles is required.

**Example 1: Transport Target Nr. 1 of the Alpine Climate Target System:**

*Modal shift of Alpine freight transit - Alpine freight transit transport (> 300km) is shifted to rail, going beyond European modal shift objectives, supported by an ambitious implementation of innovative logistics solutions.*

**Example 2: Transport Target Nr.4 of the Alpine Climate Target System:**

*Decarbonised Transport Fleet - The road transport fleet is CO2-free (heavy goods and light vehicles), through electric mobility and other alternative drive trains.*




Pyramid of climate-neutral, sustainable mobility. Source: Austria's Mobility Master Plan 2030

Following the Mobility Master Plan 2030, the use of a **backcasting approach** for the development of a coordinated environmental and transport policy is recommended. This approach is based on a sensible combination of avoiding traffic, shifting traffic and improving the efficiency of each mode of transport. It starts from a predefined future scenario and works back from this starting point to the present to identify strategies and measures. A vision of sustainable mobility in the Alpine Space, such as the Transport Targets Nr. 1 and 4 of the Alpine Climate Targets System (ACTS) for a certain target date must be developed.

In the pursuit of sustainable mobility and its climate neutrality, the following **limiting factors must be considered** in the elaboration of the backcasting results:

- Limited construction capacities;
- Long lead times for infrastructure projects;
- Limited availability of renewable energy.

In the Austrian Mobility Masterplan 2030, the following backcasting results were elaborated and can be used as a good practice:

***Backcasting result 1:*** *We need to reverse the trend away from current growth in passenger and freight transport. Freight transport growth must be decoupled from economic growth.*

***Backcasting result 2:*** *We must continue to prioritize shifting traffic to rail and public transport and must leverage existing potential to shift traffic. Additional capacity and better-quality services in both passenger and freight transport will enable more traffic to be shifted. We can expect rail services to improve in the coming years as a result of various innovative measures (digitalization, automation and digital automatic coupling).*

***Backcasting result 3:*** *Technology needs to achieve maximum efficiency, as the amount of renewable energy available is limited. The necessary zero-emission infrastructure must be available in time, and a clear roadmap is needed.*

Of course, the results refer to a detailed evaluation limited to Austrian territory. However, the application of this backcasting approach offers the possibility to **create a generally applicable strategy for sustainable mobility for the Alps**. Such an Alpine-wide strategy for sustainable mobility can be the basis for a coordinated transport policy to achieve the climate targets in the transport sector.

## Targets

**Avoid – Transitioning to less traffic, more regionalism and better quality of life**

### 2.1 Targets

Over the last two decades, the volume of transport in the form of passenger-kilometres required to cover mobility needs has increased by more than 30 per cent, while the volume of freight transport has increased by over 70 per cent. To maintain similar levels in the next 20 years, we will need to pursue the following targets.

**Passenger transport**

- The volume of passenger transport must be kept nearly constant. Due to population growth, this would mean a slight reduction in the volume of transport per person per day from 13.8 kilometres currently to roughly 12.3 kilometres.

**Freight transport**

- Economic growth must be decoupled from the volume of freight transport. With the economy expected to grow 40 per cent by 2040, the aim is for the volume of freight transport to increase only moderately, by no more than 10 per cent.

(Source: Austria's 2030 Mobility Master Plan, page 21)

## Shift – Switching to efficient, environmentally friendly and space-saving modes of transport is inexpensive, creates room and capacity, and promotes good health

### 3.1 Targets

All potential needs to be leveraged to shift traffic to energy-efficient eco-mobility, such as electrified rail and active mobility. We will pursue the following targets by improving infrastructure, improving the quality of services offered and creating the right frameworks:

**Passenger transport**

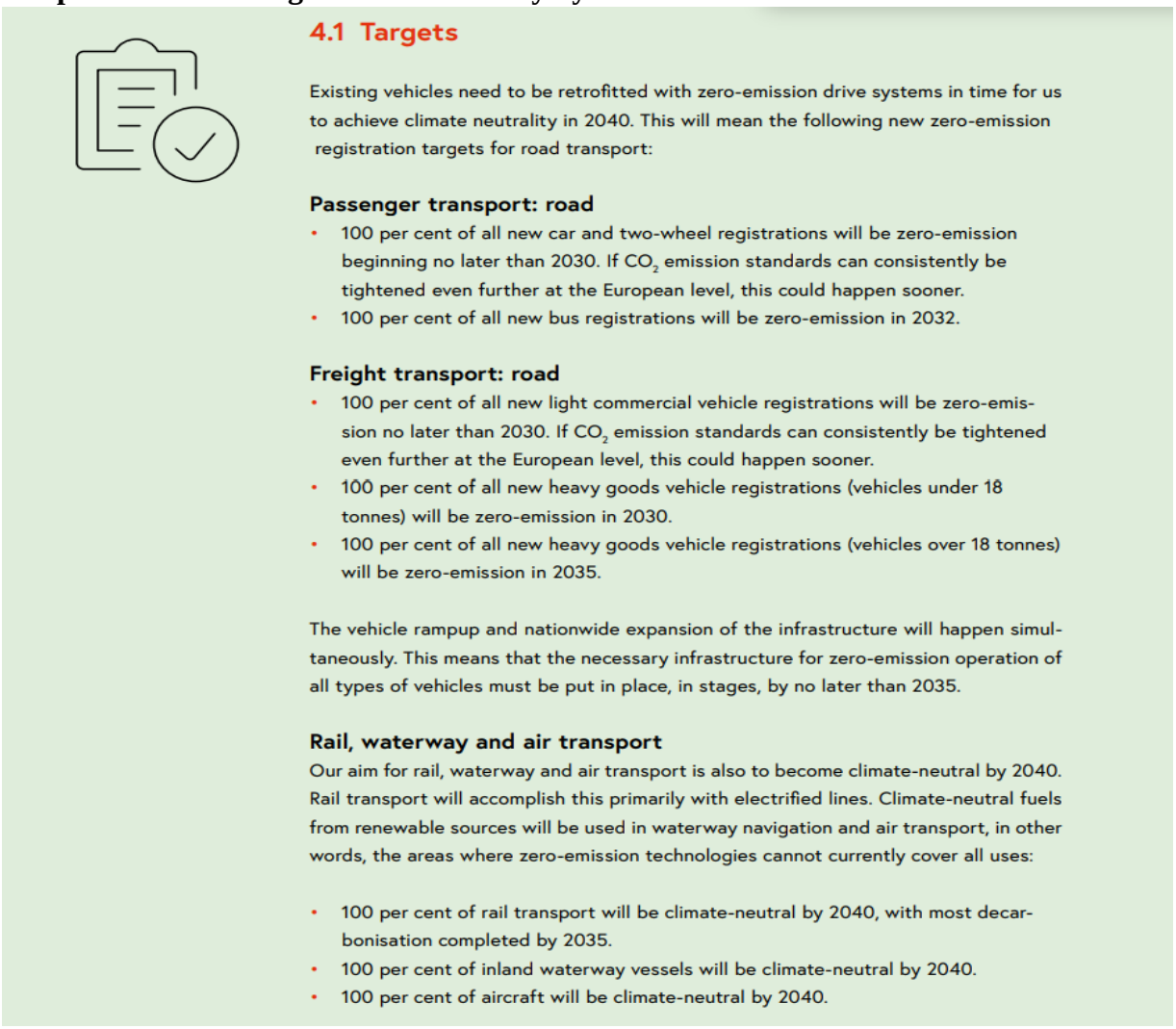
- The share of the volume of transport accounted for by eco-mobility must increase by around half, from 30 per cent to 47 per cent.
- Currently some 60 per cent of distances are travelled by car. This ratio essentially needs to be reversed, and 60 per cent of distances need to be travelled using eco-mobility.
- Cycling's share of distances travelled must double to 13 per cent by 2030.
- Private motorised transport's share needs to drop to 42 per cent, with shared mobility and micro-mobility expanded on a large scale.

**Freight transport**

- Rail's share of the modal split must be increased to 40 per cent (equivalent to some 35 billion tonne-kilometres) with the right European collaboration.
- Austria alone can achieve only a moderate increase (34 per cent).

(Source: Austria's 2030 Mobility Master Plan, page 26)

**Improve – The transition to renewable energy in the transport sector is an essential component of reaching climate-neutrality by 2040**



## 4.1 Targets

Existing vehicles need to be retrofitted with zero-emission drive systems in time for us to achieve climate neutrality in 2040. This will mean the following new zero-emission registration targets for road transport:

**Passenger transport: road**

- 100 per cent of all new car and two-wheel registrations will be zero-emission beginning no later than 2030. If $CO_2$ emission standards can consistently be tightened even further at the European level, this could happen sooner.
- 100 per cent of all new bus registrations will be zero-emission in 2032.

**Freight transport: road**

- 100 per cent of all new light commercial vehicle registrations will be zero-emission no later than 2030. If $CO_2$ emission standards can consistently be tightened even further at the European level, this could happen sooner.
- 100 per cent of all new heavy goods vehicle registrations (vehicles under 18 tonnes) will be zero-emission in 2030.
- 100 per cent of all new heavy goods vehicle registrations (vehicles over 18 tonnes) will be zero-emission in 2035.

The vehicle rampup and nationwide expansion of the infrastructure will happen simultaneously. This means that the necessary infrastructure for zero-emission operation of all types of vehicles must be put in place, in stages, by no later than 2035.

**Rail, waterway and air transport**

Our aim for rail, waterway and air transport is also to become climate-neutral by 2040. Rail transport will accomplish this primarily with electrified lines. Climate-neutral fuels from renewable sources will be used in waterway navigation and air transport, in other words, the areas where zero-emission technologies cannot currently cover all uses:

- 100 per cent of rail transport will be climate-neutral by 2040, with most decarbonisation completed by 2035.
- 100 per cent of inland waterway vessels will be climate-neutral by 2040.
- 100 per cent of aircraft will be climate-neutral by 2040.

(Source: Austria's 2030 Mobility Master Plan, page 36)

## II. ITALY'S NATIONAL ENERGY AND CLIMATE PLAN (NECP)

- 2030 targets for RES energy in road transport (0.379 Mtoe) and rail transport (0.314 Mtoe).
- Eur759 bn investment needs identified for RES energy in transport sector - Funding programme 2019-2033 for replacement of public bus fleet – BEV-CNG-PHEV buses.
- Mandatory purchase of alternative fuel vehicles by public bodies (including LPT and waste collection trucks) at least 30 % by 2022, at least 50 % by 2025 and 85 % by 2030 of powered by methane and hydrogen, and electricity and methane in the case of buses.
- Incentives to purchase low&zero emission vehicles (e.g. Eur300 mln for 0-125 g/Km $CO_2$ emission cars and vans) - Future review of the tax system on transport (tolls, registration tax, ownership tax, excises) .

- Charging points (public and private) for electric vehicles (BEV and Plug-In) from the current 2,900, approximately, up to at least 6,500 in 2022. Tax deductions for the purchase and fitting of infrastructure for charging electric vehicles, untill Dec 2021 (= 50 % of expenses covered).
- Incentives for purchasing commercial vehicles with alternative propulsion (e.g. 2021-22: Eur100 mln to incentivise the LDV-HDV fleet renewal by BioC/LNG-HEV-BEV vehicles.
- The Municipalities imposing limits on access to LTZ permit free access only to electric and hybrid vehicles.

## III. SWITZERLAND'S NATIONAL ENERGY AND CLIMATE PLAN (NECP)

Switzerland (no EU member State) defined in the energy strategy 2050[22] e.g. moduls for the mobility sector to reach the climate relevant targets for $CO_2$-emission reduction and elaborated a planning instrument very similar than the EU NECP, named "Federal Long-Term Climate Strategy" [23], showing the following milestones:

- Land transport does not generate any more greenhouse gas emissions in 2050, with few exceptions.
- In 2050, 90% of all new Cars and LDV will be BEV, the remaining 10% will be FCEV.
- HEVs are relevant during the transitional phase, they will be replaced quickly by BEV starting to 2030.
- Almost half of the drive energy required in transport sector will be provided by renewable electricity-based and biogenic fuels which are used in combustion engines.
- New HDV will account for most FCEV – Electricity-based or Biogenic renewable fuels are only used for road transport if they are not required for other purposes for which fewer alternatives exist. Bio-Gas and Bio-LNG could play a relevant role for HDV in transition period. Electric vehicles are mainly used in LPT Buses
- Inclusion of lifecycle emissions in the regulation on fleet emissions.
- The shifting from road to rail makes the major contribution to reducing greenhouse gas emissions and ensuring climate-compatible spatial development, if the (additional) power used is produced in a renewable and sustainable way.
- Digitalization and Home-Working will give a relevant contribution to reduction in the number of kilometres travelled and therefore lower energy consumption and emissions.
- Fast charging stations for e-vehicles on the Swiss highway network are promoted [24].

[22] Energy Strategy 2050 (admin.ch)

[23] Climate protection: Federal Council adopts Switzerland's long-term climate strategy (admin.ch)

[24] Ausschreibung und Vergabe von Rastplätzen für den Bau von Schnellladestationen (admin.ch)

In the sector of hydrogen mobility, the so-called H2 – mobility association is promoting the Hydrogen-mobility and refuelling infrastructure for hydrogen-vehicles [25]. Thanks to this association a huge project of hydrogen – trucks could be launched and is still running, up to 1000 Fuel Cell trucks from Hyundai are involved.[26]

In Switzerland the long-term policy in the mobility sector is, since decades, focused on developing public transport systems, both for passengers and freight. Further huge investments in stepwise rail development until 2035 and beyond are planned or are already being implemented and under construction[27].

A special focus is also put on electrification of public transport by road (buses)[28] covering a wide network especially in Alpine Regions and the multimodal mobility approach with the establishment of a federal Mobility Data Infrastructure (MODI) [29] providing data exchange in order to network government stakeholders, mobility providers, developers and managers of digital customer solutions like applications, as well as other players in research and development supporting an overall substitution of individual motorized transport.

[25] Förderverein H2 Mobilität Schweiz (h2mobilitaet.ch)

[26] Wasserstoff in der Praxis: Mit dem Brennstoffzellen-Lkw unterwegs (nzz.ch)

[27] Federal Office of Transport FOT Expansion step 2035 (admin.ch)

[28] 210421_KS_LITRA_PrixLitra_Pubikation_DE.pdf

[29] Federal Office of Transport FOT Data for an efficient mobility system (admin.ch)

# Potential analysis of existing and new technologies for the promotion of a sustainable passenger transport in the Alpine region

***Final Report***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**Transport Working Group of the Alpine Convention**

*Mandates 2019-2020 and 2021-2022*

ALPENKONVENTION
CONVENTION ALPINE
ALPSKA KONVENCIJA
CONVENZIONE DELLE ALPI

## IMPRINT

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| | |
|---|---|
| API | Application Programming Interface |
| ASTUS | Alpine Smart Transport and Urbanism Strategies |
| DB | Deutsche Bank / German Railway |
| EU | European Union |
| LEC | Low Emissions Corridor |
| LIFE | L'Instrument Financier pour l'Environnement / EU's funding instrument for the environment and climate action |
| MaaS | Mobility as a Service |
| NEAT | Neue Eisenbahn-Alpentransversale / New transalpine rail link |
| ÖBB | Österreichische Bundesbahnen / Austrian Federal Railways |
| OECD | Organization for Economic Cooperation and Development |
| P+R | Park and Ride |
| SASA | Städtischer Autobus Service AG / Municipal Autobus Service AG |
| SBB | Schweizerische Bundesbahnen AG / Swiss Federal Railways AG |
| TEN | Trans-European Networks |
| TUM | Technische Universität München / Munich University of Technology |

# INTRODUCTION

The Alps are one of the largest contiguous natural areas in Europe. Due to their specific and diverse nature, culture, and history, the Alps are deemed to be an excellent living, economic, cultural and recreational area located in the centre of Europe. Linked by this common territory and the identical challenges posed by their region, all eight states of the Alpine region (Germany, Austria, France, Italy, Liechtenstein, Monaco, Switzerland, and Slovenia) as well as the European Community have signed the Convention on the Protection of the Alps (the so-called Alpine Convention). The Alpine Convention entered into force in 1995. In the Alpine Convention, the Alpine countries commit themselves to the implementation of a transport policy in terms of sustainability and among others characterised by the elements listed here in the following:

- Cross-modal mobility design contributing to the sustainable development of the living and economic space as the basis of life for the population residing in the Alpine region.
- Ensuring intra-Alpine as well as trans-Alpine traffic through the increase of the effectiveness and efficiency of transport systems and the promotion of environmentally friendly and resource-conserving transport methods at economically viable costs.
- Ensure fair competition conditions between the different transport methods.

Today more than ever, the Alpine Convention aims at the protection, preservation, and development in terms of sustainability of this mountain region. During the month of April 2019, the ministers of the Alpine countries therefore adopted the Alpine Climate Target 2050, which aims at the achievement of climate neutrality in the Alp region by the year 2050.

To concretise the Alpine Convention, eight protocols including regulations on sectoral issues were adopted and corresponding working groups were established.[1] In the current mandate of the Transport Working Group , the focus was placed on passenger transport. As representative of the German delegation, the Federal Ministry for Digital and Transport, in close cooperation with the Bavarian State Ministry of Housing, Construction and Transport, commissioned the company TÜV Rheinland InterTraffic GmbH to prepare a study concerning the potential of the existing and new technologies for a sustainable passenger transport in the Alp region.

The aim of the said study is to show which types of the existing and new technologies are particularly suitable in the Alpine region, which are the challenges associated with the introduction of technology and its daily application, and which are the concrete recommendations for action you can deduct from it.

[1] Further background information on the Transport Working Group is available on the following website: https://www.alpconv.org/de/startseite/organisation/thematische-arbeitsgremien/detail/arbeitsgruppe-verkehr/.

# 1 OBJECTIVE AND FOCUS OF THE STUDY

According to the demarcations made by the Alpine Convention, the Alpine arc has approximately 13 million inhabitants living in a space of 190,912 km². The Alpine arc consists of approximately 100 regions and 6,200 municipalities. The Alpine region is heterogeneous in terms of settlement structure as well as of population density. On the one hand, it is characterised by local centres (urban agglomerations as well as tourist communities) and on the other hand by a structurally weaker hinterland (abandoned side valleys as well as mountain slopes). This aspect also influences the situation in terms of traffic. From the glance at the respective objective of the route, the following traffic-related division may be deducted:

- Commuter traffic (business, education, and work)
- Tourism and leisure traffic (for example leisure activities, shopping) and
- Transit traffic (road and rail).[2]

The Alpine Convention aims at the protection of the Alps as a habitat as well as an ecosystem and at the reconciliation of the same with the aspects relating to living, working, economy, infrastructure and tourism in the Alpine region. One of the six priorities of its work programme 2020-2022 consists of the promotion of sustainable transport. However, depending on whether we are talking about urban centres, rural areas, tourist centres or depopulated mountain regions, the related requirements for action are different. Accordingly, sustainable mobility concepts must consider aspects like geographical location, population density, settlement structure, economic strength, and ecological features.

The objective of the present study consists of the analysis of the potential of new and innovative technologies in the area of passenger transport in the Alpine region. The collected findings will be put at disposal of all states, municipalities, and regional actors in the passenger transport according to the Alpine Convention.

For this purpose, existing innovative projects when it comes to passenger transport in the Alpine region were identified and then discussed in a workshop on the basis of practical examples. In accordance with the categorisation of the practical examples according to the above-mentioned transport purposes, these are summarised under Chapter 5. In this context, also their potential when it comes to the application in other Alpine regions is shown. On this basis, general recommendations relating to the mobility development in the Alpine region will be formulated.

[2] Cf. (Prof. Dr. Stopka 2004) .

# 2 ALPINE SPECIFICITY AND SUSTAINABILITY

The identification and selection of transport projects implementing new and innovative technologies in the Alpine region was based on the following criteria: The projects had to (1) aim at the promotion of sustainable transport, (2) be innovative and implement new technologies, and (3) consider the specific features of the Alpine region.

## 2.1 ALPINE SPECIFICITY

In the context of this study, the term “Alpine specificity” describes the extent to which transport and infrastructure measures particularly consider the geographical, ecological as well as economic features of the Alpine region.[3] In this context, the following alpine-specific features may be quoted:

- Special topographical conditions which, on the one hand, have a separating effect on natural and settlement space and, on the other hand, influence the climatic conditions existing in valley as well as mountain regions.[4] For example, settlements and transport axes are generally concentrated in more or less narrow valleys. Only a few settlements are located on slopes or alpine pastures (formerly glacial trough shoulders).
- Heterogeneous, small-scale climatic conditions at different altitudes as well as valley-mountain deviations.[5]
- Traffic volumes subject to a strong fluctuation depending on the season due to tourism, for example as a result of winter sports activities or of hiking in the course of the summer months. Tourist travel accounts for 75% of the $CO_2$ emissions caused by annual tourism; 84% of holiday trips to Austria, for example, are made by car.[6]
- A special ecosystem and biodiversity have a crucial impact on humans and the environment.
- A pronounced “natural dynamic” typical of high mountains, characterised by erosion processes, unstable rock layers as well as natural events such as floods, avalanches, or landslides.[7] In terms of transport, this means that there is a need for securing the infrastructure.

[3] Cf. (Essl, et al. 2014, p. 26f.) .

[4] Cf. (Tischler and Mailer 2014, p. 140) .

[5] Cf. (Central Institute for Meteorology and Geodynamics 2020) .

[6] Cf. (Astelbauer-Unger 2011, p. 8) .

[7] Cf. (Bätzing 2003, p. 42) .

## 2.2 SUSTAINABILITY

The present study defines sustainable transport projects as resource-conserving, low-emission, energy- and land-efficient mobility design initiatives and the use of suitable transport methods and systems.[8] In this context, the prerequisites must not be cumulative. In fact, the relevance of one sustainability-related criterion will suffice.

The following table contains an explanation of the sustainability-related indicators by also including examples in terms of operationalisation.

**Table 1: Sustainability Indicators**

| Indicator (criterion) | Explanation | Operationalisation (examples) |
|---|---|---|
| **Reduction of harmful emissions** | These include air pollutants being harmful to health, such as nitrogen dioxide ($NO_2$), carbon monoxide (CO), sulphur dioxide ($SO_2$), lead (Pb) and particulate matter ($PM_{10}$). The mentioned air pollutants form smog, result in the ozone formation and may contribute to ecological impairments such as the acidify-cation of lakes and soils. | • Electrification in the railway sector<br>• Replacement of diesel railcars by hydrogen trains or electric railcars<br>• Replacement of diesel buses with fuel cell or electric buses<br>• Use of e-cars in the car-sharing sector |
| **Reduction of greenhouse gas emissions** | Under the Kyoto Protocol, these include emissions of carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), nitrogen trifluoride ($NF_3$) and fluorinated greenhouse gases (hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride ($SF_6$)). | • Electrification in the railway sector<br>• Replacement of diesel railcars by hydrogen trains or electric railcars<br>• Replacement of diesel buses with fuel cell or electric buses<br>• Use of e-cars in the car-sharing sector |
| **Energy consumption reduction** | The energy consumption is measured by the number of different fuels (electricity and hydrogen) to be used. | • Reduction of fuel consumption<br>• Increase in terms of energy efficiency |

[8] Cf. also the OECD definition of environmentally sustainable transport (Wiederkehr, et al. 2003, p. 3f.) .

| Indicator (criterion) | Explanation | Operationalisation (examples) |
|---|---|---|
| **Reduction of surface and/or land use** | This concerns the potential separating effect of a project and/or measure, the use of existing infrastructure and the type of land use. | • Use of the existing infrastructure<br>• The reduction of the land use to a minimum level<br>• Assessment of the project effect in terms of separation |
| **Reduction of travel time or increase of travel quality** | The sustainability criterion of travel time was supplemented by the criterion relating to travel quality by including, for example, intermodality of transport methods or digitalisation measures. | • Expansion of intersections<br>• Ticketing concepts<br>• Use of apps<br>• Digitization (for example inside the vehicle)<br>• Sharing models |

# 3 METHODICAL APPROACH

## 3.1 INVENTORY

A comprehensive inventory formed the basis for the selection of practical examples which were then used for the formulations of recommendations for action. The projects were identified through desktop research and an online survey.

### 3.1.1 Desktop Research and Online Survey

Sustainable transport projects in passenger transport were researched in the course of the desktop research. In this context, not only projects with alternative drives or technologies were included since also projects dedicated, for example, to the change in terms of user behaviour or the creation of intermodal transport services were part of the research.

The said projects were recorded and categorised on the basis of the criteria listed below:

- Project specifics (project leader / contact person, project content and objectives, project period, country, allocation (valley, mountain, city))
- Technical and transport features (target group, means of transport, role of intermodality, promotion of alternative forms of mobility or shared mobility, infrastructure requirements and technologies)
- Assessment of costs and impacts (potential displacement effects, applicability under Alpine-specific conditions, noise pollution, and transferability to other Alpine regions).

The project research was carried out on the basis of publicly accessible, especially internet-based sources. To complete the research and to highlight the practical significance of the projects, an online survey was conducted in parallel in the German and English languages. The participants were asked to name the characteristics which according to their opinion were relevant in terms of sustainability and Alpine specificity. In particular, state authorities, interest groups, scientific and research institutions, transport associations and public transport authorities as well as transport companies were included.

A total of 111 actors were contacted and asked to participate in the survey. Among them 29 actors completed the entire survey. This corresponds to a response rate of 26%.[9]

Most responses came from Austria, Switzerland, and Germany (66% in total). 8% of the respondents did not assign themselves to any country, but to a transnational organisation.

[9] Note: Within the scope of the survey, there was no obligation to answer all questions entirely. For this reason, the number of answers per question may vary. The number of participants varies per question; thus, “n” was always indicated; however, the indicated “n” may vary per question.

Of a total of indicated 53 institutions, organisations, and interest groups as well as local authorities represent the largest group of respondents with 21% and 19% respectively. 15% of the participants come from the branches of public transport authorities, transport or tariff associations or represent the fields of science and research. Approximately 13% of the participants come from transport companies. The lowest response rate concerned the business community, municipalities, and regional authorities.

### 3.1.2 Inventory Analysis

A total of 112 sustainable projects in the Alpine region emerged from the inventory analysis. These were analysed according to the aspects listed below:

(1) Regional distribution,

(2) Project focus,

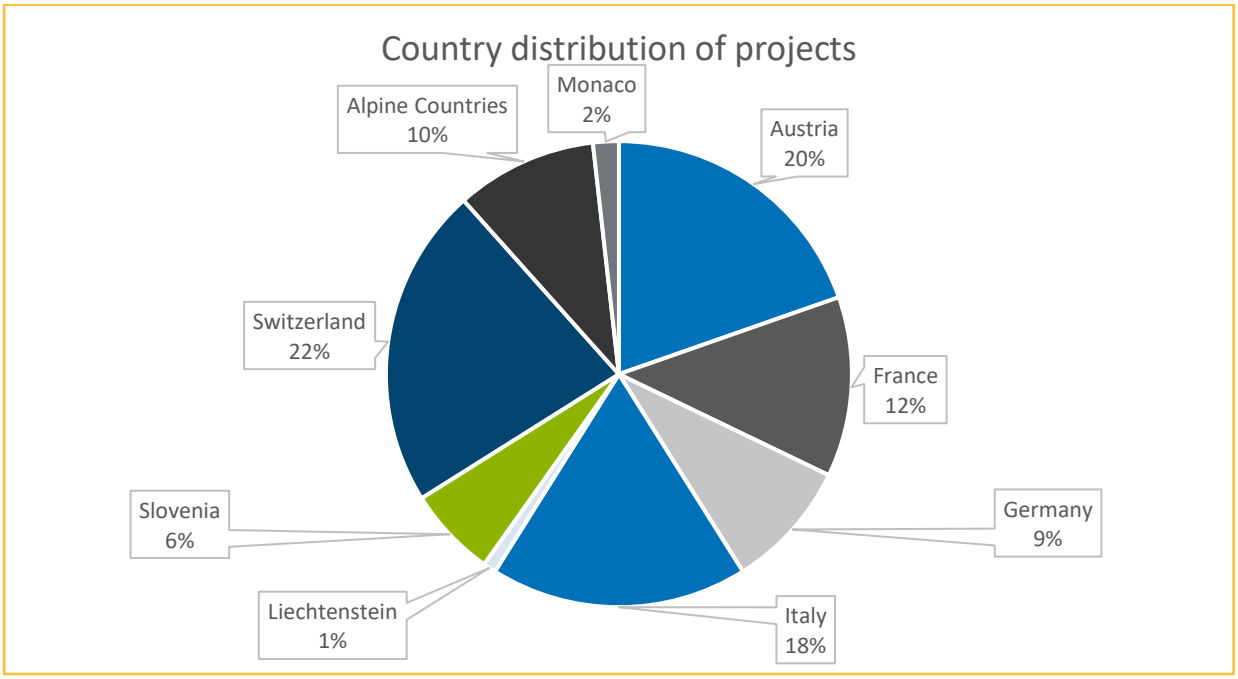
(3) Use of innovative and new technology, and

(4) Basic transferability of the projects to other Alpine regions.

#### Regional Distribution

The regional distribution of the projects roughly corresponds to the area shares of the Alpine Convention signatory states. Almost two thirds of the projects are located in Austria, Switzerland and Italy, while a good quarter come from France, Germany and Slovenia. A total of 3% comes from the states Monaco and Liechtenstein. If a project spanned several countries, it was assigned to the country where it was largely based in. Otherwise, it was assigned to the category of “Alpine countries” as a transnational project.[10]

**Figure 1: Country distribution of projects indicated percentage**




[10] Ten projects researched belong to individual countries of the Alpine Convention, but do not geographically belong to the Alpine region.

### Focus of the Projects

A significant part of the projects aims to steer the demand for mobility, often motivated by tourism, more towards climate-friendly offers. This in turn requires the creation of a corresponding range of low-emission, environmentally friendly mobility (the so-called “Soft Mobility”).

Most of the projects researched were carried out or started during the last ten years. The focus is on the design of sustainable road-based mobility being the objective of almost two thirds of all projects. These primarily include measures aimed at the reduction of tourism-induced car traffic and range from charging and rental systems for electric vehicles and the use of buses with alternative drives to the ticketing and shuttle systems to reduce individual traffic and pilot testing of the use of automated vehicles in local public transport.

Around one seventh of the projects relate to the rail sector and include both infrastructural measures for the new construction and expansion and the revitalisation of rail lines and the use of innovative technologies. Another category of measures includes ticket offers aimed at directing demand for mobility to rail.

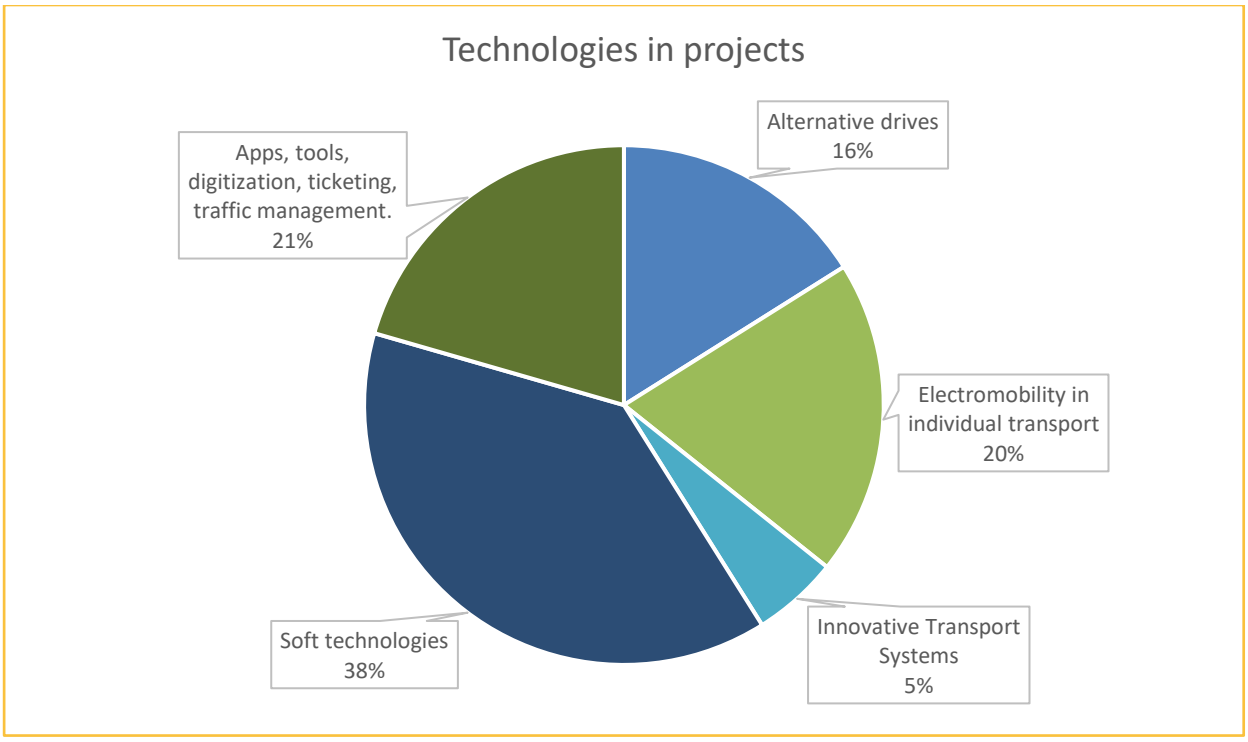
Finally, a third group, comprising about one fifth of all projects, includes various cross-modal projects for the further development of regional mobility. A notable proportion of these are measures aimed at the development of concepts for sustainable mobility and information as well as ticketing systems.

### Use of Innovative and New Technology

A wide range of new and climate-friendly technologies are being applied. For example, around one fifth of the projects each deal with the decarbonisation of individual transport, in particular through the use of electric bicycles and electric cars, and public passenger transport. The latter group includes the use of battery-electric and hydrogen-powered buses and rail vehicles, but also other innovative transport systems, for example based on cable car or air cushion technologies.

However, most of the technological focus is in the area of digital-based applications and the use of other "soft" technologies as a bundle of methods, processes and organisational applications for the provision of mobility services[11]. Their spectrum ranges from guest card systems providing access to the extensive public transport services, to travel information and traffic management systems, to platform-based mobility services and the development of corresponding mobility apps. These groups account for around three-fifths of all the projects considered.

**Figure 2: Application of Technologies in Projects**




[11] Cf. (Deakin 2009) .

### Basic transferability of the projects to other Alpine regions

A further focus of the analysis consisted of the particular identification of those projects whose results have a distinctly representative character and can consequently serve as an example for other regions and municipalities in the Alpine region.

The table below illustrates the extent to which transferability of lessons learned, adequate practices, and results may be ensured in the project categories listed below.

**Table 2: Project categories and degree of the criteria fulfilment**

| | |
|---|---|
| **Bus / Shuttle** | • In the meantime, various regions have gained experience with electric drives and hydrogen buses and are implementing the expansion of the conversion to low-emission vehicles. Examples of this are the hydrogen buses, the electric bus fleet, and the e-bus filling station of SASA South Tyrol or the electric bus strategy of the transport association in Lucerne.<br>• The application of the said technologies in different Alpine regions is possible, and the corresponding project know-how may be transferred. Important factors for deciding on the suitable form of propulsion are, for example, the total distance travelled daily, the altitude metres to be covered and the availability of adequate charging locations. |
| **Cable car** | • The transferability of ropeway projects to different Alpine regions depends on the respective conditions. The choice of ropeway technology and vessel sizes is to be adapted to the specific framework conditions existing in each individual case. |
| **Railway** | • Large railway infrastructure projects pose a particular challenge in mountainous regions due to topographical, geological, and technical aspects. Large-scale projects carried out in Switzerland show in an exemplary manner how the expansion of rail infrastructures in mountain regions is possible, feasible, and meaningful.<br>• In the rail sector, diesel vehicles are gradually being replaced by battery-powered railcars, hydrogen trains or electric vehicles. A suitable moment in time for the procurement of new vehicles is, for example, the conclusion of new transport contracts. The decisive factors for the technology-related choice include the degree of electrification of the existing route, the traffic performance and the availability of the corresponding refuelling and charging infrastructure. Examples of this are the battery-powered railcars of ÖBB (Austrian Federal Railways) and the hydrogen trains of the Zillertalbahn. |

| | |
|---|---|
| **Motorised individual traffic** | • Car sharing services with conventional drives and e-cars are also used in the Alpine region and its surroundings, for example in Bled (Slovenia), Munich and in Moos in the region of Merano. |
| **Individual traffic** | • Bike sharing as well as e-bike sharing offers have already been implemented in many ways in small communities and towns throughout the Alpine region. In this regard, a tariff-related link with public transport use or carpooling offers may be useful. |
| **Carpooling** | • Individual carpooling projects in the Alps show that they are perceived as interesting. In addition, they show that these types of projects can be implemented both by phone and app booking.<br>• Examples are the projects Taxito in Bern, the Gesäuse Sammeltaxi (shared taxi) project in Admont and the Dorfbus (village bus) in Kleinmürbisch. In this context, the connection to the existing public transport services is crucial so to avoid the creation of a competitive situation. |
| **Autonomous driving** | • Two autonomous driving projects have been identified within the Alpine region. The said projects include a test phase comprising an autonomous shuttle in Merano and the Smart Shuttle of the company Schweizer Postauto AG in Sitten / Sion, Switzerland. In addition, among others, outside the Alpine region, the test operation of an autonomous minibus in Bad Birnbach was taken into consideration.<br>• An important challenge for the application in the Alpine region is due to the climatic conditions, the altitudes as well as the existing connections to satellites and communication technology. |
| **Information systems** | • Traveller information systems or websites providing information about existing mobility offers and ticketing systems are also used. In this context, the linking and compatibility of different systems may often be problematic. |
| **Traffic management** | • To mention some examples, this system includes the establishment of environmental zones, the parking space management, or the improvement of traffic flows. Generally speaking, the said measures are transferable although they require complementary measures such as the provision of P+R parking spaces and the expansion of public transport services. |

## 3.2 PROJECT CATEGORISATION

During the next step, the researched projects were subjected to an analysis exclusively focusing on aspects relating to sustainability and also assessed in terms of quality. The assessment was carried out on the indicators described above:

- Reduction of emissions harmful to health,
- Avoidance and reduction of greenhouse gas emissions,
- Reduction of energy consumption,
- Sustainable use of the existing space and
- Reduction of travel time or promotion of travel quality.

The objective of the categorisation consisted of the capacity relating to the improved categorisation and consequently to the better comparison of the researched projects internally on the basis of the presented assessment grid. On his basis, a comprehensible selection of practical examples should be carried out whereby the said examples must be particularly suitable for a presentation in the context of a workshop with regional actors.

### General statements based on sustainability

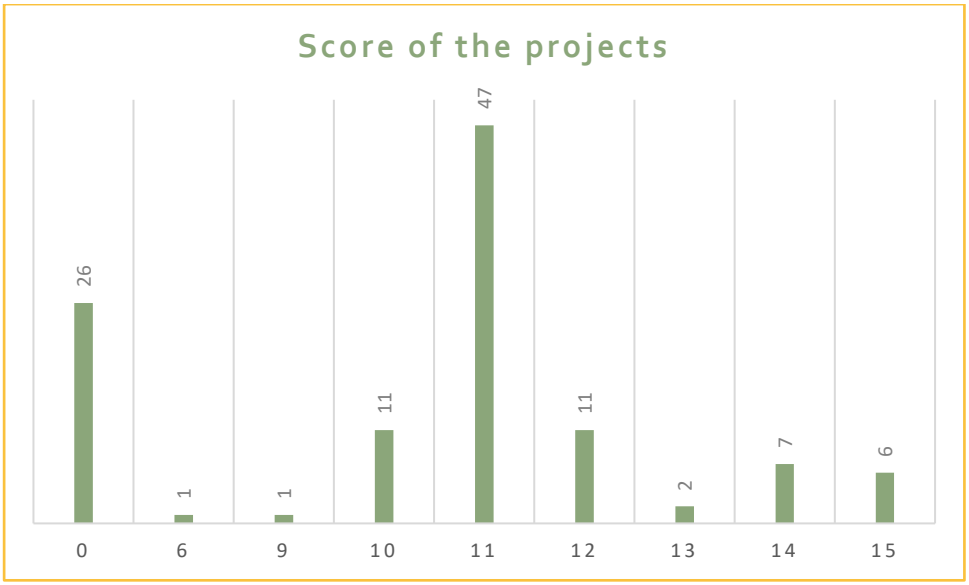
The projects were assessed on a school grade scale from 1 to 5. In Figure 3 on the X-axis the points of the projects and on the Y-axis the number of projects having received this score are shown. The lower the score, the more sustainable the project was assessed according to its measurement by means of the 5 mentioned indicators. All project scores ranged from 6 to 15 points[12]. For a number of projects, an assessment based on the comparatively narrow set of criteria proved to be less useful one. To mention an example, this was the case with planning methods and information systems which cannot be adequately operationalised by using the selected sustainability indicators. In the assessment, these projects were set to “0”.

Overall, the average project score is of 8.4, and if you exclude the projects having the score 0, the average score achieved will be 11.

The figure shows that a large project proportion is positioned in this range. 12% of the projects were rated better than average while 23% of them obtained a score beyond the average value.

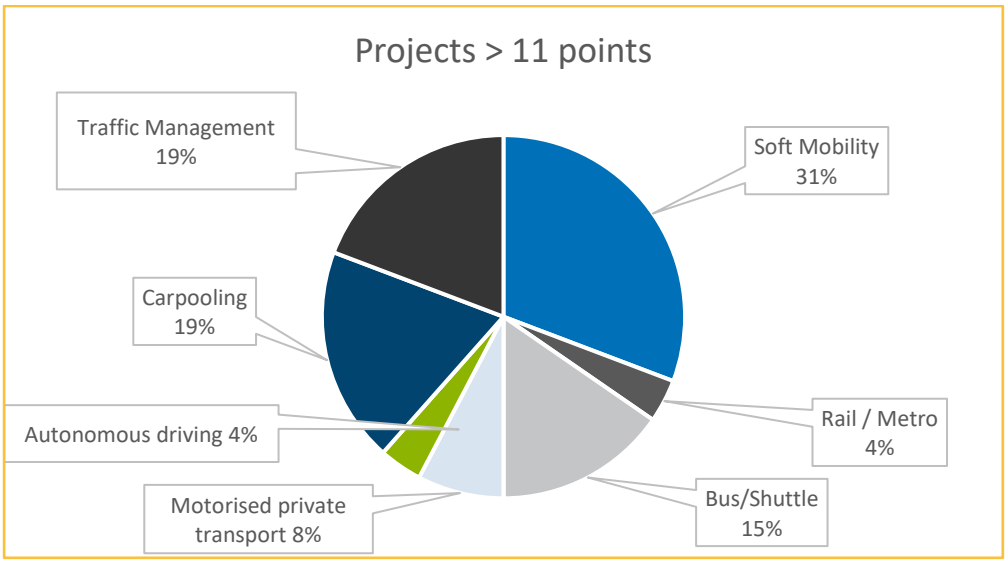
[12] Note: A higher score says nothing about the usefulness or meaningfulness of an individual project. Rather, the assessment of the projects according to the five selected sustainability criteria permits comparability so to ensure a comprehensible project selection for the workshop during the next step.

**Figure 3: Project assessment**




## Projects obtaining a score of 11≥

**Figure 4: Distribution in terms of percentage of projects per traffic type obtaining more than 11 points**

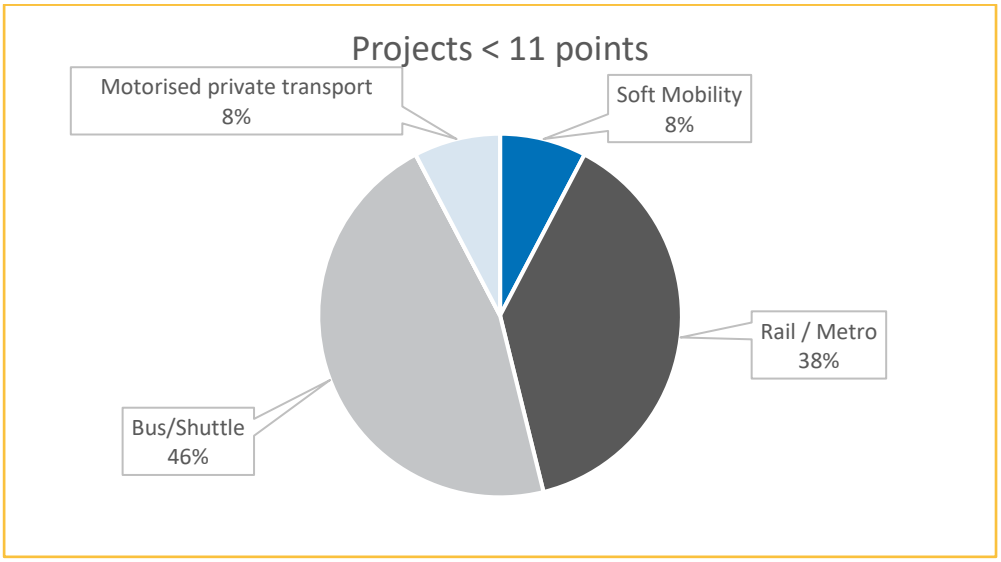



Projects obtaining a score beyond the average value particularly relate to projects in the areas of traffic management, carpooling with conventional drives (i.e. without alternative drives), and soft mobility. The said projects received higher scores in particular due to the use of drives with conventional combustion engines in the areas of emissions and energy consumption or in relation to the aspect relating to the “reduction of travel time and/or the promotion of travel quality”.

Car sharing and carpooling tended to achieve higher scores since it was assumed that they rarely cause modal shift effects by consequently having a comparatively little impact on the emission-related reduction.[13] The energy consumption was also frequently assessed at a medium level because in almost all cases there wasn't any switch to alternative propulsion systems, for example electric or hydrogen propulsion. Furthermore, the land use rarely changes if only individual users give up their own cars (shown in Figure 4 as motorised private transport). Depending on the type of car sharing (station-based or in the open road space) as well as the availability, a minor increase in terms of travel time compared to private cars may usually be assumed.

### Projects obtaining an above-average rating

**Figure 5: Distribution in terms of percentage of projects per traffic type obtaining less than 11 points**




Projects for the use of alternative drives in the areas of rail / metro and bus / shuttle received an above-average rating to a level of 10 points. They scored very well overall in terms of the reduction of emissions, the energy consumption and the use of existing infrastructure. In this context, only in the area of travel time medium points have been awarded. However, projects relying on other innovative approaches or technologies, such as car-free communities offering an additional range of alternative forms of mobility in combination with electromobility, also reached a good performance level, in particular when it comes to the emission reduction and to the aspect concerning the land use (cf. Figure 5).

[13] Cf. (Dr. Wolff, et al. 2019) .

## 3.3 SELECTION PROCESS OF THE PRACTICAL EXAMPLES

The projects presented were intended to provide examples in terms of the application of innovative technologies in the Alpine region concerning defined sustainability aspects. The basis consisted of the project categorisation described above. In a first step, practical examples with an (above)average rating were selected.

**Table 3: Benefit analysis for the selected projects**

| Project specifics | | Sustainability indicators | | | | | Score |
|---|---|---|---|---|---|---|---|
| Number | Project (country) | Reduction of harmful emissions | Reduction of greenhouse gases | Reduction of energy consumption | Land use | Improvement of the travel time or quality | Total score |
| 1 | Subway Serfaus (AUT) | 1 | 1 | 1 | 1 | 2 | **6** |
| 2 | E-bus strategy St. Gallen (CHE) | 2 | 2 | 2 | 2 | 2 | **10** |
| 3 | Léman Express (CHE) | 2 | 2 | 2 | 2 | 2 | **10** |
| 4 | Zillertalbahn (AUT) | 2 | 2 | 3 | 1 | 2 | **10** |
| 5 | Gotthard Base Tunnel (CHE) | 3 | 3 | 2 | 2 | 1 | **11** |
| 6 | Autonomous minibus Bad Birnbach (DEU) | 2 | 2 | 2 | 2 | 3 | **11** |

In addition, within the feasible limits, the selection of practical examples should reflect the different transport methods, the countries involved in the Alpine Convention and the various transport-related objectives (commuter traffic, tourism and leisure, transit traffic).

As already outlined above, for some projects an assessment based on the sustainability indicators used was not feasible. Regardless of this aspect, these projects can make a crucial contribution to the success of the mobility transition in the Alpine region, for example by advancing the digitalisation process by means of the development of new planning methods, information systems and apps.

Automated and networked or autonomous driving also represents a new and forward-looking technology, so that this area should also be represented by adequate practical examples.

Accordingly, the following projects were selected for more detailed consideration:

- *Brenner Lower Emissions Corridor (ITA)*: With its focus on the reduction of emissions in transit traffic, this project has achieved a good rating except for the criterion relating to the "reduction of travel time and/or quality" (12 points in total).
- *LinkingAlps (AUT)* - Passenger information systems aimed at the improvement in terms of cross-border traffic (without assessment)

- *$CO_2$ L-Tool and TUM Accessibility Atlas (DEU)* - Alpine Smart Transport and Urbanism Strategies (ASTUS) research project (without assessment)
- *ArcMobilité (CHE)* - Digitisation in public transport (without assessment)
- *mybuxi (CHE)* - Bridging the “first / last” mile with an on-demand ride service (including the development of an app) (without assessment).
- *ECOTRAIN (FRA)* - Autonomous driving on rail in rural areas (including the programming of new software for the autonomous operation of shuttle trains) (without assessment).

# 4 WORKSHOP

In this context, a one-day workshop was held in Munich in September 2020 in order to exchange experiences on already implemented projects involving forward-looking technologies and innovations in the field of passenger transport. The event was embedded in a meeting of the Transport Working Group of the Alpine Convention. Due to the Corona pandemic, the workshop could only be held as a hybrid event. In total, almost 30 participants participated in it on site and another 30 or so online from the majority of the Alpine Convention countries.

The following practical examples were presented in the course of the workshop:

**Table 4: Programme of the workshop held in September 2020**

| Commuter traffic | Tourism and leisure transport |
|---|---|
| • Zillertalbahn (AUT) – Hydrogen fuel cell vehicles in rail transport<br>• Léman Express (CHE) – Transnational development of urban rail systems<br>• ArcMobilité (CHE) – Digitisation in the field of local public transport<br>• $CO_2$ L-Tool and TUM Accessibility Atlas (DEU) - Research Project Alpine Smart Transport and Urbanism Strategies (ASTUS) | • mybuxi (CHE) – Driving service on demand in rural regions<br>• St. Gallen (CHE) – Integration of e-mobility in cities<br>• Serfaus (AUT) – Introduction of a subway in small community |
| **Transit traffic** | **Autonomous driving** |
| • LinkingAlps (AUT) – Passenger information systems for the improvement of cross-border traffic<br>• BrennerLEC (ITA) – Technologies for the reduction of emissions in the field of transit traffic<br>• Gotthard Base Tunnel (CHE) – Infrastructure project supporting the shift of traffic from road to rail | • Bad Birnbach (DEU) – Autonomous driving in the context of the public transport system in Germany<br>• ECOTRAIN (FRA) – Autonomous driving on rail in rural areas |

The practical examples were presented (both on site and online) by the actors responsible for the projects and then discussed together with all participants (both on site and online).

The discussion also included the current projects, such as a study conducted in Tyrol, Austria, on the topic of "Mobility-as-a-service (MaaS)"[14]. Among other things, the study aims at the creation of a range of different mobility services (for example, public transport, shuttle and sharing services) tailored to individual requirements.

Furthermore, an innovative model for the estimation of the accessibility of a destination by public transport was presented. The said model shows and analyses operational obstacles in the field of public transport on selected routes.[15]

[14] In the context of the workshop, Dr. Rumana Islam Sarker (University of Innsbruck) presented the study entitled "Mobility-as-a-service (MaaS) in Tyrol, Austria".

[15] During the workshop, Prof. Cavallaro (Politecnico di Torino) presented the article entitled "An innovative model to estimate the accessibility of a destination by public transport" (as published in Transportation Research Part D: Transport and Environment, vol. 80, March 2020, pp. 102-256).

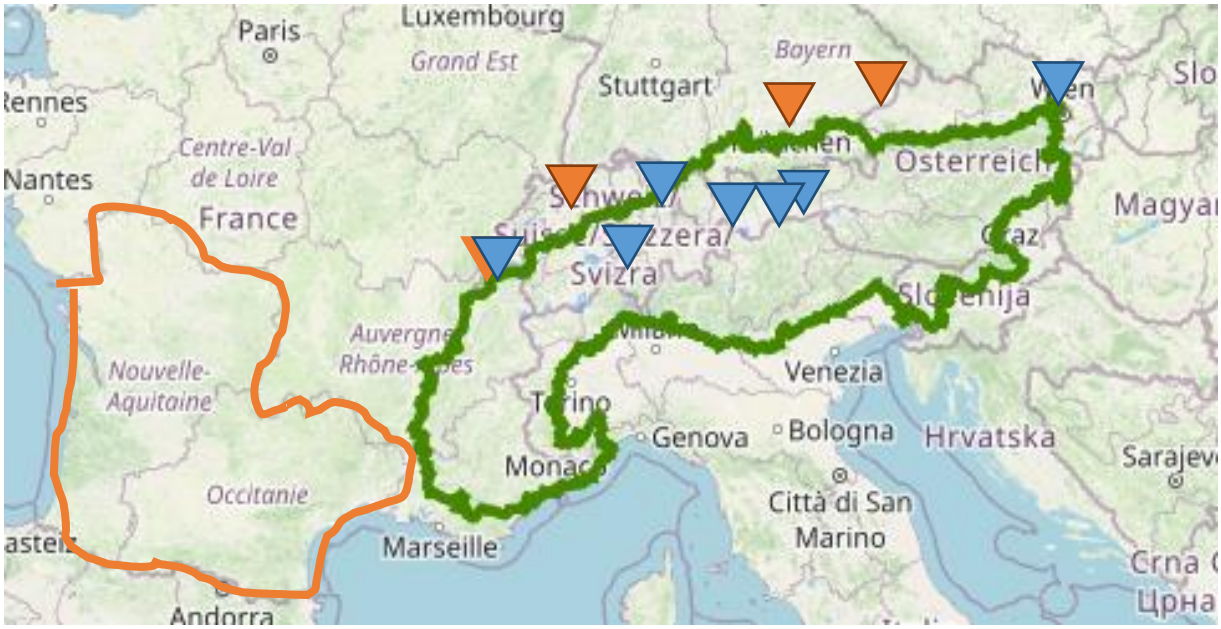
# 5 PRACTICAL EXAMPLES OF TECHNOLOGIES AND INNOVATIONS TO PROMOTE SUSTAINABLE PASSENGER TRANSPORT

Here in the following, 12 of the projects discussed in the workshop will be examined in more detail. After the brief description of the content or subject matter of the respective projects, the challenges, the objective, the taken measures, and the implemented technologies and will be introduced. On the background of the sustainability indicators, an attempt will be made to identify potential impulses of the respective project for the design of sustainable mobility.[16]

On the said basis, both the strengths and weaknesses of each project and its potential for transferability to other Alpine regions will be identified. Recommendations for action will be developed for the actors in the Alpine region (including project promoters, regional and national decision-makers) who wish to apply new technologies and innovations in the field of passenger transport with a view to the promotion of sustainable mobility in their respective regions.

Figure 6 outlines the geographical distribution of the introduced projects. Seven of the presented projects are located inside and five outside the perimeter of the Alpine Convention.

**Figure 6: Overview of all presented projects**




[16] The presentation of the practical examples is based, among other things, on the presentations in the context of the workshop and on the documents, which have been provided for this purpose.

## 5.1 PRESENTATIONS OF PROJECTS RELATING TO COMMUTER TRAFFIC

### *Zillertalbahn (AUT) - Hydrogen fuel cell vehicles in rail transport*

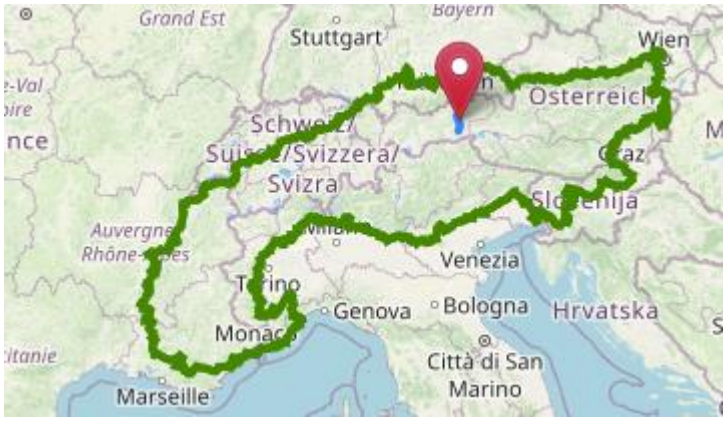



**Figure 7: Map view of the Zillertalbahn**

1. Project Description relating to the hydrogen train of the Zillertalbahn

| | **The hydrogen train of the Zillertalbahn** |
|---|---|
| **Description and problem statement:** | The Zillertalbahn is an Austrian narrow-gauge railway equipped with a gauge of 760 mm, representing the backbone of the public transport in the Austrian valley of Zillertal. The diesel vehicles which are currently in use are from the years from 1980 to 1984 and from the year 2004.<br><br>The said vehicles cover approximately 0.6 million train kilometres yearly and require approximately 0.9 million litres of diesel. On average, this means 1.49 litres of diesel per train kilometre and associated $CO_2$ emissions of approximately 2.4 million kilograms per year for the whole fleet. The generally strong increase in traffic in the valley of Zillertal, resulting in congestion on the existing road infrastructure (especially on the line B169), causes car drivers to switch to the train. These are driving forces of the considerable passenger growth of the Zillertalbahn (28.6% more passengers between 2012 and 2018). As a result, the Zillertalbahn has become the fourth largest regional railway in Austria (by passenger numbers) with its current number of 2.83 million passengers (2018) per year.<br><br>The future objective of the Zillertalbahn is to meet passenger demand and to reduce travel times by at least 10 minutes. However, the acceleration behaviour of the currently operating diesel railcars is too low to achieve the planned reduction in terms of travel times. Consequently, vehicles equipped with modern drives will be absolutely necessary.<br><br>As a result, a new vehicle procurement was initiated for the replacement of the existing diesel vehicles. In this context, the use of the following technologies was compared within the framework of an economic feasibility study: entire electrification of the line by equipping it with electric multiple units, the overhead line battery hybrid multiple units to bridge the overhead line-free sections in sensitive areas such |

| | The hydrogen train of the Zillertalbahn |
|---|---|
| | as town crossings and hydrogen electric multiple units for the overhead line-free operation on the entire line.[17]<br><br>The technology comparison showed that operation with hydrogen electric multiple unit trains is more cost-efficient over the entire life cycle than the operation with electric multiple units (pure electric multiple units or catenary battery hybrid multiple units), as the additional costs of the hydrogen electric multiple unit trains and the additionally required hydrogen infrastructure are offset by the savings of the expensive overhead line infrastructure which is not required. Another advantage offered by the use of hydrogen electric multiple unit trains is the opportunity of using the hydroelectric power plant in Mayrhofen for the production of the hydrogen.[18] |
| **Objective:** | Renewal of the existing fleet in order to achieve the reduction of travel times by 10 minutes in normal service and by 19 minutes on the high-speed line (REX). |
| **Measures:** | Procurement of five four-car hydrogen electric multiple unit trains and construction of the necessary hydrogen tank infrastructure. |
| **Technologies / innovations:** | Hydrogen electric multiple unit trains of the company Schweizer Stadler Rail AG, proton exchange membrane water electrolyser (PEM) for the generation of hydrogen, hydrogen storage and fuel columns for refuelling. |
| **Sustainability-related aspects:** | • Emissions: The emissions can be significantly reduced by the used of the hydrogen electric multiple unit trains compared to diesel vehicles. The actual emissions depend on the type of electricity required for electro-lysis. In the case under consideration, the electricity is generated with low emissions by the existing hydropower plant.<br>• Land use: The existing rail infrastructure can be used without taking any conversion measures. The hydrogen production requires the construction of a new electrolyser near the hydropower plant in Mayrhofen. For the hydrogen storage and supply, fuel pumps and hydrogen tanks will be built in Mayrhofen and Jenbach.<br>• Travel time / quality: The new vehicles will reduce the travel times, by making the use of local rail passenger transport more attractive in comparison with motorised private transport. |
| **Speakers:** | Dr. Nikolaus Fleischhacker, FEN Systems GmbH<br>Dr. Helmut Schreiner, Zillertaler Verkehrsbetriebe AG |

[17] Cf. (Schreiner and Fleischhacker 2018) .

[18] Cf. (Schreiner and Fleischhacker 2018) .

## 2. Project Assessment

The resulting strengths and/or success factors seem to be the following:

- Strengthening of the local value chain by the generation of the electricity needed for hydrogen production in the region through the nearby hydroelectric power plant located in Mayrhofen.
- Future use of the existing infrastructure as well as expansion of the same with the hydrogen-specific infrastructure (fuel pumps, hydrogen tanks, and electrolyser).
- Successful cooperation of local actors (politicians, power plant operators, and railway operators).
- Reduction of local emissions through the replacement of diesel railcars with hydrogen railcars.
- Introduction of the potentially more extensive use of hydrogen technology in the region (for example, zero-emission buses, and snowcats for the maintenance of the ski resorts).

The resulting weaknesses seem to be the following:

- Risk of delays and problems relating to the vehicle delivery and operation due to new technology.
- Dependence on good functionality of the local hydrogen production.

Alpine specificity:

- Low-cost green power generation by the hydroelectric power plant for hydrogen production.
- Protection of the tourist region: reduction of $CO_2$ emissions, preservation of the landscape thanks to the avoidance of the construction of overhead lines.
- Further regional applications of hydrogen technology (for example, emission-free buses and snow groomers for the maintenance of the ski resorts).

## 3. Potential Analysis of the Project:

The example of the Zillertalbahn shows that there is a great potential when it comes to the use of hydropower for the transport sector in the Alpine region. Due to the special topography of the Alpine region, there are numerous hydropower plants[19] which can promote the economic use of alternative drives, such as the hydrogen technology. The potential of the said energy production from renewable sources should also be increasingly exploited for the mobility sector.

[19] In the Alpine region, 1,019 hydropower plants (from 5 MW) are operated. Cf. (Baumgartner and Schönberg 2017) .

## 4. Recommendations for Action:

In case of existing railway lines operated with diesel railcars, the following is recommended to the project promoters[20]:

- Consideration of the use of alternative propulsion technologies such as hydrogen electric railcars,
- Examination of the existing funding opportunities in the field of hydrogen technology.

The regional or municipal territorial units[21] are recommended to cooperate with the regional energy industry in order to permit

- The examination of the opportunities offered in terms of local production of green hydrogen and in particular for the inclusion of the use of hydroelectric power plants.
- The exploration of the further potential uses of hydrogen (for example, hydrogen refuelling stations for cars and trucks) and
- The exploration of the opportunity in terms of a development of local and/or regional hydrogen networks.

[20] In the present case, the project promoters may be the following institutions: public transport authorities and railway undertakings in the countries of the Alpine Convention.

[21] The administrative organisation and structure of the eight member states of the Alpine Convention differs greatly. Various levels of government are attributed different economic and administrative competences. In this context and in the following discussion, the term "territorial authorities" and the addition of "regional" or "municipal" are used as an attempt to designate the adequate government level.

## *Léman Express (FRA / CHE) - Transnational development of urban rail systems*

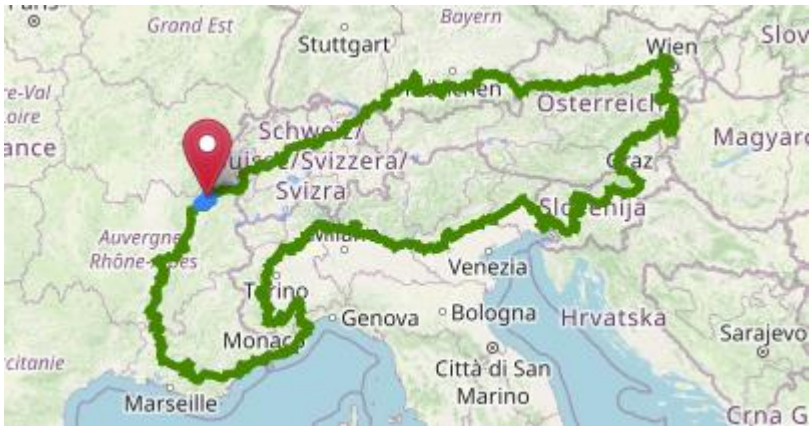



**Figure 8: Map view of the Léman Express**

### 1. Project Description Léman Express

| | **The Léman Express** |
|---|---|
| **Description and problem statement:** | The traffic flows of the Auvergne-Rhône-Alpes region and the Swiss cantons of Geneva / Vaud are characterised by a high volume of commuters and traffic. According to an estimation, approximately 500,000 commuters daily cross the French-Swiss border.[22]<br><br>A cross-border urban railway has been built since 2005 to encourage the shift of road traffic to rail. The Léman Express has been in operation since December 2019 and serves 45 stations on six lines, with a total length of 230 kilometres. 214 kilometres of railway line were already in place and used by other com-muter / regional trains before the Léman Express.<br><br>In the course of the regular services, during the weekdays, (from 05:00 am to 0:30 am) up to six trains per hour run on the main line between Geneva and Annemasse now. At weekends, a 24-hour train operation is applied.<br><br>In September 2020, the Léman Express service was already being used by 25,000 passengers per day while according to expectations 50,000 passengers per day may be reached.[23]<br><br>The following figure will give an overview in terms of route map: |

[22] Cf. (Léman Express 2021) .

[23] Cf. (Léman Express 2021) .

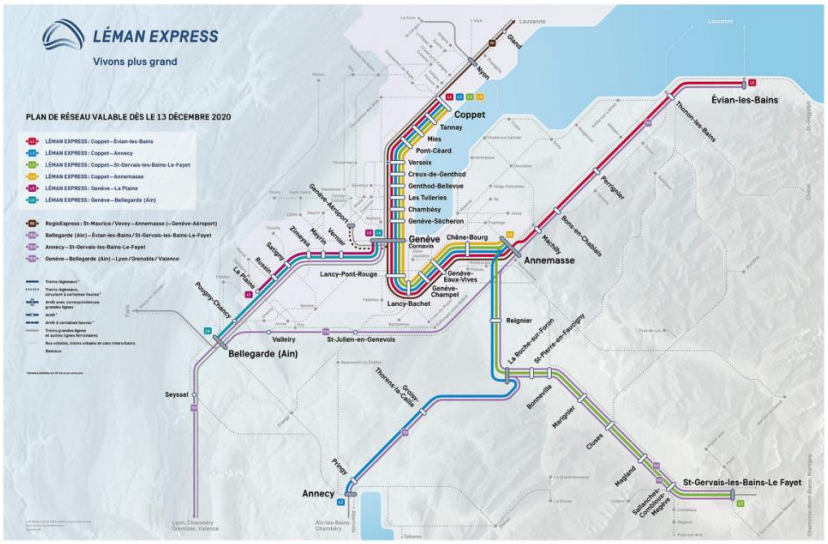



**Figure 9: Route map of the Léman Express**[24]

| | |
|---|---|
| **Objective:** | The objective of the project consists of the reduction of use of private transport in the region by 12%. |
| **Measures:** | Expansion of the cross-border public transport through the set-up and extension of a cross-border "S-Bahn network" between Geneva-Annemasse, Geneva-Évian-les-Bains and Geneva-St-Gervais-les-Bains-le-Feyet.<br>The infrastructure-related expansion will be linked to a redesign of the tariff system and the creation of multimodal connection points. Several urban and regional bus and tram lines (approximately 50) will be connected to the said points.<br>For the implementation of this project, 16 kilometres of new track, including two kilometres in France and 14 kilometres in Switzerland were laid. In addition, five new metro stations were built. An eight-kilometre network gap between Genève-La Praille and Eaux-Vives was largely closed via underground-tunnelling. |
| **Technologies / innovations:** | 17 four-unit Régiolis electric multiple trains by Alstom and 23 four-unit electric multiple trains, model FLIRT, by Stadler are in operation. All trains can run on both mains voltages and are approved both in Switzerland and France. |

[24] Cf. (Léman Express 2021) .

| | |
|---|---|
| **Sustainability aspects:** | • Emissions: The use of electric multiple trains, which thanks to their dual-frequency capability are operable in both countries, means that diesel multiple trains can be dispensed with. In addition, a crucial $CO_2$reduction is expected through the shift effect from private to regional passenger rail transport.<br>• Energy consumption: Modern electric rail vehicles have lower energy consumption and better efficiency than, for example, diesel vehicles, often used in cross-border regional services for the simplification of the infrastructure compatibility (in particular in terms of grid voltage).<br>• Land use: Use of existing infrastructure with a new line of 16 kilometres.<br>• Travel time / quality: Due to the densely timed S-Bahn network on most routes and against the background of the high traffic volume on the roads during peak hours, longer travel times in public transport (in comparison with a travel time by car with low traffic volume) may be negligible. Furthermore, the positive effects generated for commuters, resulting in a stress-free journey, in predictable travel times and in the high comfort of the new vehicles, should be mentioned at this point. |
| **Speaker:** | Prof. Dr. Laurent Guihéry, Université de Cergy-Pontoise |

## 2. Project Assessment:

The resulting strengths and/or success factors seem to be the following:

- Largest cross-border urban railway in Europe comprising a total route network of 230 kilometres.[25]
- Use of the existing infrastructure for the most part. The said infrastructure was partly supplemented by closing gaps, modernised by construction measures and/or adapted to new routing.
- Comprehensive upgrade of the whole system through the construction of new stations, the merger and expansion of existing lines and the procurement of modern regional trains.
- The rail infrastructure expansion will permit the creation of an integrated local transport network. The stops and stations of the Léman Express will be connected by several (approximately 50) urban and regional bus and tram lines. Furthermore, a cross-border fare system has been implemented for the routes.

The resulting weaknesses seem to be the following:

- The Swiss Federal Railways AG SBB and the Auvergne-Rhônes-Alpes region have not procured uniform rolling stock, which means that the trains cannot be coupled together (for example in the event of towing or extension of the train set).

[25] Cf. (Fumagalli and Oesch 2019) .

- The currently used passenger information system needs improvements to be implemented in terms of reliability and quality of passenger information.
- On some routes, the railway lines are outdated so that partly only a single-track operation is feasible. For this reason, not all regions / stops are served by the Léman Express by offering the same level in terms of quality.[26] In the future, the said bottlenecks must be eliminated.

Alpine specificity:

- Protection of the Alpine region: reduction of the $CO_2$ emissions by shifting private transport from road to rail.

### 3. Potential Analysis of the Project:

The Léman Express shows that cross-border public transport projects between rural and metropolitan areas can be successfully built and operated. This applies in particular if they can rely to a large extent on the already available infrastructure. However, the transferability to other border regions of the Alpine region seems to be subject to certain limits.

### 4. Recommendations for Action:

The following is recommended to the project promoters[27]:

- The analysis, by means of studies, whether there is a demand for cross-border public transport connections and in which manner this offer can be made user-friendly and attractive, for example, via uniform ticketing systems and passenger information.
- The examination of the extent to which the already existing infrastructure can be used and, if needed, extended to offer smooth cross-border local transport.

The operating companies are given the following recommendation:

- To ensure the technical interoperability of the trains to perform smooth cross-border services.

[26] Cf. (Fumagalli and Oesch 2019) .

[27] Here: Cities or regions that are close to the border and want to offer cross-border transport.

## *ArcMobilité (CHE) - Digitisation in local public transport*

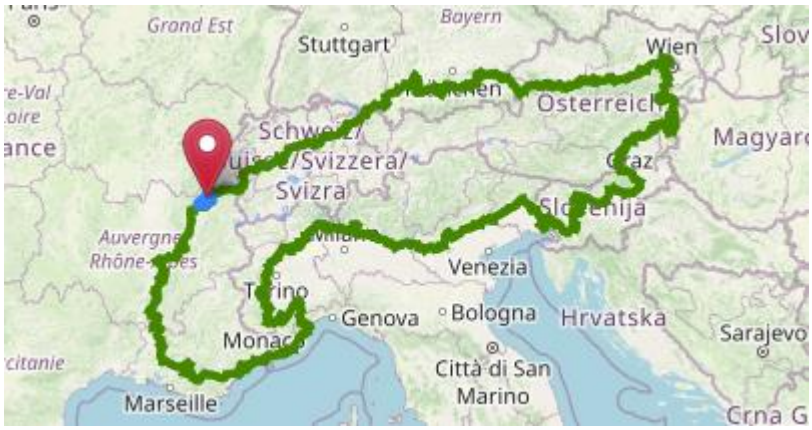



**Figure 10: Map view of the project Arc Mobilité**

### 1. Project Description:

| | **Digitisation in local public transport: The Arc Mobilité project** |
|---|---|
| **Description and problem statement:** | The Geneva-Lausanne conurbation is equipped with a well-developed and efficient public transport system. However, the volume of commuters leads to a high traffic load both in local public and in motorised private transport. At the same time, people's mobility behaviour is changing.[28] The demand for flexibility when it comes to the choice of means of transport, in order to choose the best transport method in different areas of life (work, shopping, leisure, travel) and to combine different transport means in a smart manner, is constantly increasing. A cross-provider tariff and distribution system already exists for the local public transport in the region. The same applies to the automatic ticketing via a cross-provider pay-per-use model. However, especially the private mobility service providers have not yet been integrated into these systems. For this reason, in the context of the pilot project "ArcMobilité" initiated by Schweizerische Bundesbahnen AG SBB, data from public and private mobility providers should be linked to enable multimodal mobility. |
| **Objective:** | The pilot project "Arc Mobilité" pursued the following three main objectives:<br>1. Creation of incentives for citizens to use new multimodal mobility forms.<br>2. Enablement of the public and private actors, through the establishment of a digital mobility platform, to network their mobility offers in a simple way. The created platform is open to all means of transport.<br>3. Exploration of innovative forms of financing for the provision of mobility services for cases in which purely commercial approaches would fail. |

[28] Cf. In his interview on 24 February 2021, Andreas Fuhrer stated: "The biggest winner of the networked mobility is the public transport" (Alliance SwissPass 2021) .

| | |
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| **Measures:** | The pilot project started in April 2020 with preliminary tests. Subsequently, a user community of mobility providers and end users was created. The technical solutions, the mobility offers, and the organisational framework were completed in 2021. |
| **Technologies / innovations:** | Platform-based public digital infrastructure (website or mobile app). |
| **Sustainability aspects:** | • Positive effect on emissions, energy consumption, and land use in the case of increased use of local public transport via the platform use.<br>• Travel time / quality: Improvement of travel time and quality through better information and seamless links between the mobility services. |
| **Speaker:** | Andreas Fuhrer, SBB AG |

## 2. Project Assessment:

The resulting strengths and/or success factors seem to be the following:

- Provision of a range of mobility services (MaaS) tailored to individual needs.
- Creation of a common platform for providers made of various private and public mobility providers.
- Promotion of the cooperation between the private sector and the government actors.

The resulting weaknesses seem to be the following:

- A major challenge is usually to win customers for such offers. A critical mass of transport providers and end users would be required to generate positive effects following the platform implementation.
- A potentially elevated requirement in terms of coordination due to the large number of involved partners.

Alpine specificity[29]:

- Protection of the tourist region and improvement of the living conditions of the local population: reduction of $CO_2$ emissions if there is a shift from the private transport to rail or other local public transport services.

[29] The project Arc Mobilité in the region of the Geneva Lake is not located in the area geographically covered by the Alpine Convention. However, as the canton can be geographically located in the Alpine region, alpine-specific characteristics are nevertheless given.

## 3. Potential Analysis of the Project:

The objective of the pilot project is to link public and private mobility providers in order to enable multimodal mobility. The idea of the platform developed for this purpose could be taken up, adapted, and applied by other regions of the Alpine region. The project is already considering the taking-up of project results and their transfer to other European regions.

## 4. Recommendations for Action:

The following is recommended to future providers of similar services:

- The securing of the interest of the highest possible number of mobility providers already present on the local market - by including private mobility service providers - in the approach and the securing of their participation,
- The adaptation and ("openly") further development of the already existing solutions (if possible, in a "technology-open approach"), if this is doable and meaningful, and
- If needed, the definition and highlighting of special advantages of use (for example more attractive tariffs when the platform is used in comparison to the conventionally applied tariffs).

## *$CO_2$ L-Tool and TUM Accessibility Atlas (DEU) - Research Project Alpine Smart Transport and Urbanism Strategies (ASTUS)*

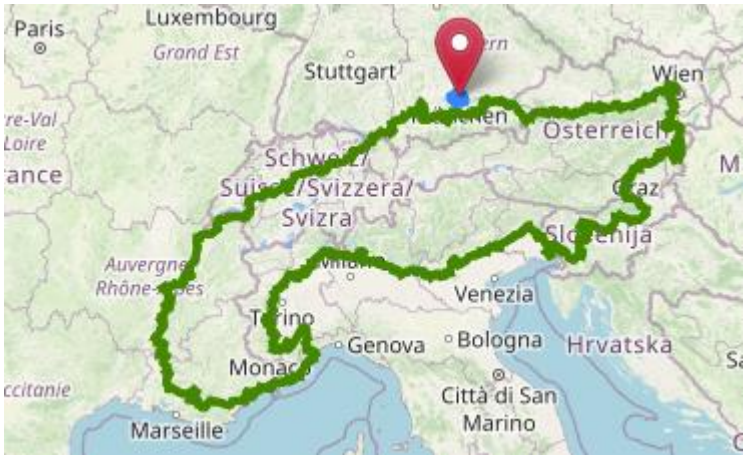


**Figure 11: Map view of the project ASTUS**

### 1. Description of the Research Project ASTUS

| | **ASTUS for the Munich region** |
|---|---|
| **Description and problem statement:** | In the framework of the Interreg[30] funding call "Spatial Development and Governance" in the Cooperation Area "Alpine region" the ASTUS research project was carried out by 12 partners from 5EU countries[31] between 2016 and 2019.<br><br>The general objective pursued by ASTUS consisted of finding innovative mobility solutions, the creation of awareness for sustainable mobility and settlement planning, the development of planning tools for the $CO_2$ reduction and offering support to local decision makers when it comes to the development and implementation of sustainable measures.<br><br>The German partners in the project were the Technical University of Munich (TUM), the Munich Transport and Tariff Association (Münchner Verkehrs- und Tarifverbund) and the City of Munich (Stadt München)[32]. The contributions made by the TUM to the research project are presented in this context. Among other things, this part of the project was motivated by the demographic development of the metropolitan areas in the Alpine region. These are often faced with the challenge of having to deal with demographic growth and with the increase of the number of commuters and the volume of leisure traffic. With partly missing or low-level local public transport services, the high dependency on the car often results in an overloaded road |

[30] The Interreg programs are part of the European structural and investment policy. They aim at the promotion of cross-border cooperation between regions and cities in areas such as transport, labour market and environmental protection. Cf. (Ahlke, Kurnol and Thul 2021) .

[31] France, Austria, Germany, Slovenia, Italy.

[32] For more information on the partners: https://www.alpine-space.eu/projects/astus/en/about/project-partners-observers.

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| | transport infrastructure by causing a higher quantity of $CO_2$ emissions as well.<br><br>The following challenges had to be faced in the German pilot regions involved in the project:<br><br>• Districts of Fürstenfeldbruck and Starnberg: Due to the non-existent or inadequate direct connections to the neighbouring districts, many passengers must use the Munich S-Bahn with a detour through the city. The objectives pursued by the districts consists of ensuring a flexible, intermodal mobility in the region.<br>• District of Munich: The district's climate targets are to be met.<br>• District of Ebersberg: Ebersberg would like to become a model region for the comprehensive car-sharing in rural areas. |
| **Objective:** | In the long term, the ASTUS project aims at the improvement of the provision of public transport, sharing services (car and bike sharing) and electric mobility, and at the initialisation of integrated intermodal mobility options as an alternative to private cars. |
| **Measures:** | The TUM developed practical planning tools for sustainable, integrated and low-carbon transport and settlement planning, the so-called "$CO_2$L-Tool" and the "TUM Erreichbarkeitsatlas / Accessibility Atlas" (see below). On the basis of said tools, the following measures were taken into consideration:<br><br>• Districts of Fürstenfeldbruck and Starnberg: The introduction of tangential (e-)express bus routes around Munich is planned. In addition, the creation of a range of flexibly combinable mobility services is planned. For this purpose, the establishment of a comprehensive network of mobility stations is planned to ensure a smooth transfer between different transport methods.<br>• District of Munich: The regional bus service, which had already been expanded in recent years, needs a conversion to alternative drives (use of green electricity).<br>• District of Ebersberg: The use of the car sharing services is to be increased step by step. At the beginning of the research project, there were already eight car sharing associations with 800 members. In the course of the research project, three municipalities and 100 members were added. Among other things, the said increase was specifically supported by the fact that the carsharing vehicles were made available as close to home as possible and across the board, as well as by the reduction of the number of parking spaces put at disposal in new development areas. |
| **Technologies / innovations:** | The $CO_2$L-Tool can be used for any study area to quantify and graphically display the $CO_2$ emissions or savings based on parameters such as trip frequency, modal split, trip length, occupancy rate, and emission factors. Spreadsheets and databases support the identification of innovative and sustainable measures in the field of |

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| | urban planning and mobility and the estimation of their effects in scenarios.[33]<br><br>The "TUM Erreichbarkeitsatlas / TUM Accessibility Atlas" enables the calculation and visualisation of accessibility levels in the Munich Metropolitan Region based on the data relating the settlement structure and transport supply. The tool is intended to support decision-making processes in connection with both integrated settlement structure and transport planning. It can display maps of catchment areas based on a defined travel budget and then analyse the effects of planning options.[34]<br><br>All instruments resulting from the research project are available on the following website: https://www.alpine-space.eu/projects/astus/en/project-results/decision-making-tools/co2-minimizer-toolbox. |
| **Sustainability aspects:** | • Potential in terms of reduction of emissions, energy consumption and land use, provided that sustainable offers can be established by means of the findings.<br>• Travel time / quality: Improvement of the travel quality by the establishment of new mobility services. |
| **Speakers:** | Dr. Julia Kinigadner, Technical University of Munich<br>Dr. Benjamin Büttner, Technical University of Munich |

## 2. Project Assessment:

The resulting strengths and/or success factors seem to be the following:

- Development of interdisciplinary assessment approaches for spatial, settlement and transport planners.
- In a region explored by the study, all transport options are evaluated and included in the problem solution (integrated approach).
- By means of the instruments, planning variants can be compared and assessed in terms of their sustainability aspects.

## 3. Potential Analysis of the Project:

The planning tools developed by TUM can be applied in any region in the Alpine region and beyond as they are able to identify, evaluate and, if needed, optimise new mobility solutions. For this purpose, the "TUM-Erreichbarkeitsatlas / TUM Accessibility Atlas" must be adapted by entering the specific data of the target region.[35] The "$CO_2$L-Tool" can be used for any study area

[33] Cf. Project Fact Sheet "$CO_2$ L-Tool", (Kinigadner, Büttner and Volpers 2019) .

[34] Cf. Project Fact Sheet "TUM Accessibility Atlas", (Büttner, Kinigadner and Ji 2019) .

[35] The Accessibility Atlas has currently only been compiled for the Munich Metropolitan Region.

to show both $CO_2$ emissions and savings by consequently contributing to the enablement of lower-emission mobility if needed.

## 4. Recommendations for Action:

The following is recommended to regional and municipal decision-makers:

- The more extended use, where needed, of tools supporting the calculation of accessibility levels and the $CO_2$ impact of relevant measures.
- The discussion of proposals developed on this basis and, if needed, the examination of their feasibility.

## 5.2 PRESENTATIONS OF PROJECTS RELATING TO TOURISM AND LEISURE TRANSPORTS

### *mybuxi (CHE) - Driving service on demand in rural areas*

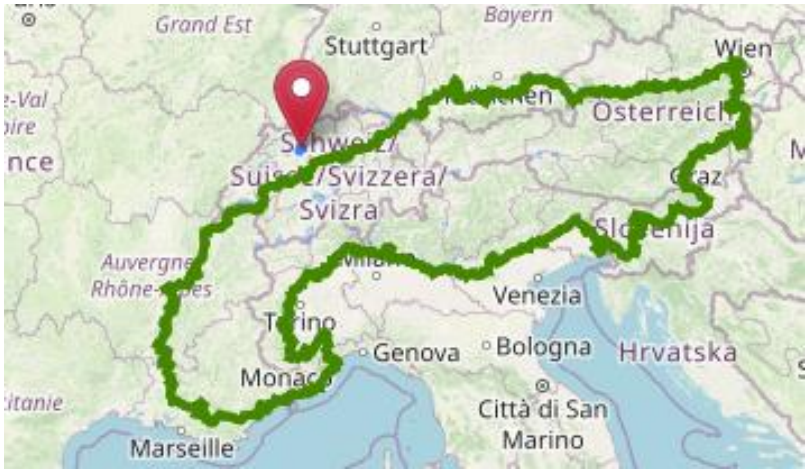


**Figure 12: Map view of Herzogenbuchsee / Switzerland - 1st location of mybuxi**

#### 1. Project Description

| | **Driving service on demand in rural areas** |
|---|---|
| **Description and problem statement:** | In rural areas of the Alpine region, due to the limited local public transport offer, the residents often depend on the use of their (own) car. Where the local public transport is available, the Alpine region may also be characterised by topographically induced long travel times and by a lacking connectivity between the individual routes.<br><br>mybuxi[36] is an on-demand driving service for sprawling, rural residential areas. Door-to-door transport services can be ordered via app or phone. The associated IT system bundles ride requests to efficiently manage both costs and routes. The transport prices are based on those applied by the local public transport.<br><br>The mybuxi service was launched in Herzogenbuchsee in 2019 and is currently being tested and introduced in other Swiss municipalities. For this purpose, the objectives of the service are being defined in cooperation with the involved local stakeholders so to ensure their ideal adaptation to local needs. In the Swiss valley of Emmental, an integrated driving and delivery service is now being established step by step. |
| **Objective:** | Bridging of the “first / last mile” of passenger transport especially for young people who have not obtained their driving licence yet for the elderly people who do not drive a car any longer. |

[36] The artificial name Buxi is a combination of bus and taxi. This is intended to reflect the feature of a public bus combined with the advantages of the flexible door-to-door availability of a taxi.

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| **Measures:** | Development of an app for the offered services, procurement of vehicles, and construction of charging infrastructure for e-vehicles. Among other thing, the project is financed through state and private start-up aids, a supporting association, and the rental of "virtual" stops, for example, to hotels, shops, etc. |
| **Technologies / innovations:** | Minibuses partially equipped with electric drive, and demand management via an IT system. |
| **Sustainability aspects:** | • Emissions: Where possible, efforts will be made to use pure e-vehicles. If the mybuxi operation results in a lower use of private cars, this can make a contribution to a general reduction in terms of $CO_2$ emissions.<br>• Land use: The existing transport and charging infrastructure will be used; additional e-parking spaces with charging points may be needed.<br>• Travel time / quality: A high level of travel quality is offered to passengers through modern vehicles, an 18h/day service and the "door-to-door" option. Due to the shared journeys, the travel time may be slightly longer in comparison with the own car. |
| **Effects on public transport:** | • mybuxi can act as a feeder and thus promote the use of regional local public transport. According to the operators, 2.5 times as many people use the bus service in Herzogenbuchsee than before the introduction of the mybuxi driving service. |
| **Speaker:** | Dr. Andreas Kronawitter, mybuxi |

## 2. Project Assessment

The resulting strengths and/or success factors seem to be the following:

- Flexible driving services combined with a simple or innovative customer interface (via app or phone) can make their contribution to mobility improvements at a regional level.
- The service complements the local public transport on the "last mile" by consequently increasing its attractiveness.
- High attractiveness also for tourism transport: Especially smaller and remote accommodations get the change of organising the pick-up and drop-off service for their guests very flexibly via such driving services.
- Extensibility to delivery services of the local retail trade: This advantage secures the supply of the population and the survival of local shops.

The resulting weaknesses seem to be the following:

- Predominantly electric vehicles are to be used for the operation. However, the charging infrastructure is still partially lacking. Furthermore, no electric all-wheel-drive minibuses are (yet) available on the market which means that regions having a challenging topography can only be served by conventional drive systems, especially during the winter months.
- To ensure the smooth functioning of the service, mobile phone network coverage must be guaranteed throughout the country, as the mybuxi driver receives his orders through his / her mobile phone. And this is not (yet) the case everywhere in the rural areas.

- The start-up and permanent financing of the services represents a challenge. For their maintenance, new business and financing models have to be found when it comes to the economic efficiency for providers and users. This aspect also includes the deployment planning because there are both volunteer drivers receiving an expense allowance and permanently employed drivers.

Alpine specificity[37]

- Protection of the Alpine region: reduction of $CO_2$ emissions through the replacement of shared and (in the foreseeable future) zero-emission vehicles.
- Increase of the inhabitants' quality of life: Improved connection of remote areas which were previously difficult to reach in terms of transport and supply. Provided that the electricity of the e-drives can be generated sustainably, for example, from local hydropower, on-demand ride services show to be an attractive zero-emission mobility solution also for remote regions of the Alpine region.
- Preservation of tourist attractiveness: In particular, the flexibility in the arrangement of stops and the comparatively small vehicle size appear to be advantageous for the Alpine region when it comes to the requirements of hiking and ski tourism (good connections to leisure, accommodation and catering facilities, and high frequency at peak times).

### 3. Potential Analysis of the Project:

The example of mybuxi shows that in the rural Alpine region the potential for the use of on-demand driving services for both residents and tourists is great. Due to the special topography, the settlement structure as well as the largely limited local public transport offer, there are numerous communities for which the offer of such a driving and potential delivery service seems to be meaningful. If the charging infrastructure is available throughout the area, cross-border operation may even be conceivable. However, transferability to other rural regions does not appear feasible without ensuring the public or private start-up financing. New business and financing models adapted to the respective regional conditions are also indispensable when it comes to the economic viability of the service.

[37] The mybuxi project in Herzogenbuchsee is not located in the area geographically covered by the Alpine Convention. However, as it can be geographically located in the Alpine space, Alpine-specific features are nevertheless given.

## 4. Recommendations for Action

The following is recommended to future providers of similar services:

- The detailed determination of the demand potential in the targeted service areas and the development of scalable entry models,
- The securing of the financing basis by involving public or private sector stakeholders (for example, municipalities, ski lifts, and accommodation providers),
- The examination of existing funding opportunities for the procurement of e-vehicles and the needed charging infrastructure,
- The entering into cooperation with private-sector stakeholders, for example with suppliers of daily necessities so to enable the combination of passenger and freight journeys, if needed, by consequently optimising the economic viability of the service.

The following is recommended to municipalities:

- The active involvement of local mobility service providers from the outset in order to counteract any competitive situations between the existing (local public transport and taxi) providers and to actively promote a cooperative interaction between all relevant stakeholders,
- The active support of the use of the service through advertising, discounts, etc. - especially at the beginning because this can help to lower the acceptance threshold in the population,
- The provision of the new service with sufficient time to take root and the creation of the design of the public support services accordingly.

## *St. Gallen (CHE) - Integrating e-mobility in cities*

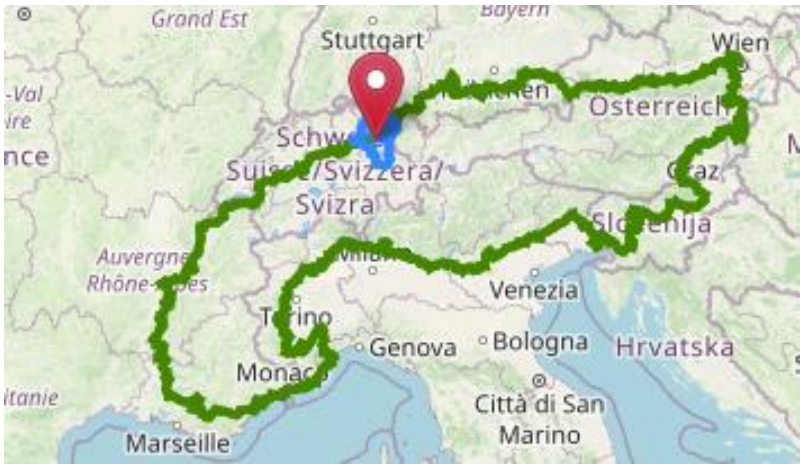


**Figure 13: Map view of St. Gallen**

### 1. Project Description

| | **Use of electric buses in local public transport** |
|---|---|
| **Description and problem statement:** | The canton St. Gallen has set itself the long-term goal of using 100% electric buses or buses equipped with alternative drives in local public transport and to operate these exclusively with renewable energy.<br><br>For the implementation of the said objective, the independent research and consulting company INFRAS was commissioned to prepare a study[38], a so-called e-bus strategy. In the study various vehicle types such as night chargers, so-called "opportunity chargers", trolleybuses (with overhead line) and combi-chargers (mix of night and opportunity chargers) with diesel buses were compared for a selection of bus routes. The conclusion of the study was that the ideal e-bus option depends on the infrastructural conditions of each individual line.<br><br>The workshop presentation focused on the case study of line 151 (Gossau - St. Gallen) of the canton with three different routes (Gossau Bhf. - St. Gallen Spisertor: 12.7 km; Gossau Bhf. - St. Gallen Spisertor (via Oberdorf): 12.5 km; Gossau Bhf. - St. Gallen Bhf.: 11.7 km) on which articulated buses are also used. |
| **Objective:** | Determination of the ideal e-bus fleet for a given line. |
| **Measures:** | In the specific case of line 151, various vehicle types were examined, assessed on the basis of various criteria (such as costs, and passenger comfort) and compared with each other. On the said basis, the opportunities and limitations of each type, the estimated costs, and the potential implementation paths were outlined by considering the technical developments. |

[38] From the following link you can gain access to the study: https://www.infras.ch/media/filer_public/41/47/4147ce14-1031-40c6-bf76-b768d043dc86/schlussbericht_e-bus-strategie_kanton_stgallen.pdf.

| | |
|---|---|
| | For what concerns line 151, a mixed fleet of battery-powered trolleybuses and night chargers seems particularly suitable thanks to the existing trolleybus network. |
| **Technologies / innovations:** | Trolleybuses with overhead line and night loader for line 151 |
| **Sustainability aspects:** | • Emissions: A significant reduction in terms of emissions will be achieved through the use of e-buses. The used electricity will come from renewable energies.<br>• Energy consumption: Modern electric buses show a lower energy consumption than diesel buses.<br>• Land use: The existing infrastructure will be used.<br>• Travel time / quality: For passengers, the use of modern buses can result in an increase in terms of travel quality, for example through quieter vehicles, without any change concerning the travel time. |
| **Speaker:** | Cornelia Graf, INFRAS AG |

## 2. Project Assessment:

The resulting strengths and/or success factors seem to be the following:

- The study recommends and develops differentiated solutions for each individual bus line.
- The assessment methodology is not limited to energy consumption and emissions, but also includes economic and infrastructural aspects. Consequently, the study makes the attempt to find solutions on the basis of the existing infrastructure, for example the continued use of the overhead line network of line 151.

The resulting weaknesses seem to be the following:

- In some cases, the charging infrastructure for the operation of electric vehicles is still missing.
- There are elevated investment and acquisition-related costs for the operator. However, most Alpine Convention countries have support programmes for the acquisition of e-buses in local public transport.

Alpine specificity[39]:

- Protection of the Alpine region: reduction of $CO_2$ emissions through the replacement (in the foreseeable future) by zero-emission vehicles.
- Increase of the quality of life of the residents and preservation of the attractiveness for tourists: Reduction of $CO_2$ emissions as well as noise and pollution (especially in the city) through the use of low-emission vehicle technology. Provided that the electricity for the e-drives can be generated sustainably, for example from local hydropower, e-buses in public transport appear to be an attractive zero-emission mobility solution.

[39] St. Gallen is not located in the area geographically covered by the Alpine Convention. However, as the canton can be geographically located in the Alpine region, Alpine-specific characteristics are nevertheless given.

## 3. Potential Analysis of the Project:

The example of the e-bus strategy implemented in the canton St. Gallen shows that the choice of the most suitable variant for each location / line through the different e-bus variants is feasible. The same can be said when it comes to achieve an emission-free urban and interurban local public transport whereby this applies provided that the needed investments are made. Consequently, the e-bus strategy from the canton St. Gallen can serve other (Alpine) regions as an example when it comes to the way operators can approach the introduction of e-buses in the field of local public transport.

## 4. Recommendations for Action:

The following is recommended to regional and municipal decision-makers:

- The examination of the feasibility of using different variants of e-buses,
- The execution of studies relating to the implementation of an individual e-bus strategy, if needed,
- The examination of existing funding opportunities for the procurement of e-vehicles and the needed charging infrastructure.

## *Serfaus (AUT) – Introduction of a subway in small community*


**Figure 14: Map view of Serfaus**

### 1. Project Description

| | **Subway in Serfaus** |
|---|---|
| **Description and problem statement:** | The Austrian municipality of Serfaus has 1,151 inhabitants (2020) and, together with the neighbouring villages of Fiss and Ladis, it offers 15,400 overnight accommodations. As early as the 1980s, Serfaus experienced an increase in tourism and associated with this, a strong seasonal increase in traffic. In 1972, following the example of some Swiss communities, a so-called "traffic relief concept" was adopted. According to the said concept, winter sports enthusiasts were to be driven to the ski resorts exclusively by collective buses. When this concept also reached its limits in the small community because of the further increase in the number of visitors, alternative transport solutions were sought to guarantee the accessibility of the valley station of the cable cars and ski lifts. In this context, the following requirements had to be met: The means of transport should be able to be operated (almost) silently and the preservation of the village image had to be ensured.[40] After having examined several potential solutions, in 1983, the local council decided to build an underground, driverless, cable-driven aerial tramway financed by the municipality. Even if the said construction required the tearing-up as well as the tunnelling under the main street of the village and an additional partially shoring-up of the foundations of the adjacent houses, this technology was chosen because it was quiet and generated a low level of vibrations which meant that the impact on local residents during operation could be kept as low as possible. When the operations started in 1986, a driving ban was additionally imposed on the community of Serfaus. Since then, guests have been allowed to drive their private cars to the accommodation on their day of arrival. However, their use in the town during their stay was forbidden. In 2016, the existing system had to be renewed after 30 years without restricting operations in the summer and winter seasons. In the |

[40] Cf. (Serfaus-Fiss-Ladis Marketing GmbH 2019) .

| | |
|---|---|
| | context of the said renewal, the system capacity should be increased as well. |
| **Project Content:** | Renewal and expansion of the existing rail system and procurement of new rolling stock with the aim of increasing the number of transported passengers by reaching a better-quality level. |
| **Measures:** | Refurbishment and modernisation of all stations (including the barrier-free access still missing in two stations) as well as the line infrastructure. Construction of an additional station. Additional procurement of new vehicles, by increasing the passenger capacity to 3,000 passengers per hour. |
| **Technologies / innovations:** | Driverless hovertrain equipped with cable drive. |
| **Sustainability aspects:** | • Emissions: The hovertrain equipped with cable drive runs electrically. Assuming the use of green electricity, climate-neutral operation is feasible.<br>• Energy consumption: The railway has a fully automatic electrical operation.<br>• Land use: The railway was built underground along the main road. Consequently, it runs independently of above-ground traffic. No further sealing of areas has taken place.<br>• Travel time / quality: The underground hovertrain has a high modal shift effect, which is further enhanced by the car-free city concept. The renewal of the entire system as well as the vehicles results in a positive travel-time balance (a reduction in terms of waiting time from 10 to 9 minutes until the next train could be achieved) and in an improved travel quality due to more comfortable vehicles. |
| **Speaker:** | Andrea Koolen, Tourism Association Tourismusverband Serfaus-Fiss-Ladis. |

## 2. Project Assessment:

The resulting strengths and/or success factors seem to be the following:

- The community made a holistic decision early on (1980) for low-emission and sustainable traffic design and relief.
- The costs were borne by the municipality, and the local inhabitants involved in this decision.[41]
- To keep the impact as low as possible, a (low-noise and underground) technology meeting the local requirement was used.
- Well-balanced project management during the construction in 1984 / 85 and the refurbishment / renewal in 2016: All measures took place during the seasonal breaks so to keep the restrictions for tourists as low as possible during the peak periods.

[41] Cf. (Serfaus-Fiss-Ladis Marketing GmbH 2019) .

The resulting weaknesses seem to be the following:

- The construction and operation of subways is very costly. For this reason, it is not always readily available within small communities.

Alpine specificity:

- Preservation of the tourist region: preservation of the image and landscape of the village. Use of underground vehicles offering the option of transporting a large number of passengers. Without the development of the railway, the further development of tourism would hardly have been achieved.
- Reduction of $CO_2$ emissions by the use of emission-free technology as well as by the avoidance of car traffic.

### 3. Potential Analysis of the Project:

The subway project in Serfaus seems to represent a successful example of low-emission and sustainable traffic design and relief within small communities exposed to a strong tourism-related influence. Nevertheless, the transferability of the subway technology to other municipalities in the Alpine region is likely to be limited due to the high investment costs involved.

### 4. Recommendations for Action:

The following is recommended to the promoters:

- The conduct of research and commission studies open to all technologies and taking into account existing examples so to find the adequate mobility solutions for the specific local conditions by making use of the suitable technologies.
- Conduct of citizen surveys and participations to incorporate the concerns and wishes of the resident population into the project selection procedure.

## 5.3 PRESENTATIONS OF PROJECTS RELATING TO TRANSIT TRAFFIC

*LinkingAlps (AUT) - passenger information systems for the improvement of cross-border traffic*


**Figure 15: Map view of the project LinkingAlps**

1. Project Description:

| | LinkingAlps |
|---|---|
| **Description and problem statement:** | In the field of the cross-border public passenger transport, there is often the problem of inconsistent availability of passenger information which is due to the fact that each regional or national transport association and each country uses its own data platforms. Consequently, the planning of a cross-border as well as cross-operator and cross-modal connection is often not easily possible for travellers.<br><br>The problem of the missing data access from other information systems for travel chains in the Alpine region is addressed by the project LinkingAlps funded by the Interreg[42] Alpine region funding program from October 2019 to June 2022. 14 partners (travel information service providers, regional transport associations, research organisations as well as consulting companies) located in six Alpine countries (AUT, CHE, ITA, DEU, FRA, SVN) are involved in this project.<br><br>To permit the access from existing traveller information services to information from other systems, the regional and/or national travel information services need to be interconnected. For this purpose, the project partners have agreed to make their routing results available to each other via an open standardised Application Programming Interface (API). For the technical implementation of this interface, it was agreed that each provider would apply a unified API based on the CEN standard for distributed routing (CEN / TS 177118: 2018), allowing the connection of different decentralised systems without the integration of the respective data into a centralised database. |

[42] The Interreg programs are part of the European structural and investment policy and promote cross-border cooperation between regions and cities in fields like transport, labour market, and environmental protection. Cf. (Ahlke, Kurnol and Thul 2021) .

| | |
|---|---|
| **Objective:** | The aim of LinkingAlps is to build a standardised programming interface linking the traveller information of the participating project partners. Furthermore, the creation of a publicly accessible manual as a decision-making aid for future users will be needed. This should ensure the know-how transfer by consequently contributing to the further application of such approaches. |
| **Measures:** | Ex-ante analysis (including application cases and system architecture); development, implementation, and assessment of a standardised programming interface; development of a framework concept (including the operator model); transfer to future users (including the creation of a decision support manual). |
| **Technologies / innovations:** | Linking of various offers via API services. |
| **Sustainability aspects:** | • Emissions: No direct impact on emissions. However, if a shift from private transport to rail can be achieved through improved passenger information, the emission reductions may be possible.<br>• Energy consumption: No direct impact on energy consumption. However, if shift effects can be achieved through improved passenger information, the energy consumption can be reduced.<br>• Land use: The existing transport infrastructure will be used.<br>• Travel time / quality: Improvement of travel quality through integrated information systems; better planning options in terms of route selection and travel times. |
| **Speaker:** | Katharina Leeb, AustriaTech - Gesellschaft des Bundes für technologiepolitische Maßnahmen GmbH (Federal Company for Technology Policy Measures) |

## 2. Project Assessment:

The resulting strengths and/or success factors seem to be the following:

- Use of a uniform European standard.
- Connection of routing results from existing operators instead of the development and publication of a new mobile app.
- The project team is aware of the requirements for what concerns traveller information. Furthermore, the country-specific data is available.
- For travellers, an improved information system can be expected, while suppliers can expect the improvement as well as the expansion of their own traveller information system.

The resulting weaknesses seem to be the following:

- A potentially elevated need for coordination due to the involvement of a large number of partners.

- If the regional or national passenger information systems currently in use need an improvement, for example in terms of reliability and quality of passenger information, this will be reflected in the entire system.

Alpine specificity:

- Protection of the tourist region: reduction of $CO_2$ emissions, if needed, provided that there is a more intensive use of public transport. The service can also be used for the promotion of sustainable tourism, as in future there will be the option to plan journeys in a traveller information system written in the traveller's own language.

## 3. Potential Analysis of the Project:

The project holds great potential for the improvement of cross-border traveller information systems in the Alpine region. Thanks to the use of an open standardised program interface, the extension of the application to other countries in the Alpine region and beyond should be “rather simple”. However, the quality and reliability of the information still depends on the respective regional and national providers. The taking-up of project results and their transferability to other European regions is already being taken into account in the context of the project, for example through the production of a decision support manual.

## 4. Recommendations for Action:

The following is recommended to future providers:

- The verification via studies whether there is a demand for cross-border connections.
- The building-up of digital solutions on a uniform standard.

## *BrennerLEC (ITA) - Technologies for the reduction of emissions in transit traffic*


**Figure 16: Map view of the Brenner motorway**

### 1. Project Description:

| | **Brenner Low Emissions Corridor - BrennerLEC: Low-emission transport corridor along the Italian Brenner motorway** |
|---|---|
| **Description and problem statement:** | The 314 km long Italian motorway A 22, also called Brenner motorway, connects the Austrian Brenner motorway A 13 with the Italian motorway A 1 near the Italian city of Moderna. For both passenger and freight traffic, the A 22 is one of the central trans-Alpine transport axes located between Germany and Italy. Between 2016 and 2021, the BrennerLEC (Low Emissions Corridor)[43] pilot project is investigating the potential management measures applicable when and where to guarantee the maximum environmental and transport efficiency. For this purpose, on a pilot test site[44] on the A 22, various measures (such as speed limits[45] were tested and assessed.[46] |
| **Objective:** | The objective consists of the test measures and the establishment of a low-emission corridor along the Brenner motorway in the Italian provinces of Trentino and South Tyrol. Furthermore, recommendations for the application of the measures to the Brenner / Kufstein-Affi corridor will be developed. |

[43] The overall project coordinator is the company Brennerautobahn AG. Project participants include the Provincial Agencies for Environmental Protection of the Provinces of Trento and Bolzano and the University of Trento. The project is co-financed by the EU Commission within the framework of the European LIFE programme (*L'Instrument Financier pour l'Environnement*), a financial instrument of the EU aiming at the promotion of environmental and climate protection measures. Further information can be found at: https://cinea.ec.europa.eu/life_de.

[44] The pilot sections are the following: BLEC-ENV (road section from Bolzano North to Rovereto South, approx. 90km); BLEC-AQ (road section from Egna/Neumarkt to San Michele, approx. 20 km); BLEC-LEZ (road sections between the northern and southern entrance gates of the cities of Bolzano, Trento and Rovereto).

[45] In Italy, there is currently no provision in the road traffic regulations concerning the introduction of speed reductions for environmental purposes - this was made possible for the pilot sections for the duration of the project.

[46] For example, after the start of the project in September 2016, in the first application phase from April 2017 to March 2018, tests have taken place in the Egna/Neumarkt - San Michele motorway section, testing the impact of speed limits for environmental purposes. During the second phase of the project, from July 2018 to September 2019, further tests were carried out by displaying the situation-adapted speed limits on digital display panels along the carriageway by using various methods.

**Measures:**

The test included the measures listed here in the following:

- Dynamic road capacity management (***BLEC-ENV***), which aims at the adjustment of speed limits according to traffic volumes by temporarily opening an additional third lane ("breakdown lane clearance") when traffic conditions are close to saturation - objective: increase of the motorway capacity[47];
- Dynamic speed limit management through "intelligent traffic signs" (***BLEC-AQ***) applied in function of current and predicted air pollution levels - objective: improvement of the air quality[48];
- Dynamic integrated traffic management (***BLEC-LEZ***), which aims at the improvement of the coordination of travel information channels in order to direct traffic via recommended routes. The information to road users is provided via a mobile application (app) - objective: provision of an incentive to use alternative routes.[49]

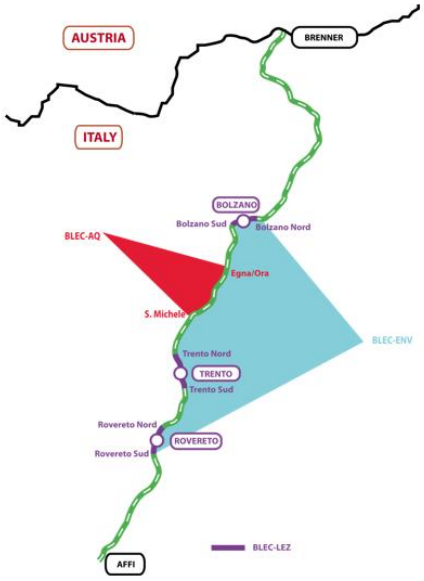


**Figure 17: Areas of application of the measures**

**Technologies / innovations:**

Use of multiple dynamic measurement systems for road capacity and speed limit management as well as integrated traffic management including an end user interface (mobile application).

[47] By means of a dynamic road capacity management (***BLEC-ENV***), the project participants expect $CO_2$ emission reductions of up to 40% for cars and up to 60% for trucks.

[48] The dynamic speed limit management (***BLEC-AQ***) is expected to achieve an emission reduction relating to passenger vehicles by up to 25% for $NO_x$ and 20% for $CO_2$. The reduction in total emissions by approx. 8% for $NO_x$ and 6.4% for $CO_2$ with a reduction in average of the $NO_2$ concentrations in Arien by approx. 5% and the reduction of noise level by 1-2 dB are expected.

[49] The expected reductions resulting from the dynamic integrated traffic management (***BLEC-LEZ***) are of the same magnitude order as for the introduction of the dynamic road capacity management.

| | |
|---|---|
| **Sustainability aspects:** | • Emissions: By means of the above-mentioned measures, it is possible to react to the respective traffic volume in order to achieve a reduction in terms of emissions.<br>• Land use: The existing infrastructure is used in a more efficient manner. The traffic situation is measured by making use of a suitable sensor technology along the route.<br>• Travel time / quality: The implemented traffic management measures can result in increases in terms of travel time. |
| **Speaker:** | Ilaria De Biasi, Autostrada del Brennero S.p.A. / Brennerautobahn AG |

## 2. Project Assessment:

The resulting strengths and/or success factors seem to be the following:

- Application of a holistic approach to the problem by combining different approaches to achieve the maximum environmental and transport efficiency with the least possible inconvenience for road users.
- The model character of the project permits its transferability to other areas after its successful implementation.
- The comprehensive database generated by the project can also be used for future decision-making.

The resulting weaknesses seem to be the following:

- The obligation of road users to download a mobile app onto a terminal device (smartphone) to use the alternative route guidance.

Alpine specificity:

- Protection of the tourist region: reduction of $CO_2$ emissions, reduction of noise pollution, increase / maintenance of the landscape-related attractiveness.

## 3. Potential Analysis of the Project:

The project shows a great potential for what concerns the optimisation of the environmental and transport efficiency on the Brenner motorway. The project includes the examination of the transferability to other Alpine corridors. For this purpose, recommendations for action are to be developed. In addition, the project shows that, despite increasing social acceptance for environmental protection measures, the use of an appropriate communication will be needed in order to convey the benefits of concrete implementations to potential users, for example for what concerns the environmentally related speed limits or the use of digital applications for traffic control (app for suggestions on traffic route changes).

## 4. Recommendations for Action:

The following is recommended to users:

- The regular evaluation of speed reduction measures with a view to the actually achieved emission reduction by also including the improvement of traffic flow.

- The promotion of digital-based measures in order to encourage the use of alternative routes depending on traffic. In this context, the user requirements are to be considered as well.

The following is recommended to the countries of the Alpine Convention:

- The examination of the extent to which the legal basis for imposing speed limits needs an adaptation for environmental reasons.

*Gotthard Base Tunnel (CHE) - Infrastructure project supporting the shift of traffic from road to rail*

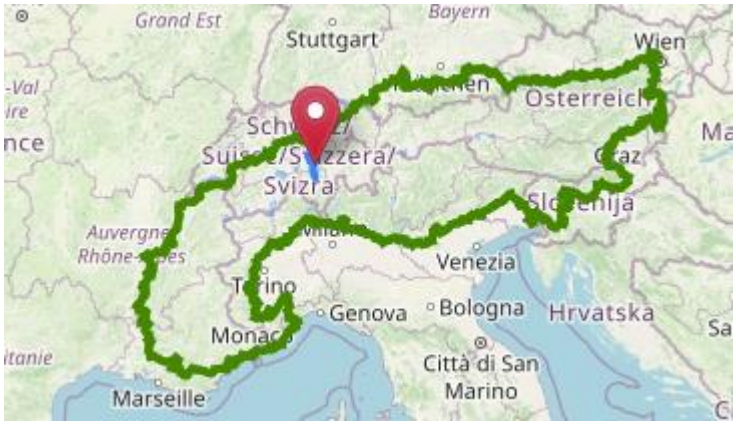


**Figure 18: Map view of the Gotthard Base Tunnel**

## 1. Project Description:

| | **Promotion of a modal shift to rail: The Gotthard Base Tunnel** |
|---|---|
| **Description and problem statement:** | The existing railway infrastructure located on the north-south axis of the Alps was already under increasing strain in the 1980s due to the high volume of traffic as well as the further increase in demand for reliable and fast rail connections. Consequently, there was the need for a solution for both rail and road traffic.<br><br>The referendum of 1992 laid the foundations for the construction of the two axes at the Lötschberg and Gotthard as well as the southern feeder road of the Gotthard Base Tunnel, the Ceneri Base Tunnel. With this "expansion" of the rail network "which seems to be giant for Swiss standards", the majority of transalpine freight traffic through Switzerland was to be shifted from road to rail. Furthermore, the travel times between northern and southern Switzerland were to be subjected to a massive reduction.<br><br>The Gotthard Base Tunnel was finally commissioned in 2016, after seventeen years of construction. With its length of 57.1 kilometres, it is currently the longest railway tunnel all over the world. Together with the Lötschberg Base Tunnel (34.6 kilometres, commissioned in 2007) and the Ceneri Base Tunnel (15.4 kilometres, commissioned in September 2020), the Gotthard Base Tunnel belongs to the so-called "New Transalpine Rail Link (NEAT) transport concept covering the entire Swiss territory. |

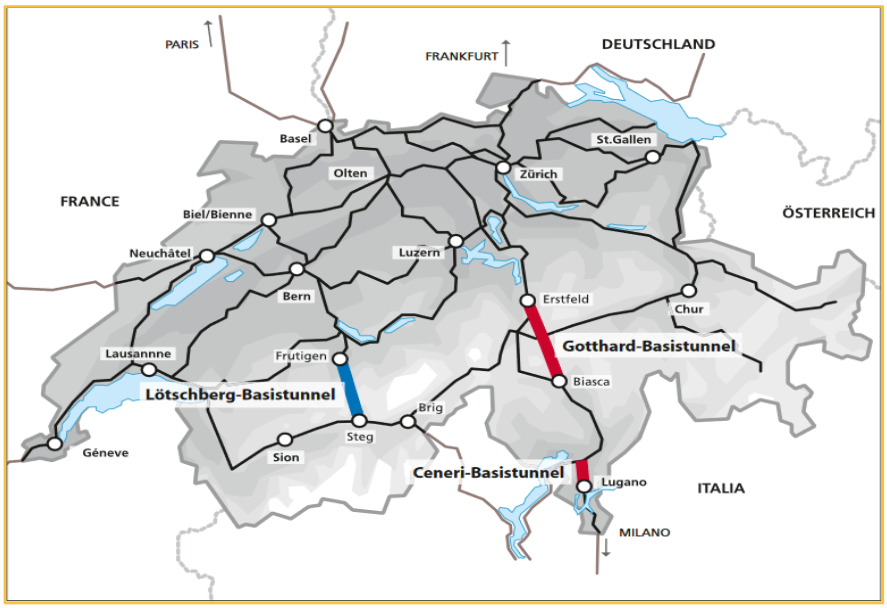


**Figure 19: Overview of the base tunnel locations**[50]

| | |
|---|---|
| **Objective:** | The main objective consists of the improvement of the rail transit traffic in order to achieve a greater shift of road freight traffic to the railways (the upper limit of 650,000 trucks per year on the roads is to be adhered to). Furthermore, the SBB expects a growth in demand in passenger transport (from 9,000 in 2015 to approximately 18,000 daily travellers in 2025 [51]). |
| **Measures:** | Tunnel construction embedded in a comprehensive overall traffic concept. |
| **Technologies/ innovations:** | Tunnel construction works and implementation of a top-level safety concept over a tunnel length of 57 km. |
| **Sustainability aspects:** | • Emissions: The hoped-for shift in road freight transport should result in a noticeable reduction in emissions. Provided that individual transport is also shifted to the railways, an additional reduction can be achieved.<br>• Energy consumption: In the case of a significant modal shift, a reduction in the consumption of fossil fuels in road transport can be achieved.<br>• Travel time / quality: In the area of passenger transport, travel times have been reduced by around one hour in comparison with the previous rail connections. In freight traffic, the time savings on the Zurich / Basel / Lucerne - Lugano and Zurich - Milan routes, for example, amount to around 50 minutes in each case. |
| **Speaker:** | Hans-Peter Vetsch, Vetsch Rail Consulting GmbH |

[50] Cf. (Federal Office of Transport FOT 2019, p. 1) .

[51] Cf. (Mandour 2016, p. 1) .

## 2. Project Assessment:

The resulting strengths and/or success factors seem to be the following:

- The planning offices (10 companies) commissioned by the Swiss government developed a holistic transport concept. For this purpose, among other things, several transport axes and transhipment hubs in different countries were analysed. The said analysis was accompanied by the development of approaches to connect the axes one with another and by the implementation of measures for freight and passenger transport.
- Government funding and grants ensured the financing of the project from the beginning.
- Regulatory measures (for example night and weekend driving bans, limits on the number of 40 t lorries per year on the roads) are increasingly putting economic pressure on hauliers to use Switzerland's railways internally.

The resulting weaknesses seem to be the following:

- Due to its cost-intensity, the construction of tunnels is only feasible if high financial resources are made available.
- Only after completion of the feeder lines outside Switzerland, the Gotthard Base Tunnel will be able to implement all the positive modal shift effects.

Alpine specificity:

- Protection of the Alpine region: reduction of the $CO_2$emissions by shifting traffic to rail.
- Preservation of the tourist region: preservation of the landscape through the use of underground routes (tunnels).

## 3. Potential Analysis of the Project:

As an integral part of the NEAT project, the Gotthard Base Tunnel is a positive example of long-term and sustainable thinking, and likewise of the feasibility and financial viability of large-scale infrastructure projects following successful involvement of the population. After the completion of the feeder lines, the Gotthard Base Tunnel will be able to develop its full potential in the Swiss Alpine region in the context of the European TEN core network.

## 4. Recommendations for Action:

The following is recommended to state project sponsors:

- Conduct of public participations to incorporate the concerns and wishes of the resident population into the project planning at an early stage.
- Reflections concerning the long-term (freight) modal shift in an overall geographical context.

## 5.4 AUTONOMOUS DRIVING

*Bad Birnbach (DEU) - Autonomous driving as part of the local public transport system*

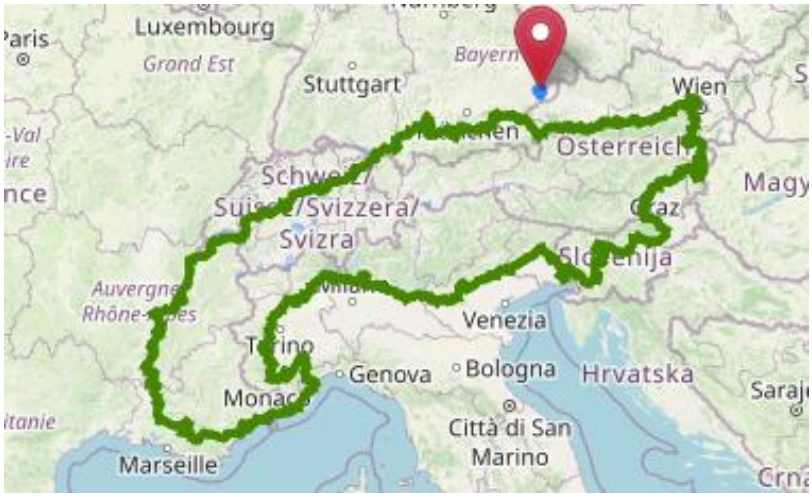


**Figure 20: Map view of Bad Birnbach**

1. Project Description:

| | **Autonomous driving in Bad Birnbach** |
|---|---|
| **Description and problem statement:** | In Bad Birnbach, a Marktgemeinde (market town) located in the Lower Bavarian district of Rottal-Inn with a population of around 5,800[52], the use of an autonomous bus (hereinafter referred to as "shuttle") in the local public transport was tested for the first time in 2017. The project differs from comparable projects implemented in Germany which are usually located in an urban environment, due to the fact that it is being used in a rural area. During its first pilot phase, the project was limited to a 700 m long route in the centre of Bad Birnbach. Due to high demand, the route was then extended from the centre to the train station (2.1 km in total) starting in 2019. Furthermore, autonomous shuttles of a newer design were used.<br><br>In 2020,[53] the shuttle ran every 20 minutes from 8:00 a.m. to 6:00 p.m. and carried approximately 90 daily passengers, who were offered a free-of-charge use of the service. During each journey, an attendant is on board[54] if any intervention is needed during the journey. |

[52] The exact number of inhabitants is 5,841 (as of 31 March 2021), cf. (Bavarian State Ministry for Digital Affairs 2021) .

[53] Due to the Corona pandemic, the shuttle had to stop its operation in November 2020, as the necessary distances as well as hygiene concepts could not be complied with in the bus with 6 seats. The service was then resumed in the end of May and/or at the beginning of June 2021. During the suspension period, the route was served by a bus with conventional drive, cf. (Pehl 2021) .

[54] In Germany, it is currently mandatory that a driving attendant must be present during the journey: Gesetz zum autonomen Fahren, German Act on Autonomous Driving § 1 et seq. (2), cf. (Brandt, et al. 2019, p. 4ff) .

| | |
|---|---|
| **Objective:** | Knowledge production concerning the benefits of autonomous shuttles in the public space, deduction of experiences relating to the operation and technology and consideration of the option of integrating autonomously driving shuttles into the existing local public transport system. |
| **Measures:** | Procurement of driverless and electric minibuses of the type EZ10 from the French start-up EasyMile; adaptation of local conditions to guarantee the safe operation of the minibus (including the construction of a lockable, heated parking area equipped with charging columns, widening of the carriageway on two sections of the route, installation of appropriate signage along the route and of three speed bumps to achieve the speed reduction of the surrounding traffic[55]). |
| **Technologies / innovations:** | Autonomously driving battery electric vehicle; adaptation of road and environmental conditions for safe operation. |
| **Sustainability aspects:** | • Emissions: Use of a battery-electric, autonomously driving vehicle operating with zero local emissions.<br>• Energy consumption: The energy consumption is estimated to be low overall due to the vehicle size and its low speed.<br>• Land use: The shuttle uses the existing road infrastructure.<br>• Travel time / quality: With a speed of up to 20km / h, fast travel is not possible. However, the shuttle makes a new technology tangible and can make its contribution to the creation of new, innovative transport services. |
| **Speaker:** | Stefan Kretzschmar, DB Regio |

## 2. Project Assessment:

The resulting strengths and/or success factors seem to be the following:

- The project shows that autonomously driving shuttles can be used beneficially in the context of the local public transport system even in smaller communities.
- Possible frictions were counteracted by the gradual implementation, which promoted acceptance - a test and learning phase was first completed by involving the resident population before the extension of the service area.[56]
- Potential stakeholders were informed about the project and involved, for example, through accompanying research[57].

[55] Cf. topic “The road”, (DB Regio Bus Bayern GmbH 2021) .

[56] Cf. (Brandt, et al. 2019, p. 9) .

[57] Cf. (Brandt, et al. 2019, p. 15) .

The resulting weaknesses seem to be the following:

- The regular operation of autonomous vehicles is not yet conceivable at present, since traffic-challenging situations cannot yet be overcome without taking any accompanying measures.
- In case of climatic conditions which are not ideal (for example heavy rain, snowfall), the autonomous operation by replacing it by a bus with conventional drive.

### 3. Potential Analysis of the Project:

The project implemented in Bad Birnbach shows the positive results of the gradual introduction of a new technology to complement local public transport services in rural areas: acceptance and consequently use by the local population and tourists is steadily increasing. Generally speaking, its transferability to rural municipalities in the Alpine region[58] seems conceivable. However, as it is the case for any transport measure, an intensive analysis of the individual initial situation must be carried out and, in particular, the cost / benefit ratio must be part of the decision-making process. Furthermore, a realisation does not seem feasible without public or private start-up financing.

### 4. Recommendations for Action:

The following is recommended to future providers of such services:

- The detailed determination of the demand potential of the envisaged connections and the development of scalable entry models which may be operated only during peak tourist periods, if needed.
- The securing of the financing basis by involving public or private sector stakeholders (for example municipalities, accommodation providers).
- The examination of existing funding opportunities, for example for the procurement of the necessary charging infrastructure.

The following is recommended to municipalities:

- Active involvement of local mobility service providers from the beginning in order to counteract any competitive situations between existing (public transport and taxi) providers together with the active promotion of the cooperative interaction between all relevant stakeholders.
- Active support of the use of the service through advertising, discounts, etc. - especially at the beginning as this can result in the reduction of the acceptance threshold in the resident population.
- Provision of a sufficient timeframe for the new service to take root and design of the duration of public support services accordingly.

[58] The autonomous shuttle project implemented in Bad Birnbach is not geographically located in the area covered by the Alpine Convention. Consequently, the point of Alpine specificity does not apply in this context. Nevertheless, the potential analysis of the project should explain the reason why a project of this kind may also be useful for the Alpine region.

## *ECOTRAIN (FRA) - Autonomous driving on rail in rural areas*

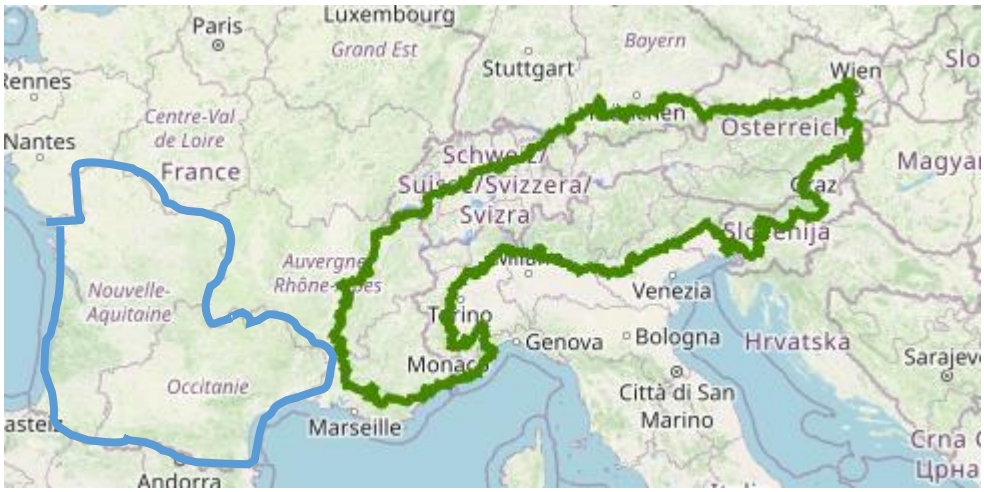


**Figure 21: Map view of the regions of New Aquitaine and Occitania**

### 1. Project Description:

| | **ECOTRAIN** |
|---|---|
| **Description and problem statement:** | Many railway lines serving rural areas were closed in the past due to cost-related reasons. Against the background of the mobility turnaround and the need to connect rural areas, there is an increasing number of approaches aimed at the examination of the reactivation of the said lines.<br><br>With the objective of operating an autonomous and battery-electric shuttle train for local public transport passengers and freight by 2026, a consortium made of five local providers is currently identifying the potential of route reactivation in the French regions of Occitania and New Aquitaine through preliminary studies. Against this background, the consortium is planning a preliminary prototyping on a test track from 2022 to 2023. The prototype construction and testing on a pilot track with 6 shuttles will then take place by 2025. The commercial sale of the shuttles and the commissioning in regional local public transport is planned, starting from 2026. |
| **Objective:** | The objective of the project ECOTRAIN consists of the reactivation of disused routes in rural areas and of the transport of passengers (up to 32) and goods (load of 5t) on these routes by making use of autonomously operating shuttle trains. |
| **Measures:** | Reactivation of disused railway lines, development, and production of shuttle trains[59] and programming of a new software for the autonomous operation of the shuttle trains. |

[59] Since the shuttle infrastructure is to be independent of the mainline rail network, less complex train control technology will be required.

| | |
|---|---|
| **Technologies / innovations:** | Autonomously driving shuttle trains powered by lithium-ion batteries for passenger and freight transport. |
| **Sustainability aspects:** | • Emissions: The battery-electric shuttle is said to have very low emissions. The consortium states 2g $CO_2$/km per passenger.<br>• Energy consumption: The consortium states that due to the lightweight construction, a lower energy consumption may be expected in comparison with diesel vehicles. Furthermore, the batteries are to be charged largely by solar panels.<br>• Land use: The existing infrastructure is used. |
| **Speaker:** | Philippe Bourguignon, Designer ECOTRAIN |

## 2. Project Assessment:

The resulting strengths and/or success factors seem to be the following:

- Identification of currently unused potentials in the railway network.
- Examination of the reactivation and use of the existing infrastructure.
- Elaboration of approaches relating to the linking of passenger and freight transport.

The resulting weaknesses seem to be the following:

- Higher costs for the novel software development for autonomous operation as well as the novel vehicle technology (for example traction batteries and charging infrastructure) in comparison with the use of conventional (diesel / electric) types of drive.
- In France, the legal basis for the regular operation of autonomous rail vehicles must still be created.

## 3. Potential Analysis of the Project:

The project ECONTRAIN pursues an innovative approach to the development of a local public transport service in rural areas based on the existing infrastructure. The acceptance and consequently the use by the local resident population and economy still has to be tested in the context of a test operation. If this is successful, generally speaking, the transferability to other rural areas in the Alpine region seems[60] conceivable. However, as it is the case for any transport measure, an intensive analysis of the individual initial situation must be carried out and, in particular, the cost / benefit ratio must be included in the decision-making procedure.

[60] The project ECOTRAIN is not located in the Alpine Convention area, so the Alpine specificity point does not apply in this context and can consequently be omitted.

## 4. Recommendations for Action:

The following is recommended to the providers of such services:

- The detailed determination of the demand potential of the envisaged connections and the execution of a demand analysis permitting the identification of the potential railway lines for reactivation, if needed.
- The examination existing funding opportunities, for example, for the procurement of the needed charging infrastructure.

# 6 GENERAL RECOMMENDATIONS FOR ACTION

*There is something like a "general rule": In order to achieve the reduction of $CO_2$ emissions caused by transport operations, technologies can contribute about three quarters, while the remaining quarter is to be achieved through changes in terms of behaviour.* [61]

The objective of the project consists of the identification of technologies for the promotion of sustainable passenger transport in the Alpine region, of their assessment by defined Alpine-specific sustainability indicators and of the deduction of the respective recommendations for action. This should support the wider diffusion of promising solutions, especially in the Alpine Convention area, and the consequent promotion of the further development of sustainable passenger transport in the region.

The scope and diversity of the researched projects clearly shows that numerous initiatives have already been undertaken or are planned in the Alpine region as well, in order to design sustainable mobility taking into account ecological, economic and social demands in a balanced manner. In this respect, the Alpine region fits seamlessly into a broad panorama of innovative transport and climate policy approaches to the transformation of mobility in Europe. In many cases, the said projects are pilot projects which dues to their local character have a regionally limited impact. Although "more projects" basically mean "more sustainability", their overall impact may be further enhanced through an increasing networking and a broad exchange of experience, as promoted, among others, by the Alpine Convention.

The selection of best practice projects, examined in detail during the workshop, can consequently only reflect a minor selection of the variety of projects and ideas. However, it can highlight important aspects of sustainable, climate and environmentally friendly mobility design representing the focus of the present research project. At the same time, all the researched projects offer a fund of ideas by providing suggestions for further local, regional, and supra-regional initiatives, also located beyond the Alpine region.

In this context, it is not just about the transformation of drive technologies, digitalisation, and automation, but also about climate-friendly mobility behaviour. The objective is to achieve a more environmentally friendly choice of mobility forms in all fields, from transit and commuter to tourism and leisure traffic.

As a result of an overall assessment, the following success factors (recommend-dations for action) emerge in particular:

**Networking, cooperation, and integration**: The projects going beyond a system framework (be it an economic sector, a transport purpose, an organisational or administrative boundary) proved to be particularly successful. Generally speaking, the resulting synergy effects outweigh a higher complexity-related additional effort. In this context, the following examples can be mentioned:

- Ensuring of a demand-oriented local public transport supply by combining passenger and goods transport,

[61] Prof. Dr. Lenz (Deutsche Zentrum für Luft- und Raumfahrt e.V. (DLR), of the Humboldt University of Berlin, Institute of Geography) made this fundamental statement during the workshop in her conference entitled "Looking ahead: The future of mobility".

- Individual support for the creation of attractive public infrastructure permitting the improvement of the competitive position of the local tourism industry as a whole,
- The pilot use of innovative propulsion technologies to generate technical, application-oriented knowledge, particularly with a view to the efficient coupling of the transport and (hydro)energy sectors.
- The cross-border cooperation of stakeholders in the field of public transport in the provision of timetable information to permit the creation of a comprehensive, non-discriminatory, inter- and multimodal and networked public transport service in the Alpine region.

**Creation of framework conditions**: The creation of a suitable regulatory and funding policy framework is a crucial aspect permitting the successful establishment of forward-looking, climate and environment-tally friendly technologies. This applies both to the conversion of vehicle fleets to alternative drive systems and to the provision of an efficient digital environment, which is essential for efficient mobility design and the introduction of new IT-supported mobility technologies. The linking of services and data does not just enable a reduction in terms of emissions, but also an effective implementation of modal shift potentials.

The examples include:

- The smart linking of different transport modes, for example through a cross-provider tariff and distribution system and automatic ticketing,
- The development of traffic relief concepts to avoid tourism-related car traffic as far as possible,
- The granting of tariff advantages to increase the acceptance of new mobility platforms,
- The creation of transport incentives to increase the use of rail-based public transport.

**Communication and transparency**: The new mobility offers must be communicated and smartly marketed so to bring about changes in terms of mobility behaviour. In this context, communication and cooperation go hand in hand. Examples of this aspect are:

- The tourism marketing of innovative, location-specific transport solutions, which can range from the use of horse-drawn carts to metro systems,
- The implementation of information campaigns to increase awareness of digital applications, for example, for traffic-guiding alternative routing,
- The involvement of local public transport providers and taxi companies in the development of regional mobility concepts.

**Targeted investments both in rail transport and charging infrastructure for alternative drives:** The conversion of vehicle drives, especially to battery-electric and hydrogen-based systems, is also visibly gaining momentum throughout the Alpine region. This is the reason why a key focus must be on expanding the needed refuelling and charging infrastructure.

Furthermore, an increase in the share of rail in the transport volume needs the expansion of the rail infrastructure which is usually very cost-intensive and time-consuming and therefore requires a careful forecasting of demand and project planning with the early involvement of all stakeholders, as well as the development of a viable financing concept. Despite these challenges, rail transport is one of the most energy-efficient transport methods.

The examples of investments in transport infrastructure include the following:

- The Serfaus underground railway, the Gotthard Base Tunnel and the Zillertalbahn,
- The establishment of rental stations for electric vehicles and the associated expansion of the charging infrastructure,
- The electrification of local public transport vehicle fleets.

Overall, it was noticeable that comparatively few of the projects identified and discussed in the study explicitly address or are determined by Alpine specificities (such as, for example, topographical conditions, tourism). However, this does not represent a disadvantage since it rather indicates that the full range of innovative approaches to the further development of efficient, climate-friendly, and sustainable mobility can be applied to face the various transport challenges existing in the Alpine region - regardless of the project-specific regional context. Consequently, it goes without saying that local experiences and findings are regularly adapted to the local - Alpine - conditions and to the mobility requirements of the local resident population in a meaningful way. In this sense, it expands the scope of the projects and initiatives presented on the one hand by showing at the same time that innovative mobility solutions developed outside the Alpine region may also be usefully adopted in this region.

At the same time, this aspect shows a potential starting point for further research by reversing the line of vision: the Europe-wide or even international analysis of successful solutions to the issues of a smart, sustainable, and future-oriented transformation of mobility with a view to their transferability to the Alpine region.

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# DAILY MOBILITY IN THE ALPS AFTER THE COVID CRISIS RECOVERY

TRANSPORT WORKING GROUP OF THE ALPINE CONVENTION

-MANDATE 2021-2022-

ALPENKONVENTION
CONVENTION ALPINE
ALPSKA KONVENCIJA
CONVENZIONE DELLE ALPI

# IMPRINT

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## 1. MANDATE GIVEN BY THE ALPINE CONFERENCE

### Setting the scene

The lockdown suddenly ordered by almost all world's governments in March 2020, after the experience of the Chinese metropolis of Wuhan, revealed, amongst others, the adaptation capacity of people, companies and institutions. Phenomena such as the escape from big cities and remote working appeared openly. It is now hard to foresee how long-lasting these trends will be and what impact the new lifestyles could have on the regional development and on the environment of the Alpine massif.

This report aims to synthetize observations, analyses and recommendations already drawn in the Alpine and in other countries since the pandemic's outburst, and to propose answers to this question of the relationship between Alpine residents and their daily environment in the future.

### The Alpine Conference requests

On 10 December 2020, in a virtual meeting held during the sanitary crisis, the XVI Alpine Conference entrusted the Transport Working Group (Transport WG or TWG) with six tasks. One of them consists in analysing "*the evolution of commuters' behaviours triggered by the sanitary crisis*". It's enunciated as follows:

"*Analyse the effects of the evolution of commuters' behaviours in the Alpine area concerning home-office mobility as well as everyday activities triggered by the recent sanitary crisis. Based on available reports in the member states of the Alpine Convention and on the results of the 2020 study report on possibilities for the reduction of transport demand through transport-saving spatial structures, new working or coworking solutions, pooling of shipments, regional and local distribution chains, changed mobility and behavioural patterns, recommendations for the implementation of measures in order to enhance quality of remote working life will be elaborated.*"

### Former publications of the Transport WG related to the topic

ALPENKONVENTION
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The Alpine Convention Transport Working Group recently released a report related to the topic of daily commuting behaviours. During its 16th session on 10 December 2020, the Alpine Conference adopted its report on *Reduction of mobility demand and shift to*

*environmentally sustainable modes - Strategies and measures in the Alps*[1] whose recommendations include the following:

- To employers: establish relevant rules for remote working and foster "tele-houses" for coworking purposes;
- To schools and universities: ensure students aren't left alone far from their teachers and friends;
- To public transport companies and local authorities: adapt ticketing policies towards remote workers who commute seldomly;
- To logisticians: foster sustainable logistics;
- To municipalities: motivate people to spend leisure time near home; improve cycling and pedestrian networks; promote green buildings.

[1] https://www.alpconv.org/fileadmin/user_upload/Organization/TWB/Transport/Transport_Annex2_AT-CH_Reduction-of-mobility-demand.pdf.

## 2. ACTIONS BY PARTNER INSTITUTIONS

The Transport WG was invited by the Alpine Conference to work in cooperation with:

- *EUSALP* Action Group 4 (AG 4 Mobility);
- The Alpine Climate Board of the Alpine Convention;
- iMONITRAF!;
- Arge Alp;
- Interreg Alpine Space Programme;
- Zurich Process and its follow-up;
- Relevant stakeholders depending on each of the objectives: local authorities, employer associations, academics, environmental associations.

### i) The European Union Strategy for the Alpine Region (EUSALP)

*EUSALP*, funded by the European Union, encompasses an area wider than just the Alpine Convention perimeter.

During its 2020 EUSALP presidency, France developed a programme[2] along seven axes. The third axis, *Developing sustainable mobility and transport solutions*, aims "*to promote sustainable transport, develop information and ticketing services, the transition from road to rail, and to promote the networking of players to avoid redundancy of action*".

The first objective of EUSALP group on 'inter-modality and interoperability in passenger and freight transport' also called Action Group 4 (AG 4[3]) was "*to promote inter-modality and interoperability in passenger and freight transport by supporting and fostering the removal of infrastructure bottlenecks, by bridging missing links, coordinating planning and timetables of public transport, modernizing infrastructure and enhancing cooperation. AG 4 is addressing this objective by focusing on infrastructure for sustainable transport in passenger- and combined transport as well as interconnecting*

[2] *Programme of the 2020 French Presidency of EUSALP*, 4 February 2020, https://www.alpine-region.eu/publications/french-presidency-work-programme.

[3] *État des lieux des activités des groupes d'action* (Situational analysis of action groups activities), European Union Strategy for the Alpine Region, October 2019.

*public transport systems, focusing on operations and information and ticketing services*"[4].

On 21 November 2019 (just before the pandemic outburst), *EUSALP* AG 4 released a report on *Cross-border mobility in the Alpine region*, that concerns about 600,000 people within the *EUSALP* perimeter, above all around Genève and Basel and in the Alpine Rhine valley. It calls for raising awareness among enterprises and commuters towards sustainable ways of commuting.

It also labelled infrastructure projects and Smart villages projects for good practice in mobility.

It took part in the Interreg Alpine Space project LinkingAlps and extended the EUSALP Platform of knowledge for Transport and Mobility.

*EUSALP* presidency was taken over by Italy on 26 January 2022 in Bozen / Bolzano. The 19th AG 4 Action Group Meeting t took place on 15 and 16 March 2022. Its priorities remain the same as previously.

### ii) CIPRA and the Alpine Climate Board

The *Commission internationale pour la protection des Alpes* (International Commission for Alps Protection – *CIPRA*) federates approximately one hundred Alpine organizations.

On behalf of the Austrian Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology, CIPRA is taking part to the *European Environment initiative – EURENI* devoted to saving land, for a shift in the way land is used in peri-urban areas. It aims at making good examples visible, elaborating conflict resolution models and gaining knowledge in the pilot regions on how to solve conflicts in land consumption. That project is indirectly linked with the question of commuting all-day mobility.

The *Alpine Climate Board* (ACB), created by the Alpine Conferenceand chaired by Austria, envisages for CIPRA the role of a "coordinator of coordinators", in a think tank approach. It focuses on freight transport.

[4] https://www.alpine-region.eu/action-group-4-mobility.

### iii) iMONITRAF!

*iMONITRAF!* brings together the Alpine transit Regions. Its priority thus is shifting on rail the transport of goods.

On 9 November 2021, it held an event in Bruxelles in the frame of the European Year of Rail.

### iv) Arge Alp

The *Arbeitsgemeinschaft Alpenländer* (Arge Alp - Alpine Countries' Work Community) promoted the Youth Alpine Interrail 2021 initiative. Moreover, it has been one of the organizers of the 3rd *Healing Power of the Alps* workshop devoted to the link between tourism and health, that took place as a hybrid event on 8 and 9 October 2021 in Bad Hofgastein and online. At its 30 September 2020 summit in Salzburg, it discussed the regulation measures to be undertaken against the Coronavirus.

### v) Interreg Alpine Space

The *Interreg Alpine Space* programme, funded by the European Union, encompasses all the Alpine Regions (NUTS 2), that is more than just the Alpine range.

It has fostered the project *LinkingAlps* on interconnecting passenger transport information in an intermodal way.

### vi) The Zurich Process

The *Zurich process* has been launched by the Declaration of Zurich, on 30 November 2001. It aimed at "*the improvement of road safety particularly in tunnels in the Alpine region*". During its 16 September 2021 online steering committee, the Swiss presidency suggested focusing in the future on the core question of freight transport modal shift. This question will be on the agenda of two meetings at ministerial level organized by Switzerland on 14 January and 26 October 2022.

## 3. REVIEW: WHAT COULD BE OBSERVED

### i) A boom of teleworking

In the Parisian region, which is taken here as an example, the ratio of workers teleworking more often grew from 22% before the pandemic to 54% in July 2020, dropping back to 47% in September 2020. Active population teleworked on average 2.1 days a week. 40% of the respondents said they moved less than before[5].

It is interesting to underline that in France, in 2019, only 3% of the employees (7% including occasional teleworkers), 5.5% in the Parisian region, regularly teleworked at least one day per week. This practice was quite usual for executives (14% of them being concerned), much less for intermediates (3%), and very rare for office workers and workers. Teleworking was mainly carried out from home (64%), otherwise in other establishments of the company (21%) and in proximity networks and coworking rooms (15%)[6].

### ii) No urban exodus yet, but a trend for citizens to leave town centres towards suburbs, or even peripherical mid-sized towns

The trend of flight from big cities seems for the moment imperceptible. Citizens grant their town a pragmatic, if not sentimental, attachment. On the other hand, the harshness of living conditions in towns during the mobility restriction times could in the future increase the trend of urban sprawl. This could raise the difficult question of reinforcement of interurban and far suburban public transport networks. For instance, a spot survey carried out in April 2020[7] showed that 38% of Parisian metropolis inhabitants wished to move away from the city. The real estate market had been strongly dampened at that time, especially in the biggest cities. At the same time, outlying smaller towns and even rural zones experienced an unexpected real estate boom. This phenomenon could become stronger in the future, considering the long-time memory of people.

### iii) Countryside people behaviours seem close to those of people living in cities

The question that interests us here is whether mobility patterns in the countryside are different from those in townships, and what sort of impact the pandemic has had on both. According to the two charts below, it seems obvious that behavioural patterns aren't quite different from each other (considering the distance covered per day) and that the rural world seems a bit more resilient than the urban one.

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[5] Source: Inov 360 survey carried out by Institut Paris Région (Paris Region Urbanism Institute).

[6] *Qui sont les salariés concernés par le télétravail ?* (Who are the employees concerned by teleworking?), French ministry of Work, DARES, 4 November 2019.

[7] Forum vies mobiles Survey.

It could thus be expected a quasi-status quo if people moved from towns to the country without staying tied up to their former residence.

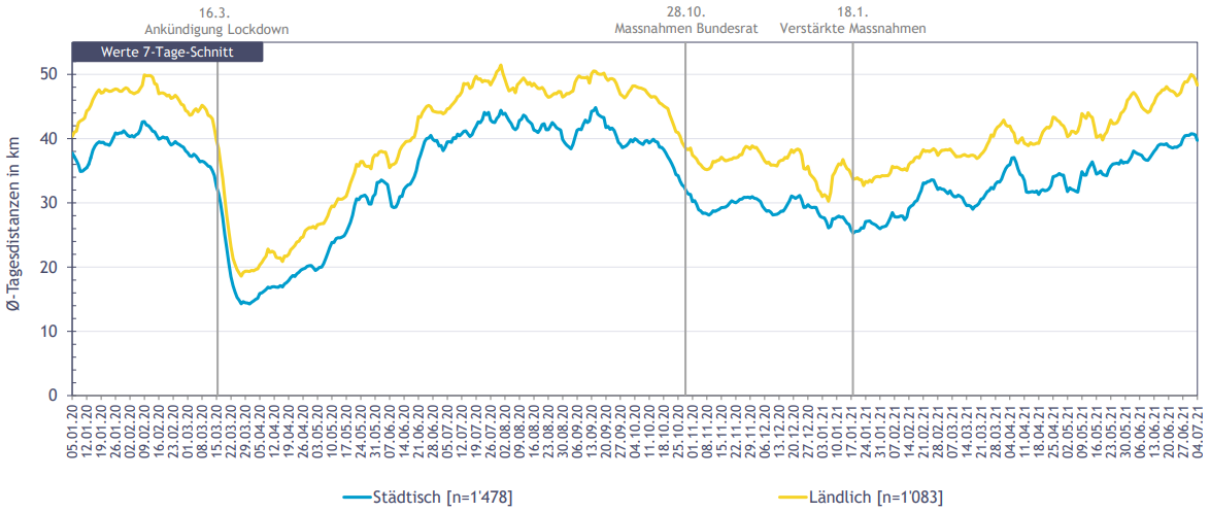


Figure 1: Daily average distance covered by citizens (blue) and countryside people (yellow) in Switzerland, source: *Mobilitäts-Monitoring COVID-19*, *Intervista*, 6 July 2021

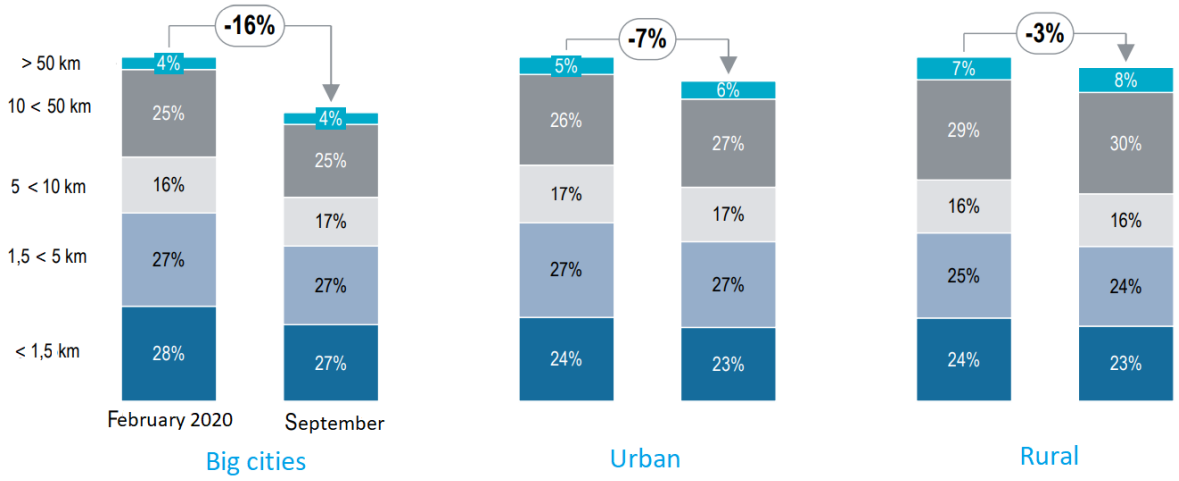


Figure 2: Evolution of trips number according to residence and distance in France in 2020, source: *Covid-19, Etat des lieux de la mobilité urbaine post-confinement* (Covid-19, inventory of urban mobility after confinement), *Kisio* and *Roland Berger*, 15 October 2020

### iv) Hard drop of public transport, for the benefit of bike and soft modes, but above all individual car

The pandemic increased people's distrust towards public transport means, presumed unsafe. Almost all the Alpine countries were confronted with this phenomenon. Of course, traffic moved to other means, especially walking and private car, the volume of which growing significantly after recovery.

In Germany, according to the *DENA* survey (16 December 2020), 66% of regular public transport users reduced their use of public transport, in favour of biking, walking, carpooling and, a bit less, private car. The use of public transport dropped slightly in the thirty-year-old population. The main reason for this trend was the fear of contamination.

Before that, the German *ADAC* survey (24 November 2020) confirmed these trends: 20% of interviewees didn't use any more public transport; 22% thought of walking, even after recovery of the crisis; and 17% thought of riding on bike instead of using public transport.

In France, the main public transport means have been the last ones to gain their clientele back. That's particularly striking in the biggest cities like Paris, even one year after the pandemic outbreak. Bike traffic for example, as measured by meters put in the towns on cycle tracks, grew by 25% between 2019 and 2021. Nevertheless, since summer 2020, this growth stopped, although cities made big investments favouring it.

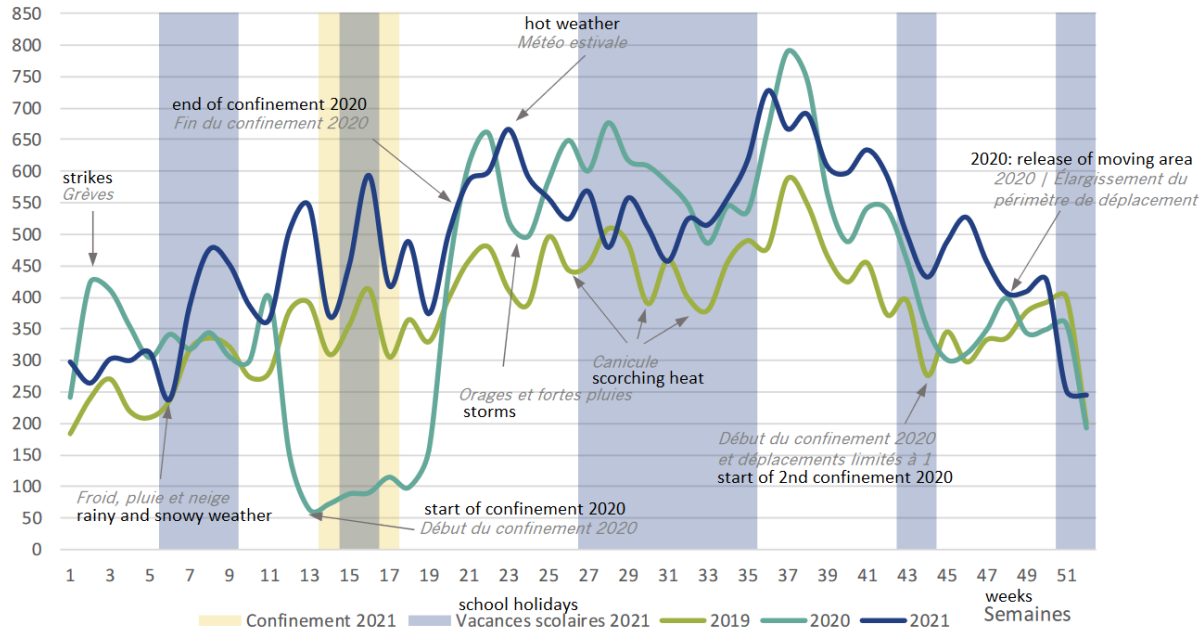


Figure 3: Average number of bicycle passages per day and per counter since 1 January 2019, source: *Vélo & Territoires*, 5 January 2022, https://www.velo-territoires.org/wp-content/uploads/2022/01/2022_01_05_Bulletin-Frquentation-vlo-en-France_9.pdf

In Italy, traffic dropped in 2020 far more in railway transport than on the road: in midsummer, it reached only 50% compared as previous year in trains and urban transport, against 90% on the road for car traffic. Soft modes didn't take off: their modal share doesn't exceed 3.5% of all movements. The private car gathers most of the passenger transport modal shift.

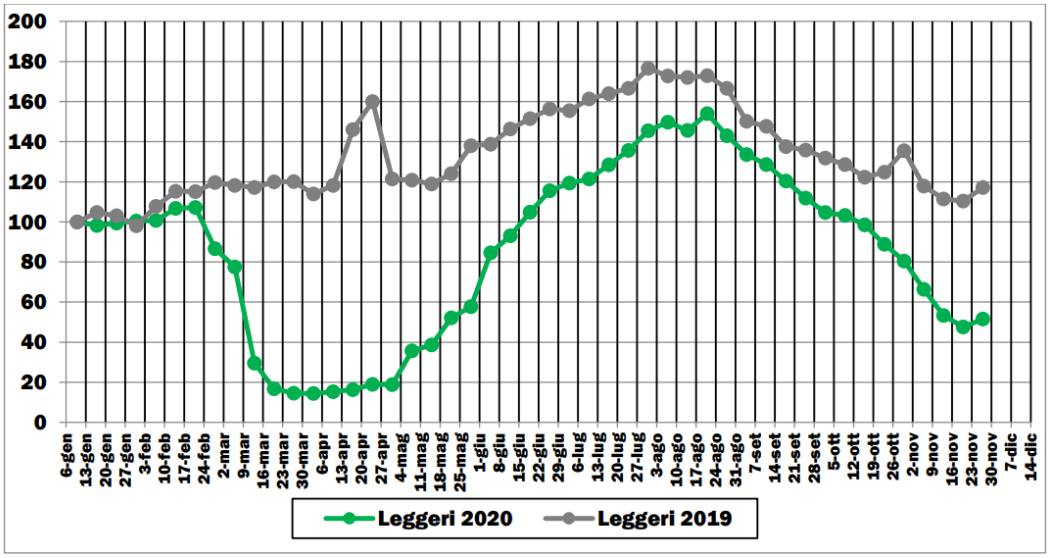


Figure 4: Traffic in 2020 compared to 2019 on the Italian highways, base 100 = 1st January, source: *Osservatorio sulle tendenze di mobilità durante l'emergenza sanitaria del COVID-19* (Observatory on mobility trends during the COVID-19 sanitary crisis), n° 2, 1 January 2021, https://mit.gov.it/sites/default/files/media/notizia/2021-01/Monitoraggio%20COVID%20volume%202.pdf

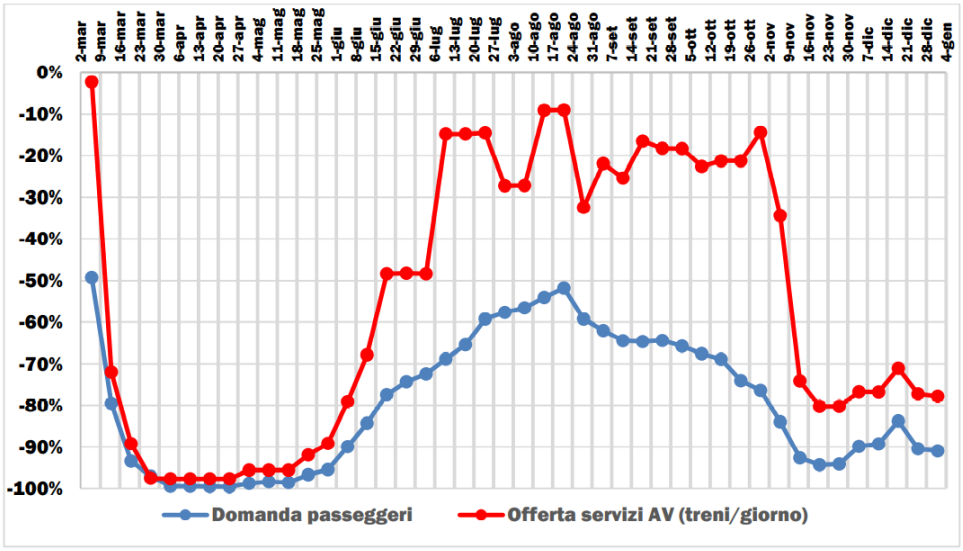


Figure 5: Supply and traffic in Italian trains between March and December 2020 compared to 2019, source: *Osservatorio sulle tendenze di mobilità durante l'emergenza sanitaria del COVID-19*, n° 2, 1 January 2021

In Switzerland, bus, according to the *MOBIS-COVID19* survey, tramways and trains remain durably full 40 to 60% below their 2019 level. At the same time, bike meets an impressive keen interest within people.

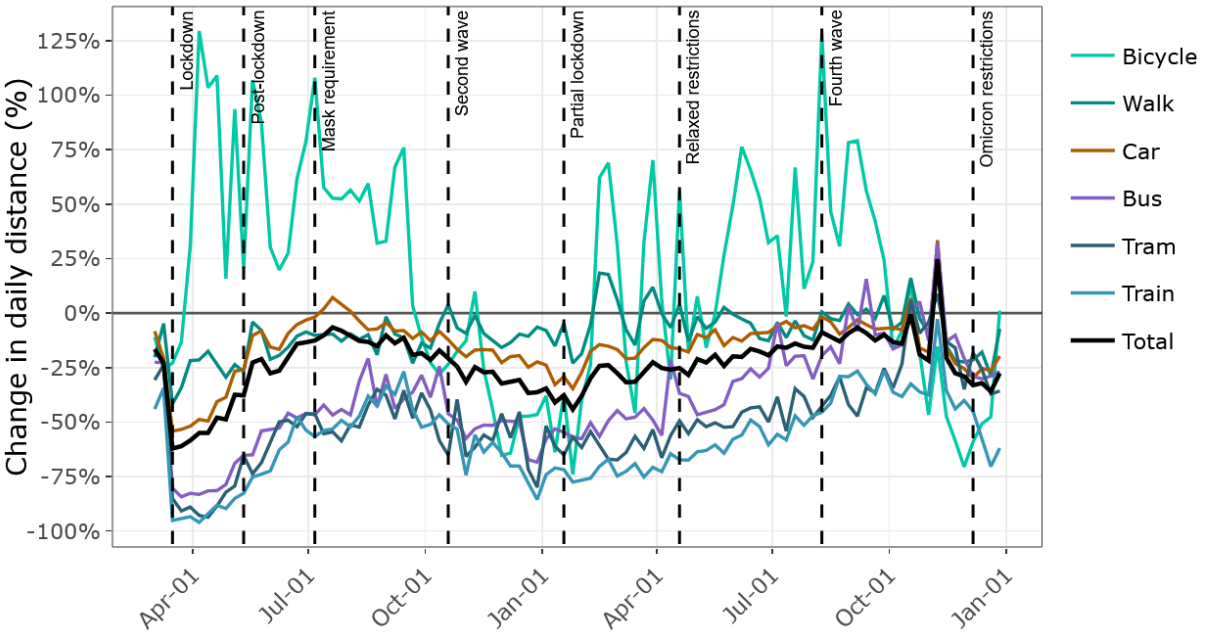


Figure 6: Evolution of daily distances travelled in Switzerland according to transport means from March 2020, source: *Mobis Covid 19*, *ETHZ* et al., 3 January 2022, https://ivtmobis.ethz.ch/mobis/covid19/reports/latest

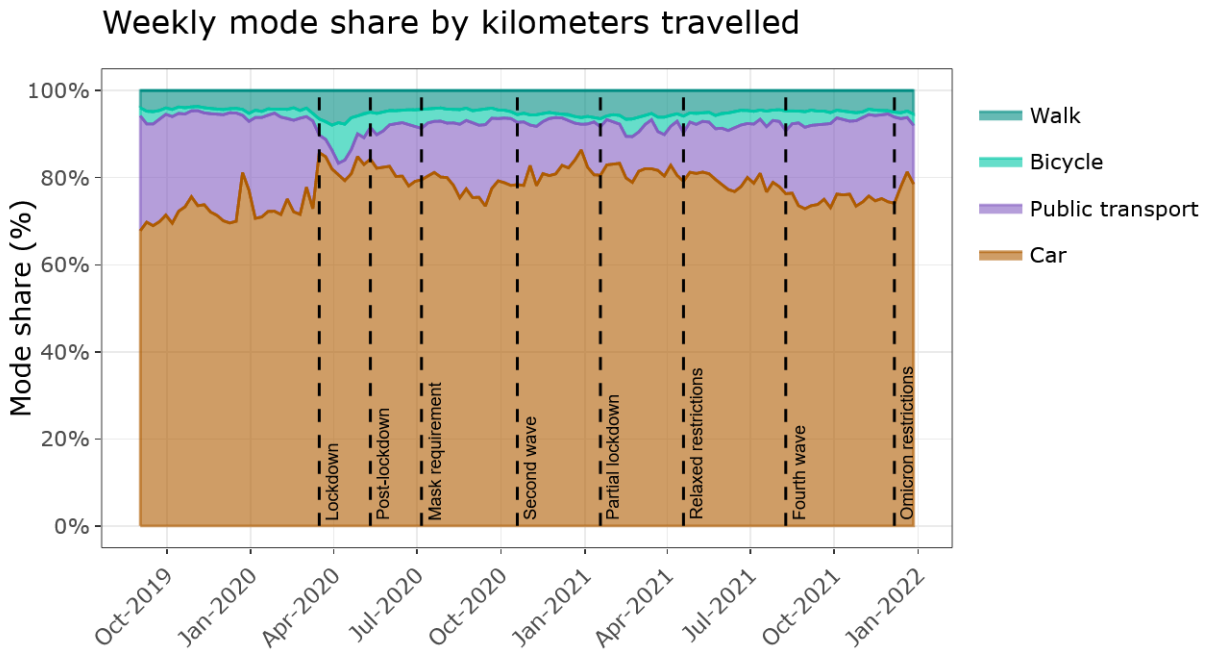


Figure 7: Weekly mode share by km travelled, source: *Mobis Covid 19*

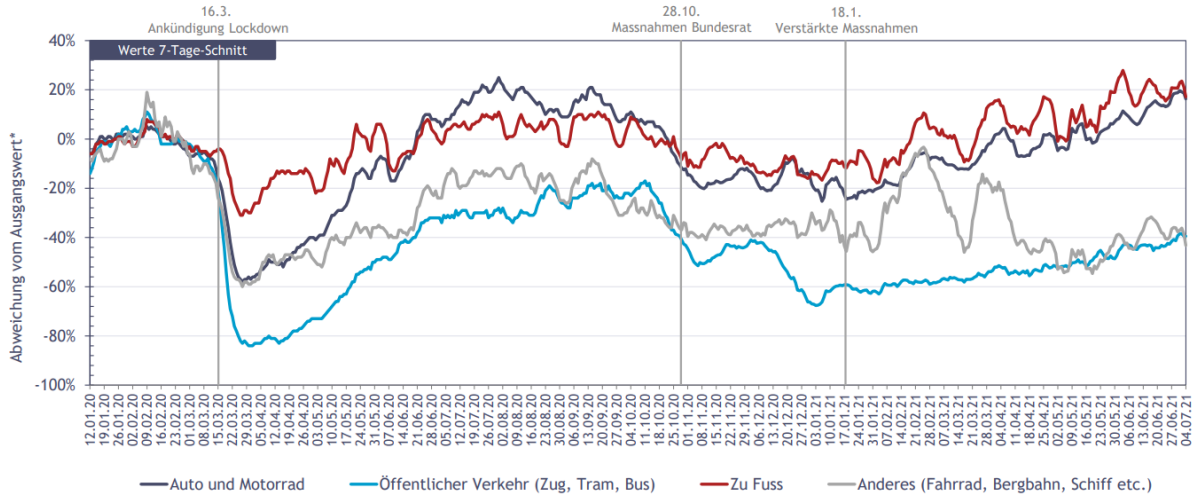


Figure 8: Evolution of daily distance covered by an individual according to the mode in Switzerland, source: *Mobilitäts-Monitoring COVID-19* (Mobility monitoring COVID-19), *Intervista*, 6 July 2021, https://www.intervista.ch/media/Report_Mobilitäts-Monitoring_Covid-19.pdf – Black: car and motorbike; blue: public transport (train, tramway, bus); red: pedestrian; grey: others (bike, cable car, boat, etc.)

### v) Even weakened, urban transport still suffers peak-hour

Peak-hour management is of course, by disrupted service as well as normally, one of the most relevant problems in urban public transport.

The last surveys released on the mobility of French citizens show a very strong exacerbation of peak-hour, especially in the Parisian region. In substance, in public transport in the capital region, about 1/7$^{th}$ of the whole day-traffic flows during the morning peak-hour, against 1/12$^{th}$ on the road network, where the peak-hour phenomenon is less marked. At that same time, most of the journeys (89% according to the regional global transport survey 2010[8]) are for work or studies purposes. Evening peak-hour is broader, lower and more diversified. Besides work and studies purposes, people move for shopping, visits, leisure and other purposes, on a broader time period.

Moreover, population segmentation by socio-professional categories shows that their own peaks aren't synchronous: students and retired people leave earlier, while executives enter the transport system as latecomers. Were it possible to delay a bit executives' timetable, one could expect a substantial improvement of the morning peak. Even one hour delay would lower its volume by 30%. Adding two complementary hypotheses: (1) the generalization of teleworking (20% for intermediates, employees and workers, 40% for blue collars, every day of the week); and (2) that students and scholars turn by 50% to

[8] Source: *Autorité pour la qualité de service dans les transports* (AQST - French Transport Service Quality Authority).

active modes (bike, walking, etc.), the peak-hour could be lowered by 46.5%, that is almost half of previous value, as show charts below[9].

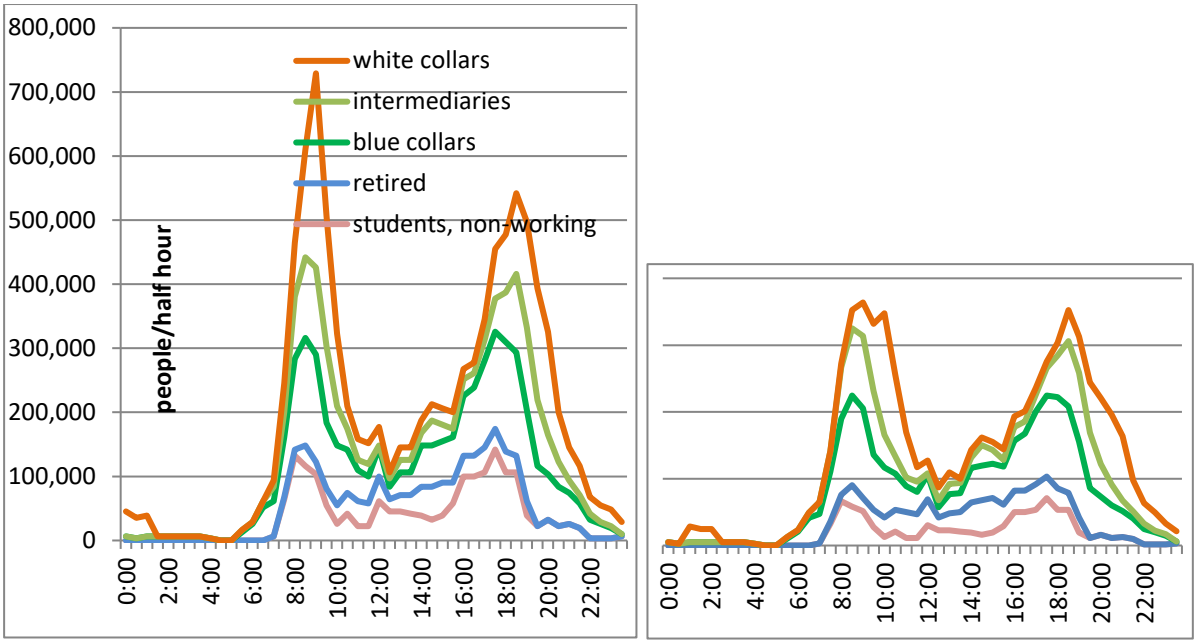


Figure 9: Working day movements in Paris region according to time of the day and to socio-professional group: as observed before pandemic (left, source: *Enquête nationale transports et déplacements 2008*), and under peak-hour applying our hypothesis (right).

It seems that active people are more flexible than expected, and that, if their interest matches that of their employers (from a sanitary point of view), lowering of peak-hour levels could be sustainable.

[9] Calculated from Paris region experience.

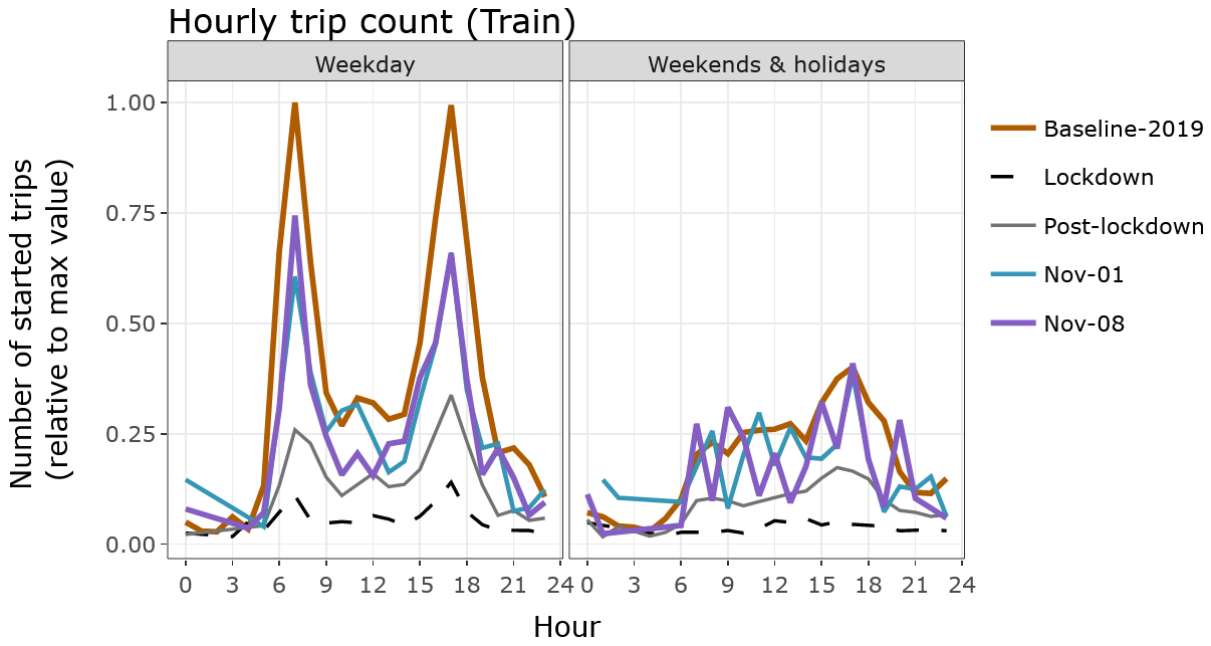


Figure 10: Railway hourly trip count in Switzerland, comparison 2019 / 2020, source: *Mobis Covid 19*, op.cit.

Long before the pandemic outburst, transport authorities started a negotiation with big employers concerning work time rearrangements in order to lower the peak. Lyon is a successful example of this.

## 4. HOW IT WAS OBSERVED

The comprehension of behavioural patterns changes requires their measurement, for which numerous techniques are available, which are described below.

### i) Traditional tools: computing and population poll

First, authorities, especially in the field of transport, have been carrying out for a long time specific computation and poll surveys.

*In France*

Passengers' computing has been tested by numerous ways:

- Ticketing;
- On board of buses, notably at Dunkerque, with the help of videoscope cameras counting each boarding and getting off;
- In a rougher way, with the help of applications that request passenger inform users' community if vehicles are full or not.

There have been numerous surveys since the beginning of the struggle against the Covid-19 virus:

- The Ministry for Transport entrusted Harris Interactive with a survey on people's intention to move the following week. The first was released on 11 May 2020, the same day people's confinement was over. The fifth and last one was released by the end of the year 2020.
- At the same time, big local authorities, transport organizing authorities, led their own surveys, such as *Inov 360* in the Parisian region and *Covimob* in Lyon.

Moreover, the Ministry for Work and Social Affairs (*DARES*) carries out surveys on work practices, especially teleworking. Unfortunately, its last survey has been released in 2019, that's before the pandemic outbreak, and cannot describe workers' adaptation to the new context.

*In Germany*

Numerous surveys have been carried out on people's behavioural change due to pandemic;

- The *Fraunhofer Institut für System- und Innovationsforschung* (ISI, Fraunhofer Institute for Research on Systems and Innovation), in collaboration with administrative and academic partners in Germany and Japan, carried out two surveys in August 2020 and March 2021;
- The *Deutsche Energie Agentur* (DENA, German Energy Agency), by call of 1,002 adults over 18 speaking German between 18 November and 1st December 2020;

- The *Allgemeiner Deutscher Automobil-club* (ADAC, German Automobile Club), by interview of 2,061 adults over 18.
- The *DLR Institut für Verkehrsforschung* (DLR, Institute of Transport Research) asked around 1,000 adults over 18 as part of an access panel (April 2020 - December 2021)[10].

Moreover, the *Bundesverband mittelständische Wirtschaft Unternehmerverband Deutschlands e.V. – Der Mittelstand BVMW* (German Federation of Middle Size Companies) released an analysis of the economic stakes of new lifestyles arisen from the pandemic.

With *Mobilität in Deutschland - MiD*[11] (about every 5 years, cross-section, over 300,000 participants) and *Deutsches Mobilitätspanel* (annual, longitudinal, over 3,000 participants) there are two mayor surveys in Germany allowing permanent observation of mobility behaviour. Both were conducted on behalf of the *Bundesministerium für Digitales und Verkehr* (BMDV, Federal Ministry for Digital and Transport).

As part of the annual mobility survey *Deutsches Mobilitätspanel*[12] participants in winter 2020/2021 were asked about possible changes in their mobility behaviour due to the COVID-19 pandemic using an additional questionnaire.

Another survey on behalf of the BMDV is the semi-annually published *Gleitende Mittelfristprognose*[13]. *As a basis for these medium-term forecasts of the traffic development in Germany,* the effects of the pandemic-related restrictions on the modes of transport were examined monthly for the year 2020 by using various available indicators (mobile phone data, data from traffic counting points, accident statistics, etc).

*In Italy*

Many polls have been released, such as:

- *Istituto Nazionale di Statistica* (ISTAT, National Institute of statistics) on 16 August 2021, from a questioning of adults over 18;
- *Groupama Assicurazioni* (Insurer), on 10 May 2021;
- *Aretè*, 6 May 2021;
- *Osservatorio Nazionale Sharing Mobility* (National Observatory on Sharing Mobility), 29 September 2020;

[10] https://verkehrsforschung.dlr.de/de/news/dlr-befragung-wie-veraendert-corona-unsere-mobilitaet

[11] www.mobilitaet-in-deutschland.de

[12] www.mobilitaetspanel.de

[13] https://www.bag.bund.de/SharedDocs/Downloads/DE/Verkehrsprognose/Monitoring_Personenverkehr_Corona.html?nn=3290816

- *Autorità di Regolazione dei Trasporti* (ART, Transport Regulation Authority), 14 July 2020, from a poll on 1,000 persons carried out between 19 and 23 May 2020.

### ii) Mobile phones movements tracking by radio relays

If a land-line owner could be located according to his home address, a mobile phone owner may be located at any time by the closest relay (except when his phone is shut down). That allows his provider to follow him in his footsteps. Precision of location depends thus on the density of relays, that is relatively low: about 500 m in town, and some km in the countryside. By the way, this technique cannot notice little movements such as going with children to school or daily shopping. Otherwise, it can identify a longer movement such as commuting in big cities, and assess density of population or main gatherings (cultural, sporting) as well as their fluctuations. Thus, phone operators suggest it for three types of surveys: tourism (assessed according bed-nights), geo-marketing (gatherings in main events, commercial centres and suburbs) and mobility.

Therefore *Orange* was able to assess the loss of population in the main French cities at time of the first confinement (17 March 2020)[14]. The published figures, that is 600,000 people leaving Paris *intra muros*, about one quarter of people usually living there, didn't stay unnoticed. A specific advantage of this imprecise technique is that it respects the anonymity of personal data. The map of France below shows people's movements registered at that time. Main losers of inhabitants are both Paris and inner suburbs, and ski resorts. Otherwise, the rural world gained people.

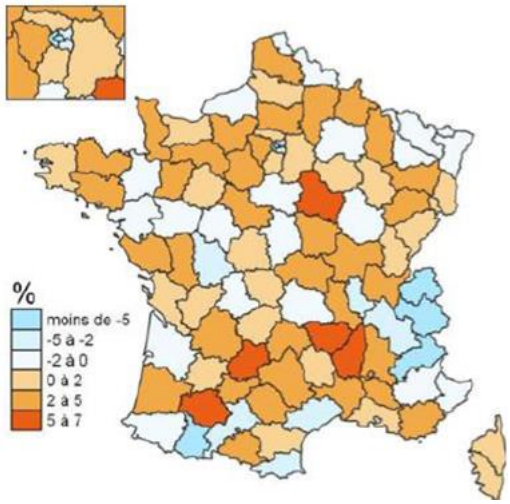


Figure 11: Evolution of French population distribution since Covid first confinement (17 March 2020), (source: Orange and INSEE - National Institute of Statistics and Economic Studies), showing population growth in the 100 French Departments during the early confinement time

14 *Population présente sur le territoire avant et après le début du confinement, premiers résultats* (Population present on the French territory before and after start of confinement, first results), press release, *INSEE* (French Institute of Statistics), 8 April 2020, https://www.insee.fr/fr/information/4477356.

Phone operators have some information about their clients, such as age bracket, home address or socio-demographic class. They can follow them in their daily movements provided they have their mobile phone with them. The analysis of their movements allows them to connect them together with temporary residence (when they stay a long time by night somewhere) or work place (the same by day). Thus, they can calculate the length and the density of commuting movements[15]. But it's more difficult for them to follow the itinerant workers.

This technique shows some weaknesses: it underrates the youngest people as well as the elderly, who quite often do not have any mobile phone in their pockets; it cannot reconstruct the precise route taken nor the transport means used; it ignores short neighbourhood movements that stay within the area covered by a single radio relay.

According to the Parisian mobility organizing authority *Ile-de-France Mobilités*, the first zooms carried out by *Orange* on the Stadium of France and the Saclay plateau, that were a matter for its field of relevance, proved disappointing. For the moment, other authorities seem likewise a bit sceptical concerning this technique. But in the near future, its geographic precision should grow thanks to the 5G and new triangulation techniques.

### iii) Passive smartphones movements tracking by satellite

Movements tracking by satellite is a different technology available on smartphones. Every smartphone owner is quite frequently invited to download several applications, such as telephone book, information sites, weather forecast, games, etc. that have the geo-localization function. Since then, unless the GPS is switched off, such a user of mobile phone can be followed by a satellite constellation in all his movements.

Unlike the tracking by radio relays, that by GPS satellites is geographically very precise, about 10 m, or less. Companies specialized in processing these data, knowing the different transport networks characteristics and the route followed by every single mobile phone, indexed by the passing time at each point reached, can determine the transport mode used. For instance, a movement on street or road covered at 5 km/h will be naturally considered as walking; a 20 km/h movement with frequent stops at crossings will be attributed to bike or personal movement engine; otherwise, to bus, car or similar. Thus, the analysis can draw "*heat maps*" of the areas surveyed according to density of population and assess infrastructure load.

15 Fin mai, les trajets matinaux n'atteignaient que 60 % de leur volume habituel (By end of May, morning movements only reached 60 % of their normal volume), Conjoncture française, INSEE, 17 June 2020.

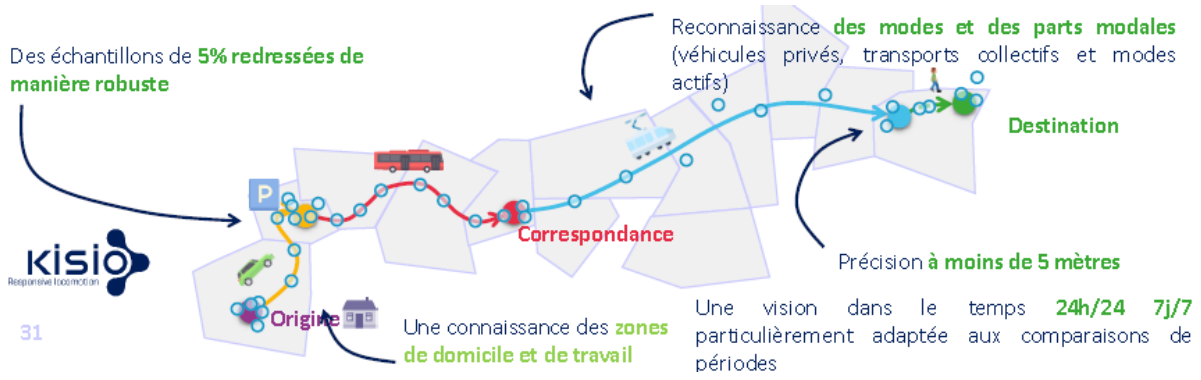


Figure 12: Principle of movements tracking by satellite, source: *Kisio*. (1) 5% samples robustly rectified; (2) modes and modal share recognition (private vehicles, public transport means, active modes); (3) precision at least 5 m; (4) home and work places knowledge; (5) H24, D7 vision, particularly fitted to time periods comparison

Temporarily going into a shadow zone, for instance a metro tunnel, doesn't any more affect software performance. In fact, the mobile phone has been pinpointed before entering the shadow zone (going down to the station of departure) and then as coming outside. Like applications for choosing a route, the software reconstructs then the most probable route taken between these two points.

Compared to the tracking techniques by radio relays, that by satellite is geographically far more precise. It allows reconstruct the route and transport means used there. However, it lacks a balanced cross-section of the population because, similarly to the previous technique, it doesn't monitor the youngest and oldest people, who don't have a smartphone. Another disadvantage, compared to the tracking by phone operators, is the lack of knowledge of the passenger's profile. Thus, it cannot easily segment socio-professional categories and movements reasons.

Some companies specialized in processing these big data. So did *Google*, *Apple*, and with more sophisticated algorithms, the Israelian start-up *Moovit*.

*Google, Apple*

Their systems allow *Google* (with *Google Maps*) and *Apple* (with *Apple Plan*) to track individual movements. On the other hand, they don't know how to allocate them to a given transport mode.

*Google*[16] is interested in activity places, such as shopping and leisure centres, groceries and pharmacies, parks, public transport stops, workplaces, residential areas. It produces a quantified assessment of each of these variables, compared to a reference date, at the scale of a geographic unit of about 10,000 km² (as large as a little Austrian or German Land, a French *Département*, an Italian Province, Slovenia, a Swiss *Canton, etc.)*.

[16] https://www.google.com/covid19/mobility/.

On its website *Mobility Trends Reports*[17], *Apple* displays results at the scale of an area as large as that of *Google* or of a big city (München, Grenoble, Milano, Zürich etc.).

That gives a rough idea of people's mobility. But there is a bias in this system, because data aren't indexed according to sociodemographic parameters, and there is a gap between a request and the movement actually done (particularly during disruption periods).

The *Osservatorio Conti Pubblici dell'Università Cattolica* of Milan (Observatory of Public Accounting of the Catholic University) used *Apple* and *Google* data in order to produce its analysis of mobility in Europe, which has been released on 10 June 2021[18].

*Moovit*

The Israelian start-up *Moovit*, since recently an Intel subsidiary, aims at helping people choosing their route by all available transport means inside a big city. It can, with the help of track analysis, reconstruct and aggregate route data and infer lines load at a given time and transport modes frequenting. In September 2020, *Moovit* could use the data of 840 million users.

Its statistics have been carefully scrutinized by the authorities during the Covid crisis.

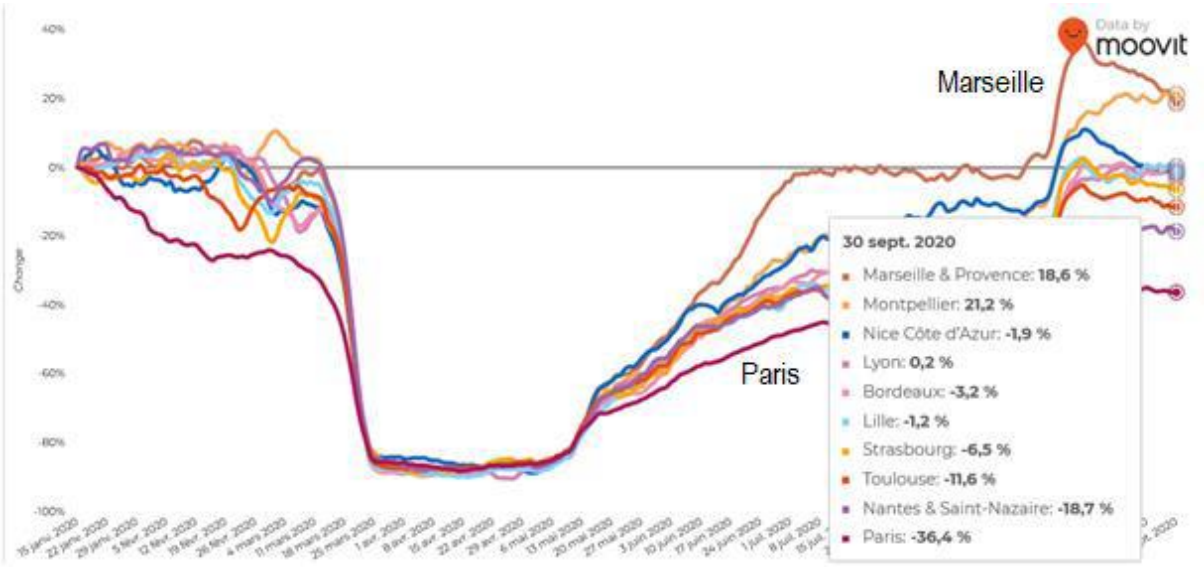


Figure 13: Public transport traffic evolution in 10 big French cities in 2020, source: *Moovit*.

*Kisio*

Unlike *Moovit*, the French *Kisio*, second degree subsidiary of SNCF, buys data to current applications (games, videos, telephone directory, weather forecast, etc.). In this way it can

[17] https://covid19.apple.com/mobility.

[18] https://osservatoriocpi.unicatt.it/ocpi-pubblicazioni-segnali-positivi-sulla-ripresa-dai-dati-apple-e-google-sulla-mobilita.

more easily sort out representative cross-sections. So, it gains a vision of lines load and transport means on one point and in one given place.

Passenger's trip time calculation could be one of the by-products of these applications. But it's a sensible parameter. The last surveys carried out in the big cities showed a quite rough growth of the citizens' movement time budget during last years, that was probably unintentional, but that asks questions on the functional organization of the city.

*Kisio* has opened with the Laboratory on Transport of the Parisian *Ecole des Ponts* (School of Civil Engineering) aiming at cooperate on smartphone tracks exploitation. This work could reveal "individuals' species" and "usage profiles" per individual on a day scale.

### iv) Collaborative smartphones movements tracking by satellite

*MOBIS-COVID19 (Switzerland): tracking by Catch-My-Day App*

The *MOBIS-COVID19* project lead by the *Eidgenossische Technische Hochschule Zürich* (ETHZ, Swiss Federal Institute of Technology in Zurich) and the Basel University (WWZ) leans on the tracking, since March 2020, of a population of 3,700 volunteers, who have been recruited in September 2019 before the pandemic outbreak for mobility tracking purpose. It uses the application *Catch-my-Day*[19] based on the *Motion Tag*[20] GPS technology and put on smartphone. In one and half year, from early 2020 to 9 August 2021, 1,300,000 movements had been recorded, for an average population of 662 volunteers, that is to say 3.6 movements per day.

This study raised some methodological questions: first of them, that of the cross-section size, that fluctuated from 500 persons in Autumn 2020 to more than 1,000 one year afterwards, and which urban zones seem to be overrepresented, what raises the question if the cross-section had been previously rectified; then, that of movements outside of the Swiss borders, that are followed, but not taken in account in the report; then, that of the criteria used for the selection of the initial panel, that took only individuals taking their car at least three times a week, condition that has been abandoned for the last recruits; finally, that evident question if individual have activated the application or not.

Movements are followed according to route (then, movement length) and time (then, duration). Analysis is made according to sex, age, travel mode, weather (considering that some modes aren't popular by rainy weather) and motive, as estimated from the declaration by individuals of their principal destination.

[19] *Catch-my-Day* App has been developed by the Swiss company *MotionTag GmbH*. It's available on smartphones. It aims at helping people to have an overview of their own daily mobility.

[20] *Motion Tag* is a German company born 2015.It can be used as an undercoat by mobility service apps providing multimodal information.

This survey led to some conclusions:

- Mobility reduction during confinement time is far less important in Geneva than elsewhere;
- The duration and length of ride grows very significantly for men during confinement time, significantly for commuters (+40% on fine days), even more for leisure (+60 to 80%).

*Mobilitäts-monitoring COVID-19 (Switzerland): GPS tracking by Footprints Research App*

The *Mobilitäts-Monitoring COVID-19*, or *Panel Intervista*, is managed by the research institute *Intervista AG*, on behalf of several institutions: *Statistisches Amt des Kantons Zürich* (Zurich Canton Statistics Bureau), Swiss National COVID-19 Science Task Force, *Konjunkturforschungsstelle der ETHZ* (KOF, Research Team of the Swiss Federal Institute of Technology in Zurich). 2,561people on average are followed in their movements, thanks to the application *Footprints Research*[21] that relies on *Google* tracks. Its panel has been selected in 2018. It was mobilized during pandemic.

It analyses according to sex, age, sociodemographic profile, reason (as estimated from the declaration by individuals of their principal destination) and residence.

The survey raises some methodological questions: first of them, that of the cross-section representativeness, considering that people under 15 or over 79 and people without smartphones don't belong to it; then, that of travels by plane or outside of the Swiss borders, that aren't taken in account in the report; finally, that about the fact that individual must have activated the application.

### v) Synthesis

The table below synthetizes the ways of computing daily traffic in the towns.

[21] The *Footprints Research* App has been developed by the Swiss company *Axinova AG*. It's managed by *Intervista AG*. It aims at providing a basis for market research.

| Technique | Author | Advantages | Disadvantages |
|---|---|---|---|
| 4-steps model | Modus, Antonin, Global, Ares, etc. | Dimensioning of infrastructures and services to be built<br>scenarios assessing | Unfit to crisis contexts |
| Opinion poll | Harris, etc. | Brings in light short-term tendencies | Qualitative<br>blind concerning long term issues |
| Collaborative platform | RATP, etc. | Real time traffic vision | Poor reliability due to lack of data |
| Ticketing | Transport service owner | Quasi real time | Route allocation impossible (cf. metro)<br>underestimation of traffic (boarding on the bus without validating) |
| Manual counting | Transport service owner | | Low precision<br>measure only charge at a given point, doesn't take in account profiles and motives |
| Automatic counting | Thetis… | Exhaustive counting<br>allocation on the route segment | Vehicles equipment cost |
| Wi-fi tracking | Kisio… | Precise location including in uncovered area (metro) | Vehicles equipment cost |
| Radio relay tracking | Phone companies | Districts and towns frequenting assessment<br>motive intuition (work…)<br>knows passenger's profile | Imprecise location: can't take in account little trips, route allocation impossible |
| Satellite tracking | Google, Apple, Moovit, Kisio… | Precise location: route allocation possible, vision of modal choice<br>intuition of motive (work…) through time series exploitation | Ignores passenger's profile<br>sampling bias |

**RECOMMENDATION:**

**(To national and local authorities): organize permanent commuters' mobility tracking in order to identify and anticipate long-term behavioural trends.**

## 5. IS IT POSSIBLE TO SHAPE LONG TERM BEHAVIOURAL CHANGES?

The pandemic outburst created a true shock in public opinion. People discovered other ways of life and communication.

In Italy, a poll carried out by *Groupama Assicurazioni* (10 May 2021) shows that 53% of interviewees would be ready to change their way of moving. But on the short-term they remain dependent on their usual transport means, that is for 90% their private car.

The *Swiss Re* prospective paper (10 December 2020) identifies five behavioural changes to be followed-up, concerning:

- Digital tools for all-day life and work;
- Mobility (teleworking, relative distrust of public transport);
- Consumption (e-commerce: in China, online orders on *Alibaba* websites gained 220% between February 2019 and February 2020; local products demand);
- Health and hygiene;
- Interindividual relationships (wedding, divorce, etc.).

Some of these address lifestyles, which will inevitably impact the job of insurances.

The *McKinsey* report, *The future of work after COVID-19* (18 February 2021), estimates that 20 to 25% of advanced economies workers could in the long run work at least three days a week at home, and reveals, from its survey on business leaders in August 2020, that they think of reducing their office surface by 30%. The same survey assesses that 25% of the active population could be faced with the necessity of changing job in the mid-term, whose impact on mobility would be negative. Moreover, it estimates that business trips could durably drop by 20%, provided that even if such trips represent a small share of plane trips (20%), they are for the companies an essential financial resource.

A report released by the chair *Pégase* in Montpellier (June 2021) estimates that the drop of business trips could by much stronger, by 38%.

### i) Work, purchasing, daily mobility: people are less bound to fixed meeting points

The Covid pandemic let most of blue collars realize that they can now carry out their professional tasks elsewhere than in the office. Not all workers of course can do it as easily: those who have to work in contact with the public, those who work at goods production or transport, for instance, cannot as easily leave their work place. Such a distortion between those who can protect themselves and those who have to stay endangered in contact with other people could be considered by the latter, who often are the least regarded in the hierarchy of the company, as unfair, and thus make social dialogue harder.

New jobs did literally explode, such as e-commerce and quick delivery. Their agents often work for big companies, but under a freelance status. In France, these "little jobs", the number of which had already tripled between 2017 and 2019[22], were very much recruited during the pandemic. During the 60s, the Saturday pilgrimage to the hypermarket was regarded by the consumer as the top of the week. But the grandchildren of those consumers now stay at home, expecting their pizza delivery. If one considers the ecological impact of such changes, one has to dread a strong regression.

It remains a positive point, meaning in a henceforth constrained framework, the inevitable professional meetings had to invent other meeting places than the office.

### ii) The pursuit for privacy

Fearing contamination, a large number of citizens gave up frequenting too crowded places such as town centres and public transport means. Some of them chose to move away from the city they worked in. This phenomenon isn't yet perceptible, considering real estate prices or big cities demography. But it's already visible in outlying small cities and villages, that have to meet a real estate boom and a related and unexpected leap in prices. Some statistics even clearly show it, such as that of school children, whose number dropped rapidly (-6,000 in one year in Paris). This trend, which could be expected long-lasting, is fuelling urban sprawl and car mobility that public bodies try otherwise to master. That's an actual challenge for them. Mobility authorities are confronted with the necessity of completely rethink their service schemes, that are historically structured by big radial backbone lines channelling suburbs to town centre, to reach the clientele living in far suburbs.

### iii) A seamless mobility

Lastly, there is a need of interoperability of urban transport supply solutions. Traditionally indeed, the mobility authority conceded to a unique operator the public transport network exploitation on its whole area, which is not possible any more. On one hand, far suburbs railway service has gained a big weight due to the geographical extension of towns. But they aren't run by the same operator as urban transport. On the other hand, the new mobility supply is exploding: new taxis, carpooling, car sharing, and electrified or active micro mobilities (free-floating or non-bike rentals, e-scooter, etc.).

Under these conditions, it's important for user to easily link vehicles supplied by different operators. That's what's called "seamless mobility". The first condition in this particular case is providing the user with an adequate information, answering the simple question: how to best travel from a point A to a point B? This information today is delivered by

[22] Rapport 2020 de l'Observatoire prospectif des métiers et des qualifications dans les transports et la logistique (Prospective Observatory of jobs and skills in the Transport and Logistics sector), November 2020.

aggregators exploiting data provided to their clients by the operators. The most prominent are private companies, like *Google*, *Apple* or *Moovit*. But mobility authorities themselves can, on their competence area and upon agreement of private operators, deliver the same information. Going further, this seamless mobility could gain in relying on a unique pricing. That's what began to do the three bis Swiss-Alemannic cities of Bern, Basel and Zürich, by contract between the Federal Railways, their urban public transport operators and some private operators.

## 6. SOME PATHS FOR MASTERING THE PHENOMENA

Will this pandemic leave behind its footprints in our children daily life and in the organization of cities? There's probably no evidence yet, it's a bit too early to assert it. The scientific observation of behaviours isn't yet structured enough in order to draw a forecast. Short term trends are at least ambiguous. They let foresee a strong increase, almost an exacerbation, and not a slowing, of mobility. The examples of e-commerce delivery and the flight of teleworkers towards remote small towns, far from their workplaces, obviously reveal trends towards the growth of mobility. The users' distrust for public transport means, which can be observed in all Alpine countries, shows a shift in favour of private car that counters the policies adopted by the authorities. Even investments made by towns in order to favour soft mobility after recovery from the sanitary crisis didn't always convince the public. So, the *DENA* inquiry (9 December 2020) revealed a shared feeling on the opportunity of the so-called *corona bike lanes* (*pop-up Radwege*), provided the crisis were over. It would be interesting to launch a new poll in order to see if the balance still weighs that way.

How could we cope with this maybe basic trends? How could they be combined with the ever-sharper requirements of sustainable development and public health? Here below some orientations are considered.

### i) Fostering coworking solutions

A first orientation concerns teleworking. The Covid pandemic outburst suddenly made commuters "teleworkers", though this new form of relationship between worker, employer and job hadn't been previously defined. In fact, before then the teleworker was a member of staff who had to do his office job at home in front of its computer. One could notice that if the best equipped among them could rather comfortably succeed in this endeavour, that wasn't as easy for those who had to manage in a single narrow space a job and a family, being deprived of the stimulating contact with their colleagues. Managers themselves did painfully adapt their methods, provided the difficulty of managing a so scattered team.

But in fact, teleworking is a quite old notion: most of senior executives spend a lot of time in meetings, interviews or journeys and spend only a short time at the office. And an important part of their work can be achieved quite comfortably outside of the office.

Coworking allows to optimize remote working managerial efficiency. In consists in providing the employees with a possibility of working in a shared office close to their home. Thus, teleworkers don't sit anymore alone in front of their computer screen, but they are member of a new work collective, and benefit from facilities such as office equipment, restoration, parking, etc.. Their one-day colleagues may not be the same the day after but they are not alone any more. Well organized coworking allows companies

to reduce office surface and office costs: many companies are by now considering such solutions.

An example of coworking facility has been illustrated in the report Reduction of mobility demand and shift to environmentally sustainable modes strategies and measures in the Alps[23]. It's that of miaEngiadina. "*MiaEngiadina is an association that merges together four organisations that offer mountain co-working spaces located in Scuol and Ftan right behind the Flüela Pass in the Swiss Alps. Together they offer 60 workplaces which offers good possibilities for local and new people to interact right there in the Engadin valley.*[24]" That report in particular recommends employers to "provide teleworking places e.g., in tele-houses for people who have no suitable home-office space".

The coworking supply develops quite quickly, in private employers, but also, especially in rural zones, on local authorities' initiative. Having already invested in a public health house or a start-up incubator, a small town can likewise create a coworking space for those of its (new) citizens, who could go to the office only a few days a week.

**RECOMMENDATION:**

**Facilitate coworking practices in residential areas away from big cities.**

### ii) Better organizing teleworking from home

Even if coworking develops, it remains that an important part of remote working will be done from home. Thus, employers and employees have to think about the best ways of organizing work from home.

In the far past, when journeys were long and tiring, people met for several days and combined their meeting with some recreational activities. In the future, one may forecast that the workplace could become the place for regular meetings of the work team and better scheduled work or conviviality time.

**RECOMMENDATION:**

**Better organize teleworking from home.**

[23] https://www.alpconv.org/fileadmin/user_upload/Organization/TWB/Transport/Transport_Annex2_AT-CH_Reduction-of-mobility-demand.pdf.

[24] www.miaengiadina.ch/mountain-coworking.

### iii) Coordinate work schedules and favour soft modes in order to lower peak-hour

Concerning big cities commuters, the problem remains that of the peak-hour. We've seen above how essential it is to try to lower peak-hour intensity. That way one could hope to let the same traffic flow in quite comfortable conditions. If the employers who can, accepted a certain flexibility, for example by allowing their staff shifted schedules, or special teleworking slots at the beginning or at the end of the day, one may forecast a substantial improvement of public transport conditions. At this price, one may forecast a progressive come-back of clientele in the public transport.

At the same time, it's essential to promote the use of soft modes by citizens.. There is of course no way to forbid the use of private transport means (mostly the car) to citizens, especially those living in suburbs, the elderly or the persons with disabilities.. The question is how to provide them, with attractive mobility solutions. There are numerous solutions, such as:

- Extension of bus services towards the far suburbs;
- Creation of secured ways and parking places for cars, bikes and personal moving vehicles to and in front of train stations in the suburbs in order to allow their residents to reach the neighbouring town in better conditions;
- Creation of relay car parks at the doors of big cities;
- Foster carpooling services between town and neighbouring rural areas;
- Etc.

If the local mobility authorities know how to provide people, insiders as well as outsiders, with an attractive service, it can notably reduce the impact of downtown traffic.

**RECOMMENDATION:**

- **(to employers, with the help of local authorities): ease work slots in order to lower peak-hour.**
- **(to local authorities): try to provide all their citizens and guests with solutions easing resorting to soft modes.**

### iv) Rethink point-to-point passenger transport logistic chain in the suburbs in the *MaaS* spirit

Due to the widening of the urban infrastructure, a single transport operator won't be able to provide transport supply on the area of a big city and its hinterland. Movements at that scale already use, from the longest to the shortest trip, train (or car), metro, tramway, bus, personal moving engine (bike, scooter…), and walking. But what interests the traveller is

first to know before leaving what sort of transport modes he'll have to take successively in order to reach his destination as well as possible.

This question is that of *Mobility as a service* (MaaS).

A growing number of mobility authorities deal with public and private operators that serve them in order to supply user with applications computing the optimal itinerary, combining all of the possible means: walking to the nearest train station, then metro, taxi or free-floating bike, etc. Some big private aggregators also supply with such services, but only concerning the operators they have agreements with. Thus, there is room for local authorities for improving traveller's information. One can consider this service as mostly strategic, in terms of digital sovereignty.

Going one step further, one may expect a deepening of the efforts towards the standardization of ticketing, allowing users to buy a single ticket, or subscribing a single abonnement, which enables them to take various transport modes run by different independent operators. Such formulae already exist but remain partial: for instance, the mutualization between train and bus in the three big Swiss-Alemannic cities, or the *OùRA* card in the Auvergne Rhône Alpes region, which combines all the abonnements to the various urban and interurban public transport means of this broad region.

**RECOMMENDATION:**

**(to local authorities): improve traveller's information and work towards the pricing and ticketing harmonization in the spirit of MaaS.**

### v) A more efficient urban logistics backing local economy

Provided e-commerce proved itself useful to numerous citizens during mobility restrictions time, it could be the solution for them, rather than traditional retail trade, in the future.

In Germany, *BVMW* estimates a 40 bil. €/year loss of turnover in city trade and the closedown of 50,000 shops.

Local authorities will have to confront these new actors of logistics to prevent urban spaces to be overrun by their vehicles and storage places. Quick delivery, which highly consumes space and natural resources, has to be strictly supervised. Building collective storage places networks will be a solution: deposit places put in passage places partner stores, locker sets on buildings ground floor, H24 open rooms at post office are examples in this direction.

Urban logistics needs to contribute to local economy, and not disturb it. As regards this phenomenon, local authorities' responsibility is crucial.

**RECOMMENDATION:**

**(to local authorities): pay attention to industrial productivity progress of B2C distribution by the new channels deriving from e-commerce to respect urban space.**

### vi) Town and village planning: for a more desirable living environment

Real estate prices have been for a long time a secondary parameter in citizens' residential choices. Thus, although inside a city the price gap can be considerable, urban sprawl, though visible for almost half a century, didn't yet prevent downtown estates from remaining a safe investment.

On the three maps below, showing the real estate distribution in the agglomeration of Geneva, one can see that, though the canton never offers – on average – flats cheaper than 7,000 CHF/m² and sales are done essentially in the heart of the agglomeration where average prices are over 10,000 CHF/m², surrounding French cities and villages don't anymore offer flats over 5,000 €/m².

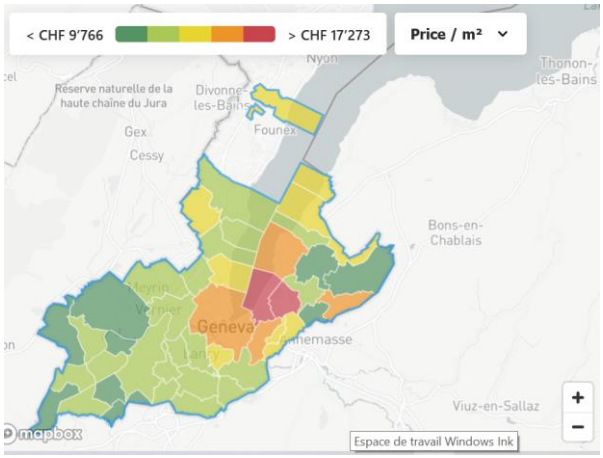


Figure 14: Real estate prices (CFH/m²) in the Canton of Geneva, 29 November 2021.

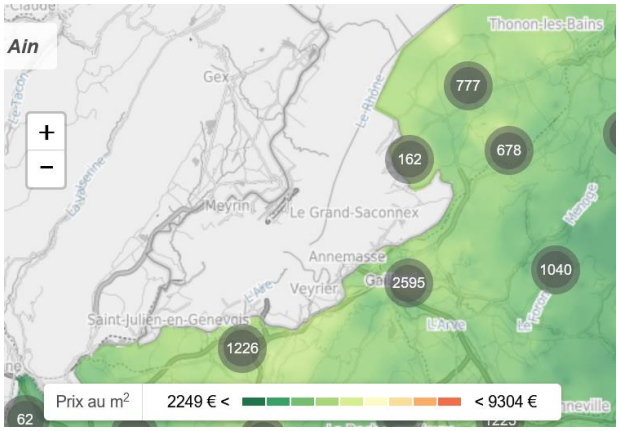


Figure 15: Flats prices (€/m²) in the French Geneva suburbs, 29 November 2021.

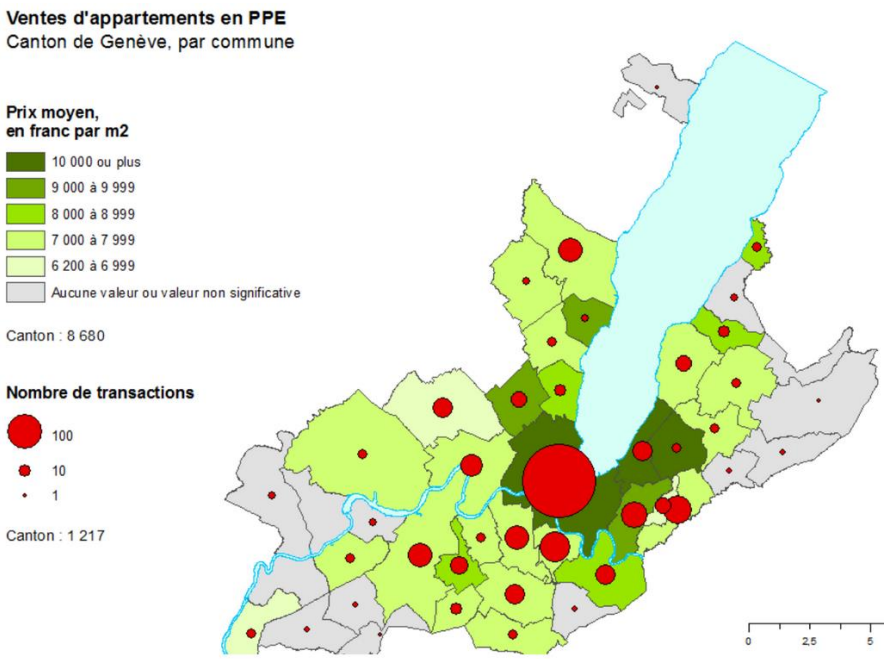


Figure 16: Flats sale (CFH/m²) in the Canton of Geneva in 2021 (source: https://www.estimation-bien-immobilier.ch/evolution-prix-immobilier-geneve-2021/).

Such a gap within a narrow geographical space has been noticed elsewhere, in France or in Italy for example, as one can see on the two maps below. It seems obvious that real estate prices being in a ratio of 1 to 10 between two cities as neighbouring as Mulhouse and Basel, important commuters' flows will arise between them. And though such an example seems to be extreme, big gaps exist too within each of the Alpine states.

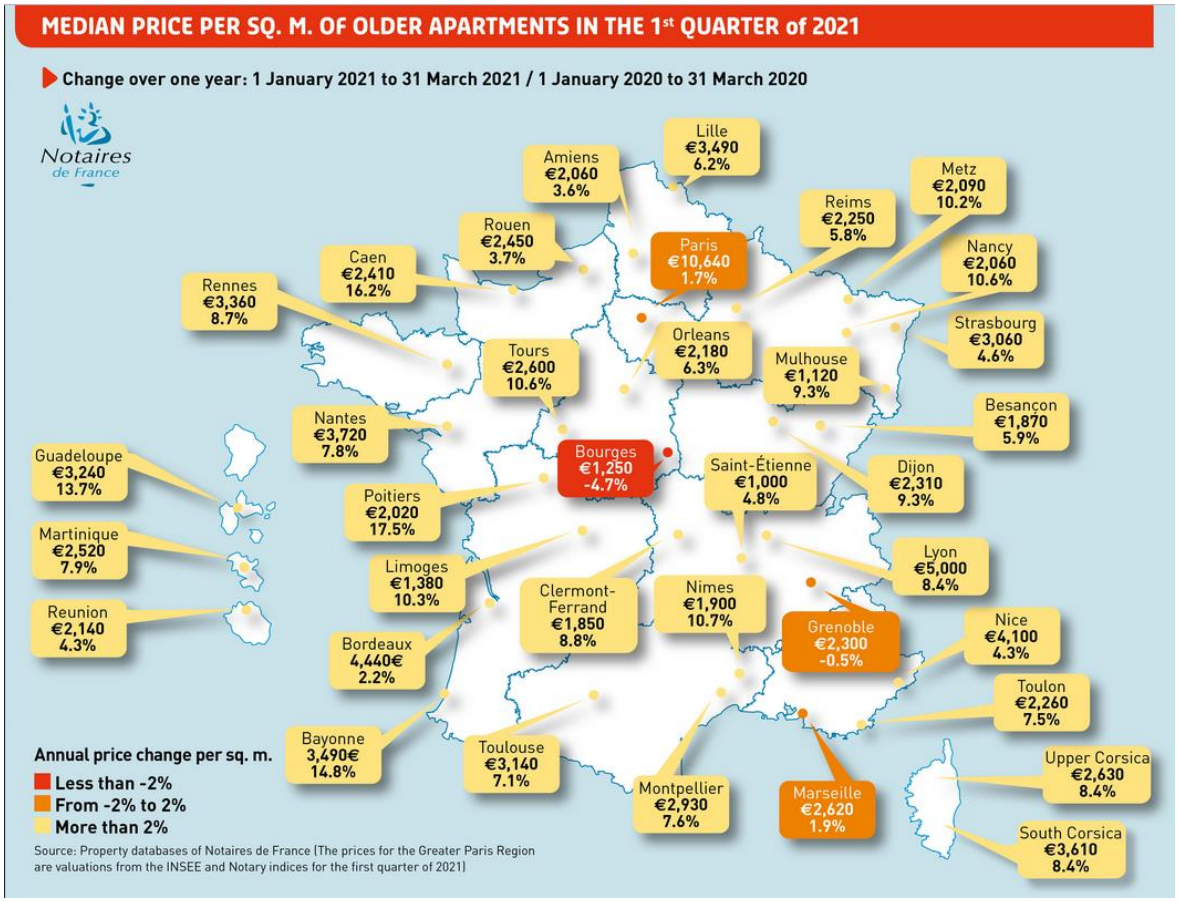


Figure 17: Median price (€/m²) of older apartments in the first term of 2021 in France, source: *Notaires de France* (French notaries), https://www.notaires.fr/multimedia/NCI/NCI_UK_52_prices_old_appartment.jpg

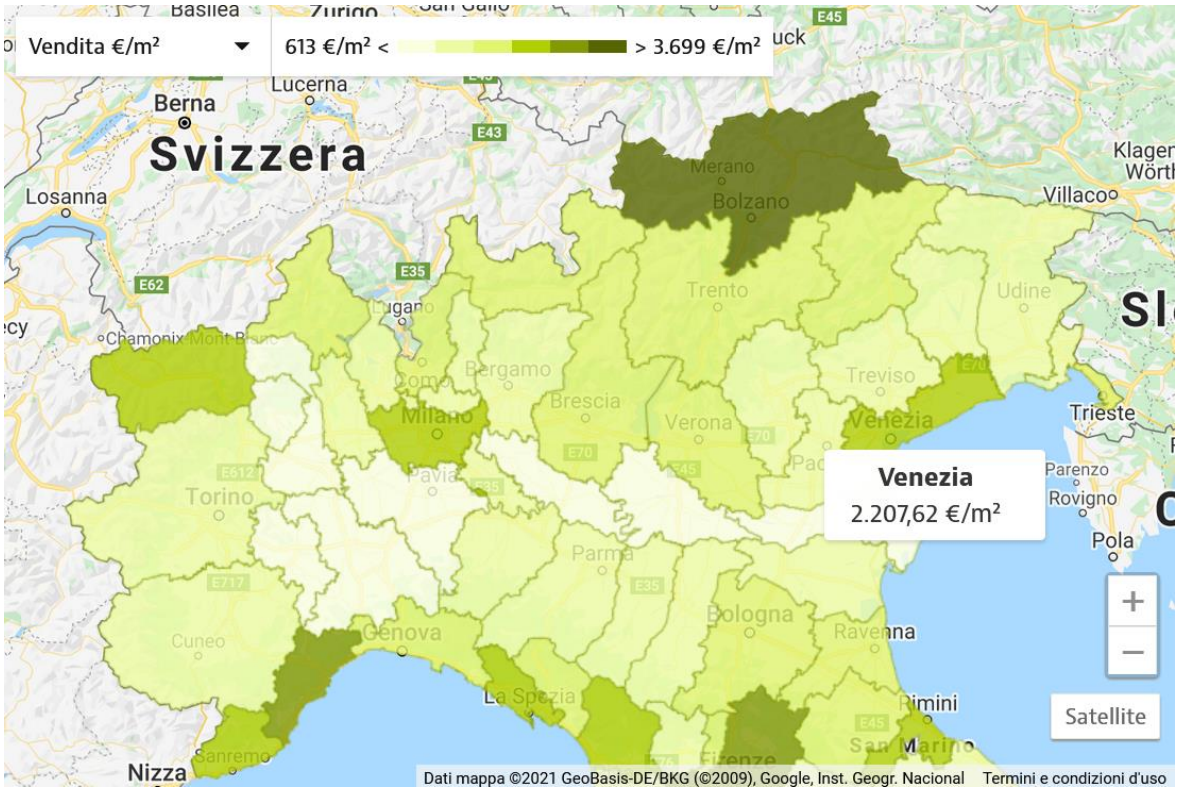


Figure 18: Real estate sale (€/m²) in Northern Italy in 2021, source: https://www.idealista.it/maps/

Nevertheless, it seems that the Covid crisis already begun changing people's attitudes. Square meter flat price for five years in France grew quicker than that of detached house: the two curves suddenly crossed in 2021. It's too early to assess if, what seems a flight from the big city, is purely cyclical or a long-lasting phenomenon. But nevertheless, this trend should probably be confirmed in the future, considering that big chuncks of population showed their weakness during the pandemic time.

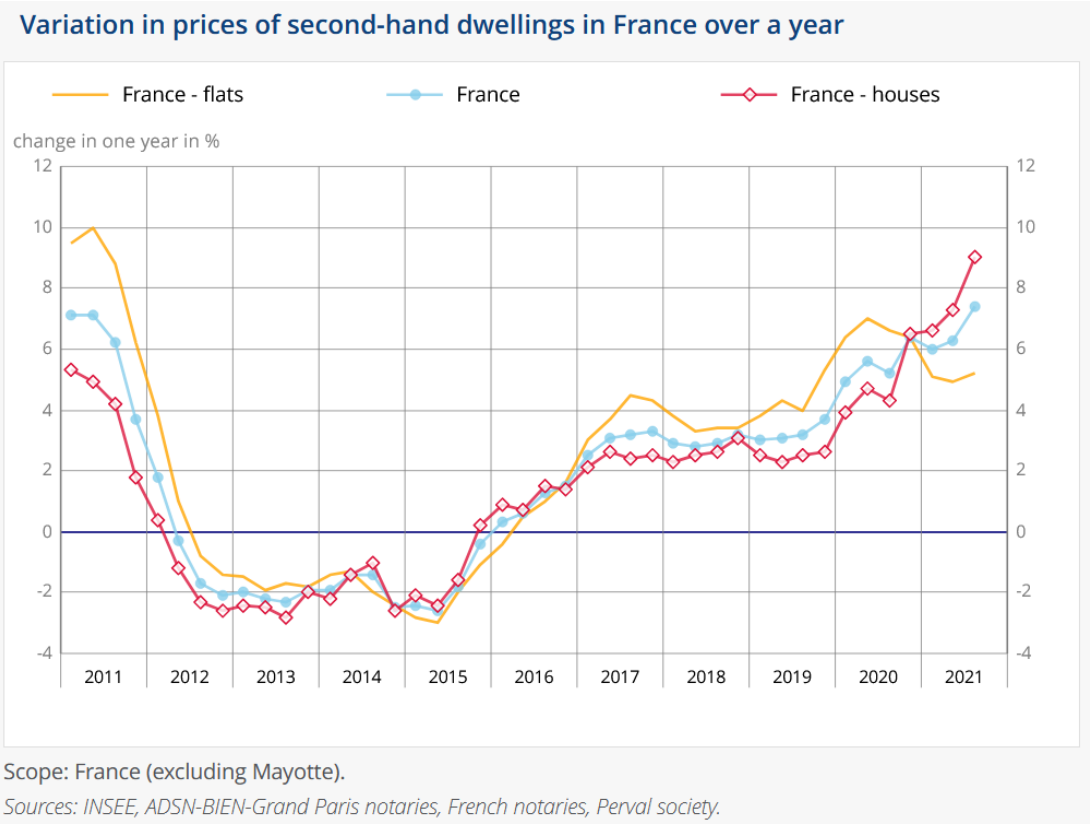


Figure 19: Variation in prices of second-hand dwellings in France over a year, source: https://www.insee.fr/en/statistiques/5892813

In Switzerland, such a trend had been already noticed before Covid pandemic outburst, as can be seen on following chart. It's sure that the trend of demand orientation towards greener zones became stronger since then.

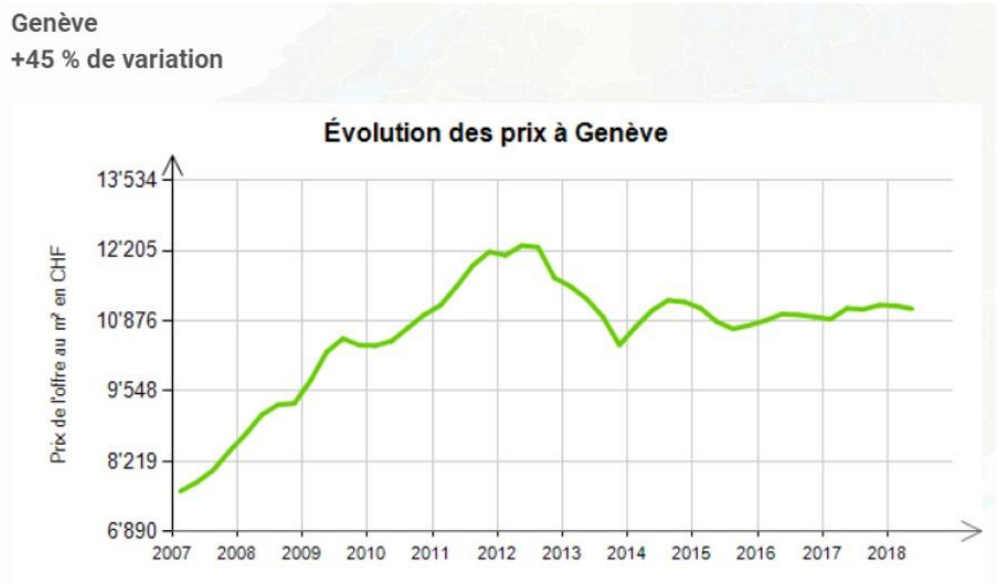


Figure 20: Real estate prices (CHF/m²) evolution in the Canton of Geneva since 2007, source: https://www.estimation-bien-immobilier.ch/evolution-prix-m2-immobilier-geneve-2020/

What can be done to ensure the attractiveness and soft power of historical cities? In Germany, *BVMW* calls to build greener cities, more open, open to all transport means, refusing the "ban and taxation culture". The report *Reduction of mobility demand* of the Transport Working Group of the Alpine Convention underlines that "a possible consequence of Covid-19 is that also space-saving buildings for more families should provide private green, e.g., on terraces", and thus recommends that city planners "consider this requirement by greening existing buildings, development of new building forms and support the implementation by planning laws".

Nevertheless, it will be necessary to organize daily mobility at an ever bigger urban level, including a vast hinterland. Under these conditions, providing a performant frequent service between city centre and hinterland and making last mile service linked to this service easier will be essential.

**RECOMMENDATION:**

**(to local authorities): provide amenities at the heart of town. Organize backbone service linking it to its hinterland, and not forget easing last-mile service there and linkage with the backbone network.**

## 7. CONCLUSIONS AND RECOMMENDATIONS

The approach suggested herein intends to draft guidelines for a closer follow-up of quickly and unpredictably changing behaviour patterns after the sanitary crisis and mastering traffic troubles occurring because of these changes.

This report proposes seven recommendations to this purpose, listed once again here below:

**RECOMMENDATIONS**:

- **(To national and local authorities): organize permanent commuters' mobility tracking in order to identify and anticipate long-term behavioural trends.**
- **Facilitate coworking practices in residential areas away from big cities.**
- **Better organize teleworking from home.**
- **(To employers, with the help of local authorities): ease work slots in order to lower peak-hour; (to local authorities): try to provide all their citizens and guests with solutions easing resorting to soft modes.**
- **(To local authorities): improve traveller's information and work towards pricing and ticketing harmonization in the spirit of MaaS.**
- **(To local authorities): pay attention to industrial productivity progress of B2C distribution by the new channels deriving from e-commerce to respect urban space.**
- **(To local authorities): provide amenities at the heart of town. Organize backbone service linking it to its hinterland, and not forget easing last-mile service there and linkage with the backbone network.**

It's obvious that all of them don't aim at the Alpine Convention itself, but at relevant institutions and bodies, Alpine Convention member States are members of.

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# 9. ANNEX: WHAT COULD BE OBSERVED DURING THE PANDEMIC OUTBURST IN THE USA

### No urban exodus, but an escape to the green and cheap suburbs

The question of citizen drain has prompted a hot debate in the United States of America. Newspapers emphasized that the pandemic outbreak exacerbated population fears concerning its safety, that had been brought back after violent events such as George Floyd's murder. Thus, there was a hot debate on sanitary lack of safety in big cities and a possible urban exodus. In practice, departure flows from urban neighbourhoods, as defined according to a population density over 2,700 inhabitants per square kilometre (Europe rather would put the threshold at 4,000), doubled during the pandemic, from 28,000 p/month to 56,000 in the whole country. New-York City and San Francisco were the most impacted cities, more than Chicago and Seattle. Thus, New-York lost 90 net departures per 100,000 inhabitants per month. According to a *World Built Environment Forum* – WBEF (13 July 2021), some American Cities could have lost more than 15% of their population since the pandemic outbreak. According to *Bloomberg* (26 April 2021), resumed by WBEF, 84% of moves from New-York and 79% of those from San Francisco were in fact in order to settle in their far suburbs, what contributes to hollow out the heart of the city. That phenomenon had been called "*donut effect*". In fact, there is no actual urban exodus, except maybe in New-York and San Francisco.

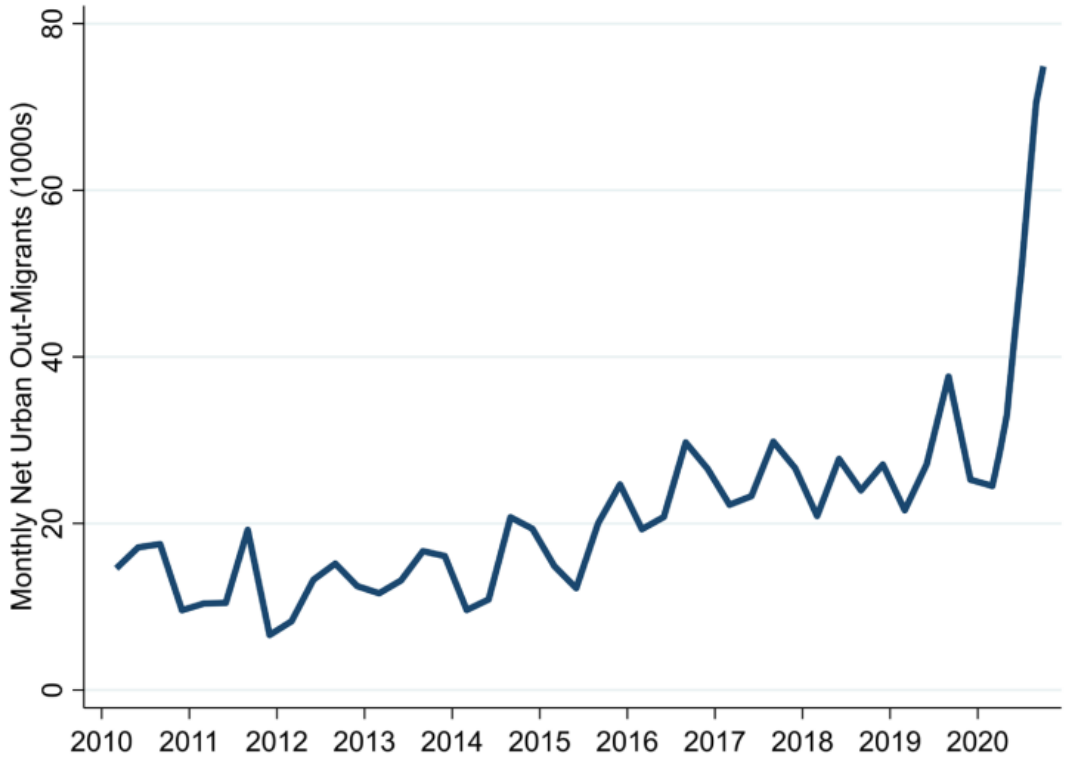


Figure 21: Monthly net out-migrants in the United States from 2010 to 2020, source: *Federal Reserve Bank of New York / Equifax Consumer Credit Panel, American Community Survey*

### Moves tracking by post addresses

In order to follow long-term movement of population, the *Postal Office* database may be fruitful. It enables to follow movements and thus indicates where people intend to live.

Such a survey has been carried out in the United States of America. Home address can be there followed from two sources:

- The *Federal Reserve Bank of New York, Equifax Consumer Credit Panel* (CCP) consumer credit database, that holds an anonymous cross-section of 5% among American population holding a consumer credit, given the fact that 90% of Americans have subscribed one. Thus, this data base may be considered as representative. Lenders give each month to *Equifax* their borrowers' postal address;
- The *US Postal Office* database of addresses, that notices every change of address