Annual Report 2023

New measures to support the Combined Scenario:
Capacity management & regional support for zero-emission HGV

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iMONITRAF! Annual Report 2023

New measures to support the Combined Scenarios: Capacity management & regional support for zero-emission HGV

INFRAS / Climonomics / Eurac Research with inputs of iMONITRAF! partners

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CONTENT

The iMONITRAF! year 2023 at a glance

iMONITRAF! network – Common voice and thematic hub on transalpine freight traffic

Since its launch in 2005, the Alpine regions have developed iMONITRAF! as central hub for all aspects related to transalpine freight transport. Thanks to the continuous development of the common monitoring system as well as the broad knowledge pool on modal shift measures and related policies, iMONITRAF! has established itself as common voice for the Alpine regions along the major transit corridors and has become an important partner for stakeholders at both national and European level.

As transport volumes are projected to further increase in the coming years and as there is a related need to better manage both road and rail infrastructures in a joint approach, the Alpine regions are challenged to strengthen their cooperation and to closely exchange experiences and insights. Not only modal shift measures but also the support to decarbonise road freight transport should be developed in a coordinated way to ensure that incentives become effective on all Alpine corridors and that distributional impacts are avoided. In this respect, iMONITRAF! can build also on its strong political voice by bringing together political decision makers to discuss relevant challenges and solutions.

Capacity management as a new element of the iMONITRAF! pathway

The iMONITRAF! policy pathway includes steering instruments as well as capacity management/reservation systems as back-up elements if traffic volumes on the Alpine corridors remain high. In 2022, impulses from the major iMONITRAF! corridors Brenner and Gotthard have initiated a debate around new capacity management instruments, especially the future role of slot systems for better managing traffic volumes on the Alpine corridors. To support the discussions at corridor level, iMONITRAF! has developed policy suggestions on capacity management in 2023 to ensure a comprehensive view on the topic and to guarantee that any new measure supports the Combined iMONITRAF! scenario (modal shift and fleet improvement). The suggestions are based on an overview on existing measures and initiatives that have a link to capacity management; further a typology of measures and interfaces to the broader policy mix has been elaborated. The suggestions illustrate that capacity management instruments can fulfil multiple objectives if they are designed in a smart and differentiated way.

Regional measures to support the uptake of zero-emission HGV

A second work focus of iMONITRAF! in 2023 was an exchange on regional measures to support the uptake of zero-emission HGV. A fast decarbonisation of the remaining road transport fleet is the second objective of the Combined Scenario and the regions have considerable opportunities to accelerate the uptake of zero-emission vehicles. An exchange on existing regional measures highlights the role of different policy approaches. Both regulatory and pricing measures are applied already throughout the iMONITRAF! regions, e.g. by providing exemptions for zero-emission HGV in the frame of driving bans, by including provisions on charging infrastructures in new spatial planning frameworks or by specific toll rates for electric or hydrogen vehicles. The new provisions of the EU Eurovignette Directive provide the relevant framework for differentiating road tolls according to CO_2-emissions and first Alpine countries as for example Austria and Germany have already implemented this approach. Also, direct subsidies are provided in several iMONITRAF! regions or at national level, supporting both the acquisition of zero-emission HGV and the set-up of relevant charging infrastructures. This also includes seaside connections for charging at the

seaports linked to Alpine freight transport. Industry support and Research & Development is promoted in the frame of pilot projects and demonstration initiatives, e.g. regarding the role of hydrogen for regional transport.

EU level: Towards a comprehensive new framework to support modal shift

Several important initiatives were launched at European level in 2023 to support the ambitious implementation of the European Green Deal in the freight transport sector. Looking at the Policy Pathway of iMONITRAF!, several of the dossiers are highly relevant to iMONITRAF!. The **revision of the TEN-T Regulation** was finalized at the end of 2023 and provides a new framework for governing and further developing the TEN-T infrastructures. The **Greening Freight Package** includes crucial policy instruments and regulatory frameworks to support both modal shift and the decarbonisation of the vehicle fleet.

While the two elements "Regulation on the Use of Railway Infrastructure Capacity" as well as the "CountEmissionsEU Methodology" are generally assessed in a positive way from an iMONITRAF! viewpoint, especially the new proposal for the **Revision of the Weights & Dimensions Directive** includes several critical elements that could, in fact, lead to a reverse modal shift. The proposal foresees a more flexible approach for using European Modular system (=Gigaliners) in cross-border transport and also extends weights limits for Diesel HGV – thus also counteracting other proposals to accelerate the uptake of zero-emission HGV. Also, a new proposal for the **revision of the Combined Transport Directive** was published at the end of 2023, including a complete new definition for Combined Transport, based on externality savings as well as new provision to develop national frameworks for supporting CT. An integrated statement on the Weights & Dimensions and the CT Directive is currently under development.

Monitoring update for the year 2022 – trends are back to pre-pandemic levels

First rebounds of HGV volumes after the effects of the COVID pandemic were already observed in the previous years. For the monitoring year 2022, traffic volumes are now back to the pre-pandemic level and a rising trend. About **24,400 heavy vehicles per day** (HV/day) crossed the seven major transalpine corridors, exceeding the values of the last pre-pandemic year (2019) by 2.4%. Also for light vehicles, the effects of the COVID pandemic are no longer visible as no more travel restrictions were in place throughout 2022. A total of **83,700 light vehicles per day (LV/day)** crossed the Alpine corridors, an increase of nearly 30% compared to 2021 and +2.3% compared to 2019. The analysis of monthly data registers the effects of the third COVID-phase in winter 2022, but after that trends and monthly patterns have fully returned to situation in 2019.

Transported goods on the iMONITRAF! corridors sum up to a total of about 165.8 mio. tons, 110.7 mio. tons by road (67%) and 55.1 mio. tons by rail (33%). The total amount registered in 2022 is roughly similar to 2021 but 4% higher than 2019. Compared to 2021, the modal split road-rail slightly decreased, with -1% at the expense of rail transport. The **annual air pollutant concentrations** of NO_2 show a further decreasing trend: in 2022 the annual average values of NO_2 did not exceed the EU annual limit value of 40 µg/m3 for any stations. However, two stations along the Brenner corridor (Bressanone sud/Brixen Süd and Avio) and one station along the Gotthard (Camignolo) are still very close to that limit. If the new Air Quality limits that are currently discussed at EU level were considered, most of the monitoring stations would exceed the proposed values of 20 µg/m³.

Regarding the **new iMONITRAF! target indicator**, the developments of 2022 need to be assessed in a differentiated way. While developments on the Gotthard corridor remain in line with the target path for modal shift, thanks to the availability of the new rail infrastructures (base tunnel

and 4 meter corridor), the target path on the Brenner has been missed. Regarding the target path for a reduction of HGV volumes, developments both at the Brenner and the Gotthard lie clearly outside the target path as traffic volumes have increased instead of meeting the annual reduction target.

Best Practices 2023 – Making use of new EU frameworks and dealing with emergencies

Based on the relevant European and national frameworks, policy measures were further developed and optimised in all iMONITRAF! regions throughout 2023. In Tyrol, exemptions for regional transport were phased-out in the frame of the existing driving bans and addition efforts were put into the enforcement of relevant regulatory frameworks. Thanks to the new provisions of the revised Eurovignette, HGV tolls were further developed by adding a CO_2-charge in the Austrian and German HGV toll systems – affecting the costs of road transport on the Brenner. On the Gotthard axis, unforeseen challenges came up after an accident of a freight train in August 2023 which led temporary to a full closure of the new railway base tunnel. In a very short timeframe, it was necessary to develop a set of emergency measures which include a priority for freight rail transport in the Base Tunnel and a higher compensation for transalpine CT to offset the negative impacts. Without that accident, the new Swiss report on modal shift shows the overall positive effects of the comprehensive new infrastructures and the 4m corridor and illustrates some potential further developments of the instrument mix. In Région Sud Provence-Alpes-Côte-d'Azur, considerable funding is provided for the extension of CT infrastructures along the Alpine corridors. Regarding passenger transport, the improvement of cross-border mobility remained an important objective in 2023 – especially between the regions along the Brenner corridor.

iMONITRAF! Aktivitäten im Jahr 2023 – Das Wichtigste in Kürze

iMONITRAF! - Gemeinsame Stimme & Themen-Hub zum alpenquerenden Güterverkehr

Seit Projektbeginn im Jahr 2005 haben die Alpenregionen iMONITRAF! zu einer zentralen Plattform für alle Aspekte des alpenquerenden Güterverkehrs entwickelt. Dank der kontinuierlichen Weiterentwicklung des gemeinsamen Monitoringsystems sowie des breiten Wissenspools zu Verlagerungsmaßnahmen und - politiken hat sich iMONITRAF! als gemeinsame Stimme für die Alpenregionen entlang der wichtigsten Transitkorridore etabliert und ist zu einem wichtigen Partner für Akteure auf nationaler und europäischer Ebene geworden.

Das für die kommenden Jahre prognostizierte Verkehrswachstum stellt die Alpenregionen vor die Herausforderung ihre Zusammenarbeit zu stärken und Erfahrungen und Einblicke noch enger auszutauschen. Nur so kann eine optimierte Nutzung der begrenzen Kapazitäten auf Straße und Schiene gesichert werden. Nicht nur Maßnahmen zur Verkehrsverlagerung sondern auch die Dekarbonisierung des Straßengüterverkehrs sollten koordiniert entwickelt werden, damit Anreize auf allen Alpenkorridoren wirksam und Verteilungseffekte vermieden werden. In dieser Hinsicht kann iMONITRAF! auch auf seine starke politische Stimme bauen, indem es politische Entscheidungsträger zur Diskussion gemeinsamer Herausforderungen und Lösungsansätze zusammenbringt.

Kapazitätsmanagement als neues Element des iMONITRAF!-Pathways

Der iMONITRAF! Policy Pathway (Politikpfad) beinhaltet sowohl Lenkungsinstrumente als auch Kapazitätsmanagement-/Reservierungssysteme als Back-up Strategie für den Fall dass das Verkehrsaufkommen auf den Alpenkorridoren weiterhin steigt. Im Jahr 2022 wurde sowohl am Brenner als auch am Gotthard-Korridor eine Debatte über neue Kapazitätsmanagement-Instrumente angestoßen. Im Vordergrund stand dabei die künftige Rolle von Slot-Systemen zur besseren Steuerung des Verkehrsaufkommens auf den Alpenkorridoren. Um die Diskussionen auf Korridorebene zu unterstützen, hat iMONITRAF! im Jahr 2023 Empfehlungen zum Kapazitätsmanagement entwickelt: einerseits soll damit eine umfassende Sicht auf das Thema gewährleistet werden, andererseits soll sichergestellt werden, dass zusätzliche Maßnahmen das kombinierte iMONITRAF! Szenario (Verkehrsverlagerung und Flottenverbesserung) unterstützen. Die Vorschläge basieren auf einem Überblick bestehender Maßnahmen und Initiativen mit Bezug zum Thema Kapazitätsmanagement; außerdem wurde eine Typologie von Maßnahmen und Schnittstellen zum breiteren Policy-Mix erarbeitet. Die Vorschläge verdeutlichen, dass Instrumente des Kapazitätsmanagements bei intelligenter und differenzierter Ausgestaltung mehrere Ziele erfüllen können.

Regionale Maßnahmen zur Förderung des Einsatzes von emissionsfreien Lkw

Ein Austausch zu regionalen Maßnahmen zur Förderung des Umstiegs auf emissionsfreie Lkw war ein zweiter Arbeitsschwerpunkt im Jahr 2023. Eine schnelle Dekarbonisierung der verbleibenden Straßenverkehrsflotte ist das zweite Ziel des kombinierten Szenarios von iMONITRAF! und die Regionen haben beträchtliche Möglichkeiten, um die Einführung von emissionsfreien Fahrzeugen zu beschleunigen. Ein Austausch über bestehende regionale Maßnahmen verdeutlicht die Rolle unterschiedlicher politischer Ansätze. In den iMONITRAF!-Regionen werden bereits sowohl ordnungspolitische als auch finanzielle Anreiz-Maßnahmen angewandt, z. B. durch Ausnahmeregelungen für emissionsfreie Lkw im Rahmen von Fahrverboten, durch die Aufnahme von Bestimmungen über Ladeinfrastrukturen in neue raumplanerische Strategien oder durch spezifische Mautsätze für Elektro- oder Hybridfahrzeuge. Die neuen Bestimmungen der Eurovignet-

ten-Richtlinie bieten den entsprechenden Rahmen für eine Differenzierung der Straßenbenutzungsgebühren nach CO_2-Emissionen, und erste Alpenländer haben diesen Ansatz bereits umgesetzt (Österreich, Deutschland und die Schweiz über die Neuausrichtung der Schweizer Schwerverkehrsabgabe LSVA). Außerdem werden in mehreren iMONITRAF!-Regionen oder auf nationaler Ebene direkte Subventionen gewährt, die sowohl die Anschaffung von emissionsfreien Lkw als auch die Einrichtung der entsprechenden Ladeinfrastruktur unterstützen. Dies umfasst auch die Anbindung der für den alpenquerenden Güterverkehr relevanten Seehäfen an erneuerbare Landstromversorgung. Forschung und Entwicklung, auch im industriellen Kontext, wird im Rahmen von Pilotprojekten und Demonstrationsinitiativen gefördert, z. B. im Hinblick auf die Rolle von Wasserstoff im Regionalverkehr.

EU-Ebene: Auf dem Weg zu einem umfassenden neuen Rahmen zur Verkehrsverlagerung

Im Laufe des Jahres 2023 wurden auf europäischer Ebene mehrere wichtige Initiativen zur ehrgeizigen Umsetzung des Europäischen Grünen Deals im Güterverkehr gestartet. Im Hinblick auf den Policy Pathway sind mehrere dieser Dossiers für iMONITRAF! von großer Bedeutung. Die Überarbeitung der TEN-V-Verordnung wurde Ende 2023 abgeschlossen und setzt nun höhere Anforderungen an die TEN-V-Infrastrukturen. Das „Greening Freight Package“ umfasst wichtige politische Instrumente und rechtliche Rahmenbedingungen um sowohl die Verkehrsverlagerung als auch die Dekarbonisierung der Fahrzeugflotte zu unterstützen.

Während die beiden Elemente "Verordnung über die Nutzung der Kapazität der Eisenbahninfrastruktur" sowie die "CountEmissionsEU-Methode" aus Sicht von iMONITRAF! grundsätzlich positiv zu bewerten sind, enthält insbesondere der neue Vorschlag zur Revision der Richtlinie über Gewichte und Abmessungen mehrere kritische Elemente, die eine Rückverlagerung von der Schiene auf die Straße riskieren. Der Vorschlag sieht einen flexibleren Ansatz für die Verwendung des European Modular Systems (=Gigalinern) im grenzüberschreitenden Verkehr vor und erweitert außerdem die Gewichtsgrenzen für Diesel-LKWs. Diese Elemente wirken auch dem Vorschlag zur Beschleunigung der Einführung von emissionsfreien LKWs entgegen. Außerdem wurde Ende 2023 ein neuer Vorschlag für die Überarbeitung der Richtlinie über den kombinierten Verkehr veröffentlicht, der eine völlig neue Definition für den kombinierten Verkehr auf der Grundlage von externen Kosten sowie neue Bestimmungen zur Entwicklung nationaler Programme für die Förderung des KV enthält. Eine integriertes Statement von iMONITRAF! zur Richtlinie über Gewichte und Abmessungen und zur KV-Richtlinie steht kurz vor der Veröffentlichung.

Monitoring 2022 – Verkehrsentwicklung ist zurück auf dem vor-Pandemie Trend

Der Wiederanstieg des Lkw-Aufkommens nach den Einschränkungen der COVID-Pandemie wurde bereits in den Vorjahren beobachtet. Für das Monitoringjahr 2022 hat das Verkehrsaufkommen nun wieder das Niveau vor der Pandemie erreicht, mit steigender Tendenz. Rund **24.400 schwere Nutzfahrzeuge pro Tag** (Lkw/Tag) querten die sieben großen alpinen Korridore, der Wert aus dem letzten Vorpandemiejahr (2019) wurde somit um 2,4% übertroffen. Auch bei den **leichten Fahrzeugen** sind die Auswirkungen der COVID-Pandemie nicht mehr sichtbar, da es im Jahr 2022 keine Reisebeschränkungen mehr gab. Insgesamt querten 83.700 Leichtfahrzeuge pro Tag (LV/Tag) die Alpenkorridore, was einem Anstieg von fast 30 % gegenüber 2021 und +2,3 % gegenüber 2019 entspricht. Die Analyse der monatlichen Daten zeigt die Auswirkungen der dritten COVID-Welle im Winter 2022, danach kehrten die Trends und monatlichen Muster vollständig zur Situation des Jahres 2019 zurück.

Die auf den iMONITRAF!-Korridoren **transportieren Güter** beliefen sich auf insgesamt rund 165,8 Mio. Tonnen, davon 110,7 Mio. Tonnen auf der Straße (67%) und 55,1 Mio. Tonnen auf

der Schiene (33%). Das Gesamtaufkommen im Jahr 2022 entspricht in etwa dem von 2021, liegt aber 4 % über dem von 2019. Im Vergleich zu 2021 ist der Modalsplit Straße-Schiene leicht zurückgegangen, mit -1% zu Lasten des Schienenverkehrs. Die **jährlichen Luftschadstoffkonzentrationen** von NO_2 zeigen einen weiter sinkenden Trend: 2022 überschreiten die Jahresmittelwerte von NO_2 an keiner Messstation den EU-Jahresgrenzwert von 40 µg/m3, obwohl zwei Stationen entlang des Brennerkorridors (Bressanone sud/Brixen Süd und Avio) und eine Station am Gotthard (Camignolo) noch sehr nahe an diesem Grenzwert liegen. Würden die neuen Luftqualitätsgrenzwerte, die derzeit auf EU-Ebene diskutiert werden, berücksichtigt, würden jedoch die meisten Messstationen die vorgeschlagenen Werte von 20 µg/m³ überschreiten.

Im Hinblick auf die neuen **Zielindikatoren** von iMONITRAF! muss die Entwicklungen im Jahr 2022 differenziert betrachtet werden. Während die Entwicklung auf dem Gotthardkorridor dank der Verfügbarkeit der neuen Bahninfrastrukturen (Basistunnel und 4-Meter-Korridor) mit dem Zielpfad für die Verkehrsverlagerung vereinbar ist, wird der Zielpfad auf dem Brenner verfehlt – statt eines Anstiegs wurde für 2022 ja ein Rückgang im Modal Split Straße-Schiene beobachtet. Was den Zielpfad für die schrittweise Reduktion des Lkw-Aufkommens anbelangt, so liegen die Entwicklungen sowohl am Brenner als auch am Gotthard mit dem Anstieg des Verkehrsvolumens außerhalb des Zielpfads.

Best Practices 2023 - Nutzung der neuen EU-Rahmenbedingungen und Umgang mit unvorhersehbaren Ereignissen

Unter Berücksichtigung der relevanten europäischen und nationalen Rahmenbedingungen wurden die Maßnahmen in allen iMONITRAF!-Regionen auch 2023 weiterentwickelt und optimiert. In Tirol wurden die Ausnahmeregelungen für den Regionalverkehr im Rahmen der bestehenden Fahrverbote schrittweise abgeschafft und zusätzliche Anstrengungen zur Durchsetzung der relevanten rechtlichen Rahmenbedingungen unternommen. Dank der neuen Bestimmungen der überarbeiteten Eurovignette wurde die Lkw-Maut weiterentwickelt, indem eine CO_2-Gebühr in das österreichische und deutsche Lkw-Mautsystem aufgenommen wurde, was sich auf die Kosten des Straßenverkehrs am Brenner auswirkt. Auf der Gotthard-Achse traten nach einem Güterzugsunfall im August 2023 unvorhergesehene Herausforderungen auf, die vorübergehend zu einer Vollsperrung des neuen Eisenbahnbasistunnels führten. In kürzester Zeit musste eine Reihe von Sofortmaßnahmen entwickelt werden, die unter anderem eine Priorität für den Güterverkehr im Basistunnel und eine höhere Subventionierung für den alpenquerenden KV vorsehen, um die negativen Auswirkungen auszugleichen. Wenn man die Folgenden dieses Unfalls ausklammert, zeigt der neue Schweizer Bericht zur Verkehrsverlagerung die insgesamt positiven Auswirkungen der umfassenden neuen Infrastrukturen und des 4m-Korridors auf und veranschaulicht einige potenzielle Weiterentwicklungen des Instrumentenmixes. In der Région Sud Provence-Alpes-Côte-d'Azur werden erhebliche Mittel für den Ausbau der KV-Infrastrukturen entlang der Alpenkorridore bereitgestellt. Im Bereich des Personenverkehrs bleibt die Verbesserung der grenzüberschreitenden Mobilität auch 2023 ein wichtiges Ziel - insbesondere zwischen den Regionen entlang des Brennerkorridors.

iMONITRAF! nel 2023: L'essenziale in breve

Rete iMONITRAF! - Voce comune e hub tematico sul traffico merci transalpino

Sin dal suo lancio nel 2005, le regioni alpine hanno sviluppato iMONITRAF! come hub per tutti gli aspetti legati al trasporto merci transalpino. Grazie al continuo sviluppo del sistema di monitoraggio comune e all'ampio bacino di conoscenze sulle misure di trasferimento modale e sulle relative politiche, iMONITRAF! si è affermato come voce comune per le regioni alpine lungo i principali corridoi di transito ed è diventato un partner importante per gli stakeholder a livello nazionale ed europeo.

Poiché si prevede un ulteriore aumento dei volumi di trasporto nei prossimi anni e la necessità di gestire meglio le infrastrutture stradali e ferroviarie con un approccio congiunto, le regioni alpine sono chiamate a rafforzare la loro cooperazione e a scambiare esperienze e conoscenze. Non solo le misure di trasferimento modale, ma anche il sostegno alla decarbonizzazione del trasporto merci su strada dovrebbero essere sviluppate in modo coordinato, per garantire l'efficacia degli incentivi su tutti i corridoi alpini ed evitare impatti distributivi. A questo proposito, iMONITRAF! può avvalersi anche della sua forte voce politica, riunendo i decisori politici per discutere le sfide e le soluzioni pertinenti.

La gestione della capacità come nuovo elemento del percorso iMONITRAF!

Il percorso politico di iMONITRAF! prevede strumenti di guida e sistemi di gestione/riservazione della capacità come elementi di riserva nel caso in cui i volumi di traffico sui corridoi alpini si mantengano elevati. Nel 2022, gli impulsi provenienti dai principali corridoi iMONITRAF! del Brennero e del Gottardo hanno avviato un dibattito sui nuovi strumenti di gestione della capacità, in particolare sul ruolo futuro dei sistemi di slot per una migliore gestione dei volumi di traffico sui corridoi alpini. Per sostenere le discussioni a livello di corridoio, iMONITRAF! ha elaborato nel 2023 suggerimenti politici sulla gestione della capacità, per assicurare una visione globale dell'argomento e garantire che qualsiasi nuova misura sostenga lo Scenario Combinato iMONITRAF! (trasferimento modale e miglioramento della flotta). I suggerimenti si basano su una panoramica delle misure e delle iniziative esistenti che hanno un legame con la gestione della capacità; è stata inoltre elaborata una tipologia di misure e di interfacce con il più ampio mix di politiche. I suggerimenti mostrano che gli strumenti di gestione della capacità possono soddisfare molteplici obiettivi se progettati in modo intelligente e differenziato.

Misure regionali a sostegno dell'adozione di veicoli pesanti a zero emissioni

Un secondo obiettivo di lavoro di iMONITRAF! nel 2023 è stato lo scambio di informazioni sulle misure regionali per sostenere l'adozione di mezzi pesanti a emissioni zero. Una rapida decarbonizzazione del restante parco veicoli su strada è il secondo obiettivo dello Scenario Combinato e le regioni hanno notevoli possibilità di accelerare l'adozione di veicoli a emissioni zero. Uno scambio di informazioni sulle misure regionali esistenti evidenzia il ruolo dei diversi approcci politici. Sia le misure normative che quelle tariffarie sono già applicate in tutte le regioni iMONITRAF!, ad esempio prevedendo esenzioni per i veicoli pesanti a emissioni zero nell'ambito dei divieti di circolazione, includendo disposizioni sulle infrastrutture di ricarica nei nuovi quadri di pianificazione territoriale o prevedendo tariffe di pedaggio specifiche per i veicoli elettrici o a idrogeno. Le nuove disposizioni della direttiva UE Eurovignette forniscono il quadro di riferimento per differenziare i pedaggi stradali in base alle emissioni di CO_2 e i primi Paesi alpini hanno già attuato questo approccio. Inoltre, in diverse regioni iMONITRAF! o a livello nazionale vengono erogati sussidi diretti per l'acquisto di veicoli pesanti a emissioni zero e per la creazione di infrastrutture di ricarica. Ciò include anche i collegamenti marittimi per la ricarica presso i porti collegati al trasporto

merci alpino. Il sostegno all'industria e alla ricerca e sviluppo viene promosso nell'ambito di progetti pilota e iniziative dimostrative, ad esempio per quanto riguarda il ruolo dell'idrogeno nel trasporto regionale.

A livello UE: Verso un nuovo quadro globale per sostenere il trasferimento modale

Nel 2023 sono state lanciate diverse importanti iniziative a livello europeo per sostenere l'ambiziosa attuazione del Green Deal europeo nel settore del trasporto merci. Guardando al percorso politico di iMONITRAF!, diversi dossier sono molto rilevanti per iMONITRAF! La **revisione del Regolamento TEN-T** è stata completata alla fine del 2023 e fornisce un nuovo quadro di riferimento per la gestione e l'ulteriore sviluppo delle infrastrutture TEN-T. Il **pacchetto "Greening Freight"** comprende strumenti politici e quadri normativi fondamentali per sostenere sia il trasferimento modale che la decarbonizzazione del parco veicolare.

Mentre i due elementi "Regulation on the Use of Railway Infrastructure Capacity" e "CountEmissionsEU Methodology" sono generalmente valutati in modo positivo dal punto di vista di iMONITRAF!, soprattutto la nuova proposta di **revisione della Direttiva Pesi e Dimensioni** include diversi elementi critici che potrebbero, di fatto, portare a uno spostamento modale inverso. La proposta prevede un approccio più flessibile per l'utilizzo di sistemi modulari europei (=Gigaliner) nel trasporto transfrontaliero ed estende i limiti di peso per i mezzi pesanti diesel, contrastando così altre proposte volte ad accelerare l'adozione di mezzi pesanti a emissioni zero. Inoltre, alla fine del 2023 è stata pubblicata una nuova proposta di **revisione della Direttiva sul Trasporto Combinato**, che include una definizione completamente nuova di "trasporto combinato", basata sui risparmi di esternalità, e nuove disposizioni per sviluppare quadri nazionali a suo sostegno. È attualmente in fase di sviluppo una dichiarazione integrata su Pesi e Dimensioni e sulla Direttiva sul Trasporto Combinato.

Aggiornamento del monitoraggio per l'anno 2022 - le tendenze sono tornate ai livelli pre-pandemia

I primi rimbalzi dei volumi di traffico pesante dopo gli effetti della pandemia COVID erano già stati osservati negli anni precedenti. Per l'anno di monitoraggio 2022, i volumi di traffico sono tornati al livello pre-pandemico, con una tendenza all'aumento. Circa **24.400 veicoli pesanti al giorno** (HV/giorno) hanno attraversato i sette principali corridoi transalpini, superando del 2,4% i valori dell'ultimo anno pre-pandemico (2019). Anche per i veicoli leggeri, gli effetti della pandemia COVID non sono più visibili, dato che per tutto il 2022 non sono state applicate ulteriori restrizioni alla circolazione. Un totale di **83.700 veicoli leggeri al giorno** (LV/giorno) ha attraversato i corridoi alpini, con un aumento quasi del 30% rispetto al 2021 e del +2,3% rispetto al 2019. L'analisi dei dati mensili registra gli effetti della terza fase COVID nell'inverno 2022, ma in seguito le tendenze e i modelli mensili sono tornati completamente alle condizioni del 2019.

Le **merci trasportate** sui corridoi iMONITRAF! ammontano a un totale di circa 165,8 milioni di tonnellate: 110,7 milioni di tonnellate su strada (67%) e 55,1 milioni di tonnellate su rotaia (33%). La quantità totale registrata nel 2022 è all'incirca simile a quella del 2021, ma superiore del 4% rispetto al 2019. Rispetto al 2021, la ripartizione modale strada-ferrovia è leggermente diminuita, con un -1% a scapito del trasporto ferroviario. Le **concentrazioni annuali di inquinanti atmosferici** di NO_2 mostrano un'ulteriore tendenza alla diminuzione: nel 2022 i valori medi annuali di NO_2 non hanno superato il valore limite annuale dell'UE di 40 µg/m^3 per nessuna stazione, sebbene due stazioni lungo il corridoio del Brennero e una stazione lungo il Gottardo siano ancora molto vicine a tale limite. Se si considerassero i nuovi limiti di qualità dell'aria attualmente in discussione a livello europeo, la maggior parte delle stazioni di monitoraggio supererebbe i valori proposti di 20 µg/m^3.

Per quanto riguarda il **nuovo indicatore target iMONITRAF!**, gli sviluppi del 2022 devono essere valutati in modo differenziato. Mentre gli sviluppi sul corridoio del Gottardo rimangono in linea con il percorso target per il trasferimento modale, grazie alla disponibilità delle nuove infrastrutture ferroviarie (tunnel di base e corridoio di 4 metri), il percorso target sul Brennero è stato mancato. Per quanto riguarda l'obiettivo di riduzione dei volumi di traffico pesante, gli sviluppi sia al Brennero che al Gottardo sono chiaramente al di fuori dell'obiettivo, in quanto i volumi di traffico sono aumentati invece che raggiungere l'obiettivo di riduzione annuale.

Best Practice 2023 - Utilizzo dei nuovi quadri dell'UE e gestione delle emergenze

Sulla base dei quadri di riferimento europei e nazionali, le misure politiche sono state ulteriormente sviluppate e ottimizzate in tutte le regioni iMONITRAF! per tutto il 2023. In Tirolo, le esenzioni per il trasporto regionale sono state gradualmente eliminate nel quadro dei divieti di circolazione esistenti e sono stati compiuti ulteriori sforzi per l'applicazione dei quadri normativi pertinenti. Grazie alle nuove disposizioni dell'Eurovignetta revisionata, i pedaggi per i mezzi pesanti sono stati ulteriormente sviluppati con l'aggiunta di una tassa sul CO_2 nei sistemi di pedaggio austriaci e tedeschi per i mezzi pesanti, incidendo sui costi del trasporto su strada sul Brennero. Sull'asse del Gottardo, si sono presentate sfide impreviste dopo l'incidente di un treno merci nell'agosto 2023, che ha portato temporaneamente alla chiusura totale della nuova galleria ferroviaria di base. In un lasso di tempo molto breve, è stato necessario sviluppare una serie di misure di emergenza che includono una priorità per il trasporto ferroviario delle merci nella galleria di base e una compensazione più elevata per il trasporto combinato transalpino per compensare gli impatti negativi. Senza questo incidente, il nuovo rapporto svizzero sul trasferimento modale mostra gli effetti complessivamente positivi delle nuove infrastrutture e del corridoio di 4 metri e illustra alcuni potenziali ulteriori sviluppi del mix di strumenti. Nella Région Sud Provence-Alpes-Côte-d'Azur, sono previsti ingenti finanziamenti per l'estensione delle infrastrutture di trasporto lungo i corridoi alpini. Per quanto riguarda il trasporto passeggeri, il miglioramento della mobilità transfrontaliera è rimasto un obiettivo importante nel 2023, soprattutto tra le regioni lungo il corridoio del Brennero.

L'année 2023 d'iMONITRAF en un coup d'oeil

Le réseau iMONITRAF ! - Une voix commune et un centre thématique sur le transport de marchandises transalpin

Depuis son lancement en 2005, les régions alpines ont développé iMONITRAF ! en tant que plaque tournante pour tous les aspects liés au transport de marchandises transalpin. Grâce au développement continu du système de suivi commun et au vaste réservoir de connaissances sur les mesures de report modal et les politiques connexes, iMONITRAF ! s'est imposé comme la voix commune des régions alpines le long des principaux corridors de transit et il est devenu un partenaire important pour les parties prenantes, tant au niveau national qu'européen.

Étant donné que les volumes de transport devraient continuer à augmenter dans les années à venir et qu'il est nécessaire de mieux gérer les infrastructures routières et ferroviaires dans le cadre d'une approche conjointe, les régions alpines sont invitées à renforcer leur coopération et à échanger étroitement leurs expériences et leurs points de vue. Non seulement les mesures de report modal, mais aussi le soutien à la décarbonisation du transport routier de marchandises doivent être développés de manière coordonnée pour s'assurer que les incitations deviennent efficaces sur tous les corridors alpins et que les impacts distributifs soient évités. À cet égard, iMONITRAF! peut également s'appuyer sur sa voix politique forte en réunissant les décideurs politiques pour discuter des défis et des solutions pertinents.

La gestion des capacités, nouvel élément de la voie iMONITRAF!

L'itinéraire iMONITRAF ! comprend des instruments de pilotage ainsi que des systèmes de gestion/réservation des capacités comme éléments de secours si les volumes de trafic sur les corridors alpins restent élevés. En 2022, les impulsions données par les principaux corridors iMONITRAF! du Brenner et du Saint-Gothard ont lancé un débat sur les nouveaux instruments de gestion des capacités, en particulier sur le rôle futur des systèmes de créneaux horaires pour mieux gérer les volumes de trafic sur les corridors alpins. Pour soutenir les discussions au niveau des corridors, iMONITRAF! a élaboré des suggestions politiques sur la gestion des capacités en 2023 afin d'assurer une vision globale du sujet et de garantir que toute nouvelle mesure soutienne le scénario combiné iMONITRAF ! (report modal et amélioration du parc de véhicules). Les suggestions sont basées sur une vue d'ensemble des mesures et initiatives existantes qui ont un lien avec la gestion des capacités ; une typologie des mesures et des interfaces avec l'ensemble des politiques a également été élaborée. Les suggestions illustrent le fait que les instruments de gestion des capacités peuvent remplir des objectifs multiples s'ils sont conçus de manière intelligente et différenciée.

Mesures régionales pour soutenir l'adoption de poids lourds à zéro émission

Un deuxième axe de travail à l'initiative d'iMONITRAF! en 2023 a été un échange sur les mesures régionales visant à soutenir l'adoption de poids lourds non polluants. Une décarbonisation rapide du reste de la flotte de transport routier est le deuxième objectif du scénario combiné et les régions ont des possibilités considérables d'accélérer l'adoption de véhicules à zéro émission. Un échange sur les mesures régionales existantes met en évidence le rôle des différentes approches politiques. Des mesures réglementaires et tarifaires sont déjà appliquées dans les régions iMONITRAF!, par exemple en prévoyant des exemptions pour les poids lourds à zéro émission dans le cadre des interdictions de circuler, en incluant des dispositions sur les infrastructures de recharge dans les nouveaux cadres d'aménagement du territoire ou en appliquant des tarifs de péage spécifiques pour les véhicules électriques ou hybrides. Les nouvelles dispositions de la directive européenne sur l'eurovignette fournissent le cadre adéquat pour différencier les péages

routiers en fonction des émissions de CO_2 et les premiers pays alpins ont déjà mis en œuvre cette approche. Par ailleurs, des subventions directes sont accordées dans plusieurs régions iMONITRAF! ou au niveau national, pour soutenir à la fois l'acquisition de poids lourds à zéro émission et la mise en place des infrastructures de recharge correspondantes. Cela inclut également les connexions maritimes pour la recharge dans les ports liés au transport de marchandises dans les Alpes. Le soutien à l'industrie et la recherche et le développement sont encouragés dans le cadre de projets pilotes et d'initiatives de démonstration, par exemple en ce qui concerne le rôle de l'hydrogène dans le transport régional.

Au niveau de l'UE : Vers un nouveau cadre global pour soutenir le report modal

Plusieurs initiatives importantes ont été lancées au niveau européen en 2023 pour soutenir la mise en œuvre ambitieuse du *Green Deal* européen dans le secteur du transport de marchandises. Si l'on examine le cheminement politique de l'initiative iMONITRAF!, on constate que plusieurs des dossiers sont très pertinents. La révision du règlement RTE-T a été finalisée à la fin de l'année 2023 et fournit un nouveau cadre pour régir et développer les infrastructures RTE-T. Le paquet "Greening Freight" comprend des instruments politiques et des cadres réglementaires décisifs pour soutenir le report modal et la décarbonisation de la flotte de véhicules.

Si les deux éléments que sont le "Règlement sur l'utilisation des capacités de l'infrastructure ferroviaire" et la "Méthodologie de comptage des émissions de l'UE" sont généralement évalués de manière positive du point de vue d'iMONITRAF!, la nouvelle proposition de révision de la directive sur les poids et les dimensions comporte plusieurs éléments critiques qui pourraient, en fait, conduire à un report modal inversé. La proposition prévoit une approche plus flexible pour l'utilisation des systèmes modulaires européens (=Gigaliners) dans le transport transfrontalier et étend également les limites de poids pour les poids lourds diesel - allant ainsi à l'encontre d'autres propositions visant à accélérer l'adoption de poids lourds à émissions nulles. Une nouvelle proposition de révision de la directive sur le transport combiné a également été publiée à la fin de l'année 2023, incluant une nouvelle définition complète du transport combiné, basée sur les économies d'externalité, ainsi qu'une nouvelle disposition visant à développer des cadres nationaux pour soutenir le TC. Une déclaration intégrée sur les poids et dimensions et la directive sur le TC est actuellement en cours d'élaboration.

Mise à jour du suivi pour l'année 2022 - les tendances reviennent aux niveaux d'avant la pandémie

Les premiers rebonds des volumes de trafic de poids lourds après les effets de la pandémie de COVID ont déjà été observés au cours des années précédentes. Pour l'année de surveillance 2022, les volumes de trafic ont retrouvé leur niveau d'avant la pandémie et une tendance à la hausse. Environ 24 400 véhicules lourds par jour ont traversé les sept principaux corridors transalpins, dépassant de 2,4 % les valeurs de la dernière année prépandémique (2019). Pour les véhicules légers également, les effets de la pandémie de COVID ne sont plus visibles car aucune restriction de circulation n'a été mise en place tout au long de l'année 2022. Au total, 83 700 véhicules légers par jour (VL/jour) ont traversé les corridors alpins, soit une augmentation de près de 30 % par rapport à 2021 et de 2,3 % par rapport à 2019. L'analyse des données mensuelles enregistre les effets de la troisième phase COVID au cours de l'hiver 2022, mais après cela, les tendances et les schémas mensuels sont entièrement revenus à la situation de 2019.

Les marchandises transportées sur les corridors iMONITRAF! représentent un total d'environ 165,8 millions de tonnes, dont 110,7 millions de tonnes par la route (67%) et 55,1 millions de tonnes par le rail (33%). Le volume total enregistré en 2022 est à peu près similaire à celui de 2021, mais supérieur de 4 % à celui de 2019. Par rapport à 2021, la répartition modale route-rail

a légèrement diminué, avec -1% au détriment du transport ferroviaire. Les concentrations annuelles de NO_2 dans les polluants atmosphériques affichent une nouvelle tendance à la baisse : en 2022, les valeurs moyennes annuelles de NO_2 n'ont dépassé la valeur limite annuelle de l'UE de 40 µg/m3 dans aucune des stations, bien que deux stations le long du corridor du Brenner et une station le long du Gothard soient encore très proches de cette limite. Si les nouvelles limites de qualité de l'air actuellement discutées au niveau de l'UE étaient prises en compte, la plupart des stations de surveillance dépasseraient les valeurs proposées de 20 µg/m³.

En ce qui concerne le nouvel indicateur cible iMONITRAF!, les développements de 2022 doivent être évalués de manière différenciée. Alors que l'évolution sur le corridor du Saint-Gothard reste conforme à l'objectif de report modal, grâce à la disponibilité des nouvelles infrastructures ferroviaires (tunnel de base et corridor de 4 mètres), l'objectif sur le Brenner n'a pas été atteint. En ce qui concerne l'objectif de réduction des volumes de trafic de poids lourds, les derniers développements tant au Brenner qu'au Saint-Gothard se situent clairement en dehors de l'objectif puisque les volumes de trafic ont augmenté au lieu d'atteindre l'objectif de réduction annuelle.

Meilleures pratiques 2023 - Utiliser les nouveaux cadres de l'UE et faire face aux situations d'urgence

Sur la base des cadres européens et nationaux pertinents, les mesures politiques ont été développées et optimisées dans toutes les régions iMONITRAF ! tout au long de l'année 2023. Au Tyrol, les exemptions pour le transport régional ont été progressivement supprimées dans le cadre des interdictions de conduire existantes et des efforts supplémentaires ont été déployés pour faire respecter les cadres réglementaires pertinents. Grâce aux nouvelles dispositions de l'Eurovignette révisée, les péages pour les poids lourds ont été développés en ajoutant une taxe sur le CO2 dans les systèmes de péage autrichien et allemand pour les poids lourds, ce qui a affecté les coûts du transport routier sur le Brenner. Sur l'axe du Saint-Gothard, des défis imprévus sont apparus après l'accident d'un train de marchandises en août 2023, qui a entraîné la fermeture temporaire du nouveau tunnel ferroviaire de base. Dans un délai très court, il a été nécessaire d'élaborer un ensemble de mesures d'urgence qui comprennent une priorité pour le transport ferroviaire de marchandises dans le tunnel de base et une compensation plus élevée pour le TC transalpin afin de compenser les impacts négatifs. Sans cet accident, le nouveau rapport suisse sur le transfert report montre les effets positifs globaux des nouvelles infrastructures et du corridor de 4m et illustre certains développements potentiels de la combinaison d'instruments. En Région Provence-Alpes-Côte-d'Azur, un financement considérable est prévu pour l'extension des infrastructures de TC le long des corridors alpins. En ce qui concerne le transport de passagers, l'amélioration de la mobilité transfrontalière reste un objectif important en 2023 - en particulier entre les régions situées le long du corridor du Brenner.

1 Background and objectives

iMONITRAF! network – Common voice and thematic hub on transalpine freight traffic

Since its launch in 2005, the Alpine regions have developed iMONITRAF! as central hub for all aspects related to transalpine freight transport. Based on the continuous development of the common monitoring system, the broad knowledge pool on all measures and policies related to modal shift and to limiting the negative effects of increasing freight traffic volumes, iMONITRAF! has successfully become a common voice for the regions most affected by transit traffic and has established itself as an important partner with stakeholders at both national and European level. The analyses and background information provided by iMONITRAF! are also highly valued within the Alpine community and serve as a basis for the activities of other stakeholders.

As transport volumes are projected to further increase in the coming years and as there is a great need to better manage both road and rail infrastructures in a joint approach, the Alpine regions are challenged to strengthen their cooperation and to closely exchange experiences and insights. Not only modal shift measures but also the support to decarbonise the remaining road transport freight should be developed in a coordinated way to ensure that incentives become effective on all Alpine corridors and that distributional impacts are avoided. In this respect, iMONITRAF! can build also on its strong political voice by bringing together political decision makers to discuss relevant challenges and solutions.

Main activities of iMONITRAF! and their evolvement over time are summarized in the following figure.

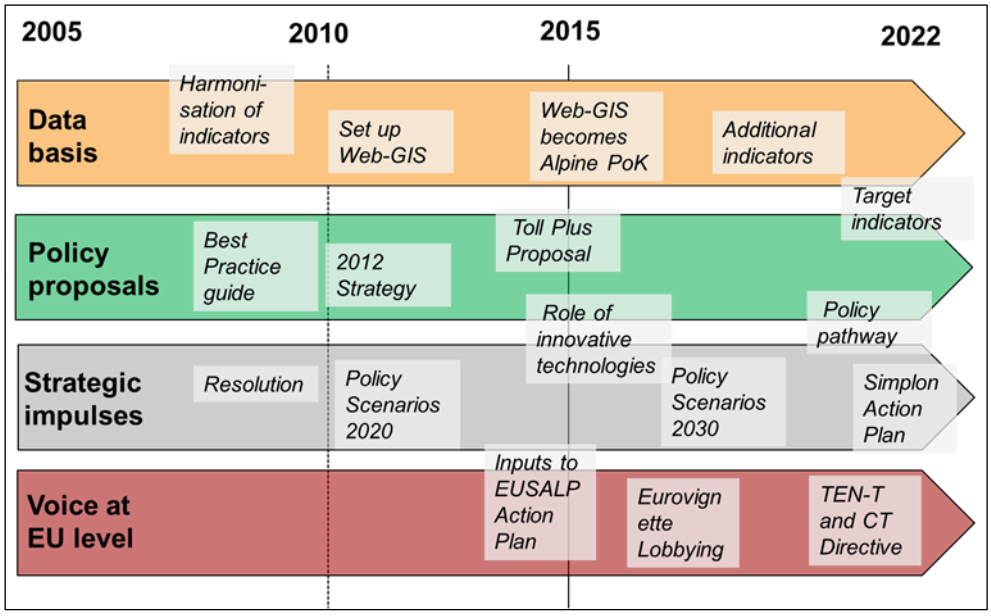

Figure 1: *Main fields of action and topics of the iMONITRAF! cooperation since 2005*

Transitioning to the new work programme 2023-2025

The important value of the network was confirmed by political representatives during a political roundtable at the end of 2022 with the signature of a new partnership agreement for the period 2023-2025. This partnership agreement provides the basis for the future cooperation, defines the relevant work focuses and identifies the roles for partners and observers.

Regarding the strategic work focuses, iMONITRAF! will focus on topics that are reflected in the iMONITRAF! Resolution 2020, the new policy pathway 2021 and set of target indicators. Current activities will be continued throughout the new work programme, with a special view to further developing the target indicators and their implementation in the monitoring approach. Regarding strategic work focuses, two main activities need to be highlighted:

- Impulse on capacity management/reservation and control instruments: iMONITRAF! has set the objective to investigate the potential of additional steering and reservation instruments to improve capacity use of the Alpine corridors. This will require a closer look at the role and potential of digital technologies. This activity shall support ongoing activities at corridor level.
- Regional view on alternative drive systems: in the Combined Scenario, which serves as a guideline for the iMONITRAF! work, the decarbonization of road freight transport also plays a central role. Transit regions have the potential to establish themselves as pioneers here. iMONITRAF! would like to strengthen the perspective of the regions in this respect.

Objectives 2023 – Further definition of elements from the iMONITRAF! policy pathway

With increasing transport volumes and growing difficulties related to capacity management, different iMONITRAF! regions launched new discussions on how to deal with traffic management at peak times and how to ensure a better flow of traffic. These discussions at corridor level provided a window-of-opportunity for iMONITRAF! to develop an input paper on reservation systems/capacity management. This input paper had the main objective to provide a comprehensive overview on different mechanisms and typologies and to serve as basis for further discussions.

Also, several other elements of the iMONITRAF! pathway were further developed throughout 2023, especially with a close link to developments at European level, for example regarding the further development of the TEN-T network but also the framework on Weights & Dimensions and support mechanisms for Combined Transport.

For 2023, also some improvements in the monitoring system were implemented and discussed by partners. Considering the strategic work focus on alternative technologies, the indicator “Unitary pricing components” was further developed to provide a more comparable overview and interpretation on how taxation systems can set incentives for the uptake of alternative technologies. Also, the target indicators were implemented as integral element in the monitoring system.

Annual Report 2023 – overview on main iMONITRAF! activities

As in previous years, the Annual Report provides a glance at all relevant iMONITRAF! activities summarized in one document – including developments in the Alpine regions, at national as well as at European level.

The report includes the main activities of the year 2023. It starts out with a summary of the input paper developed by iMONITRAF! on capacity management (chapter 2) and then provides an overview on developments at EU level with a special focus on the elements of the Greening Freight Package. Chapter 4 presents networking activities with EUSALP AG4 and other relevant Alpine-wide institutions, initiatives and projects. In chapter 5, an update of monitoring results is presented, including an interpretation of monthly data for some selected indicators to better interpret the impacts of the COVID-19 pandemic. Chapter 6 presents insights on the other focus topic of this Annual Report and provides a special insight on regional measures to support the uptake of alternative technologies. Chapter 7 then presents the update of Best Practice, including information on all iMONITRAF! policy pillars. Finally, the report includes an outlook to the two remaining years of the work programme 2023-2025.

2 Capacity management as new element of the iMONITRAF! policy mix: a review from iMONITRAF!

2.1 Needs and potential role for capacity management

Starting point

The iMONITRAF! policy pathway includes steering instruments as well as capacity management/reservation systems as back-up elements if traffic volumes on the Alpine corridors remain high. In 2022, impulses from the major iMONITRAF! corridors Brenner and Gotthard have initiated a debate around new capacity management instruments, especially the future role of slot systems for better managing traffic volumes on the Alpine corridors.

- At the Brenner, discussions emerged from the growing pressures resulting from freight transport for which the existing instrument mix comes to a limit. Upcoming renovation work on the Brenner motorway will require additional efforts to ensure traffic flow and to avoid unwanted distribution impacts.
- On the Gotthard, passenger transport poses a growing challenge, especially around peak travel times during weekends and the holiday season. Due to the dosing system, extensive congestion can be observed on many days which also results in a reduced accessibility for the local population (commuters), local and regional transport but also for tourists with destination in Central Switzerland.
- On the French-Italian corridors, the renovation works of the Mont Blanc Tunnel lead to closures and requires traffic management solution considering as well the alternatives especially on the Fréjus corridor.

Considering the growing pressure and the existing initiatives along the corridors, iMONITRAF! partners and political representatives have thus agreed to launch a broader review of existing measures that contribute to capacity management on the Alpine corridors and how they are interlinked with the existing instrument mix. On this basis, iMONITRAF! developed recommendations for the further discussion on capacity management and reservation systems (also contributing to the Simplon Action Plan) and can highlight interfaces to potential steering instruments.

Political initiatives on the iMONITRAF! corridors

Both on the Brenner and Gotthard corridor, political initiatives have been launched to further explore the role of capacity management. For the Brenner, the focus is on HGV-capacity management. South Tyrol has set an impulse for the discussion of a smart capacity management with an in-depth study for a slot system.[1] This impulse was taken up at political level and in April 2023, the State Governor of Tyrol, the State Governor of the Autonomous Province of Bolzano – South Tyrol and the Prime Minister of the Free State of Bavaria have signed a letter of intent to develop a common digital traffic management system based on slot reservation for lorries.

In Switzerland, as an answer to the growing challenges related to peaks in passenger transport volumes, the Canton of Uri launched an initiative to implement an improved traffic management system (incl. slot reservation) for passenger cars. This has been brought to the political discussion. In the discussion in the Cantonal parliament, the initiative received complete support from all parties. But there are no specific technical proposals yet. During the year 2023, the discussion

[1] Brenner Digital Green Corridor: Machbarkeitsstudie für eine Potentialanalyse der digitalen Verkehrssteuerung entlang des Brennerkorridors. Online here.

has further evolved and it was agreed that a slot reservation system should only be an intermediate solution and that rather a capacity-oriented pricing system should become the long-term solution. At the same time the idea of a fee for passenger cars in peak times came up.

Existing experiences with capacity management

After the fatal accidents in the Mont Blanc tunnel 1999 and the Gotthard tunnel 2001, the Suivi de Zurich process started an initiative to install traffic management systems to improve safety in alpine tunnels. In this context, as well a broader evaluation of instruments has been undertaken.

Since 2001, Switzerland has installed a traffic management system for lorries passing the alpine tunnels Gotthard and San Bernardino in a combination with traffic control centres for lorries (Schwerverkehrszentren) in Erstfeld and Ciornico and a drip-feed system (Tropfenzählersystem).

To avoid high levels of congestion, in 2017, Tyrol has installed a dosing system to control the number of lorries that cross the border on the Brenner motorway in Kufstein at specific days. These days are determined ex-ante on the basis of simulations and are published six months in advance. Also, traffic control centres are installed along the Brenner in North Tyrol and are under construction in South Tyrol. To limit negative impacts during traffic peaks, the iMONITRAF! regions furthermore control access and exits on the relevant motorway sections. Additional existing measures are illustrated in the iMONITRAF! Best Practice Guide (2010) which includes a broad list of measures that contribute to capacity management on the Alpine corridors.

The measures have different objectives:

- Safety: especially the measures to manage traffic flows in the tunnels have a strong safety objective (implemented after the tunnel fires in Mont Blanc and Gotthard).
- Air quality: some measures also have an air quality objective, i.e. permanent or dynamic speed limits as well as the night driving ban, the sectoral driving ban and the driving ban for special Euro classes in Tyrol.
- Congestion/traffic flow: With increasing limits of congestion (especially on the Brenner, but also on the Gotthard during vacation peaks), some measures also have the main focus to manage traffic flows and to avoid negative effects for local and regional accessibility.

→ iMONITRAF! developed an internal discussion paper on how to further develop capacity management instruments on the iMONITRAF corridors and presented the major contents at the EUSALP conference in Lugano Sept. 1st .

2.2 Embedding capacity management in the iMONITRAF! policy mix

From the iMONITRAF! viewpoint, it is crucial to frame the discussion on capacity management in the context of the iMONITRAF! Combined Scenario. Modal shift remains the basic rationale and this needs to be considered when designing the technical parameters for the capacity management system (e.g. the number of available slots). Also, innovative ideas could be developed on how capacity management on the road could be linked to rail transport (e.g. via integrated approach with rolling motorway services, voucher systems, etc.).

Further, iMONITRAF! is dedicated to the top-runner approach and any capacity management system should be designed in a way to support the Alpine corridors to become a model region for zero-emission freight and passenger transport. The technical parameters for a slot system provide many entry points for this (e.g. providing specific slots for zero-emission vehicles in the reservation process).

The policy mix related to modal shift and environmental objectives is already quite complex and has been finetuned and optimized over the last two decades. The iMONITRAF! Best Practice collection (since 2010) highlights major developments and illustrates the dynamic processes around the coordination of regional measures. When further discussing the role of capacity management on the Alpine corridors, the interfaces to the existing instrument mix need to be closely considered to avoid any unwanted trade-offs with other measures along the corridors or new distributional effects between them. Especially, the set-up of new capacity management measures should not have any negative impacts on measures related to noise protection or air quality and that no ambivalent effects emerge for the competitiveness of rail and combined transport.

2.3 Typology of approaches

A broad range of measures for both freight and passenger transport with the objective to manage capacity on the Alpine corridors are already implemented. Most measures have a regional focus (due to their necessity to regulate on regional level), several measures are already coordinated between the regions (along the corridors and partly also between them).

The table below provides an overview, based on the following two dimensions:

Dimension 1: Basic rationale of the instrument

What is the objective behind the management system?

- Traffic flow: Related instruments have the clear and only objective to ensure traffic flow on the motorways or on specific sections (tunnels or bridges) to ensure the security of supply of goods and/or the accessibility of mountain areas. If they are implemented on the corridors in general, they have the objective to avoid congestion.
- Safety & social standards (and further compliance issues): Measures for traffic management can also be linked to further considerations, especially regarding the enforcement of safety, social and environmental standards.
- (Integrated) Environmental objectives: Measures related to capacity management can also have a broader scope and can consider different environmental objectives.
- All objectives in this dimension relate to both passenger and freight transport and are thus relevant for the discussions both at the Brenner and the Gotthard.

Dimension 2: Mechanism of the instrument

Which logic is used for managing/steering the capacities?

Different mechanisms/systems can be used for managing the relevant capacities and objectives:

- Simple management systems based on “first come, first serve” logic: instruments in this category follow a rather simple approach: a specific quantity of traffic volumes is defined and managed on a first come, first serve basis. Road users receive very limited support in dealing with this instrument, this means that waiting areas need to be provided.
- Management systems linked to vehicle controls: traffic controls and vehicle inspections of HGV at dedicated stations offer another approach to manage capacities and flows on the Alpine motorways.

- Smart systems making use of efficient allocation methods: to enable a more efficient functioning of the capacity management systems, smart reservation systems can be applied. These can again be linked to different allocation approaches: first come – first serve, grandfathering[2] or dynamic pricing/auctioning.
- In this dimension, the logics of both simple and smart management systems are also applicable for passenger transport – although the implementation of smart systems with specific allocation methods seems less feasible for passenger transport. Simple systems with "first come, first serve" logic are already known to traffic users (e.g. from booking ferries) and would be the easiest entry-point. Systems linked to vehicle controls are however only relevant for freight transport.

Role of digital solutions and other and additional traffic management instruments

The second dimension also covers different degrees of digital integration: while the simple management system can function without any digital solutions (or only very simple tools for automatization like vehicle counting stations or real-time traffic information), the smart systems are based on digital platforms for booking, information and support and also require smart infrastructures along the corridor to provide a smooth customer journey.

This means that the path for moving from the rather simple towards smart systems is closely linked to the roll-out of digital solutions and automatization in the logistics sector but also to the further development to autonomous vehicles and smart traffic systems. The timeline with specific implementation steps needs to developed in a dynamic way to keep pace with progress in deploying digital solutions. The approach of South Tyrol to integrate both aspects in a "Green and digital corridor" seems promising in this respect.

The table also highlights the interfaces to other instruments in the iMONITRAF! policy pathway and regional measures already implemented along the iMONITRAF! corridors. Here, especially the existing measures for passenger transport to avoid detour traffic to the secondary road network become visible since they belong to integrated traffic management systems.

Additional measures from outside the Alpine region have also been reviewed, especially regarding solutions for passenger transport. However, many of the existing good practices are not applicable to the iMONITRAF! corridors as they require the availability of a larger road network with multiple lanes (e.g. reserved lanes for carpooling as in the Los Angeles) or are linked to really scarce capacities (e.g. ferries).

[2] protection of vested rights based on the existing use.

OVERVIEW CAPACITY MANAGEMENT: RATIONALES OF THE INSTRUMENTS, MECHANISMS AND ROLE FOR FREIGHT & PASSENGER TRANSPORT

		Basic rationale: What is the objective behind the instrument		
		Control of traffic flow (avoid congestion)	**Safety and social standards**	**Integrated environmental objectives**
Mechanism of the instrument	**•Simple systems " first come, first serve**	• Manual or automated control of traffic flows through regulating access to motorway *Example: Dosing system Tyrol (freight)* • Mechanism to control a fair distribution between Mont Blanc and Fréjus tunnels (new regime foreseen to handle forthcoming renewal of Mont Blanc tunnel starting in 2023)	• Tunnel dosing systems: ensure max. number of vehicles in tunnel + safety distances: *Example: Drip-feed system Gotthard, dosing systems Mont Blanc tunnel (freight & passenger)*	• *Extension of safety criteria to environmental capacities* *(no examples)*
	Systems linked to vehicle controls	• Waiting rooms at traffic control centres Example: General system Switzerland (freight)	• Smart Traffic control centres": Capacity management via Traffic Control centres Example: Traffic control centre Erstfeld and Giornico (freight)	• Emphasis to environmental targets (no examples)
	•Smart systems, efficient allocation methods	• Digital reservation system for slots *Example: proposal South Tyrol (focus is on freight transport, but could be extended to passenger transport)*	• Traffic control centres 2.0: HGV controls could be linked to slot systems/booking platforms (e.g. to book priority handling)	• Alpine Crossing Exchange 2.0 (freight) (ACE proposal requires an update to use the full potential of digital solutions) • Ökopunktesystem 2.0 (freight)
Interfaces to existing regulatory measures		• Driving bans „Ausweichverkehr"/evasive traffic: restricted access to the secondary road network, closure of specific motorway exits/accesses (focus passenger) *Example: police traffic controls to address detour traffic to the secondary road network in Tyrol and Salzburg during holiday seasons, closure of exits/access on Gotthard motorway and on A13 San Bernardino Route*	• Driving bans in tunnels for dangerous goods (freight)	• (Dynamic) Speed limits based on air quality concentrations (focus passenger) *Example: Tyrol Tempo 100 (permanent speed limit on a section of the A12 Inntal motorway), test cases in Brenner LEC project*

Table 1:

In addition, there are potential interfaces to modal shift measures. These are mostly relevant for freight transport but incentive measures/vouchers could also be used for passenger transport.

- Link to rolling motorway: capacity management systems could also be linked to RoLa: if a RoLa trip is booked, HGV can use a priority access or bypass a dosing system. There is no existing practice with explicit incentives.
- Cross-financing/vouchers: if slots are booked in a reservation management, an additional voucher system could be implemented: for each slot, transport companies receive a voucher for using combined transport or rail.
- Link to charging systems: the differentiation of charges and infrastructure pricing systems according to times of the day (peak/off-peak) is a further option to manage capacities. Charging systems could also be developed towards dynamic pricing systems. This is possible for both freight and passenger transport.

2.4 Next steps and role for iMONITRAF! in the ongoing discussions at corridor level

iMONITRAF! has a long-established knowledge base on the functioning and interaction of the policy mix on the Alpine corridors and offers a role as sparring partner in the ongoing technical and political discussions on the Brenner and Gotthard corridors. Especially, iMONITRAF! can provide insights on embedding the new measures in the existing instrument mix and to ensure that they support the iMONITRAF! policy pathway and Combined Scenario.

- iMONITRAF! can ensure the interaction and exchange between the two processes: ideally, new slot systems should be designed in a compatible way – so that they can be extended to other corridors and that they are applicable for both freight and passenger transport.
- Keeping in mind the rationale of the iMONITRAF! Combined Scenario, it is necessary to have a close look at potential synergies of new capacity management instruments with the modal shift policy framework and environmental issues. Capacity management instruments should not only focus on efficiency improvements for road transport but should also provide incentives for modal shift and environmental improvement of the HGV fleet.
- iMONITRAF! can further ensure an information flow and exchange between the corridors: insights from the Gotthard corridor, especially with using the traffic control centres for capacity management, could be useful for the discussions at the Brenner corridor. Also, stakeholders in Switzerland need to keep up to date with development along the Brenner to anticipate impacts on the other corridors.
- Also, iMONITRAF! will maintain its role for thinking one step ahead, especially when it comes to fine-tuning the parameters and frameworks for capacity management instruments to serve multiple objectives.

3 Trends for transport and environmental policies at EU level

At EU level, several important initiatives were launched in 2023 aiming at an ambitious implementation of the European Green Deal in the transport sector, with a special focus on freight transport. The initiatives implement the objectives of the EU Smart and Sustainable Mobility Strategy and aim at putting transport on track to reaching its target of cutting transport emissions by 90% by 2050.

Looking at the Policy Pathway of iMONITRAF!, several of the dossiers as launched at EU level provide important framework conditions and are thus highly relevant to iMONITRAF!. The revision of the TEN-T Regulation was finalized at the end of 2023 and provides a new framework for governing and further developing the TEN-T infrastructures. The Greening Freight Package includes crucial policy instruments and regulatory frameworks to support both modal shift and the decarbonisation of the vehicle fleet.

The relevant legislative packages are shortly presented in this chapter, also highlighting the new funding opportunities as provided by the Next Generation EU funding which has provided funding for several regional measures illustrated in the Best Practice section of this report (chapter 7).

Revision of the TEN-T Regulation to ensure that the TEN-T serves EU climate objectives

The Regulation for the development of the trans-European transport network (TEN-T Regulation) provides the legislative framework for national and EU investments in transport infrastructure and also defines technical requirements and the take-up of innovative digital solutions to foster interoperability on the whole network. To better meet the objectives of the European Green Deal, a revision of the TEN-T Regulation was already launched in 2020 and the final trilogue discussions took place in 2023. Just before the end of the year, the Council and Parliament were able to strike a deal with a provisional agreement on the TEN-T

Regarding the key elements that were mentioned in the last Annual report of iMONITRAF!, the provisional agreement can be interpreted as follows:

- **Requirements for freight transport on the rail network:** The agreement is mostly in line with the iMONITRAF! claims to set more ambitious standards and requirements for the rail network: the agreement includes a more ambitious approach for the deployment of the European rail traffic management system (ERTMS) on the extended core and comprehensive network is, the migration to European standard nominal track gauge as well as the increase of the number of 740-meter-long freight trains
- **Requirements for border-crossings:** the agreement also includes a new approach to regulate the maximum waiting time at borders to 15 minutes (dwelling time). This is especially important for the Alpine corridors which cross several national borders on a short distance.
- **Accelerated development of terminal infrastructures:** also, boosting the development of terminals is included in the agreement. The co-legislators maintained the obligation to have at least one multimodal freight terminal per urban node by 31 December 2040, where economically viable.
- **Governance framework:** as big success, the governance framework for TEN-T was also strengthened in the revision as the working plans of the TEN-T coordinators will turn into implementing acts with yearly reporting. These are seen as a more suitable framework to kick-off infringement procedures if works on the TEN-T infrastructures are delayed

Greening freight package

In July 2023, the Commission published a package of measures to make freight transport more efficient and more sustainable, by improving rail infrastructure management, offering stronger incentives for low-emission lorries, and better information on freight transport greenhouse gas emissions. The Greening freight package includes the following dossiers:

- **The Regulation on the Use of Railway Infrastructure Capacity:** The proposed Regulation aims at optimising the use of the increasingly congested rail infrastructure network. Especially, cross-border coordination shall be improved and punctuality and reliability increased to attract more freight companies to rail. Passengers will benefit from additional rail services as the capacity of the network will be better used, impacting positively the cross-border services. The main objective of the regulation is to better reflect the different needs of the rail sector: stable timetables and early booking of tickets for passenger services, and flexible train runs adapted to just-in-time supply chains for freight shippers.
- **Revision of the Weights & Dimensions Directive:** the Weights and Dimensions Directive sets the maximum weight length, width and height for heavy-duty vehicles. The new proposal aims at integrating new technological developments in this framework and at setting additional incentives for the uptake of alternative technologies as well as supporting intermodal solutions (see the detailed section below for further information).
- **CountEmissionsEU Methodology:** With this dossier, the Commission is proposing a common methodological approach for companies to calculate their greenhouse gas emissions if they choose to publish this information, or if they are asked to share it for contractual reasons. Reliable data on door-to-door emissions will enable operators to benchmark their services and allow consumers to make informed choices on transport and delivery options.
- **Combined Transport Directive:** The revision of the CT Directive is also a part of the Greening Freight Package but was only published at a later stage in November 2023. The relevant elements of the proposal are described in a detailed section below.

Weights & Dimensions Directive: risks of reverse modal shift

The proposal supports the uptake of zero-emission HDVs and intermodal transport, tackles fragmentation of the market for longer and heavier vehicles, and improves enforcement of the rules. Three main elements are relevant for iMONITRAF! and freight transport on the Alpine transit corridors:

- To incentivise the take-up of cleaner vehicles, the proposal allows additional weight for vehicles using zero-emission technologies by increasing the weight of HDVs (by 4 tonnes). It is proposed that the extra allowance would be disconnected from the weight of the zero-emission technology, to provide further incentives for uptake of such vehicles, as the operators will gain additional loading capacity if the zero-emission technology becomes lighter. In order to increase energy efficiency of vehicles, the rules also encourage the uptake of more aerodynamic cabins and other energy-saving devices.
- The rules also aim to promote intermodal transport by classifying trucks, trailers and semi-trailers used in intermodal transport operations as intermodal transport units that will benefit from the same extra weight allowance as road vehicles that carry containers or swap bodies. A new allowance for extra height will also facilitate the transport of so-called high-cube containers.

- As third important element, the proposed rules clarify that countries that allow European modular systems (EMS) will also be able to use them in international operations among the neighbouring EU countries that allow EMS, without the need for a bilateral agreement and without the restriction of crossing only one border. This, in fact, would also lead to an increase of weight limits for Diesel HGV (as several EU countries already today have a 44t weight limit) that are used in cross-border transport.

The different elements of the proposal need to be seen in a differentiated way: while all elements that strengthen the role and uptake of combined transport solutions are supported by iMONITRAF!, all elements that lead to indirect additional advantages for road transport need to be seen critically. Especially, the Commission aims at enabling a cross-border circulation of European Modular System (= "Gigaliners") in the new proposal. This would lead to the effect that these long and heavy vehicle combinations can be used in long-distance and cross-border transportation, a segment with a high rail-affinity. Also, the extension of European Modular System would increase operational complexity for combined transport, as different vehicle combinations and trailer solutions would need to be handled at CT terminals.

A recent evaluation conducted by different European Rail Freight associations highlights the risks of the proposal for reverse modal shift, indicating that the impact on the various rail freight segments such as single wagonload and full trainload traffic risk a potential reverse modal shift up to 21 %.[3]

CO_2 emission standards for trucks

In 2023, the Commission proposed a revision of the Regulation on CO2 emission standards for heavy-duty vehicles. This proposal included new, stronger CO2 emission standards for heavy-duty vehicles from 2030 onwards, and extend the scope of the Regulation to cover smaller trucks, city buses, long-distance buses and trailers. The initial regulation from 2019 only covered four groups of trucks, representing 60% of annual sales (70% of emissions). Several new groups have now been added, amounting to 90% of sales and 95% of emissions. To stimulate faster deployment of zero-emission buses in cities, the Commission also proposes to make all new city buses zero-emission as of 2030. The new targets build on those adopted in 2019, which were the first-ever EU-wide CO2 emission standards for heavy-duty vehicles.

The European Parliament finalised its position in November 2023, agreeing on more ambitious targets compared to the 2019 regulation. Under the Parliament's position, heavy-duty vehicle manufacturers would need to reduce the carbon emissions of their new offerings by 45% from 2030, 65% from 2035, and 90% as of 2040 – reduction targets that are in line with the European Commission's initial proposal. Whilst the Parliament's environment committee recommended a 70% cut by 2035, a 65% target was agreed following pushback from conservative lawmakers.

A controversial aspect is the compromise of the EP to include a new class of vehicles that run exclusively on renewable fuels. This compromise was taken to avoid the so-called carbon correction factor (CCF), a mechanism under which the quantity of renewable fuels in Europe's fuel mix would be counted towards the final CO2 targets that must be met by vehicle manufacturers. The debate is similar to the ones on passenger cars, though it expands the definition of carbon neutral fuels to include biofuels

[3] D-fine (2024): Study on Weights and Dimensions - Impacts of the Proposed Amendments to the Weights and Dimensions Directive on Combined Transport and Rail Freight Transport
https://uirr.us17.list-manage.com/track/click?u=196f1f0b3ab164b1063727b8d&id=1326199245&e=9065ea26bf

Combined Transport Directive

A proposal for revising the CT Directive was finally published by the Commission in November 2023. This proposal includes a complete new approach to defining CT operations and, in addition, proposes several new elements for support CT. The following four elements are at the core of the proposal:

- Definition of combined transport: the current definition (based on distances of the road legs and the distances to the "nearest terminals") will be replaced by a definition based on externality differences which exist between the modes. Here, as proposed by iMONITRAF! in an initial statement, the eligibility is based on a broad set of external cost savings (40% savings) including greenhouse gas emissions, air pollution, injuries and fatalities, noise and congestion.
  → While the general principle is much appreciated, the technical implementation still needs to be reviewed in detail.

  → Also, it needs to be ensured that the over-proportional external costs in the alpine regions is considered in the new external cost calculator for CT.
- Alignment of regulatory and incentive mechanisms to support CT: Each Member State needs to design a national support framework for CT, based on a common toolbox that will be provided by the Directive. These national frameworks each need to meet a target of 10% cost reductions for CT.
  → In this respect, the proposal also mentions a complete exemption for CT within all existing driving bans, this being a critical element for the iMONITRAF! regions.
- Transparency on market functioning: All information on the national policy frameworks needs to become transparent to improve market functioning and interoperability.
- Terminal transparency: as last point, the proposal foresees a better exchange of information on capacity use, availability, existing services, etc. in the CT terminals.

iMONITRAF! is currently working on a common statement on the CT Directive and is working with network partners at EU level to ensure that the revision process can be used in an optimised way and that no unwanted effects occur.

New EU Air Quality Standards

In November 2023, the Council adopted its negotiating mandate for talks with the European Parliament on a proposal to set EU air quality standards to be achieved by 2030 and to put the EU on a trajectory closer to its zero-pollution vision for air by 2050. It also seeks to align EU air quality standards more closely with World Health Organization (WHO) guidelines. Compared to the initial proposal of the Commission, the Council's texts introduces some flexibility for Member States in the implementation of the Directive.

In addition to setting out air quality provisions to move the EU closer to achieving the zero-pollution objective for air quality by 2050, thus contributing to a toxic-free environment, the new rules set out enhanced EU air quality standards for 2030 in the form of limit and target values that are closer to WHO guidelines. The revised directive covers a host of air-polluting substances, including fine particles and particulate matter (PM2.5 and PM10), nitrogen dioxide (NO2), sulphur dioxide (SO2), benzene, arsenic, lead and nickel, among others. For instance, the annual limit values for the pollutants with the highest documented impact on human health, $PM_{2.5}$ and NO_2, would be reduced from 25 µg/m³ to 10 µg/m³ and from 40 µg/m³ to 20 µg/m³ respectively (the WHO guideline values are 5 µg/m³ for PM2.5 and 10 µg/m³ for NO2).

New funding opportunities linked to Next Generation EU funding

NextGenerationEU is the EU's 800 billion Euro temporary recovery instrument to support the economic recovery from the coronavirus pandemic and build a greener, more digital and more resilient future. The centrepiece of NextGenerationEU is the Recovery and Resilience Facility - an instrument that offers grants and loans to Member States but also to centrally managed EU programmes to support reforms and investments in the EU Member States for a total of €723.8 billion in current prices (the remaining funding of 83 billion Euro is earmarked to other programmes, e.g. Horizon Europe). Bi-annual funding plans provide information on the relevant available funding in the period. In the first half of 2023, the European Commission issued €40 billion of single-branded EU-Bonds, in the second half the same amount was provided again.

As shown in the chapter on regional measures, several of the iMONITRAF! regions and their relevant national entities have used this new instrument, especially for funding infrastructures for alternative vehicle technologies and for support programmes to accelerate the uptake of new technologies.

4 Synergies with EUSALP and other networking activities

Synergies with EUSALP AG4

EUSALP Action Group 4 Mobility (AG4) had an intensive work year as the development of the new work plan 2023-2025 was finalized and first implementation activities were prioritized. For the first time, the EUSALP work plan was strengthened by additional cross-cutting priorities which were approved by the EUSALP Executive Board in August 2023. The four priorities have been developed to strengthen the EUSALP concerning its political relevance and success. With the cross-cutting priorities, the EUSALP action groups have taken first steps to consolidate topics and thus increase the possibilities for cooperation and to be more creative by adopting a cross-disciplinary approach to finding solutions. AG4 is involved in the cross-cutting priority "Accelerating the Energy Transition for a Carbon-Neutral Alpine Region" which will develop activities with a close link to iMONITRAF!.

The new Work Plan 2023-2025 for AG4 includes several activities with an interface to iMONITRAF!. Especially, activity 1 "Smart clean logistics and policy measures in freight transport to support modal shift" will lead to synergies for iMONITRAF!. This activity will follow-up on activities that optimise rail and CT infrastructures, services and logistic processes. This includes measures supporting modal shift but also to accelerate the uptake of innovative technologies, e.g. infrastructure projects related to inland terminals and ports, smart CT, smart rail, automatisation of logistic processes, and freight matching that support modal shift from road to rail.

In addition to the development of the new work plan, the following activities of AG4 can be highlighted:

- Workshop "Tackling the energy crisis in transport": During the 4th EU Macro-Regional Strategies Week, AG4 organized a workshop on the energy transition for the transport sector that had the objective to illustrate existing, smart solutions from all macro-regional strategies and to discuss potential elements for a joint policy dialogue. The outcomes of this workshop will support the work in the cross-cutting priority and serve as basis for a follow-up policy dialogue.
- Cervino – Energy data: AG4 also contributed to the Cervino project (Alpine Space Progamme) that has the objective to set-up a platform with comparable energy data. The platform shall include specific data also for the transport sector, including energy consumption of the different transport modes and the availability of charging structures for alternative vehicles. The results of Cervino can, in the future, support the information of the iMONITRAF! monitoring system.
- Project labelling: The activity with labelling projects with macro-regional value added has been continued in 2023 as well. However, a new round of project assessment was postponed to 2024 as only few new projects were announced by the AG4 members.
- Alternative fuels: On October 12th and 13th 2023 the Austrian Ministry of Climate Action and the Austrian National Competence Center for E-Mobility in cooperation with EUSALP (AG4) organized the AFIR ("Accelerating the Electrification of Road Transport in the Alps") stakeholder meeting in Innsbruck. The event focused on the infrastructure development for zero-emission vehicles in the west of Austria and the central and western parts of the Alps

Furthermore, iMONITRAF! participated in the "Mobility & Transport Conference" which was organized in Lugano in September 2023 under the Swiss Presidency of EUSALP. Transport was one of the key topics of the Swiss Presidency and the conference was jointly organized by the Swiss Federal Office for Spatial Planning and the Canton of Ticino. The iMONITRAF! group was able to present first insights on the capacity management topic.

iMONITRAF! partners during their presentations and interventions in Lugano (© David Schweizer)

Simplon Alliance and Working Group Transport of the Alpine Convention

The signature of the Simplon Action Plan "Towards net-zero emissions in the transport sector in the Alps by 2050 at the latest" was completed with the signature of Italy in July 2023. Specific implementation steps have not been launched yet, but iMONITRAF! has stated its interest in supporting specific implementation activities. Especially, all activities related to a better coordination of tolls and pricing systems, the support for CT and the exchange on capacity management instruments is highly relevant for iMONITRAF! and considerable synergies could be used.

With respect to the second element of the iMONITRAF! Combined Scenario, the Conference "Alternative Fuels Infrastructure" which was jointly organized by the Working Group Transport of the Alpine Convention and EUSALP AG4 was of high interest for iMONITRAF! and several member of the network participated in the event. Presentations and discussions gave a comprehensive overview on the status of technological development and availability of vehicles for decarbonizing the road transport fleet. Representatives from several important OEMs provided insights into their business strategies and upcoming market developments. Also, the development of large-scale infrastructures for alternative fuels was discussed during the Conference – especially highlighting the way forward to meet the ambitious targets of the European Alternative Fuels Infrastructure Regulation.

Alpine Climate Board, ACB Transport Community and further networking

iMONITRAF! has further closely cooperated with the Transport Community of the Alpine Climate Board, especially with respect to sharing information and knowhow and the objective to coordinate political lobbying activities at EU level. Two webinars have been organized in 2023, the first one focusing on "The Swiss freight policy framework: a stakeholder viewpoint" and the second one presenting the study "Energy Efficiency of transit freight transport on the Brenner corridor". Also, two exchange meetings were organized to coordinate activities related to developments at EU level.

iMONITRAF! closely cooperated with other institutions and stakeholders in the field of transalpine freight transport. The Lead Partner of iMONITRAF! also represents the network during the meetings of the Alpine Convention's Working Group Transport.

5 Monitoring of iMONITRAF indicators

As monitoring data for a full calendar year is only published by the different sources throughout the following year, the monitoring data presented in the iMONITRAF! Annual Reports always focuses on the previous year. The Annual Report 2023 thus presents monitoring data for 2022 regarding indicators related to road traffic volumes, transported tons and modal split, concentration of nitrogen dioxide and particulate matter and exposure to noise.

To follow up on the impacts of the Covid-19 pandemic in 2022, the monitoring chapter includes monthly-level data (for the years from 2019 to 2022), which allow a better understanding of the implications of the pandemic crisis. Monthly data is presented for (a) road traffic volumes, (b) transalpine freight transport (rail and road), and (c) air pollution concentrations. Additionally, considerations about the impacts of the Covid-19 pandemic are included in the description of all the other indicators when relevant.

All data reported in this report are available also in the **iMONITRAF! WebGIS application**[4]. It allows visualising and analysing the data contained in this report, as well as all data collected in the iMONITRAF! framework in the last 20 years.

5.1 Evaluation of monitoring results

This chapter provides the main findings from the data analysis of the iMONITRAF indicators, which include road traffic volumes, transported tons and modal split, concentration of nitrogen dioxide and particulate matter, exposure to noise, toll prices, prices of fuel, recharging stations with alternative fuels, and national pricing components for road transport. For all the indicators, some methodological choices have been made both for the collection, analysis and interpretation of data. This chapter focuses on the description of the monitoring results, while the Annex provides all the relevant methodological explanations for each indicator.

To identify the eight transalpine corridors object of the analysis, a consistent colour scale is adopted: yellow = Ventimiglia, orange = Fréjus/Mont Cenis, red = Mont Blanc, blue = Gotthard, light blue = San Bernardino, cyan = Simplon, green = Brenner, violet = Tarvisio/Tauern.

Indicator "Road traffic volumes"

(1) **Figure 2** analyses the **overall annual average daily traffic for all vehicles** in the years 2005-2022, while Figure 5 (at the end of this section) provides a focus on the data of 2022 only. This indicator is the sum of total light and heavy vehicles circulating along the different corridors, divided by 365 (366 in leap years). In 2022, the number of vehicles crossing all iMONITRAF! corridors is about 108,000 per day, with an increase by 22.6% compared to 2021, and by 2.3% compared to 2019, i.e. the last year before the Covid-19 pandemic (which reached ca 105,600 vehicles/day). This highlights a general reestablishment of the growth trend in the years before the pandemic.

With an average of 31,900 vehicles per day, the Brenner corridor presents the highest traffic flows, followed by Ventimiglia and Gotthard (24,700 and 18,600 vehicles). Tarvisio lies in the

[4] Link to the iMONITRAF! WebGIS application: http://sdi.eurac.edu/AlpinePoKforTransportandMobility/

middle with 14,500 vehicles. Finally, San Bernardino, Fréjus and Mont Blanc present the lowest values, with 8,070, 5,540 and 4,750 vehicles per day.

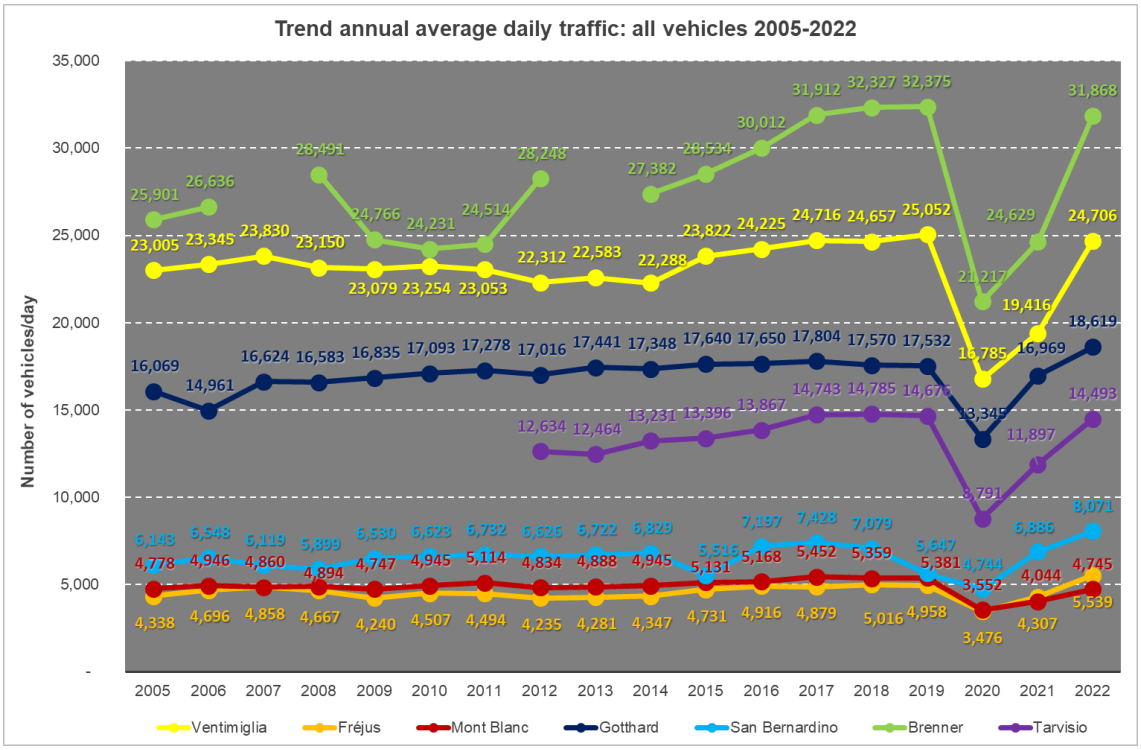

Figure 2: Annual average daily traffic: all vehicles per day

MAIN INSIGHTS: *Over 108,000 heavy and light vehicles per day: + 22.6% compared to 2021, + 2.3% compared to 2019. Flows have exceeded the pre-pandemic values (exception Brenner and Ventimigila).*

The analysis of the **period 2005-2021** shows different trends. If we consider the absolute traffic volumes, Brenner presents the highest values and a generalised increase of flows until 2019 (+ 25%). In the long term (2005-2019), Ventimiglia and Gotthard also show an overall growth of vehicles (respectively + 8.9% and + 9.1%). In addition, Tarvisio reveals a generalised increase (+ 16%), but for this corridor, data is available only from 2012 onwards. Finally, from 2005 to 2019, Fréjus and Mont Blanc registered a relative increase of more than 10% but absolute values are lower. These growing trends until 2019 were broken by the Covid-19 pandemic years 2020-2021. In 2021, a first rebound of flows is visible (roughly + 20% compared to 2020 considering all corridors).

In 2022, the effects of the Covid-19 pandemic appear almost completely compensated, although some differences among corridors are visible. San Bernardino, Fréjus and Gotthard register higher flows in 2022 than in 2019: + 43%, + 12% and + 6%, respectively. Brenner, Ventimiglia and Tarvisio show values slightly lower than in 2019. Finally, flows at Mont Blanc are still 12% lower than in 2019. However, this condition has to be observed considering also the maintenance works of the Mont Blanc tunnel occurred in spring and summer 2022, which have conditioned the traffic flows.

(2) Considering the **annual average daily traffic of heavy vehicles** (Figure 3) for the period 2005-2022 and Figure 5 for a focus on 2022), the aggregated number of heavy vehicles crossing all iMONITRAF! corridors summed up to 24,400 vehicles per day in 2022 (+ 2.6% compared to 2021 and + 2.4% compared to 2019). Therefore, the values of 2022 have exceeded those registered in the last pre-pandemic year.

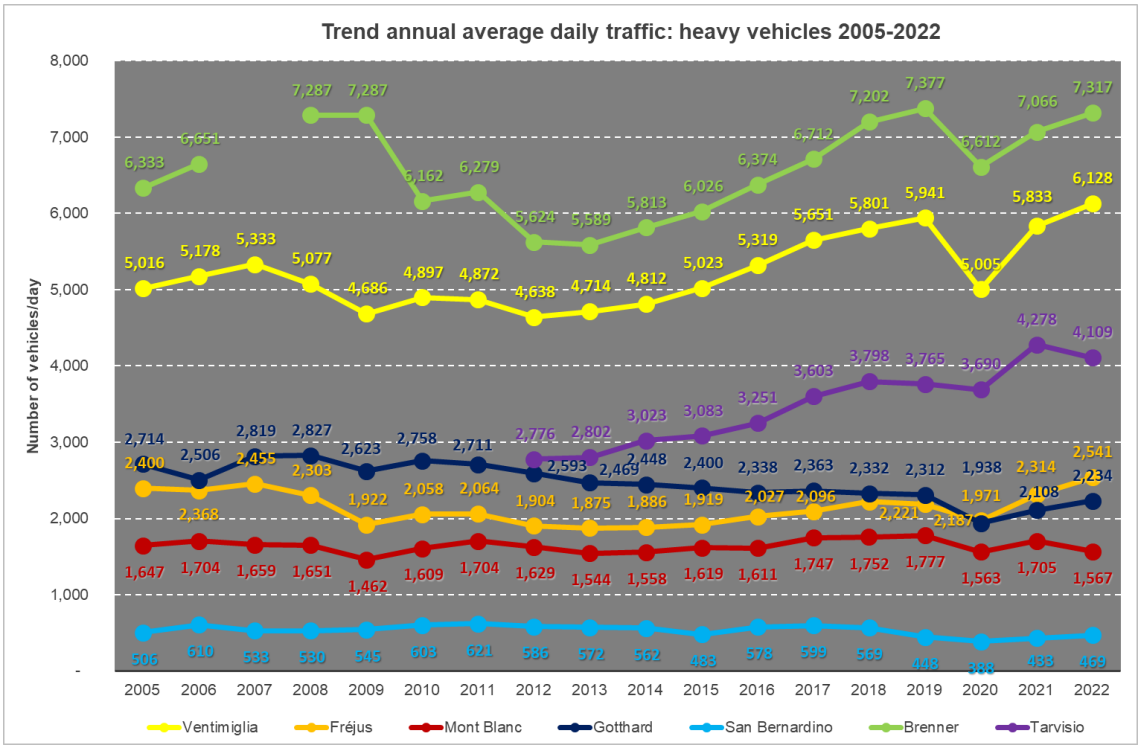

Figure 3: Annual average daily traffic: Heavy vehicles per day

MAIN INSIGHTS: *No reversal of the trend in sight: Turning back to levels before the pandemic crisis: 24,366 vehicles per day in 2022, + 2.6% compared to 2021, + 2.4% compared to 2019 (last pre-pandemic year).*

By analysing the **period 2005-2021**, several phases can be distinguished: between 2005 and 2007, the volume of heavy vehicles increased at all corridors for which data is available (i.e. Brenner and Tarvisio excluded). This development is followed by a decline until 2009, reflecting the impact of the economic crisis. The year 2010 showed some rebound (except for Brenner), followed by another generalised decrease in 2011-2013. In the period 2014-2019, a constant increase has been registered at Brenner and Ventimiglia. Tarvisio, Mont Blanc and Fréjus also showed an increase from 2014 to 2018 and a slight decrease in 2019. A decline is visible along the Swiss corridor of Gotthard for the same period 2014-2019 due to the ambitious modal shift policy implemented in Switzerland. Due to the Covid-19 pandemic, 2020 represents a decrease phase for all corridors. In particular, Brenner and Ventimiglia register the strongest variations, while Tarvisio and San Bernardino the lowest ones. In 2021, the effects of the first pandemic waves are partially compensated and the flows registered across all corridors are almost identical to those of 2019 (- 0.3%).

In 2022, the rebound of flows continues. Registered data are higher than those of 2019 for four out of the seven observed corridors: Ventimiglia, Fréjus, San Bernardino and Tarvisio. For the Brenner, 2022 flows have reached again the values of 2019. On Gotthard, the numbers are lower than in 2019 which is due to the now fully operable 4m corridor along the Gotthard corridor and its effects on modal shift. In detail, the highest number of heavy vehicles was registered at Brenner, where an average of 7,317 vehicles per day was counted (+ 3.6% compared to 2021 and - 0.8% compared to 2019). Ventimiglia follows with 6,100 vehicles per day (+ 5.1% compared to 2021 and + 3.2% compared to 2019). Tarvisio is the third corridor with 4,100 vehicles (- 4.1% compared to 2021 but + 9.1 compared to 2019). Along these three corridors, a constant increase has been registered since 2012, the trend has been inverted in 2020 due to the effects of the Covid-19 pandemic, while a rebound has been registered in 2021 and 2022 till a complete return to pre-pandemic conditions. A similar trend has affected also the other corridors with a lower

amount of vehicles per day. Specifically, Fréjus registered 2,540 vehicles per day (+ 16.2% compared to 2019), Gotthard registered 2,230 vehicles per day (- 3.4% compared to 2019), Mont Blanc 1,570 vehicles per day (- 11.8% compared to 2019), and San Bernardino 470 vehicles per day (+ 4.9% compared to 2019). As explained above, the 2019-2022 gap visible for Mont Blanc can be linked to the maintenance works of the tunnel in 2022, which have influenced the flows of heavy and light vehicles.

(3) Considering the **annual average daily traffic for light vehicles** (Figure 4) for the period 2005-2022 and Figure 5 for a focus on 2022), the aggregated number of light vehicles crossing all iMONITRAF! corridors was at 83,700 per day in 2022 (+ 29.9% compared to 2021 and + 2.3% compared to 2019). Compared to heavy vehicles, the relative decrease registered for light vehicles during the two pandemic years 2020-2021 is much higher, as well as the new increase of 2022 is more evident. This is consistent with the mobility restrictions posed by the Covid-19 pandemic measures to the movement of people rather than goods.

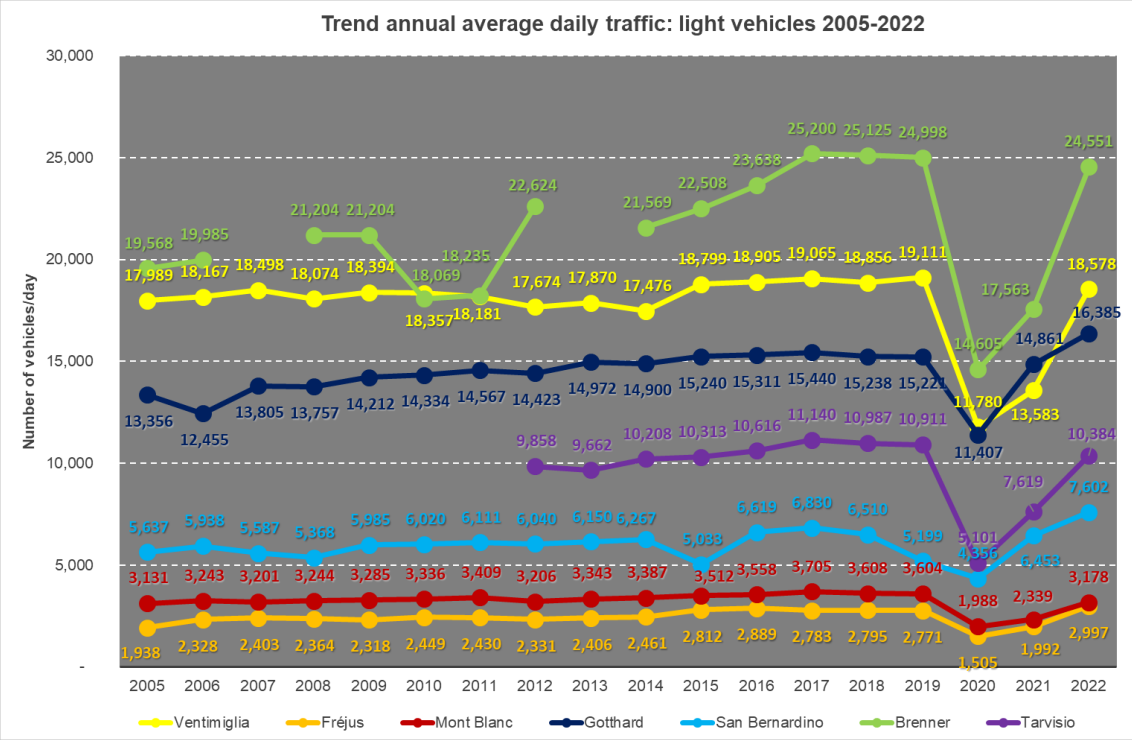

Figure 4: Annual average daily traffic: Light vehicles per day

MAIN INSIGHTS: *The effect of the pandemic crisis has complitely vanished: 83,675 vehicles per day, + 29.9% compared to 2021, + 2.3% compared to 2019 (last pre-pandemic year).*

The analysis of the **period 2005-2021** depicts a moderate increase of light vehicles until 2009, followed by a general stabilisation for the years 2010-2013 (not valid for the Brenner corridor, which registered a significant reduction of flows in 2010 and 2011). After this phase, a general increase is recognised for all corridors in 2014, 2015 (except for San Bernardino, for a temporary closure of the road and for an incomplete dataset), 2016 and 2017. In 2018 and 2019 the trend was negative again (overall - 1.2% in 2018 and - 1.6% in 2019). Comprehensively, until 2019, a generalised increase of flows along all corridors was registered. All these trends have been reversed by the exceptional events of 2020. Due to the Covid-19 pandemic, an overall decrease of flows by 38% compared to 2019 has been registered across all corridors, with the most severe impacts at the Tarvisio (- 53.2%) and Fréjus (- 45.7%). A first rebound occurred in 2021 (ca + 27% compared to 2020 across all corridors), although overall flows are still ca 20% lower than in 2019.

In 2022, a second rebound is registered (ca + 30% compared to 2021 across all corridors), bringing the values back to the pre-pandemic condition of 2019. The highest values of 2022 were recorded at Brenner with 24,600 vehicles per day, followed by Ventimiglia (18,600), Gotthard (16,400), Tarvisio (10,400) and San Bernardino (7,600). The number of transits between France and Italy along Mont Blanc and Fréjus was the lowest (respectively 3,180 and 3,000 vehicles per day). Values of 2022 are very close to those of 2019 for most corridors. The two most evident negative differences regard the Month Blanc (- 12%) and Tarvisio (- 4.8%), with values at Mont Blanc influenced by the maintenance works affecting the tunnel in 2022. Ventimiglia and Brenner have almost evened the 2019 values (- 2.8% and - 1.8%). Fréjus, Gotthard and San Bernardino have instead exceeded the values of 2019 (+ 8.2%, + 7.7% and + 46.2%, respectively).

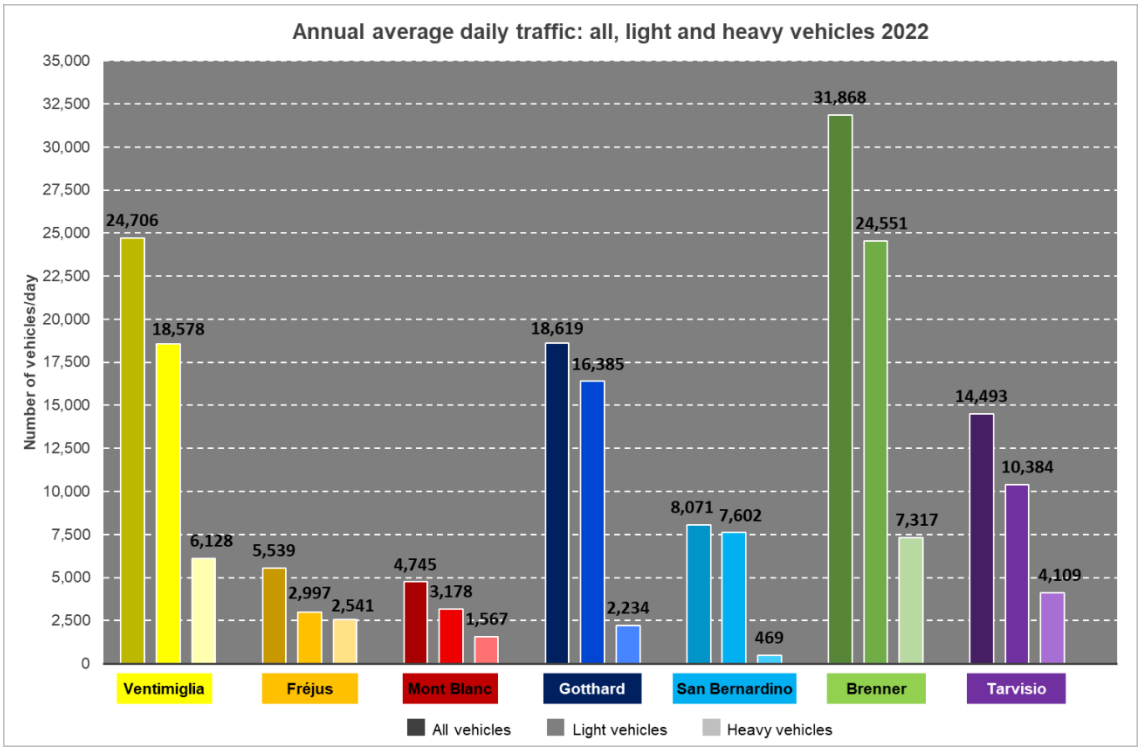

Figure 5: Annual average daily traffic: all, light and heavy vehciles per day in 2022

MAIN INSIGHTS: *The Brenner corridors registers the highest amount of both light and heavy vehicles (24,551 and 7,317), leading to a total amount of 31,868 vehicles.*

Indicator "Road traffic volumes" – Monthly data 2019-2022

(1) By observing the **monthly average daily traffic for all vehicles from 2019 to 2022** (Figure 6), it is possible to recognise the impacts of the pandemic waves of spring 2020 and winter 2020-2021, as well as the rebounds of the second half of 2021 and 2022.

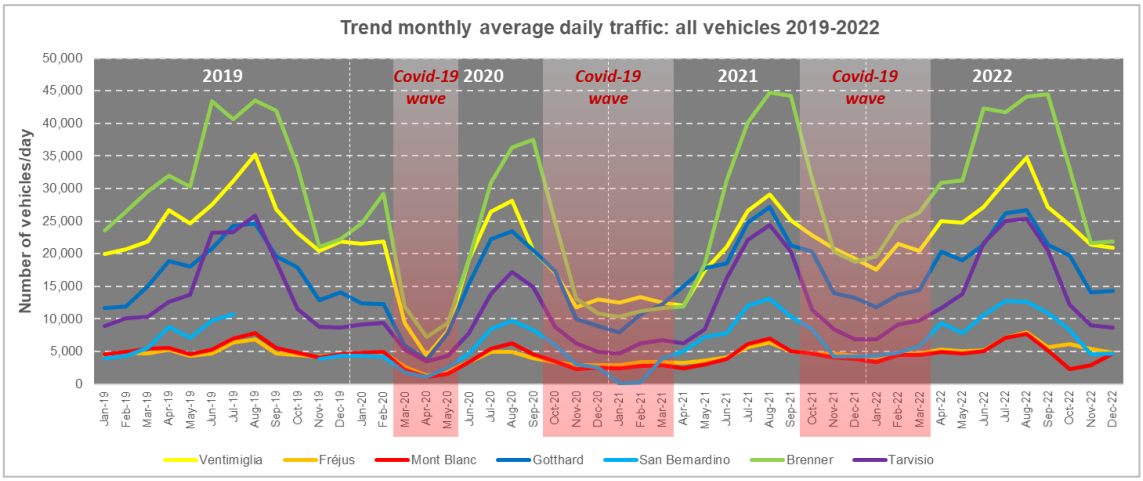

Figure 6 : Monthly average daily traffic: all vehicles per day 2019-2022

MAIN INSIGHTS: *Peaks in in the summer months, especially for the corridors with high traffic volumes. Main drops related to the Covid-19 pandemic crisis in spring 2020 and winter 2020-2021. Higher flows in winter 2021-2022.*

The impacts of the Covid-19 pandemic are most visible when comparing monthly data between 2019 and 2020. In March, April and May 2020, values registered along all corridors are on average lower compared to the same months in 2019. During the first months of 2021, the prevention measures have been kept in several EU countries and this is reflected by the flows registered in the timeframe January-April 2021 compared to the same period in 2019. On average, registered flows in January, March and April 2021 are lower compared to the same months in 2019. As there were no further travel comprehensive restrictions, the second half of 2021 has registered much higher flows, which are closer to the pre-pandemic trend and in some cases even higher.

2022 has seen the (minor) return of a pandemic wave in the first winter months. Accordingly, flows registered in January 2022 are on average 10.5% lower than January 2019. However, during the rest of 2022, the situation gradually changes, returning to pre-pandemic values: - 6.2% in March 2022 compared to 2019, + 1.0% in June 2022 compared to 2019, and + 7.7% in September 2022 compared to the same month of 2019. This confirms an almost complete return to the pre-pandemic trend of overall traffic flows.

(2) The general trend affecting all vehicles is consistent with that one regarding **monthly average daily traffic for heavy and light vehicles** respectively. However, some differences may be noticed (Figure 7 and Figure 8). In particular, the reduction of road traffic volumes experienced by heavy vehicles in 2020-2022 is less evident than the one affecting light vehicles (according to the different measures adopted for individual mobility and freight transport).

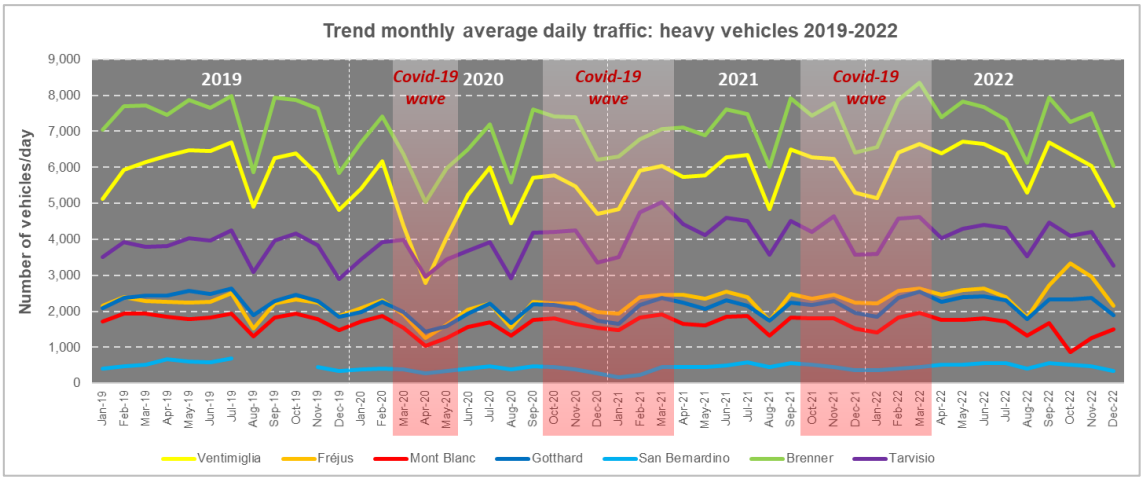

Figure 7: Monthly average daily traffic: Heavy vehicles per day 2019-2022

MAIN INSIGHTS: *Visible waves especially in spring 2020 due to the Covid-19 pandemic crisis, rebound in 2021-2022.*

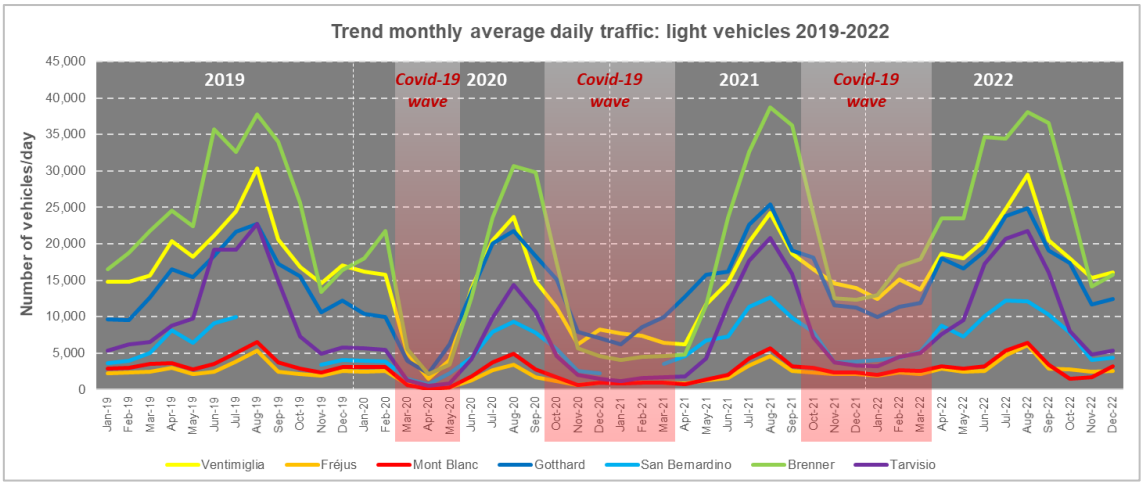

Figure 8: Monthly average daily traffic: Light vehicles per day 2019-2022

MAIN INSIGHTS: *Very visible waves due to the Covid-19 pandemic crisis in spring 2020 and winter 2020-2021, rebound in the second half year 2021 and in 2022.*

3rd pandemic wave (Oct-21 / Mar-22): A general rebound of flows is visible compared to the previous periods. In the second half of 2021, a general rebound is similarly registered for both light and heavy vehicles. This is visible by comparing the data registered across all corridors from July until November 2021 compared to 2019. The variation of light-vehicle flows ranges between - 5.1% and + 2.3% compared to the same months of 2019; while the variation of heavy-vehicle flows is between - 6.6% and + 6.1%. The rebound trend is generally confirmed in early 2022, although differences between light and heavy vehicles are visible. For instance, in March 2022, light-vehicle flows are 13.9% lower than in 2019, but heavy-vehicle flows are instead 6.8% higher. From summer until winter 2022, the rebound is more evident, with higher flows in 2022 than in 2019. For instance, September 2022 registers + 7.8% for light vehicles and + 2.6% for heavy vehicles compared to September 2019 across all corridors.

Indicator "Transalpine freight transport rail and road"

(1) Regarding the **amount of tons transported along all the corridors by road and rail**, in 2022 165.8 Mt were carried across the above-mentioned corridors, 110.7 Mt by road (67%) and 55.1 Mt by rail (33%). The total amount registered in 2022 is roughly identical to 2021 (- 0.1%) and 4.1% higher than 2019. Compared to 2021, road-transported tons are increased by 1.1%, while rail tons are decreased by 2.5%. Figures 9 and 10 report the 2005-2022 trend and the values of 2022 only.

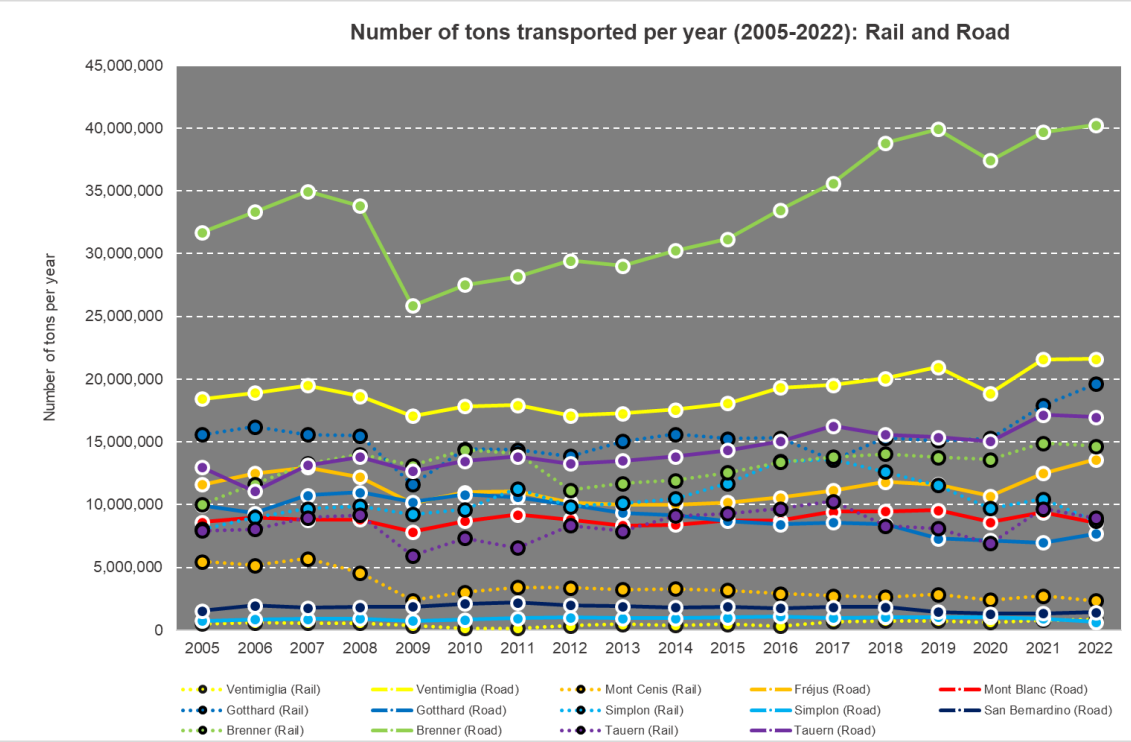

Figure 9: Transported tons per corridor, period 2005-2022

MAIN INSIGHTS: *110.7 Mt by road (67%) and 55.1 Mt by rail (33%): similar to 2021 and + 4.1% compared to 2019.*

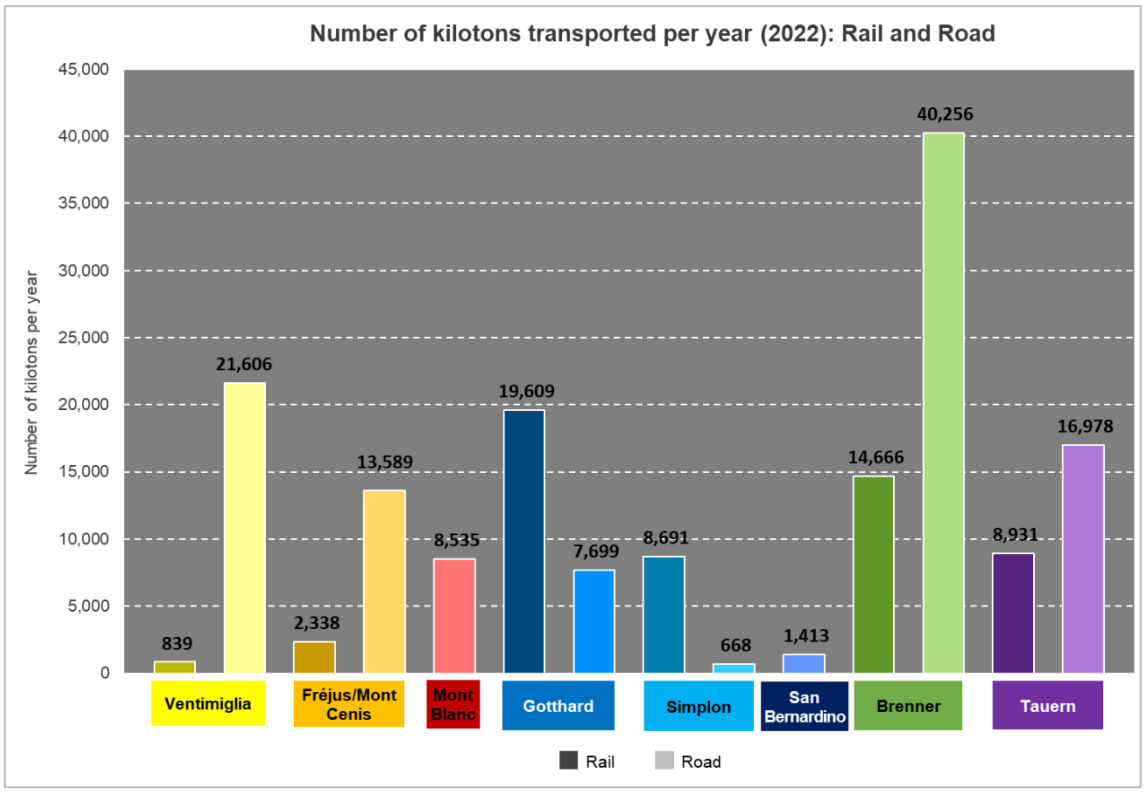

Figure 10: Transported tons per corridor, year 2022

MAIN INSIGHTS: *Highest road volumes at the Brenner (40.26 Mt/year) and rail ones at the Gotthard (19.61 Mt/year).*

As regards the single corridors, an increase of the overall freight volumes is detected at Brenner (from 54.6 Mt to 54.9 Mt, + 1%). This trend is the result on a decrease in rail transport (dropping from 14.9 Mt to 14.7 Mt; i.e. - 1.6%), and an increase in road transport (rising from 39.7 Mt to 40.2 Mt; i.e. + 1.5%). Along the Tauern, the other IT-AT corridor, the number of tons transported is less than half of the Brenner and it has decreased by 3% in the past year: 26.8 Mt in 2021 and 25.9 Mt in 2022. The decrease affects especially the rail (- 8% between 2021 and 2022) and also the road (- 1%). Swiss corridors of Gotthard and San Bernardino register an increase in transported tons, while Simplon shows the opposite trend (- 18% from 2021 to 2022). At the Gotthard, an increase of volumes by 10% from 2021 to 2022 was caused by rail and road jointly (+ 9% and + 10%). At the San Bernardino, the increase between 2021 and 2022 was of 7% (freights only by road). Along the French-Italian corridors, the total amount of transported tons has increased except for the Mont Blanc. At Ventimiglia, the total increase is less than 1%, caused by a 5% increase in the rail-transported tons. Along the Fréjus/Mont Cenis, a general increase by 5% is caused by a road increase by 9% counterbalanced by a rail decrease by 14%. Along the Mont Blanc, where no rail connection is available, goods transported by road have decreased by 9% compared to 2021, also due to the maintenance works of 2022 that have limited the circulation in spring and summer.

(2) Considering **modal split** (Figure 11), the Swiss-Italian corridors of Simplon and Gotthard were the corridors with the highest share of rail and the only ones that exceeded the threshold of 50% of goods transported by train also in 2022.

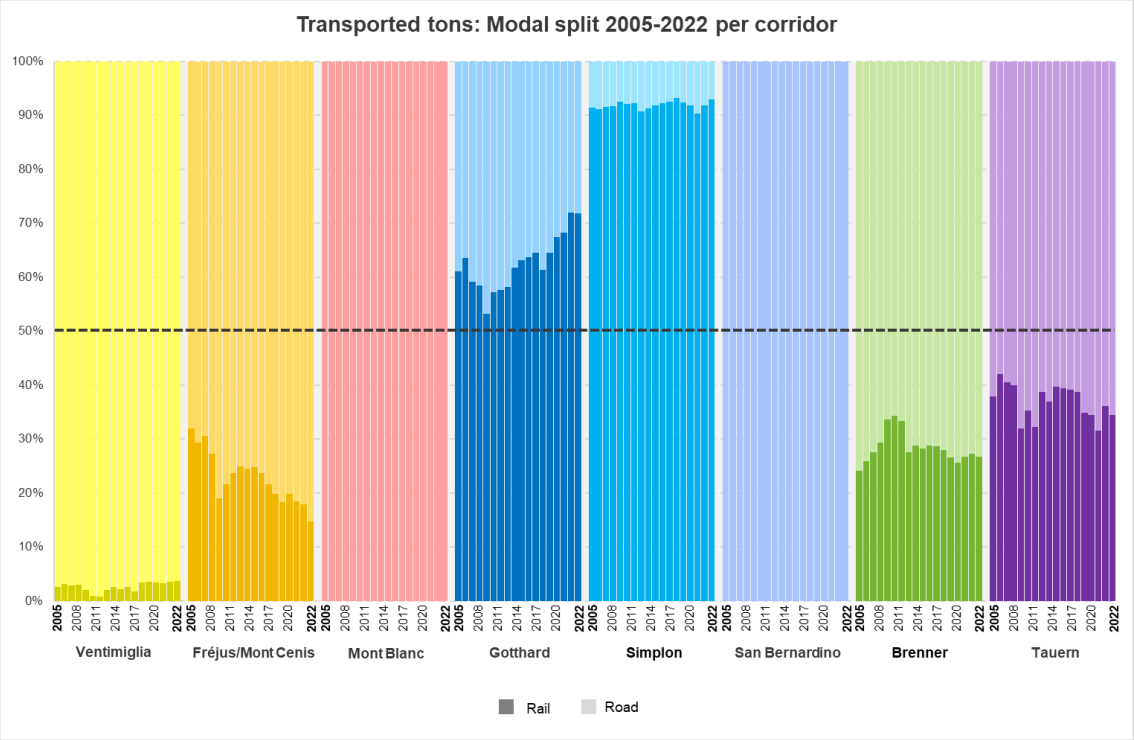

Figure 11: Transported tons, modal split per corridor

MAIN INSIGHTS: *General stabilisation or decrease in rail share for most of the corridors, apart for a 1% increase registered at the Simplon in 2022 compared to 2021.*

Rail volumes at Gotthard increased in the period 2009-2014 and remained stable at 64% in the years 2015-2016, decreasing to 61% in 2017 (due to a construction accident on the German Upper Rhine rail access in Rastatt) and again increasing in 2018, reaching 65%. During the period 2019-2022, the percentage further increased despite the Covid-19 pandemic in 2020 and the following rebound in 2021 and 2022 (67% in 2019, 68% in 2020, 72% in 2021 and 2022). The numbers highlight the positive impacts of the now fully operable 4m corridor and the related modal shift measures. Simplon always presented rail values above 90%, and in 2022, the share was at 93%, i.e. 3% more than in 2020 (first pandemic year). Along the Brenner, the rail share has steadily decreased from 34% to 28% in the period 2010-2014. Between 2015 and 2017, this share has remained almost stable (28-29%). Finally, in the years 2018-2022 the rail share has been constant to 26-27%, i.e. slightly lower than in the previous period. In 2022, the percentage at Tauern was 34% for rail (the same of 2019 and 2% less than in 2021). Referring to the French-Italian corridors, the rail data for 2022 shows a decrease at the Fréjus/Mont Cenis (15% in 2022 against 18% in 2021), while Ventimiglia registered the same values of 2021 (4% rail, 97% road). Finally, Mont Blanc and San Bernardino do not have a transalpine rail connection, therefore 100% of freight is transported across their corridors on road.

(3) When referring to the **railway component** (Figure 12), it is also possible to distinguish the type of service between conventional transport, unaccompanied combined transport (UCT) and accompanied combined transport (ACT). Along the two French-Italian corridors with rail connection (i.e. Ventimiglia and Mont Cenis), UCT and conventional rail transport play the major role. In 2022, along the Ventimiglia line, UCT constituted 44% of rail movements and the remaining 56% were conventional. Along Mont Cenis, UCT counted for about 47% and conventional transport for 53%. The condition was similar along the two Swiss corridors, with UCT as the main component (72% at Gotthard and Simplon), followed by conventional transport (28% at Gotthard and 14% at Simplon). Along Brenner, UCT counted for 61% of total freight transport, followed by conventional

transport and ACT (connection Wörgl-Brennersee-Trento), with, respectively, 21% and 19% of total volumes. Finally, at Tauern, most of the rail traffic (64%) is conventional, followed by UCT (36%).

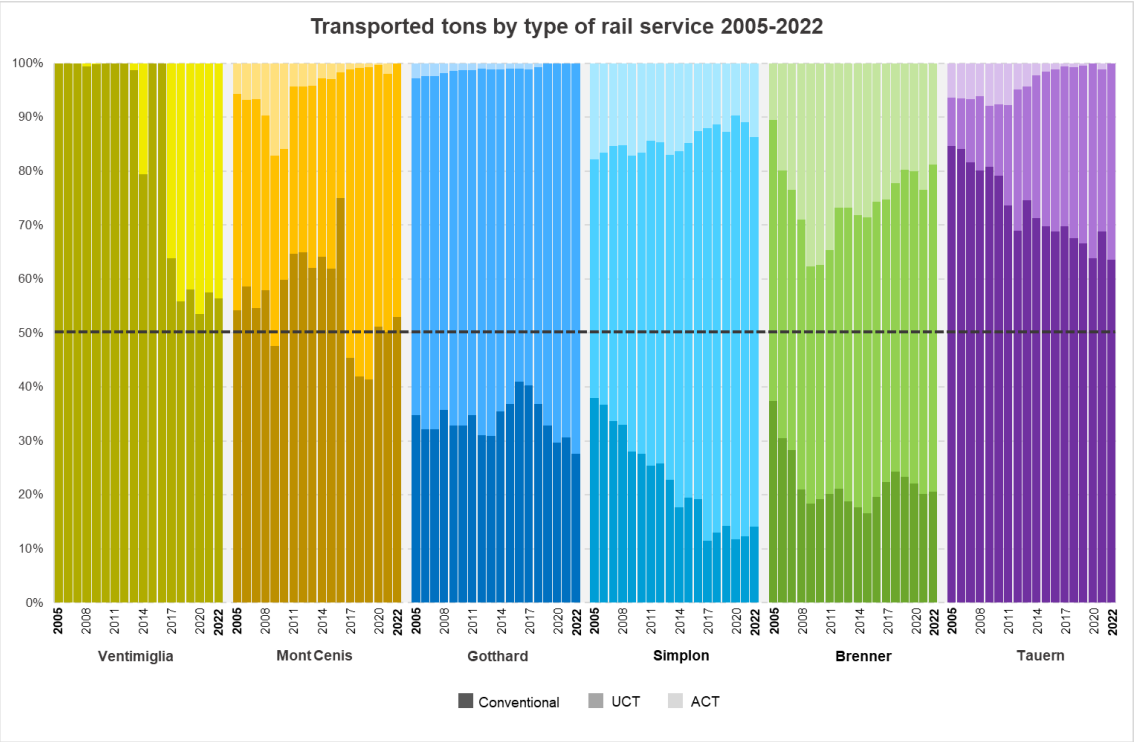

Figure 12: Transported tons by rail, type of services

MAIN INSIGHTS: *Conventional rail service less sensitive during the Covid-19 pandemic crisis.*

Indicator "Transalpine freight transport rail and road" – Monthly data 2019-2022

(1) Figure 13 shows the number of tons transported by road and rail per month during the years from 2019 to 2022 along the eight transalpine corridors. The impact of the Covid-19 pandemic and of the following rebound is particularly evident by comparing for each corridor and component (road and rail) the data registered in the same months of 2022, 2021, 2020 against 2019. In particular, spring 2020 and winter 2020-2021 show the most evident impacts of the pandemic crisis, while the rest of 2021 and 2022 tend to show a rebound of values.

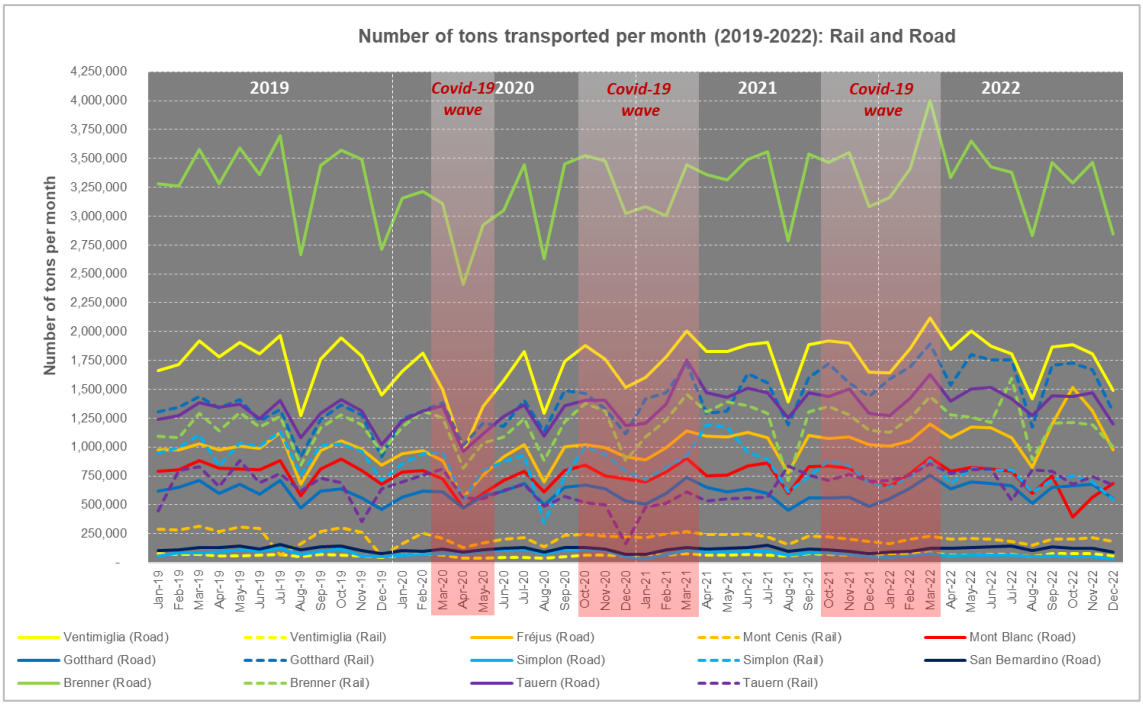

Figure 13: Transported tons per corridor per month (2019-2022)

MAIN INSIGHTS: *Most visible wave effects in spring 2020 and winter 2020-2021, while the rest of 2021 and 2022 show limited negative impacts and a general rebound of values.*

3rd pandemic wave (Oct-21 / Mar-22): The period October-December 2021 shows a rebound of transport volumes. In November 2021, overall transported volumes across all corridors were 13% higher than in November 2019 (+ 7% for road and + 21% for rail). This increase grows up to + 30% when comparing December 2021 and 2019 (+ 10% for road and + 58% for rail). These values highlight the general resurgence of the transport volumes in late 2021. The strongest increases of autumn 2021 regard Simplon and Tauern for road transport (+ 24.7% along Simplon and + 14.9% along Tauern in November 2021 compared to November 2019). For rail volumes, the highest increases are visible along Gotthard (+ 21.3% in November 2021 compared to 2019), as well as along Tauern (+ 115.7% in November 2021 compared to 2019). In the period January-March 2022, this rebound is partially contrasted by a new decrease in flows in January and February, followed by a new rebound in March 2022. Overall, transported volumes have been 3.7% lower in January 2022 than January 2019. This trend reverses in March 2022 (+ 4.9% compared to March 2019), as well as in most of the other months of 2022. For instance, in November and December 2022, the overall amount of transported tons is on average 12.5% and 21.9% higher than in the same months of 2019, suggesting an almost complete return to the pre-pandemic conditions.

Indicator "Air pollution concentrations measured"

(1) Figures 14 and 15 illustrate the trend in annual average for **nitrogen dioxide (NO_2)** ambient concentrations between 2005 and 2022 near the highways, since NO_2 is mainly related to road transport (and particularly to diesel vehicles). In general terms, the year 2022 registered a decrease compared to 2021 in about 2/3 of the measuring stations (nine out of 16 active stations), no variation for two stations, and an increase for the remaining five stations. This condition is linked to the new increase of flows in 2021 and 2022, after the first pandemic year 2020.

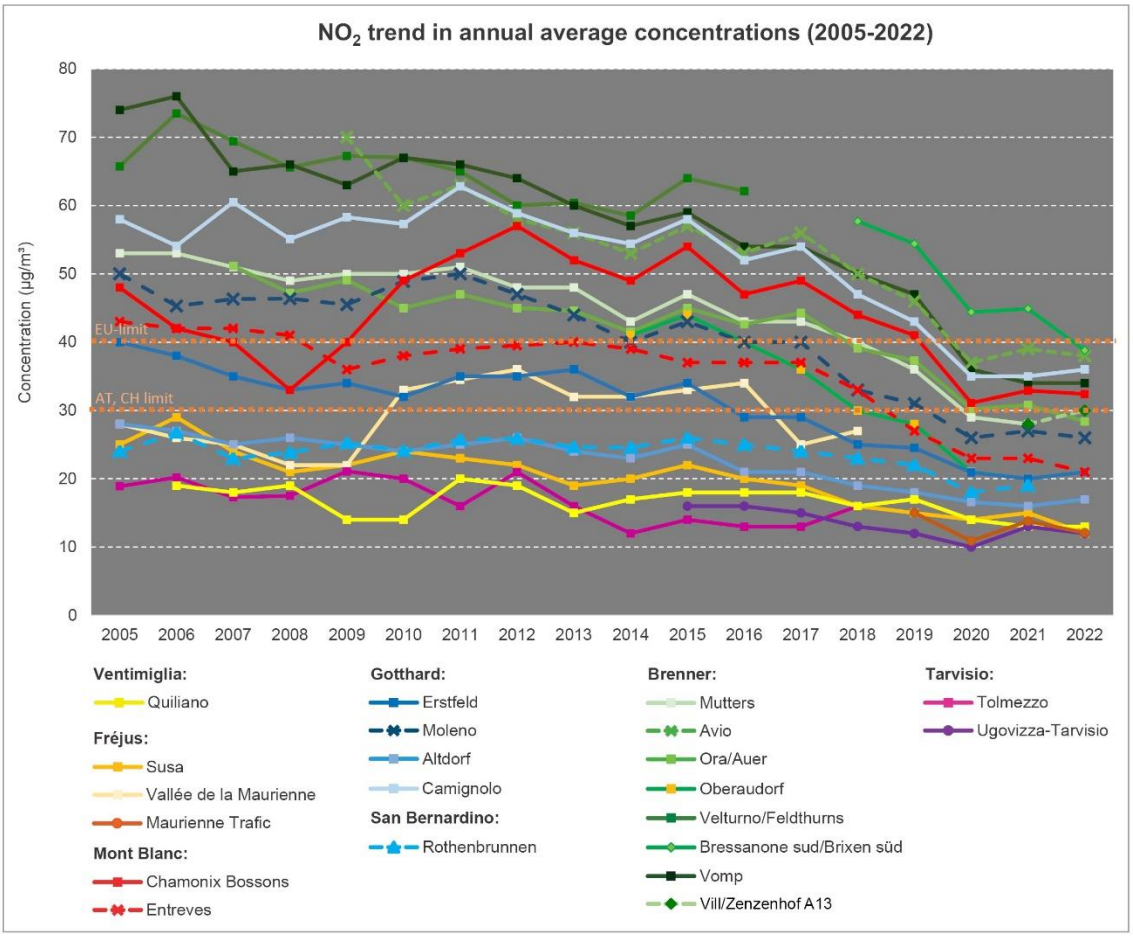

***Figure 14: NO_2 trend in annual average concentrations* (2005-2022)[5]**

MAIN INSIGHTS: *Slight rebound in 2022 (as in 2021) after the lower values of 2020 due to the Covid-19 pandemic crisis. Nevertheless, 2022 values are lower by 3% than those of 2021 across all the measuring stations.*

[5] The value for the station Vallée de la Maurienne in 2011 represents the average 2010-2012; the value for Entreves in 2011 and 2012 represents the average 2010-2013.

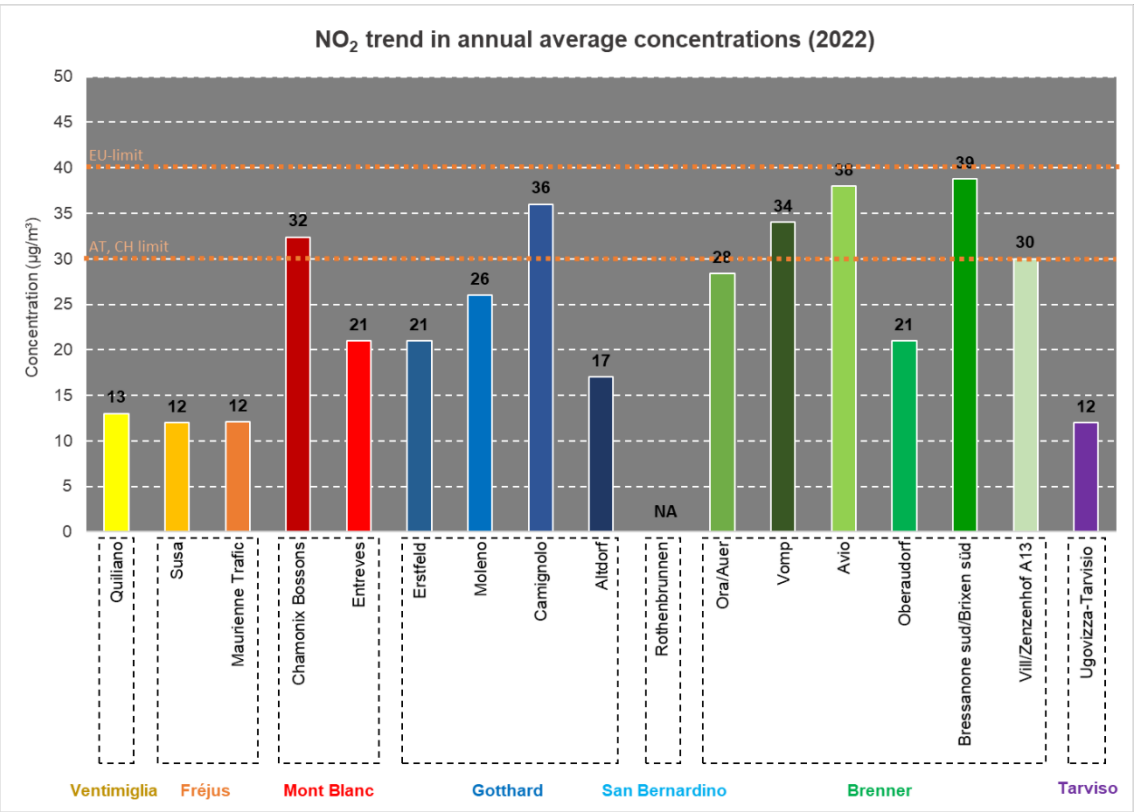

***Figure 15: NO_2 trend in annual average concentrations* (2022)**

MAIN INSIGHTS: *No station exceeding the EU limit of 40 µg/m³. Stations with the highest values along the Brenner, Gotthard and Mont Blanc.*

As in the last years, the highest concentrations of 2022 were measured along the Brenner (green colour scale), Mont Blanc (red) and Gotthard (blue) corridors, while lower values are visible along Fréjus, Ventimiglia, San Bernardino and Tarvisio (orange, yellow, light blue and violet colours). This result is related to the road traffic volumes presented in Figures 2-4, but it includes other effects, as well: composition of vehicle fleet (share of vehicle categories, share of EURO classes) and meteorology. In 2022, the annual average values of NO_2 did not exceed the EU annual limit value of 40 µg/m³ for any stations, although Bressanone sud/Brixen Süd and Avio along the Brenner corridor are very close to that limit (39 and 38 µg/m³), followed by the Camignolo station along the Gotthard: 36 µg/m³. The station of Camignolo on the Gotthard exceeded the national air concentration limits as defined for Switzerland, while the station of Vomp on the Brenner exceeded the limit of 30 µg/m³ but complied with the tolerance value of 35 µg/m³ applied in Austria.

Overall, the condition of 2022 is slightly improved compared to 2021 (when one station exceeded the EU limit), and significantly improved respect to 2019, when five stations registered values above the EU annual limit. Compared to 2021, the highest decreases in NO_2 concentration have been registered in Susa (Fréjus; - 20%), Bressanone sud/Brixen süd (Brenner; - 14%) and Maurienne Trafic (Fréjus; - 12%). Conversely, highest increases affected Vill/Zenzenhof A13 and Altdorf (+ 7% and + 6% respectively). On average, the variation registered across the measuring stations was - 3%.

(2) Similar to the description of NO_2, the analysis of the **particulate matter (PM_{10})** concentration is restricted at the roadside stations (Figures 16 and 17). Compared to 2021, a general increase of values is visible in 2022 (+ 11% across all stations). When comparing the values with 2019, this increase is of 12% across all measuring stations.

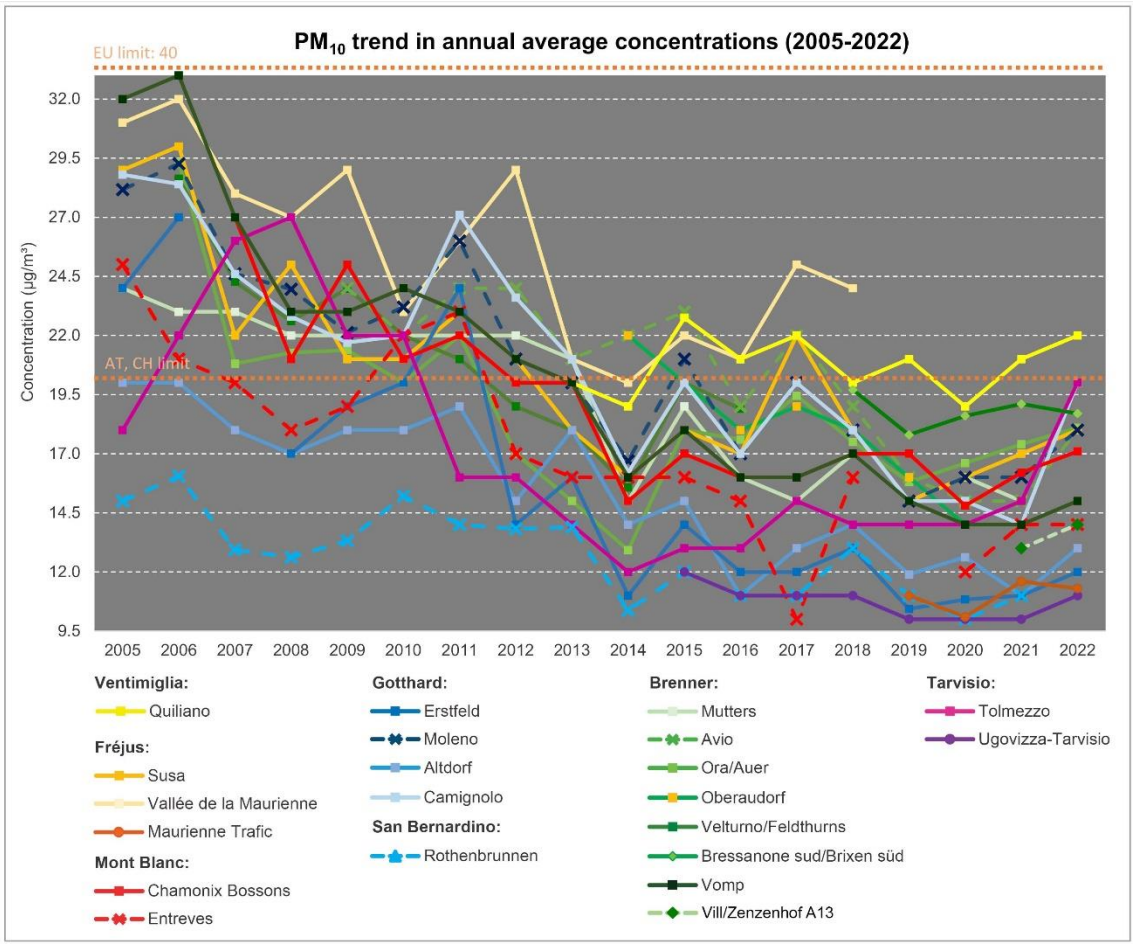

***Figure 16: PM_{10} trend in annual average concentrations* (2005-2022)**[6]

MAIN INSIGHTS: *Rebounds effects in the period 2021-2022 are visible after the values of the first pandemic year 2020. This applies especially to 2022 (+ 11% across all measuring stations compared to 2021).*

[6] The value for Vallée de la Maurienne in 2011 represents the average of the years 2010 and 2012.

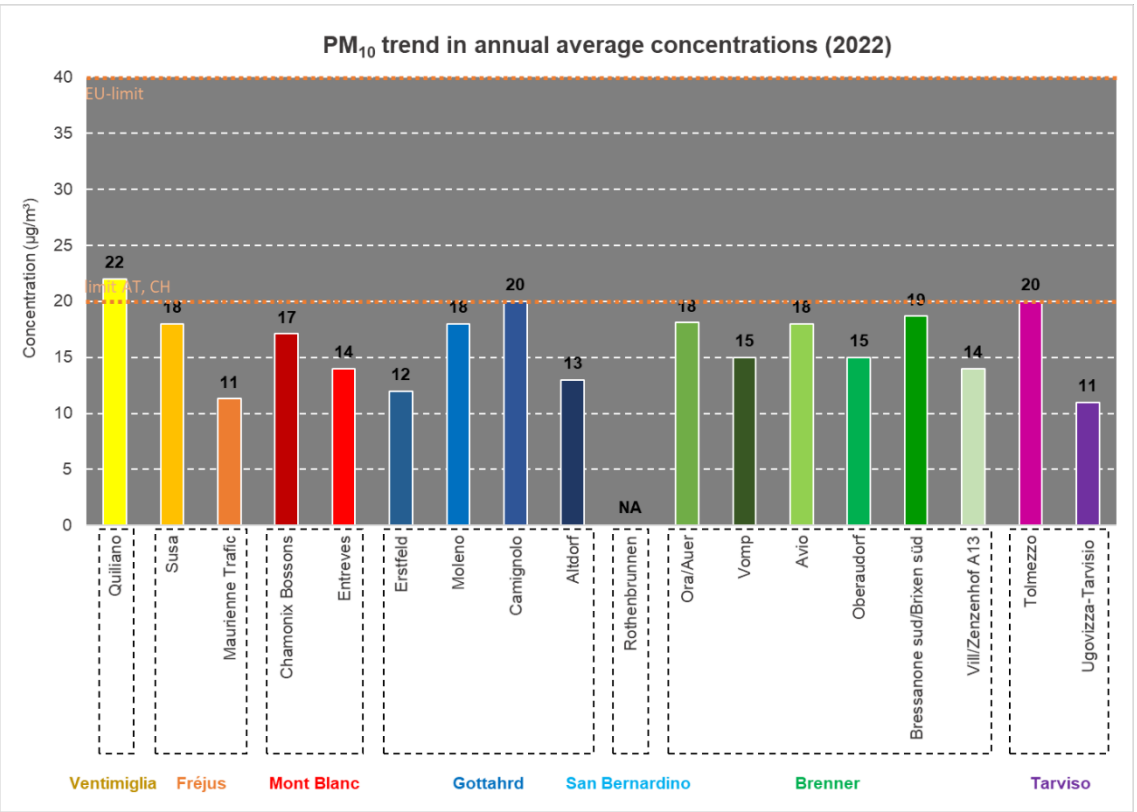

***Figure 17: PM_{10} trend in annual average concentrations* (2022)**

***MAIN INSIGHTS:** Highest values registered in Quiliano (Ventimiglia), Camignolo (Gotthard) and Tomezzo (Tarvisio): 20-to-22 µg/m³. No station exceeding the EU limit of 40 µg/m³.*

For two stations (Maurienne Trafic and Bressanone sud/Brixen süd), PM_{10} concentrations have slightly decreased by 3% and 2%. For one station (Entreves), values are the same as in 2021. For all the remaining stations (14 out of 17 active in 2022), values have increased in the range from + 4% to + 43%, with the highest relative increase scored by Camignolo (+ 43%), Tolmezzo (+ 33%) and Avio (+ 20%). The highest PM_{10} concentrations (in the range 20-22 µg/m³) have been registered at Quliano (Ventimiglia), Camignolo (Gotthard) and Tolmezzo (Tarvisio). Conversely, the lowest value (11-12 µg/m³) regarded Erstfeld (Gotthard), Ugovizza-Tarvisio (Tarvisio) and Maurienne Trafic (Fréjus). The limit value for the annual average that has been fixed by the EU (40 µg/m³) was not exceeded at any station and the limit values of Austria and Switzerland (20 µg/m³) were not exceeded at any Austrian or Swiss station (except for Camignolo reaching it).

A couple of caveats is necessary: PM_{10} concentrations are (more strongly than NO_2) influenced by sources other than transport such as wood heating installations. This partially explains why the influence of the Covid-19 pandemic in less evident for the PM_{10} than for the NO_2. Secondary PM_{10}, built from gaseous precursor concentrations (NO_x, SO_2, NH_3, VOC), can contribute to half of the PM_{10} concentrations measured. The long-term trends can therefore not only be traced back to the development of PM_{10} emissions of road vehicles.

Indicator "Air pollution concentrations measured" – Monthly data 2019-2022

(1) Figure 18 complements the previous data by focusing on the monthly trend for **nitrogen dioxide (NO_2)** ambient concentration during the period 2019-2022. This allows a more accurate observation of how concentration values registered before the Covid-19 pandemic (2019) have

changed during 2020-2022. As expectable, 2022 shows (similarly to 2021) a rebound of the decreasing trend affecting 2020.

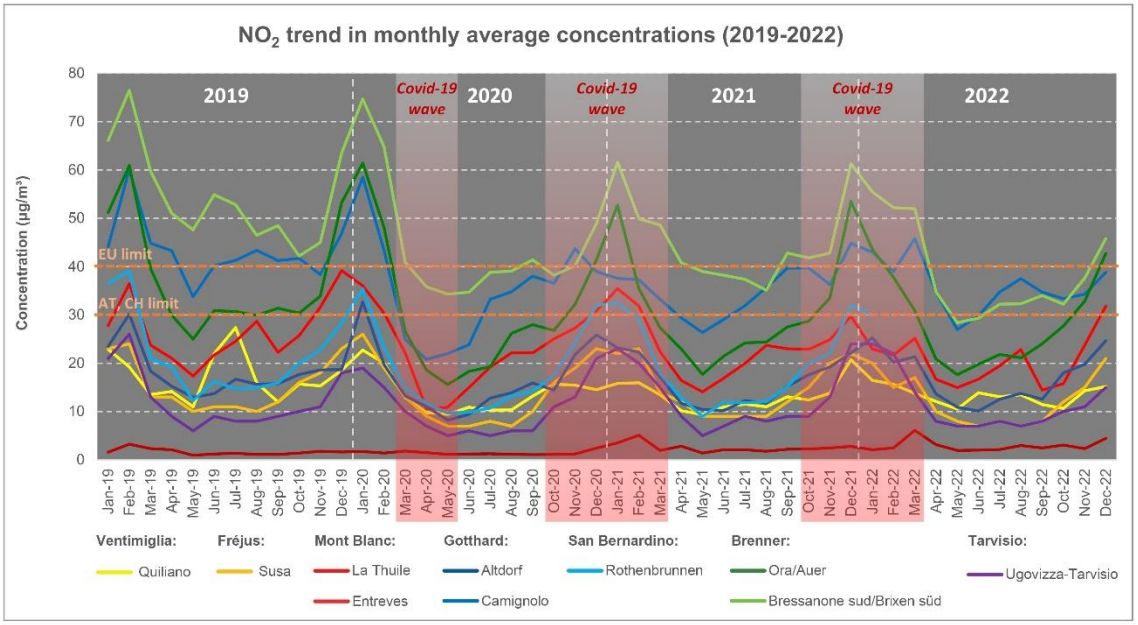

Figure 18: NO_2 trend in monthly average concentrations for 2019-2022

MAIN INSIGHTS: *Similar rebound of the monthly concentrations in 2022 as in 2021, especially in spring 2022 (compared to the period of the first Covid-19 pandemic wave in 2020 during which NO2 concentrations in March and April were considerably lower than in previous years).*

Monthly data for the year **2019** shows a fluctuation of NO_2 ambient concentration that is mostly consistent across all corridors. Due to meteorological conditions, the highest values are generally registered at the beginning and end of the year, while the lowest one affect the summer months. This pattern is not visible in **2020**. After a peak reached in January 2020 for almost all corridors, a significant decrease is registered in spring 2020, followed by a small increase in the period June-December 2020. **2021** shows a partial re-alignment to the pattern of 2019, especially in the first months of the year. However, the peak reached in December 2021 is still lower than that one shaping December 2019. In **2022**, values show a trend similar to 2021. In January 2022, values are generally lower than in 2019, although slightly higher than in 2021. In March 2022, seven out of the ten measuring stations register concentration values even higher than in March 2019. A similar condition affects the last months of 2022 (October-December). Even in this case, values tend to be lower than those of 2019 and very similar to those of 2021 in the same months. This trend indicates a progressive realignment of the NO_2 values to the pre-pandemic trends.

The impacts of the Covid-19 waves are visible also by comparing values registered in the same month between the four years for all measurement stations. Between **2020** and 2019, the decreases registered in March, May and July were on average of 22%, 23% and 29% across all corridors. When it comes to **2021**, the difference with 2019 is still visible but less evident considering the same three months: - 10%, - 12% and - 15% in March, May and July. In **2022**, the differences with 2019 are equal to: + 9% in March, - 12% in May, and - 25% in July. Although heterogeneous, these values show a rebound of flows in 2022 higher than that one experienced in 2021, especially in spring.

(2) Figure 19 focuses on the monthly trend for **particulate matter (PM_{10})** ambient concentration during the period 2019-2022. For sake of consistently, the same measurement stations considered above are taken into account, i.e. Quiliano (Ventimiglia), Susa (Fréjus), Rothenbrunnen (San Bernardino), Ugovizza-Tarivisio (Tarvisio), La Thuile and Entreves (Mont Blanc), Altdorf and Camignolo (Gotthard), and Ora/Auer and Bressanone Sud/Brixen Süd (Brenner).

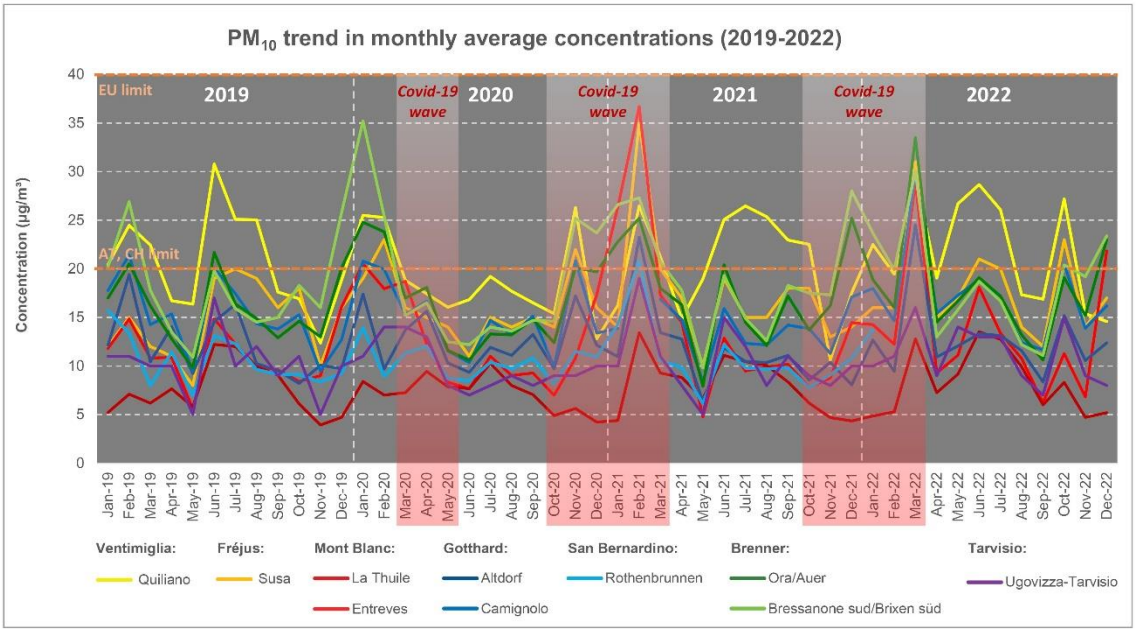

Figure 19: PM_{10} trend in monthly average concentrations for 2019-2022

MAIN INSIGHTS: *Similarly to NO2 concentrations, the PM_{10} monthly trend of 2022 is close to 2019 and similar to 2021, showing a rebound compared to 2020 (first Covid-19 pandemic year).*

Data for **2019** shows three main peaks in February, June and December respectively. Conversely, values tend to decrease from March to May 2019, as well as from July to November 2019. The same trend is not visible in **2020**. After the peak registered in January 2020, values tend to steadily decrease until October 2020, with a little rebound in July 2020. A second peak is then reached in November 2020. In **2021**, the values are once again closer to the ones registered in 2019: there are three main peaks for most corridors in February, June/July and December. **2022** follows the logic of 2021, although the monthly peaks are located in different points, i.e. March, June and October. Overall, this trend indicates a progressive realignment with the pre-pandemic condition of 2019.

Differences and similarities between 2019, 2020, 2021 and 2022 (related to the different phases of the Covid-19 pandemic) are visible especially when comparing values registered in the summer months of June and July for the three years. Between **2020** and 2019, the decreases registered in June and July were on average of 44% and 18%. Between **2021** and 2019, the differences are smaller, with average registered decreases of 11% and 14% in June and August 2021 compared to the same months of 2019. In **2022**, the differences with 2019 are similar to 2021: - 12% in June and - 6.5% in July compared to the same months of 2019. This trend is in line with the progressive rebound of values showed by the annual figures.

Indicator "Noise"

(1) Noise has been measured through the **indicators L_{den} and L_{night}.** The former defines the overall level registered during the day, evening and night and is used to describe the general annoyance caused by noise. The latter is the indicator for sound levels during the night and it is used to describe sleep disturbance. Figure 20 and Figure 21 show that, in 2022, L_{den} lies in the range between 79.4 dB(A) and 70.4 dB(A), while L_{night} lies between the 72.0 dB(A) and the 62.2 dB(A). As in previous years, the highest value for both indicators was registered at Reiden and the lowest at Châtillon.

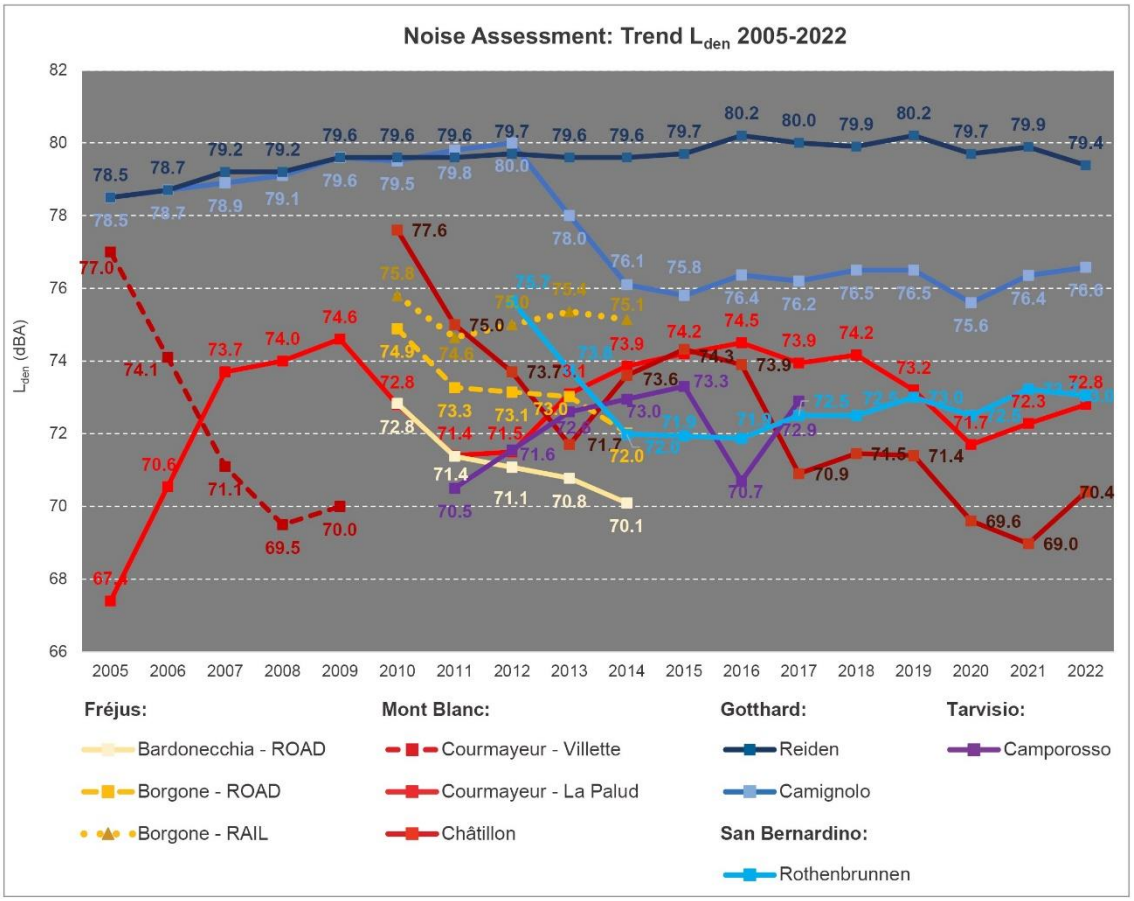

Figure 20: Daily average noise levels L_{den} trend[7]

MAIN INSIGHTS: *Similarly to air pollutant concentrations, rebounds of noise values in the period 2021-2022 are visible, as occurred between 2021 and 2020.*

[7] Data for Courmayeur – La Palud (year 2006), Bardonecchia and Camporosso (year 2012) is not available. The average value between the previous and the following year has been considered.

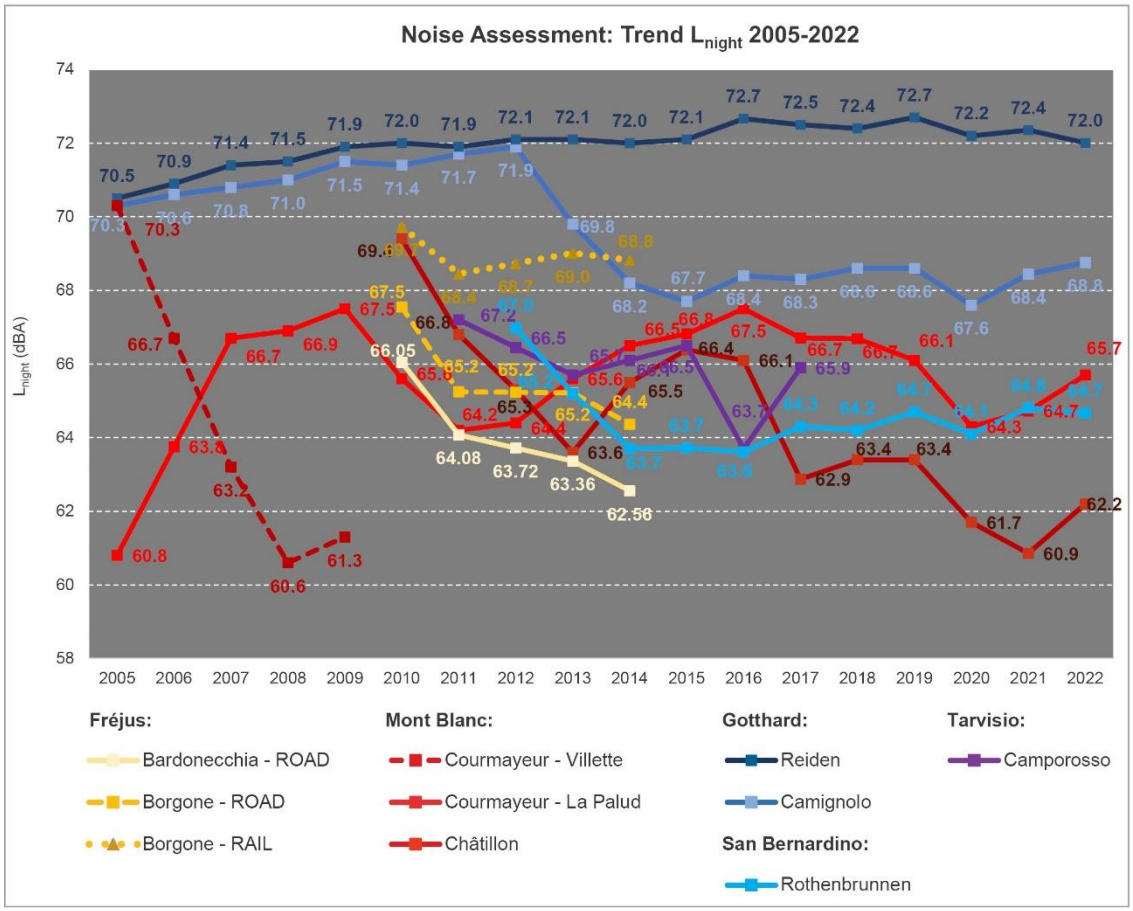

Figure 21: Average noise levels during night L_{night} trend[8]

MAIN INSIGHTS: *Similarly to air pollutant concentrations, rebounds of noise values in the period 2022-2021 are visible, as occurred between 2021 and 2020.*

According to the restrictions posed by the Covid-19 pandemic, all measurement stations registered noise reductions in **2020** compared to 2019, which range between - 2.5% and - 0.6% for L_{den}, and between - 2.7% and - 0.7% for L_{night}. Specifically, the highest reductions were registered in Courmayeur-La Palud (- 2.0% for L_{den} and - 2.7% for L_{night}) and Courmayeur-Villette (- 2.5% for L_{den} and - 2.7% for L_{night}). In **2021**, data has increased again compared to 2020 for almost all measuring stations (+ 0.7% for L_{den} and + 0.9% for L_{nigh} on average). The highest increases compared to 2020 are registered in Reiden and Rothenbrunnen for L_{den} (both + 1.0%), as well as in Camignolo and Rothenbrunnen for L_{night} (+ 1.2% and + 1.1% respectively). In **2022**, a further increase of values compared to 2021 is visible for Camignolo (+ 0.3% for L_{den}; + 0.5% for L_{nigh}), Châtillon (+ 2.1% and + 2.2% respectively) and Courmayeur-La Palud (+ 0.7% and + 1.5% respectively), while the two remaining stations of Reiden and Rothenbrunnen experience a small decrease (in the range - 0.2/- 0.6%). Overall, the values of 2022 are still lower than those of 2019 (last pre-pandemic year) for three out of the five observed measuring stations, slightly higher for Camignolo (+ 0.10% for L_{den}; + 0.23% for L_{nigh}) and the same of 2019 for Rothenbrunnen.

[8] Data for Courmayeur – La Palud (year 2006), Bardonecchia and Camporosso (year 2012) is not available. The average value between the previous and the following year has been considered.

Indicator "Toll prices"

(1) Compared to the other monitoring indicators, all cost-related indicators are presented for the year 2023. **Toll prices** of 2023 are calculated as the distance between the entering and exiting toll stations of localities that are situated along the transalpine axis under evaluation and that are relevant nodes of the infrastructural network. The assessment is performed for the passage of a standard passenger car and three standard heavy duty vehicles of 5 axles and 40 t, with a distinction between EURO-classes II, V and VI. The sums for the alpine passages for the year 2023 are visible in Figure 22.

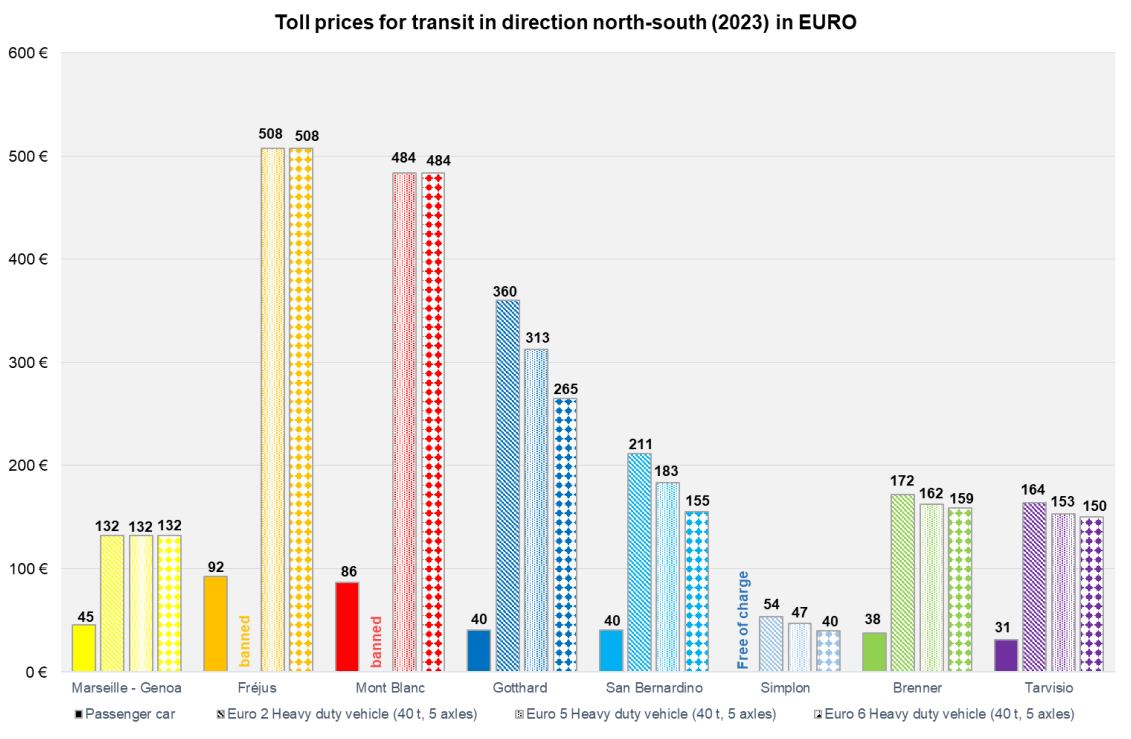

Figure 22: Toll Prices for a single transit on the iMONITRAF! corridors in direction North-South

MAIN INSIGHTS: *Similarly to the previous years, considerable differences along the transit axis are visible. The French-Italian corridors with specific charges for using the road tunnels are those with the highest toll prices.*

For **passenger cars,** the highest charges are applied for the Fréjus and Mont Blanc corridors (€ 92.30 and € 86.40 respectively). Here, apart from the highway tolls, the additional tunnel tolls are responsible for the high overall sum compared to the other corridors. It is also important to point out that the tunnel tolls on the Fréjus and the Mont Blanc differ according to the direction of travel, due to the different VAT applied: they are higher when travelling from Italy to France (€ 52.30 instead of € 51.50 in the opposite direction). With € 45.30, € 40.35 and € 37.50, the charges for Ventimiglia, the Swiss highways and Brenner are in the midrange of the corridors, while the costs for a passage on Tarvisio are the lowest (€ 31.10).

Charges have increased for all corridors from 2022 to 2023. Major increases are registered for Fréjus and Mont Blanc (+ 6.2% and + 5.8%), mid-range increases affect Ventimiglia and Tarvisio (+ 3.7% and + 3%). Finally, minor variations are visible for Brenner and for the Swiss corridors (+ 2.2% and + 1.3%). This increase of charges is linked to inspection and maintenance works along various highway and tunnel sections (e.g. for the Mont Blanc), as well as to an overall increase in prices affecting all involved countries due to inflation trends. Finally, it is important to highlight that the Simplon corridor is free of charge for passenger cars: indeed, the highway A26 ends in Gravellona Toce, and to reach the national border, a state road (SS 33) is available, and

for the Swiss part, the Vignette is not due. Data referred to this corridor has been fine-tuned and is not comparable with reports before 2020.

For **heavy duty vehicles**, road tolls follow the similar West-East-divide as for passenger cars. Fréjus and Mont Blanc charge the highest tolls, while Gotthard and San Bernardino charge medium-ranged sums. Leaving aside Simplon (of which the distance is considerably shorter than that of the other corridors), Ventimiglia, Tarvisio and Brenner charge the lowest tolls for a passage. Different than for light vehicles, German highways are not free of charge for heavy vehicles, so this component concurs in defining the tolls along the Brenner corridor. As opposed to Switzerland, Germany and Austria, the Italian and French toll systems have not yet applied a differentiation of charges between emission classes. For instance, at Ventimiglia, the toll for EURO II and EURO VI is the same (€ 132.2). In 2023, an increase of prices has been registered as compared to 2022 for all corridors also for heavy vehicles. Major differences are visible for the Mont Blanc and Fréjus. For Mont Blanc, tolls have increased by 6.7% for EURO V and VI heavy vehicles. For Fréjus, the increase is of 6.8% for the same classes. Middle-range increases are registered along Ventimiglia, Brenner and Tarvisio (in the range + 2.4 to + 3.8%). However, along the Brenner, the toll for EURO II heavy vehicles is sensibly increased (+ 6.83%) mostly due to the toll along the German section. Finally, minor increases affect the Swiss corridors (+ 1.3% for all EURO classes).

The toll of the Italian part of the Brenner corridor (from Brenner to Verona) is € 40.20 for each EURO class (as in 2022). On the contrary, the German and Austrian systems (from Munich to Kufstein and from Kufstein to Brenner) introduced tolls that are differentiated according to EURO classes. In Germany, tolls are € 28.62 for EURO II, € 18.78 for EURO V HDVs and € 15.58 for a EURO VI HDV. In Austria, 2023 tolls have been aligned across the EURO classes (€ 103.26), while they were the same for EURO II and V and slightly lower for EURO VI in 2022. Therefore, a higher increase of tolls for EURO VI heavy vehicles has been applied in 2023 compared to 2022 (+ 4.1%). These factors explain the slight difference among EURO classes visible in Figure 22. The biggest difference among EURO classes is visible at Mont Blanc and Fréjus, where EURO II vehicles are not allowed to circulate. Like for passenger cars, the tunnel tolls on Fréjus and Mont Blanc differ according to the direction of travel for heavy duty vehicles: due to the different VAT, the charge is higher when travelling from Italy to France (€ 381.90 compared to € 375.60 for a EURO V or EURO VI truck at Fréjus and Mont Blanc). Finally, along the Gotthard corridor, a EURO V truck pays € 312.58, about 87% of the charge of a EURO II vehicle (€ 360.23). This percentage further lowers to 74% when EURO VI (€ 264.94) and EURO II trucks are compared.

(2) This analysis shows the absolute costs of selected trips. For freight forwarders, the **distance-specific costs – costs per vehicle kilometre** – are another important criterion for choosing the most convenient corridor and transport mode. To this aim, Figure 23 shows the specific costs by dividing the absolute costs presented in figure 22 by the number of kilometres for each corridor, as explained in the chapter on methodological explanations . The order of corridors from highest to lowest costs remains similar to absolute costs.

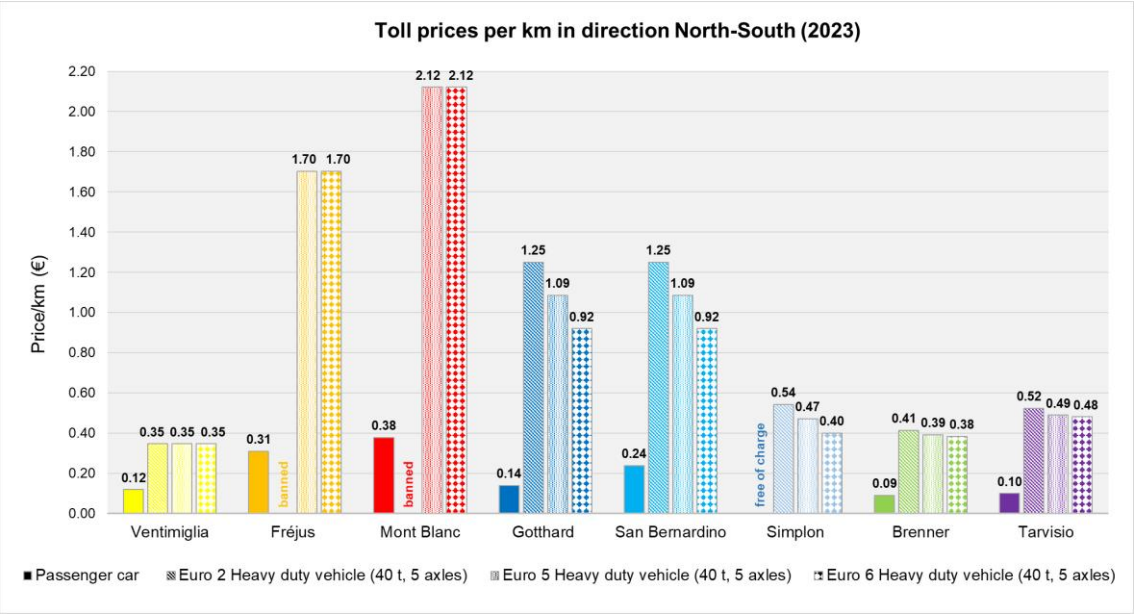

Figure 23: Distance-specific toll prices (€/km) for a transit on the iMONITRAF! corridors (direction North-South)

MAIN INSIGHTS: *Considerable differences between the kilometric toll prices can be seen – showing a similar pattern than the absolute values. Generally, corridors with high kilometric toll prices tend to have lower traffic volumes and vice versa.*

If we consider a heavy vehicle with EURO VI technology and 40 t, specific toll prices are the highest at Mont Blanc and Fréjus (€ 2.12/veh-km and € 1.70/veh-km), they lie in the middle for Swiss corridors (€ 0.92/veh-km at Gotthard and San Bernardino) and are the lowest at Tarvisio (€ 0.48/veh-km), Simplon (€ 0.40/veh-km), Brenner (€ 0.38/veh-km), and Ventimiglia (€ 0.35/veh-km). Compared to the values of 2022, these values are slightly higher (between 1 and 12 Euro-cents per km) for almost all corridors. A general feature of absolute and specific costs is that high tolls correlate with low traffic volumes and vice versa: recalling Figure 2 and Figure 22, Fréjus and Mont Blanc have high tolls and low traffic volumes, while Brenner, Ventimiglia and Tarvisio have lower costs and higher traffic volumes.

Indicator "Fuel price"

(1) This indicator monitors the **average prices of diesel and petrol** (normal petrol) at the national level in Austria, France, Italy, Switzerland and Germany. The values shown in Figure 24 are the annual averages of the values officially registered in every country on four days in all seasons (15th Jan, May, Jul, Oct). Data is provided by ÖAMTC for Austria, the Federal Statistical Office for Switzerland SFSO, ISTAT for Italy, INSEE for France and ADAC for Germany. Average prices in 2023 were € 1.80 for diesel and € 1.81 for petrol (lower than the record values of 2022, but still much higher than those of 2021).

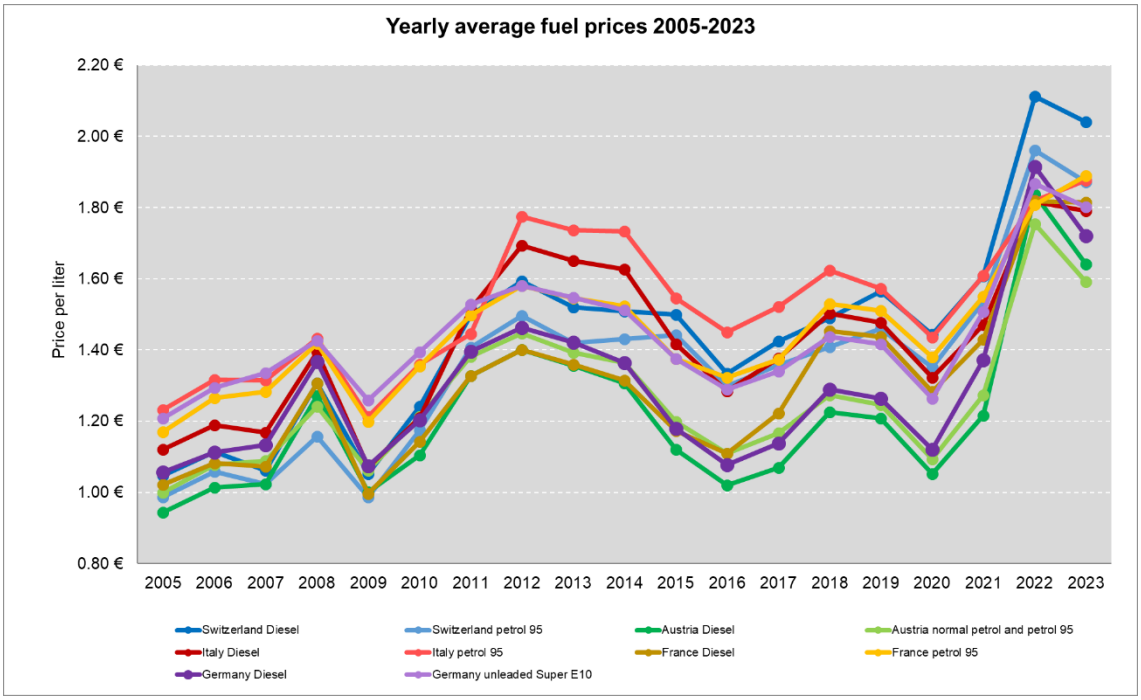

Figure 24: Annual average fuel prices in € per litre.

MAIN INSIGHTS: *General decrease of prices after the spike of 2022. Prices are still much higher than in 2021.*

In comparison to 2005, an overall increase of prices happened in all countries, but with a significant fluctuation during the economic crisis of 2008 and 2009. From 2009 onwards, there has been a strong increasing trend until 2012, followed by a decrease in all countries for the years 2013-2016. The decrease is particularly relevant between 2014 and 2016 for Italy, France and Austria and can be explained by the drastic plunge in prices of crude oil. In Switzerland, the decrease seems less marked (diesel) or even in countertrends (petrol). However, this result must be interpreted by considering the unit of measure selected for our analysis (€) and the financial policies adopted by the Swiss National Bank, which in January 2015 decided to discontinue the minimum exchange rate of CHF 1.20 per Euro and to lower the interest rate. After four years of decreasing prices, 2017 and 2018 show a general increase, which has led to the levels of the year 2015. For 2019, a slight reduction of prices is recognised except for Switzerland. Again, if the variation of the exchange rate is accounted[9], the trend is the same as in the other countries in this case, too. In 2020 (first Covid-19 pandemic year), a relevant decrease of prices is registered for all countries as compared to 2019 (about - 9% for diesel and - 10% for petrol). In 2021 and 2022, a significant increase has been registered in all countries: + 15% on average in 2021 (for both diesel and petrol); + 34% and + 23% on average in 2022 (for diesel and petrol respectively). This is linked to the increase in prices of crude matters that involved the European energy sector as a whole in 2021; as well as to the beginning of the war in Ukraine in February 2022. Increases have most strongly affected Austria, Germany and Switzerland. Conversely, Italy showed the least evident increase, also according to the national (fiscal) measures introduced to limit the price escalation.

In 2023, prices have decreased compared to 2022, but they are still much higher than in 2021. Overall, diesel prices have decreased by 5%, and petrol 95 ones by 2%. However, relevant differences may be observed across countries. In Austria, Germany and Switzerland, prices have

[9] Exchange rate EUR/CHF 2017: 1.111, 2018: 1.155, 2019: 1.112, 2020: 1.078, 2021: 1.081, 2022: 1.005, 2023: 1.009. (https://www.estv.admin.ch/estv/de/home/direkte-bundessteuer/wehrpflichtersatzabgabe/dienstleistungen/jahresmittelkurse.html)

decreased in a range between - 3% and - 11%, with the strongest reductions in Austria: - 11% and - 9% for diesel and petrol. Conversely, in Italy and France, prices have remained stable or have slightly increased between 3% and 5% (highest increase for petrol in France: + 5%). These differences may be linked to the different national policies. For instance, Italy has reintroduced in 2023 the fuel taxes ("accise") suspended for part of 2022 due to first the effects of the war in Ukraine.

Indicator "Alternative Fuels per corridor"

(1) This indicator shows the **recharging stations for electric vehicles (EVs)** and the **service stations providing alternative fuels** (hydrogen, LNG, CNG, LPG[10]) along the iMONITRAF! corridors (using the same origins and destinations described in the indicator related to toll prices). For each corridor, the AFs stations located in the service areas and in the parking areas of the toll gates as well as those stations located in the traffic centres and at the entrance/exit of the road tunnels are identified. Figure 25 illustrates the AFs stations per corridor in both directions (North-South and South-North), available in 2023.

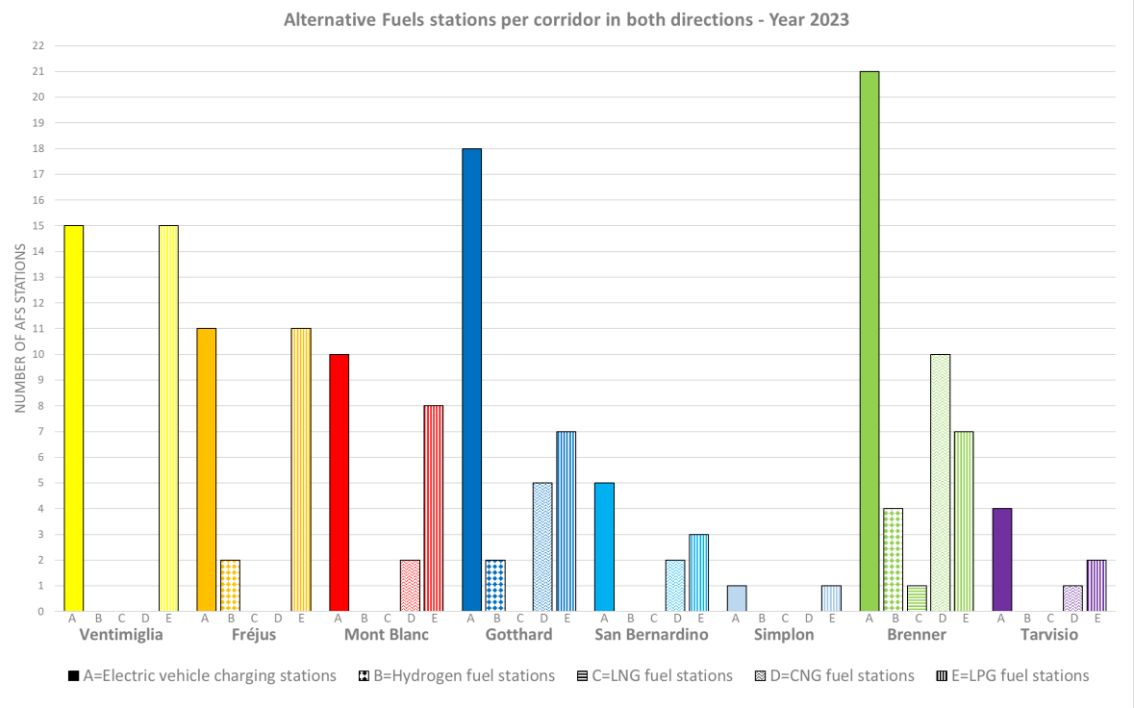

Figure 25: AFs stations per corridor in both directions (North-South and South-North) – year 2023

MAIN INSIGHTS: *Considerable infrastructures available for electric vehicles; several LPG stations available especially along the Mont Blanc and Fréjus; low density for hydrogen.*

EV charging stations include different types of charging points of which quantification is beyond the limit of this analysis. With 21 and 18 stations, the Brenner and Gotthard corridors reveal the highest number of EV charging stations (regardless of the number of single charging points), followed by Ventimiglia (15), Fréjus (11) and Mont Blanc (10). Compared to 2022, the number of electric recharging stations has increased in various cases: + 5 for Ventimiglia, + 1 for Fréjus, and + 3 for Brenner. The other corridors have maintained the same values of 2022. **LPG** also has filling stations at each corridor. The highest numbers were recorded along the FR-IT corridors of

[10] LNG: liquefied natural gas, CNG: compressed natural gas, LPG: liquefied petroleum gas

Ventimiglia (15 stations) and Fréjus (11 stations). Concerning the **hydrogen** fuel stations, only three out of eight corridors offer the possibility of recharging vehicles: Brenner, Fréjus and since 2021 also Gotthard. Regarding **LNG** fuel stations, only one station located at the autoport of Sadobre (Italian side of the Brenner corridor) is available. Finally, existing stations for **CNG** are mainly located along the Brenner and Gotthard corridors (10 and 5 stations).

Indicator "Unitary pricing components"

This indicator includes taxes to be paid for the purchase and ownership of vehicles[11], which play an important role in influencing the modal and vehicle choices of users (e.g. in purchasing an electric rather than petrol car). They include the *purchase tax*, *registration tax*, *ownership tax* and *insurance tax*. As reported in Figure 25 and in the methodological section, the pricing components have been first calculated for each country and for four sample vehicles: petrol car, electric car, diesel HGV and electric HGV. Then, their values have been converted (thanks to a set of conversion factors) in euros to be paid for each year of the expected vehicle lifespan. This has allowed the aggregation of the components and the achievement of a synthetic value for each sample vehicle and country (Figure 26).

(1) Light vehicle (petrol): Overall, Italy is the country with the highest total cost across the observed countries (1,008 €/year), while Switzerland registers the lowest value (410 €/year). This difference is mostly due to the purchase tax, which reaches the highest value in Italy (642 €/year). The purchase tax is also the component representing the largest share of the total value in all countries, ranging from 55% in Switzerland to 75% in Germany. Conversely, the registration tax has a minor influence in all countries. Its maximum absolute value is € 49 (in Italy) and its highest relative incidence is 5% (always in Italy). The ownership and insurance tax show more heterogeneous trends. The former ranges from € 0 in France (not due) to € 233 in Austria (depending on the vehicle power and on a fixed component). The latter goes from € 42 in Switzerland to € 181 in France. It highly depends on the VAT applied by each country on the insurance premium (ranging from 7.7% in Switzerland to 33% in France), and the average insurance premium.

(2) Light vehicle (electric): Compared to petrol light vehicles, it is relevant to underline that electric cars tend to require higher costs in all countries except for Austria (where the cost is 2% lower than for petrol cars: 879 €/year against 895 €/year). In particular, the highest increase is in France, where the overall cost is 27% higher for the sample e-car than the petrol car (1,000 €/year against 789 €/year). As for the purchase and insurance taxes, the cost of an e-car is respectively 36% and 15% higher in all countries. This is due to the higher purchase price and average insurance premium of the e-cars compared to the petrol ones. The registration tax has instead different declinations. In Switzerland, Austria and Germany, it has the same value for petrol and e-cars. In France, e-cars benefit from a tax reduction. In Italy, this tax is calculated based on a fixed national cost and a variable cost depending on the vehicle power in kW. Since the sample e-car has a higher kW power than the petrol one (225 vs 81 kW), this results in a higher registration tax for the e-car. Finally, the ownership tax is not due in France both for e- and petrol cars. Austria and Germany exempt e-cars from its payment. Switzerland and Italy offer partial reductions: by 44% in Italy and 5% in Switzerland (where only the basic tax of CHF 120 is due from 2023 in Ticino).

[11] The main sources used for data concerning the pricing components are the ACEA Tax Guide. See as example the 2021 report: https://www.acea.auto/files/ACEA_Tax_Guide_2021.pdf
Additional sources are used for each country.

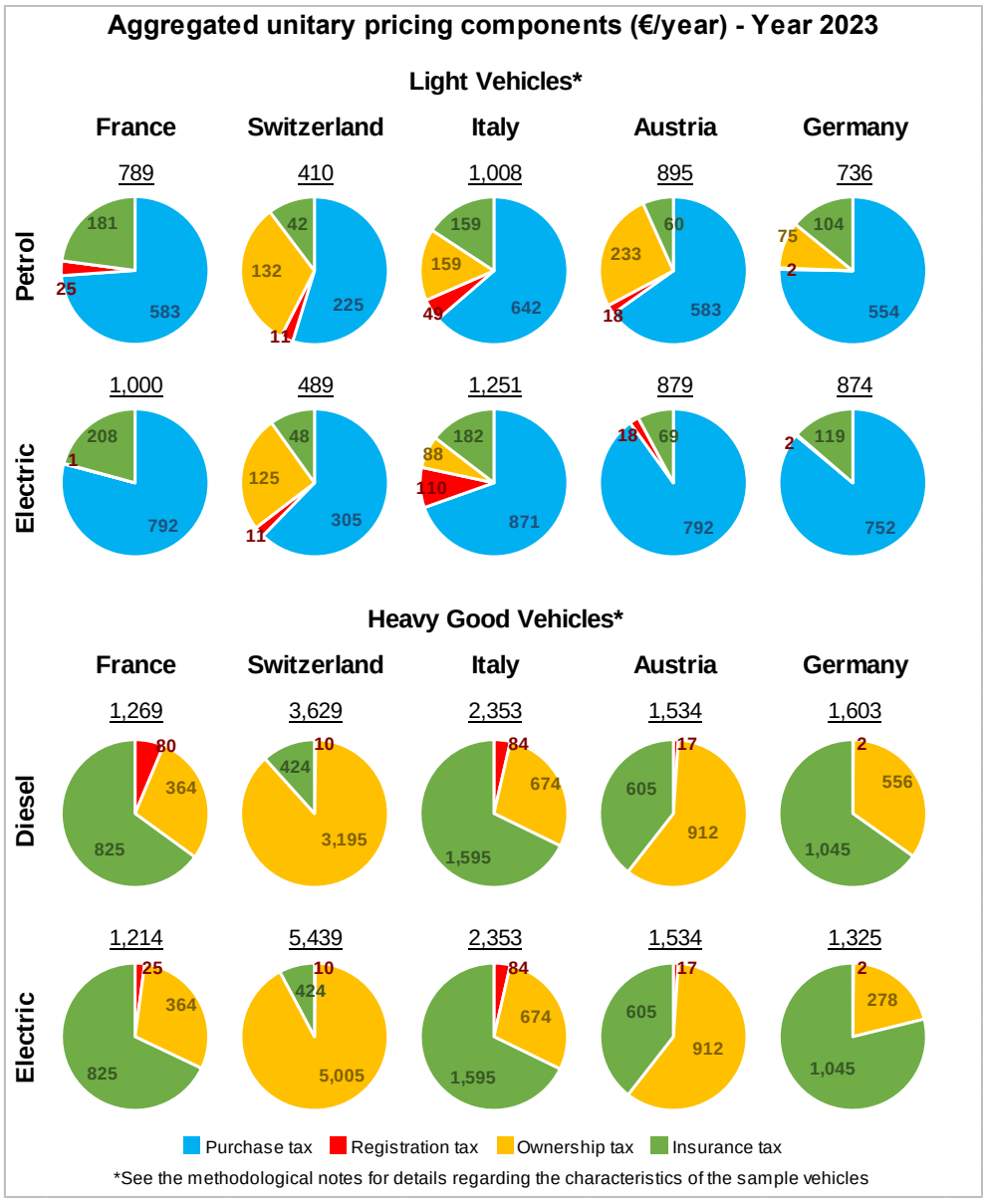

Figure 26: Aggregated unitary pricing components – Year 2023

MAIN INSIGHTS: *Italy and Switzerland register the highest total costs when considering the aggregated tax components. Some tax deductions for electric light and heavy vehicles are available, but they significantly vary across countries.*

(3) Heavy good vehicle (diesel): Overall, Switzerland is the country with the highest tax cost (3,629 €/year), followed by Italy (2,353 €/year). Conversely, France registers the lowest value with 1,269 €/year. These differences are mostly linked to the ownership and insurance tax, while the purchase and registration tax have minor influences. In particular, the purchase tax is deductible in all countries for commercial vehicles. Therefore, this component does not appear in the graphs of Figure 26. The registration tax ranges from a minimum of 2 €/year in Germany (€ 26.30 to be paid once with the purchase of the vehicle), to a maximum of 80 €/year in France (€ 943.76 o be paid once), and 84 €/year in Italy (€ 990.58 obtained as sum of a fixed national cost and a variable cost depending on the vehicle power). Nevertheless, they represent only 6% (in France) and 4% (in Italy) of their total cost. As regards the ownership tax, its incidence varies significantly across countries, depending on the calculation logic. For instance, in Switzerland and Austria, this component represents 88% and 59% of the total cost, respectively. Conversely, in Italy and France it

is 29% of the total costs. A similar condition affects the insurance tax, with a relative incidence on the total cost ranging from 12% in Switzerland to 68% in Italy. As such, these two last pricing components are the most influent for heavy vehicles.

(4) Heavy good vehicles (electric): One premise is necessary: electric heavy vehicles are still limitedly diffused in EU and this affects also the existence of ad-hoc directives in the observed taxation systems. The condition of electric heavy vehicles in comparison with their diesel counterparts significantly varies across countries. In Italy and Austria, diesel and electric trucks pay the same amount (since no specific deduction is given). In France and Germany, limited reductions of overall costs are registered (- 4% in France and - 17% in Germany). Specifically, the registration tax is lower in France for electric trucks (€ 298.76 for electric HGVs and € 943.76 for diesel ones); while the ownership tax is reduced by 50% in Germany for electric HGVs (€ 278.00 against € 556). As for Switzerland, the total costs are 50% higher for electric heavy vehicles since their higher kW power negatively affects the ownership tax (according to the online calculator of the Canton of Ticino). Indeed, explicit measures to reduce the ownership tax are applied to electric passenger cars, but have not been found for heavy vehicles. Finally, as regards the insurance tax, no variation between electric and diesel HGVs is registered in any of the considered countries. This is linked to two factors: a) the VAT applied to the insurance premium does not change; and (b) data about the average insurance premium for electric HGVs is hard to retrieve and thus we assume the insurance premium to be the same for diesel and electric HGVs.

5.2 Developments with respect to the iMONITRAF! target indicators

To establish a stronger link between the iMONITRAF! monitoring activities and the policy pathway, iMONITRAF! partners developed a new set of target indicators throughout 2022. The proposed indicators found political support during the political roundtable discussions in December 2022 and are now an integral part of the Annual Report.

The target indicators strengthen the fact-based approach of iMONITRAF! as they show if developments are in-line with the target paths or if additional action is necessary. Results can be seen as “early-warning”. If developments are not in line with the target path, joint efforts need to be improved.

Thanks to the data collected every year by the iMONITRAF! partners, it is possible to integrate the modal split target indicators in the monitoring system, in order to analyse the data time series according to the expected goals for the years 2030 and 2040 respectively.

Progress in reaching the modal split target indicators

Modal split targets were defined on the basis of existing strategies and frameworks of the iMONITRAF! regions. For the Brenner, the path leads to the target of a 50% share of rail transport in 2040, assuming that the Brenner Base Tunnel (BBT) and its access tracks are in full operation at this point in time. As intermediate target, a modal split of 36% shall be reached by 2030.

For the Swiss corridors, a modal split of 83.7% is envisaged for 2030. After that, the additional potential is very limited.

The following Figure 27 displays the available modal split data for the Brenner and Swiss corridors (Gotthard, San Bernardino and Simplon) and put them in comparison with the rail modal split targets for 2030 and 2040.

Comparing the 2022 monitoring data with the target paths, it can be seen that developments both on Brenner and the Swiss corridors went into the wrong direction in 2022: on the Brenner, the modal split of rail declined from 27.3% to 26.7% - leaving a considerable gap to the target path. On the Swiss corridors, rail modal share also decreased by one percentage point but the development is still in line with the target path – thanks to achievements in the previous years.

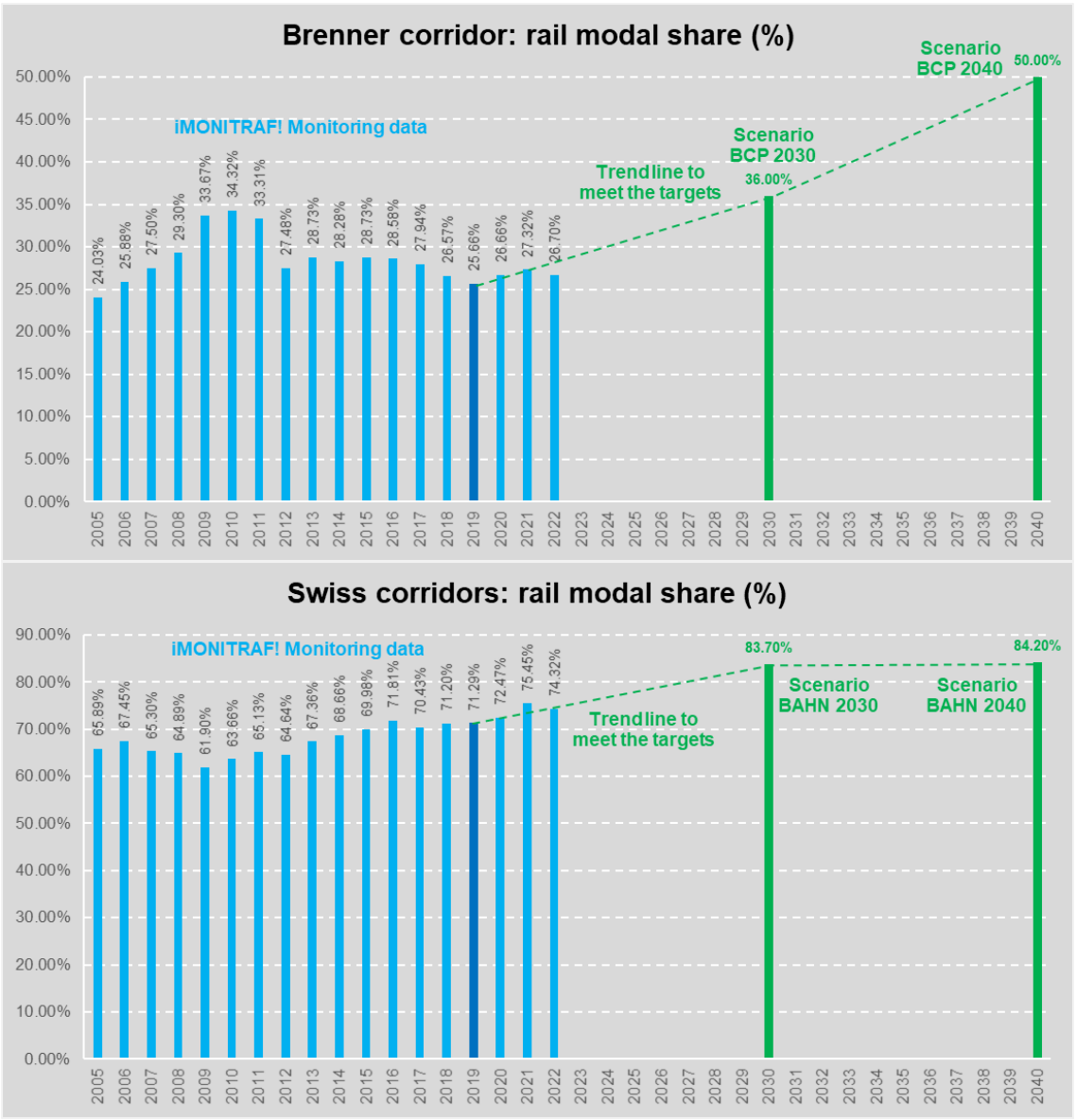

Figure** 27**: Modal split target indicator and target path for the Brenner and the Swiss corridors

The graph shows in blue the monitoring data collected since 2005. In green there are the target indicators for the Brenner and Swiss corridors for 2030 and 2040. The blue trend line (dashed) shows the evolution of figures in the previous years and the green line indicates the target path that should be seen in the next years to reach the defined targets (for information on data sources please refer to the Annex).

Progress in reaching the HGV target indicators

Similarly, Figure 28 below highlights the progress in reaching the HGV target indicators. When interpreting the figure, the special effects of the COVID-19 pandemic need to be considered which led to the visible “dip” in HGV volumes in 2020. The figures show the obvious rebound of traffic volumes – both on the Brenner and the Gotthard corridors. Developments on both corridor are no

longer in line with the target path as traffic volumes have reached the pre-pandemic levels. Additional efforts are thus necessary to bring the traffic volumes back to the target path.

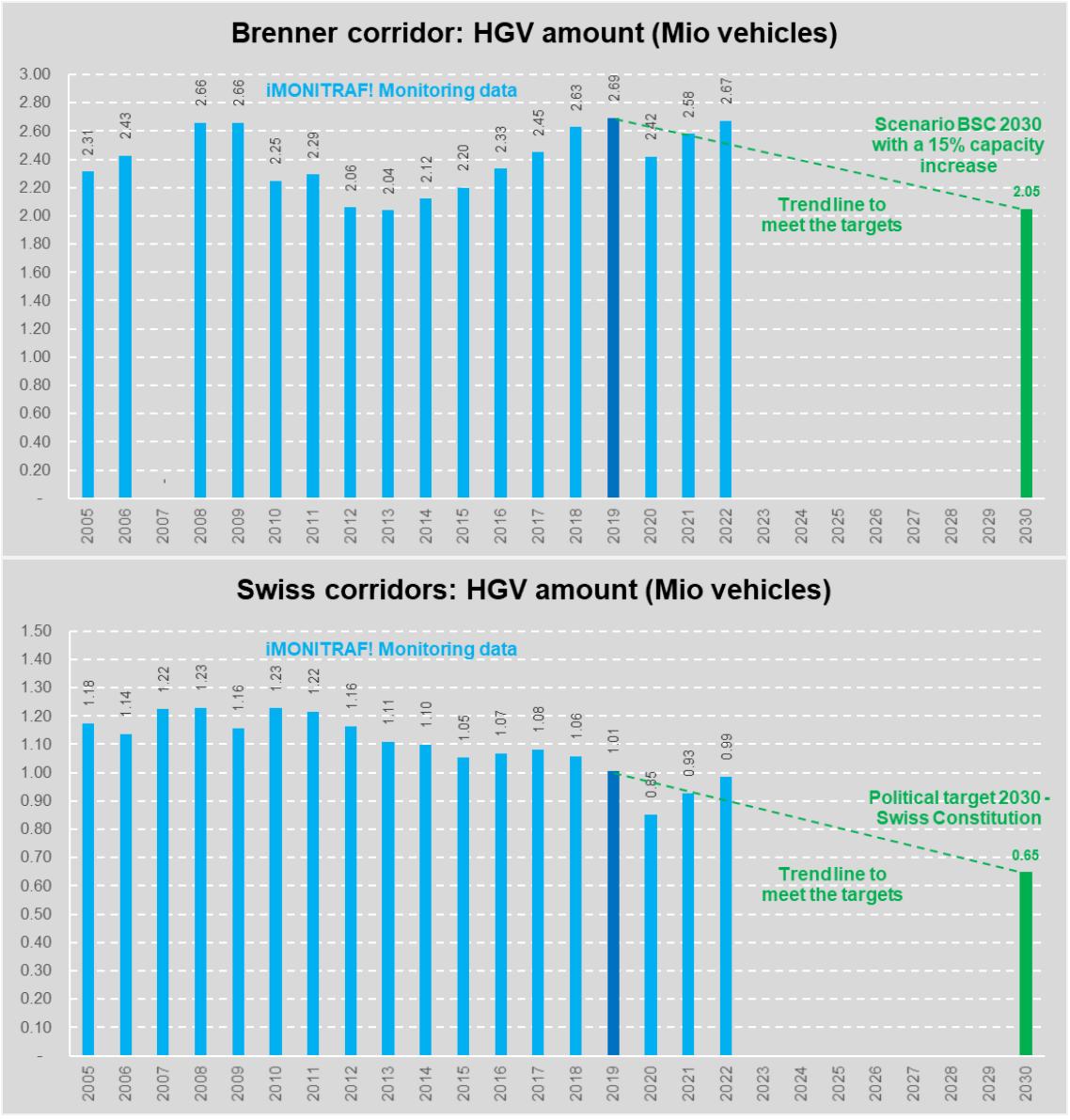

Figure** 28**: HGV target indicator and target path for the Brenner and the Swiss corridors

The graph shows in blue the monitoring data collected since 2005. In green there are the target indicators for the Brenner and Swiss corridors for 2030 and 2040. The blue trend line (dashed) shows the evolution of figures in the previous years and the green line indicates the target path that should be seen in the next years to reach the defined targets.

6 Special focus on regional measures: decarbonisation of vehicle fleet

While modal shift remains the main rationale for the iMONITRAF! cooperation, the second objective of the Combined Scenario is the decarbonisation of the remaining road vehicle fleet in the logic of the toprunner approach. The Alpine corridors shall be developed into model regions for the promotion of alternative technologies to guarantee that the new technologies can fully profit the sensitive mountain environment. For 2023, the iMONITRAF! partners have thus agreed to put a specific focus on the role of the iMONITRAF! regions for promoting zero-emission HGV and to exchange information on relevant measures in the regions. On this basis, follow-up activities can be developed in the remaining work programme to better streamline the approaches along and between the corridors.

Different approaches and opportunities are applied in the iMONITRAF! regions for promoting zero-emission HGV. According to previous typologies used within iMONITRAF! analysis, the following types of measures can be differentiated:

1. **Regulatory measures:** Specific regional measures can set incentives for the use of zero-emission HGV, e.g. exemptions from night driving ban, priority access to specific sections of the road network, etc.
2. **Pricing measures:** Exemptions or reductions in regional pricing measures provide additional financial incentives, e.g. in the frame of HGV charging systems that considerably affect operating costs.
3. **Direct subsidies/financial support:** To strengthen the financial incentive, additional direct subsidies or support measures can be implemented, e.g. subsidies for the acquisition of zero-emission HGV for regional companies?
4. **Infrastructure development:** This includes regional approaches to further develop charging infrastructures for zero-emission HGV.
5. **Industry support/R&D:** Further activities can include research/demonstration/innovation projects targeted at the roll-out of zero-emission HGV.

The following tables provides an overview on how these different approaches are applied in the iMONITRAF! regions. A detailed description for each type of measure is provided below.

OVERVIEW: REGIONAL MEASURES TO SUPPORT THE UPTAKE OF ZERO-EMISSION HGV

	Regulatory measures	Pricing measures	Direct subsidies/financial support	Infrastructure development	Industry support/R&D
Switzerland	– Requirements on the set-up of charging infrastructures for zero-emission vehicles in new buildings or new parking spaces (e.g. canton Uri)	– Full exemption from HGV fee (LSVA) for fossil free trucks.	– Cantonal Tax differentiaton according to EURO norms and fuel consumption, reductions for fossil free vehicles (e.g. canton Ticino)	– National programme for fast charging stations along the highways – Cantonal programmes for charging stations	– Pilot installations for hydrogen power stations, e.g. at Coop supermarkets/fuel stations
Tyrol	– Exemptions for fully-electric or hydrogen HGV for all driving bans in Tyrol (night driving ban, Euro class driving ban and sectoral driving ban)	– Reduced toll rates for zero-emission HGV (general road toll and specific sections on the Brenner motorway)	– National funding programme "ENIN" with subsidies for acquisition of zero-emission HGV and relevant infrastructure	– new LADIN funding from the federal government to support underserved areas (60%)!	– Direct financial support for demonstration projects, e.g. MPREIS – Project "H2Alpin" for testing and demonstrating the roll-out of hydrogen in the Alpine area
Autonomous Province of Bolzano	–	–	–	– "Project LifeAlps" with support for charging infrastructure at bus depots and hydrogen infrastructure – H2 fuelling stations along motorway A22	– Project "Südtirol hydrogen valley": development of local H2 production, storage and distribution.
Bavaria	–	–	–	–	–
Provence-Alpes-Côte-d'Azur	–	–	–	– Set-up of shore connections and charging infrastructure at the three major seaports – Set-up PV systems for own electricity consumption in ports.	–

Table 2: Source: Compilation of the iMONITRAF! network

Regulatory measures

Comprehensive exemptions for all driving bans are implemented in Tyrol for fully electric or hydrogen HGV. All existing driving bans relate to the "Immissionsschutzgesetz-Luft" (IG-L) which shall enforce the achievement of European air quality limits. As zero-emission HGV emit no relevant local pollutants, they are exempted from the night driving ban and the Euroclass driving ban on the Inntal motorway as well as from the sectoral driving ban. These exemptions are not new but have rather been implemented with the initial introduction of the IG-Luft regulations in Tyrol.

In Switzerland, the night driving ban has the main objective of noise reduction during the night and the second objective to support modal shift. No specific exemptions are foreseen for zero-emission HGV. Also, the other iMONITRAF! regions have not adjusted their regulatory frameworks so far.

Regulatory measures can also relate to the development of charging infrastructures. In this respect, several cantons (e.g. Canton of Uri) provide an interesting new approach which is defined by the New Energy Law as agreed in 2023: the new Energy Law establishes a link between the building and the transport sector and defines the requirement that each new building or each redevelopment of parking spaces needs to provide charging space for zero-emission vehicles.

Pricing measures

As road tolls/road charges are a considerable cost component for road transport, specific considerations for zero-emission HGV can play an important role for setting financial incentives for the uptake of alternative technologies. Several iMONITRAF! regions (or their relevant national frameworks) make use of this opportunity:

- In Switzerland, zero-emission HGV are fully exempted from the HGV fee (LSVA).
- In Austria and especially on the special motorway sections in Tyrol, fully electric and hydrogen trucks pay much lower toll rates. These exemptions have been implemented in 2019.
- Also in Bavaria, the tolls for zero-emission HGV are considerably lower as the German HGV toll includes specific toll rates.

The level of exemptions in the EU countries is regulated by the Eurovignette Directive. As a reminder: the new European framework allows a differentiation of charges according to CO_2 emission classes (new Article 7ga), but a full exemption is not allowed. Zero-emission vehicles which are defined as CO_2 emission class 5 are allowed to receive a reduction of 50% to 70% compared to the charge applied for the lowest emission class.

Direct subsidies/financial support

The role of vehicle taxation and its incentives for the take-up of zero-emission HGV is already highlighted by our monitoring indicator "Unitary pricing components" (see page 47). All relevant cost components – registration tax, ownership tax, insurance tax – can be differentiated to set incentives for the use of zero-emission HGV. In Switzerland, several Cantons apply tax reductions for fossil free vehicles. However, due to the limited uptake/availability of zero-emission HGV, most Cantons have focused their measures at private cars up to now.

Also, direct subsidies/financial support for the acquisition of zero-emission HGV is provided – this however coming rather from the national level. In Austria, the federal programme ENIN "Zero-emission commercial vehicles and infrastructure" provides 80% funding to cover the additional costs for the purchase of zero-emission commercial vehicles. With an overall budget of 365 Mio.

Euro, the programme is financed by national funds as well as by the EU Recovery and Resilience Facility.

Infrastructure development

In Switzerland, several programmes support the roll-out of charging infrastructures for zero-emission HGV. To support the fast charging infrastructures along the highways, the Federal Road Administration has launched a programme to facilitate the instalment of fast chargers along the motorway. This allows to use the services areas which belong to the national motorways for the set-up of fast chargers. Different Cantonal programmes also provide financial support for the set-up of charging stations for electric vehicles (public parking spaces, apartment buildings) within cantonal programmes (e.g. BS, ZH, TI, Uri).

In Austria, the new LADIN programme “Charging infrastructure” has to objective to promote the construction of publicly accessible charging infrastructure in the form of fast charging stations and their upstream infrastructure for cars and commercial vehicles in currently underserved areas along the low-ranking road network. Areas are defined as "underserved areas" if they are further than 7 km driving distance from existing fast charging infrastructure and are designated as residential, industrial or agricultural areas. The programme provides 60% of investment costs in form of non-repayable grants.

To support the decarbonisation of the vehicle fleet, the Autonomous Province of Bolzano is involved in the ongoing project “LifeAlps", aiming at a basic coverage of South Tyrol with the necessary loading infrastructure for battery vehicles and fuel cell vehicles. The measures include the installation of fast charging columns and charging columns at the depot of bus concession holder SASA for battery buses. Furthermore, hydrogen filling stations for cars, freight vehicles and shuttle buses and the creation of necessary services. In addition, to promote emission free transport several new hydrogen fuelling stations will be built along the corridor of the whole Brenner motorway A22. Project partner is the A22 motorway company. The initiative is cofounded by the National Resilience and Recovery Plan (PNRR). In South Tyrol the new station will be built at the Sadobre service station close to the Brenner.

Along the Brenner, the activities for the set-up of new charging infrastructures for hydrogen are coordinated by the H2 Corridor Brenner/o working group which is formed by the regions along the Brenner corridor, the respective Chambers of commerce, the infrastructure operators and the Hydrogen competence centers. The aim of the group is to share knowledge and best practice and to help each other to implement the H2 as technology in the mobility sector with a special regard towards HGV.

With the “Zero Smoking Stopover Plan” Région Sud Provience-Alpes-Côte-d’Azur has voted in 2019 to establish electric shore connections in the three seaports in the region by 2025 – Marseille, Toulon, Nice. A budget of 30 Mio € was provided in regional and European funding to solve air pollution linked to maritime activity. In October 2020, a call with an indicative amount of 10 Mio. € was launched, aiming at using low-carbon fuels in the region’s seaports and commercial urban fringe areas. The expected duration for the physical implementation projects was limited to 31 March 2023. Regarding ERDF grants, the Port of Toulon and the Grand Port Maritime de Marseille have received funding of 4.3 Mio. € in 2021 and 4.9 Mio. € in 2022 respectively.

Sustainable development also involves the Region's support for the energy mix of ports with the development of photovoltaic power stations in the ports of Marseille and Toulon, which can be used for self-consumption in particular to be able to connect an additional cruise ship.

Industry support – Research & Development

Pilot activities in the industry sector are also an important field of action in most of the iMONITRAF! regions. In Switzerland, the retail company Coop which also operates fuel charging stations at some of its sites provides hydrogen charging infrastructures at six sites throughout Switzerland.

In Tyrol, the retail company MPREIS is conducting large-scale trials to produce their own green hydrogen and to fuel their own distribution fleet. The project is supported through the EU-funded project “Demo4Grid” and is also a lighthouse project in the frame of "HyWest", a Tyrolean hydrogen initiative. Furthermore, the Province of Tyrol has initiated the project “H2Alpine” which shall test and demonstrate the roll-out of hydrogen in the Alpine area – outside the dense urban settlements. The project is aimed at buses and commercial vehicles and is supported by the Austrian Climate & Energy Fund.

Also, the Autonomous Province of Bolzano is supporting the decarbonisation of the vehicle fleet by development of local H2 production, storage and distribution. The project “South Tyrol Hydrogen Valley” is financed by the National Resilience and Recovery Plan (PNRR) and includes the construction of a new hydrogen production plant in a disused industrial zone in Bolzano as well as the construction of four new filling stations for public transport and private vehicles in the region. Project partners are public and private actors.

7 Moving ahead on regional and national level: Update on Best Practices

7.1 Overview on revised and new Best Practices

Policy measures and frameworks were further developed and optimized in all iMONITRAF! regions in 2023. The collection of regional measures as provided by the iMONITRAF! partners and observers provides insights on recent developments along the five policy pillars (see table below). As in the previous years, enforcement of existing measures played an important role in pillar 1. Regarding pillar 2 with the set of regulatory measures, only few adjustments were reported in 2023, given that the instrument mix in this policy pillar is already very comprehensive and ambitious in most iMONITRAF! regions. In policy pillar 3 which is dealing with modal shift, developments included updates in the pricing frameworks with first implementation steps of the new Eurovignette as well as further developments of key infrastructures. In Switzerland, emergency measures were necessary due to an accident in the new Gotthard base tunnel in August.

For passenger transport, the iMONITRAF! regions reported several interesting measures which make cross-border transport more attractive by providing new services, ticketing solutions and better information. Also, the decarbonization of public transport was an important field of action in 2023.

OVERVIEW: BEST PRACTICE UPDATE 2023

Policy Pillar	Name of measure	Country/region
Pillar 1: Monitoring, Information & awareness raising	New HGV control center for freight transport in Giornico (incl. traffic management options)	Canton of Ticino
	Extension of HGV controls in Tyrol	Tyrol
	New insights from permanent noise measurement station along the Brenner railway line	Autonomous Province of Bolzano (in collaboration with RFI)
Pillar 2: Limiting negative impacts of Alpine transport	Adjustment of Euroclass driving ban	Tyrol
	Project "BrennerLEC After-Life"	Autonomous Province of Bolzano
	New noise barriers along Brenner motorway A22	Autonomous Province of Bolzano
Pillar 3: Modal Shift	**Modal shift policy mix and CT**	
	Implementation of CO_2 charge according to Eurovignette	Austria & Germany
	Pilot project on modal shift for wood transport	Autonomous Province of Bolzano
	Support measures and subsidy system for CT (continuation of financing)	Autonomous Province of Bolzano, Autonomous Province of Trento
	Report on modal shift and proposals for adjustment of policy mix	Switzerland
	Financial support for rail freight transport in the area (single waggon transport)	Switzerland

Policy Pillar	Name of measure	Country/region
	Emergency measures to support period of closure of one tube of the base tunnel	Switzerland, Cantons of Uri and Ticino
	Infrastructure	
	Extension of Lower Inntal Valley railway	Tyrol
	Brenner Base Tunnel and access routes: milestones	Tyrol, Autonomous Province of Bolzano, Autonomous Province of Trento
	Southern access routes: Doubling railway line Fortezza Verona	Autonomous Province of Trento
	First insights from operation of NEAT	Switzerland
	Further development of CT terminals and infrastructures to better connect the seaports	Provence-Alpes-Côte-d'Azur
	Programming of an interface for terminal registration for CT and interface to artificial intelligence for fleet planning	Bavaria (with pilot sites Munich Riem and Nuremberg)
Pillar 4: Passenger transport	Decarbonisation strategy for public transport	Tyrol
	Adjustment of ticketing system	Tyrol
	Pilot project "Urban pass" – free use of motorway in Bolzano	Autonomous Province of Bolzano
	Provincial cycling plan and "bike map"	Autonomous Province of Bolzano
	New ticketing and information system for public transport	Autonomous Province of Bolzano
	Cross border mobility by bus between Tyrol and South Tyrol	Autonomous Province of Bolzano, Tyrol
	Common multi-system trains for cross border transport services in the Euregio Tyrol-South Tyrol-Trentino	Autonomous Province of Bolzano, ÖBB, Tyrol
	Electrification of Vinschau/Val Venosta railway line – conclusion of safety works	Autonomous Province of Bolzano
	Construction of railway variant of the Val di Riga/Riggertal	Autonomous Province of Bolzano
	New train stop San Giacomo/St. Jakob on the Brenner railway line	Autonomous Province of Bolzano
	New hydrogen vehicles for public transport	Autonomous Province of Bolzano
Pillar 5: Innovative approaches	Declaration on capacity management system for the Brenner corridor	Bavaria, Tyrol, Autonomous Province of Bolzano
	Resolution on rail transport on the Brenner corridor	Tyrol, Autonomous Province of Bolzano

Table 3: *Source: Compilation of the iMONITRAF! network*

7.2 Best Practices per policy pillar

7.2.1 Pillar 1: Information, monitoring, awareness raising

Overall, monitoring campaigns are continued as in previous years and as summarised by the iMONITRAF! monitoring activities (see chapter 5).

As reported in the last Annual Report, the **Autonomous Province of Bolzano** together with municipality of Salorno/Salurn and the Italian railway infrastructure manager RFI have installed Italy's first **fixed noise measurement station along the Brenner railway line** in the municipality of Salorno/Salurn. Throughout 2023, this new permanent station was able to continuously measure noise, length and speed of passing trains and to record all relevant data. The collected data is analysed in real time and enables continuous monitoring of railway noise. As noise measurements have been carried out along the Brenner railway since 2016, the new data allows a comparison between the noise values recorded in previous years and the values from the new fixed measuring station. The comparison shows a reduction of railway noise of up to 5 dB (A) which is probably due to modern rolling stock and the renewal of the braking systems of old freight trains in accordance with EU Regulation No. 774 /2019.

Also, **enforcement of relevant environmental and social legislation and technical controls** of HGV is reported within pillar 1 and several updates can be highlighted from both the Brenner and the Gotthard corridor.

To support the existing **HGV control centres along the Gotthard**, a new control centre for HGV has opened in December 2022 in **Giornico** (Canton of Ticino). In addition to Erstfeld (North), Giornico takes on the same tasks of controlling heavy traffic from south to north on an area of approx. 170,000 m2. The large parking areas also provide relief for the highway and rest areas for parked trucks from both directions of traffic during night breaks. As explained in the chapter on capacity management (chapter 2), the control centres along the Gotthard corridor are linked to the dosing system of the Gotthard tunnel and support the capacity management in times of high traffic volumes.

In **Tyrol**, the **controls and inspections of HGV** have been intensified over the last year. Data for 2023 is not yet available, but for 2022 the operating hours of the control centres were increased to 6,958 operating hours in Radfeld, 6,606 in Kundl and 3,762 on the Brenner Pass. In addition, checks are also carried out on a large scale at the checkpoints on the provincial roads. In 2022, a large number of violations of regional measures were reported, e.g. a violation of the night driving ban was reported in 1.811 cases and a violation of the sectoral driving ban in 768 cases.

7.2.2 Pillar 2: Limiting impacts of Alpine transport

Pillar 2 deals with all regulatory measures that have the direct objective to limit negative impacts of transalpine freight transport, especially regarding air quality and noise.

Especially along the Brenner corridor, pressures related to air pollution and congestion still remain high so that the existing set of regulatory measures was again optimized in 2023. Since the beginning of 2023, the **Euroclass driving ban and the sectoral driving ban in Tyrol** has been adjusted to also cover origin and destination traffic (regional transport) with Euroclass V HGV. That means, that origin and destination traffic now only can make use of its exemptions if it uses Euro VI HGV. As with the beginning of 2023, the Euroclass driving ban thus ensures that only EURO VI vehicles are in operation on the Brenner motorway.

On the Italian side of the Brenner motorway, the Autonomous Provinces of Bolzano and Trento have implemented the “BrennerLEC” project in the years 2016-2021 to test the impact of dynamic

speed limits on the A22 motorway. In 2023, a follow-up project **"BrennerLEC After-Life"** has been launched which concerns two measures on the Brenner motorway A22: i) the introduction of further five sections with dynamic speed reduction on the Brenner motorway for the purpose of environmental protection and ii) dynamic speed reduction on the Vipiteno/Sterzing-Ala section of the motorway on days with high traffic volumes. The aim of the project is to improve air quality while at the same time increasing the fluidity of traffic. The partners are the Brenner motorway A22 company, the provincial environmental agencies of Bolzano and Trento, universities and research institutes.

To further limit negative impacts of noise, the **Autonomous Province of Bolzano** has nearly concluded the **construction of six additional noise barriers** with a total length of 5 km in the municipality of Bressanone/Brixen along the A22 motorway. The new sound-absorbing structures are capable of significantly reducing both noise and air pollution.

7.2.3 Pillar 3: Modal shift

Pillar 3 focuses on modal shift measures, including both push and pull measures. It includes policy measures related to modal shift, with a special focus on developments related to the common measures of the iMONITRAF! strategy as well as infrastructure measures.

Policy measures

Within the iMONITRAF! policy mix, the **Toll Plus approach** plays a crucial role. The basic idea of Toll Plus is to develop charging systems for HGV on the Alpine corridors that fully implement the polluter-pays principle and that make use of smart differentiation approaches to set incentives for modal shift and the uptake of zero-emission HGV. With the revised **Eurovignette Directive** (see Annual Report 2022), the European framework now allows some new potentials for further developing HGV charges in EU countries and both Austria and Germany have taken first steps to make use of this opportunity:

In **Austria**, the Federal Road Toll Act has been amended in 2023 on the basis of the new Eurovignette. Especially, the pricing framework now considers the new external cost charge for CO_2 emissions which comes on top of the already existing air pollutions and noise charge. The CO_2 charge will be implemented in a step-wise approach over three years. In 2024, only 30% of the full CO_2-charge will be implemented, 50% in 2025 and 70% in 2026. From 2027 onwards, the full CO_2-charge will be applicable. The first step in 2024 will lead to an increase in HGV tolls by about +7.4%.

In **Germany**, the Federal Government has agreed a revision of the HGV toll including:

- Introduction of a CO_2 charge: On December 1, 2023, a new toll component was introduced to cover the costs of transport-related CO_2 emissions. This consists of a CO_2 surcharge of 200 euros per tonne of CO_2. In future, the toll rates will therefore be made up of four cost components: Infrastructure costs, air pollution, noise pollution and CO_2 emissions.
- Differentiation of HGV toll according to CO_2-emission classes: as of December 1, 2023 the toll charges are also differentiated according to CO_2-classes (as foreseen by the Eurovignette Direcitve). All existing vehicles that were registered before July 2019 belong to Emission class 1 and thus have to pay the highest rate.
- Earmarking of toll revenue: The use of toll revenue will be newly regulated. The toll revenue is no longer only earmarked to the improvement of the federal motorway infrastructure but can now only support other measures in the mobility sector - with a focus on federal railroads.

- Toll obligation for trucks over 3.5 tons: On July 1, 2024, the toll obligation will be extended to trucks with more than 3.5 tons. Craftsmen's vehicles under 7.5 tons tzGm are exempt from the toll obligation.
- Emission-free vehicles: Emission-free vehicles are exempt from the toll until December 31, 2025. From January 1, 2026, they will pay a 75% reduced toll rate for infrastructure costs - plus the toll rates for air and noise pollution.

Subsidies for combined transport were also continued in 2023, for example the subsidies for combined transport in the **Autonomous Province of Bolzano** were maintained. This subsidy focuses on the section Brenner-Salorno/Salorno-Brenner for Accompanied Combined Transport (ACT) or Unaccompanied Combined Transport (UCT) (similar to the years before).

In addition to the subsidies for CT, the Autonomous Province of Bolzano has launched a pilot project for **modal shift for wood transport**. In a very short timeframe, abandoned loading platforms at Bolzano railway station were reactivated for wood transportation. It concerns damaged wood due to bark beetle infestation and storm Vaja. Instead of being transported on road, wood is transported by rail from Bolzano to wood processing companies in Jenbach/Tyrol (Austria). Each train consists of 18 wagons, which corresponds from 40 to 45 lorries per train journey. Four trains per week have been operated, making this pilot a successful cross-border project. The project was initiated by the Autonomous province of Bolzano. Other partners are the Italian rail network operator RFI, local authorities and private actors.

Switzerland has released a new modal shift report at the end of November 2023. In a bi-annual format, this report summarizes the major results and developments related to transalpine freight transport and gives recommendations for improving the policy mix. The report suggests the following adjustments of modal shift measures

- The Federal Council is planning to use supportive measures to shift road transport, which currently runs on the Brenner axis. It is foreseen to adapt the conditions for the tendering process for combined transport crossing the Alps in such a way that funding and thus a relocation of the transport that currently travels by road over the Brenner Pass is possible.
- It also foreseen to create the basis for greater financial support for rail transport on routes of less than 600 kilometres.
- It is foreseen to adjust the tariffs of the Swiss HGV fee to general inflation and thus increase by 5%.
- The treatment of dangerous goods (esp. in the canton of Valais) will be treated according to a specific road map, including a reduction in the transport of the most dangerous goods, voluntary reporting of dangerous goods at the Simplon Pass, tighter security controls on the A9 Simplon, establishment of dangerous goods monitoring on the Simplon Pass road, the set-up of infrastructures to offer intermodality, checks on other road axis and the set-up of a central point of contact regarding the transport of dangerous goods.

In addition, the Federal Council has launched a proposal to improve the framework conditions for rail freight transport and wants to subsidise aera wide transports (single waggon load system).

Short-term measures - Dealing with unforeseen challenges

In August 2023, a freight train derailed in the Gotthard Base Tunnel due to a broken wheel, leading to considerable damage to the infrastructure. The tunnel was completely closed for almost two weeks. The single-track east tunnel was initially reopened for freight trains on August 23, 2023. Since September 29, 2023, individual passenger trains have also been using this option. According to SBB, normal operations are expected to be possible again from September 2024.

After detailed investigations, it became apparent that the extent of the damage was significantly greater than initially estimated. In total, around 8 kilometres of track need to be replaced. The track bed is badly damaged in the Faido gauge multifunctional area. It will take several months to replace all the damaged parts of the track system. SBB currently assumes that both tunnel tubes will be available for rail traffic again to a limited extent at the beginning of 2024.

The following support measures due to accident in the Gotthard base tunnel were implemented as pragmatic approach:

- Priority for freight rail transport: Since the eastern tube of the Gotthard Base Tunnel was put back into operation, it has been available exclusively for freight traffic. Around 100 tracks per day are possible. A further 30 trains per day run over the mountain route. Cross-Alpine rail freight transport has a total of 130 tracks every day. For comparison: in 2022, an average of 120 trains crossed the base tunnel every day. Thanks to this measure, the freight railways can handle rail freight traffic with practically no restrictions. The route over the mountain route involves considerable additional effort. But it essentially affects domestic traffic.
- Higher compensation for transalpine combined transport The compensation per C.T. shipment has been increased by CHF 200 to up to CHF 1,100 for 2023.

Infrastructure measures and services

The Swiss modal shift report provides insights into first experience with the **opening of the base tunnels Gotthard (GBT) and Ceneri Base Tunnel (CBT)**. Overall, the opening of GBT and CBT proved to be satisfactory to industry players on the corridor. However, due to the current quality and punctuality deficits on the access routes and several construction sites, especially in Germany, the situation has not yet significantly improved. Nevertheless, the expansion of the Gotthard is seen as a step forward in the offer for the transporting shipments with a height of 4 meters. The demand for combined transport is increasing, but still needs to be consolidated. The potential for increasing the proportion of craneable trailering is considered very big.

The CBT saves more than an hour of travel time in Ticino. It therefore currently enables primarily to compensate for delays that occurred elsewhere along the corridor. Further in the north-south direction, thanks to the CBT, trains no longer need to be strengthened by an additional locomotive. Overall, there are still many expectations from the stakeholders regarding the development of the rail infrastructure along the north-south axis. In particular, they expect a better coordination of the construction sites and a rapid expansion of the infrastructure to ensure uniform trains regarding clearance profile, length and weight.

On the **Brenner corridor**, the construction of the Northern access routes to the new Brenner Base Tunnel were continued in 2023. The “Angath” construction tunnel is the first major construction project for the second phase of the new Lower Inn Valley Railway. Between Schaftenau and Radfeld, ÖBB will construct a new railroad line more than 20 kilometres long at the northern approach to the Brenner Base Tunnel. The aim of the project is to relieve the Wörgl railroad station and provide additional modern rail transport capacity through the Lower Inn Valley for local and long-distance transport. Next steps for the infrastructure development in the Lower Inn Valley, also including the connection to Germany, are currently in the planning phase.

For the **Brenner Base Tunnel**, some further milestones could be reached in the Tyrolean section. Main works include the large construction lot H21 Sillschlucht which is being constructed between 2020 and the end of 2024 and which connects the Brenner Base Tunnel to the main station in Innsbruck. Within this construction lot, a major milestone was reached at the end of November 2023: after a construction period of around 15 months, the last wall and ceiling elements of the "Tunnel Silltal" were finalized. This means that all tunnel structures in this construction lot have been completed.

On the **southern side of the Base Tunnel**, the works were concluded in the tunnel construction works on the complex “Eisackunterquerung” construction lot. The main technical challenge of this construction lot included the undercrossing of the Eisack river, which runs right through the construction site. Also, the Southern access routes are further developed: the construction site for the Fortezza/Franzensfeste-Ponte Gardena/Waidbruck access section was installed in 2023 and geological exploratory drilling for the Bolzano freight train bypass was started. As third element, preparatory construction works for the lot A of the access route Fortezza/Franzensfeste – Ponte Gardena/Waidbruck were started. The 22.5 km long double track railway line runs mainly in the tunnel. Estimated construction time is 7 years.

Also, construction works on the Southern access routes in the Autonomous Province of Trento have been launched in 2023 – especially on section Fortezza-Verona for which a doubling of railway capacities is foreseen. This section (lot 3B) includes the bypass of the city of Rovereto. Throughout 2023, the feasibility document of design alternatives was prepared. It involves a total of 23.6 km of infrastructure, including more than 17 km of tunnels. A technical and economic feasibility project is planned for 2024.

As this new bypass makes the historic railway line through Rovereto obsolete, local authorities and RFI have launched a process to explore the dismantling of the historic railway line within a process of urban regeneration of the provincial capital of Trento.

In the **Région Provence-Alpes-Côte-d’Azur**, several priority projects focus on the further development of combined transport infrastructures to better connect the seaports. A regional funding of 3 Mio. € was provided by the Region, including 1.3 Mio. € for the extension of the transport site in Grans-Miramas combined transport site (Clésud), 0.8 Mio. € for the refurbishment of the terminals in Fos (located in the port of Marseille-Fos) and 0.6 Mio. € for the railway branch line between Fos and the Alteo plant in Gardanne.

Bavaria is promoting the **programming of an interface for terminal registration for combined transport** and the dispatching of haulage companies. This should enable digital registration and dispatch at the terminal with the exchange of the necessary information and documents between the truck handling system of the terminal and the transport management system (TMS) of the haulage company. Ideally, the driver will no longer have to take action themselves, as the truck will be registered by the TMS and then recognized by the truck handling system. The interface is supplemented by the development of an artificial intelligence (AI) to simulate the optimized deployment planning of the truck fleet in combined transport. Here, an AI is trained in such a way that it can ideally combine the existing fleet and drivers with the booked time slots at the terminal. This combination of an interface for terminal registration and AI for fleet planning contributes to the digitalization and automation of the supply chain and improves the utilization of existing capacities.

7.2.4 Pillar 4: Passenger transport

Further development of information and ticketing solutions

In **Tyrol**, the new ticketing systems as implemented in 2022 attracted more and more customers and the services of public transport were successfully extended in 2023. For example, 20 new city jet trains were purchased in 2023 and will be taken into operation up until mid-2024. In November 2023, almost a fifth of the population in Tyrol regularly traveled by public transport: 160,000 people already have a climate ticket and use the sustainable mobility services offered by Verkehrsverbund Tirol.

In the **Autonomous Province of Bolzano**, a new ticketing and information system for public transport was implemented in 2023. A new ticketing system with new validators and modern software was installed in 700 buses and all ticketing machines in railway stations were changed. The transition from the old to the new system was made during ongoing operations and was a big challenge. The new system allows an efficient monitoring of user data, of real time-utilization level of buses and optimization of real time information for passengers. Moreover, the mobile app Südtirolmobil now allows the online purchase of single tickets for bus and train services (function already available in 2022 only for the subscriptions “Südtirol Pass”).

Infrastructures and services for public transport and cycling

To further develop public transport and to improve its quality, several milestones could be reached in relevant infrastructure works. Several projects were already illustrated in previous Annual Reports and have reached new milestones in 2023:

- **Missing link between Brenner railway and Val Pusteria/Pustertal railway:** Thanks to the final approval achieved in 2022, the construction of the infrastructure project of the Val di Riga/Riggertal has been launched in 2023. The 3.8 km long Riggertal loop enables a direct train connection from the Brenner railway line in Bressanone/Brixen to the Val Pusteria/Pustertal railway line. The contract for the construction work with a total value of 138 million has been awarded. Once the ongoing surveys and soundings have been completed, construction work can begin.
- **Electrification of railway lines** in the Autonomous Province of Bolzano: for the electrification of the Vinschau/Val Venosta railway line, all safety works were concluded in 2023. The railway is running again on the entire route, after the closure of the section Merano/Meran-Tel/Töll for several months due to safety works in the tunnels. The partial closure remains in place only in the evening hours. Also, electrification works of the Vinschgau/Val Venosta railway are progressing at full speed with the construction of the pylon foundations.
- **New train stop on the Brenner railway line**: A new train stop will be built in the district of S. Giacomo/St. Jakob (municipality of Laives/Leifers) along the Verona-Brennero railway line, with connections every 30min. The stop will become a mobility hub and also serve Bolzano airport. The project (approx. 15.4 Mio. euros) is almost entirely financed by the European Union via the Fund for Development and Cohesion. Construction works started at the of end 2023.
- **Cross border mobility by bus** between Tyrol and South Tyrol: Introduction of a new cross-border bus service between Mals (South Tyrol) and Landeck (Tyrol). The service is offered seven days a week for 14 round trips.
- **Improvement of cross-border transport services**: The province of South Tyrol and the Austrian railway company ÖBB are jointly purchasing six new Coradia Stream multi-system

trains for cross border Euregio train services. Longer stops and changes at the Brenner Pass will no longer be necessary. The province of South Tyrol has already purchased 15 vehicles of the same type and is thus further expanding its modern train fleet.

The **Autonomous Provinces of Bolzano and Trento** also continued its efforts to extend cycling infrastructures. To implement the strategy of the Provincial Cycle Plan (agreed in 2022), a 28 Mio. Euro financing for 2022/23 has been provided by the Provincial budget and the ERDF for the construction and extraordinary maintenance of the cycle network. Further 12 Mio. Euro have been confirmed by the Italian Ministry for Transport. A new online "bike map" (used also by the neighbour regions Tyrol and Trentino) gives updated information on ongoing works or closures of the cycling paths. The aim is to promote the share of bikes in urban areas as daily transport mode but also to improve the touristic cycling offer.

Transition towards alternative fuels in public transport

In **Tyrol, the decarbonisation strategy for public transport** (bus services only) was agreed by the regional government in September 2022 and is now under implementation. The strategy has the major objective to decarbonise all 640 buses in Tyrol up to 2035. As intermediate target, 136 vehicles shall be converted to zero-emission technologies by 2027. Until 2025, this will lead to additional costs for vehicles and infrastructure of up to 23.2 Mio. Euros.

The **Autonomous Province of Bolzano** further strengthens its role as model region for the use of hydrogen vehicles and has purchased five new hydrogen buses for public urban transport throughout 2023. The fuel cell buses are 100% emission-free and the used hydrogen is "green". Funding is provided by the provincial budget and partly with funds from the National Resilience and Recovery Plan (PNRR). The measure is limited to urban centres with more than 100.000 habitants. The low emission buses will circulate in the municipality of Bolzano and the neighbour municipalities which are reached by the urban bus lines.

To reduce the use of fossil fuels, also remaining railway lines running on Diesel locomotives are electrified in the iMONITRAF! regions.

Capacity management in urban areas

As increasing congestion is also relevant for the urban areas in the iMONITRAF! regions, approaches for capacity management also relate to commuter mobility . In the Autonomous Province of Bolzano, the pilot project "Urban pass" has been implemented throughout 2023 which enables a free use of the motorway in Bolzano. The initiative is the result of an agreement between the province and Brenner motorway A22 and provides free use of motorway between Bolzano North and Bolzano South on working days from 7.00 to 9.00 am and from 4.00 to 7.00 pm. In this way, part of the through traffic in the city of Bolzano is being diverted to the A22 Brenner motorway in order to reduce pollution and traffic in specific parts of the town.

7.2.5 Pillar 5: Innovative approaches and political initiatives

As already highlighted in chapter 2 on capacity management instruments, the three regions of South Tyrol, Tyrol and Bavaria signed a position paper and agreed to deepen the implementation of a digital traffic management system for heavy goods vehicles on the Brenner corridor. The

approach is based on the feasibility study for a “slot system” which was commissioned and already presented by South Tyrol. Experts of the three regions are engaged to follow the project on political (also with the Ministries) and technical level by involving all relevant stakeholders.

Also along the Brenner, Tyrol and South Tyrol have adopted a resolution in favour of strengthening the railways and simplifying cross-border rail transport for goods and passengers. The focus is on modal shift, digitalisation and the removal of country-specific regulations as well as other barriers. One of the goals is to introduce a continuous regional connection between Innsbruck and Bolzano every half hour by the 2027 timetable change.

8 Outlook 2024 and beyond

The work programme 2023-2024 already provides a framework for the upcoming years and how to build on the initiatives as developed throughout the first implementation year. The topic of capacity management will play an important role also in the next years as political discussions at corridor level will continue. Also, the dynamics at European level at the end of 2023 were very ambitious and many ongoing discussions have a high relevance for modal shift on the Alpine corridors. Similarly, developments in Switzerland and the recent report on modal shift highlight the need for further action – specifically mentioning the coordination with the other corridors.

For the year 2024, the network will thus focus on the following topics:

- **Policy measures for combined transport:** The new Swiss modal shift report mentions a review of support measures for CT and the revised proposal for the CT Directive also puts a strong focus on the need for a more consistent policy framework. Thus, policy measures to support combined transport will be one focus topic for iMONITRAF! activities in 2024. Insights and proposal will be closely coordinated with other stakeholders at Alpine and European level to ensure that the common voice can become effective in the frame of the ongoing revision processes.
- **Capacity management:** Based on the initial input paper, the iMONITRAF! approach can be further developed and insights from the technical discussions can be shared with the relevant working groups at corridor level.
- **Decarbonisation:** Based on the initial overview on regional support measures for alternative vehicles, iMONITRAF! will further investigate joint solutions to support the use of alternative technologies for heavy-duty vehicles and to develop the Alps into a model region for decarbonised road-freight transport. This will also consider the development of relevant charging infrastructure for long-distance vehicle.
- **Networking and exchange**: Specific activities to implement the measures of the Simplon Action Plan are not yet identified. But iMONITRAF! has already signalled its interest to support the implementation of the Action Plan, especially with respect to the capacity management measures and the role of the regions for decarbonising road freight transport.

To meet these objectives for 2024 and beyond, activities will be necessary at different levels. In this respect, the iMONITRAF! network can build on its broad experiences and its networking partners at national, macroregional and European level.

- **Technical level:** Regarding the finetuning of policy measures and proposals, a further detailed exchange at technical level will remain the foundation for the work also in 2024.
- **Political level:** Considering the important developments at EU level and the many insights that iMONITRAF! can provide for the relevant discussions, it will also be important to closely involve the political level through 2024. Also, the next steps on discussing capacity management and regional support for zero-emission HGV would require a political involvement.
- **Networking level:** The ambivalent aspects of the Greening Freight Package require a coordinated effort at EU level to make the common voice visible at EU level – possibly coordinated with other Alpine stakeholders. Similarly, further activities to support the implementation of the Simplon Action Plan will take place on this networking level.

In order to reflect this different levels of activities, different events and networking opportunities are already foreseen for 2024, including a strategy meeting for the technical level in April 2024 and possibly a political exchange towards the end of the year. This could be linked to ongoing discussions at European and national level.

Annex: Monitoring indicators – methodological explanations

Indicator "Road traffic volumes"

Road traffic volumes can be measured in different ways, according to the measuring stations and the counting systems considered. Regarding the **measuring stations**, for Fréjus, Mont Blanc, San Bernardino and Gotthard data is taken from the stations at the entrance of the tunnels. For Brenner and Tarvisio, the data series stem from the Austrian stations of Brennersee and Maglern, which are the closest toll stations to the Italian-Austrian border at the time being. Finally, for Ventimiglia, the Italian toll station of Ventimiglia (that is the closest to the FR-IT border) has been considered. Regarding the **counting systems**, Brenner and Tarvisio adopt the Austrian classification for road detection, as provided by ASFiNAG: all vehicles below 3.5 t are counted as light vehicles, whereas those above 3.5 t are classified as heavy vehicles. For Swiss corridors, the official classification adopted by the Federal Office of Transport (FOT) has been considered: vehicles belonging to classes 1-3 (passenger cars, motorcycles and light commercial vehicles) are counted as light vehicles; those belonging to classes 4-7 (buses, coaches, HDV trucks, HDV truck trailers and HDV articulated trucks) as heavy vehicles. Finally, vehicles along Italian-French corridors are reckoned according to the system used by the Italian highways: the light vehicle category consists of vehicles belonging to class A (height below 1.3 m), while the heavy vehicle category includes those means belonging to class B (height above 1.3 m) and classes 3, 4, 5 (according to the number of axles). This methodological approach implies some **limitations** that are worth mentioning. In particular, the selection of a single measuring station to represent the flows along each corridor implies that flows may be either underestimated or overestimated compared to specific corridor sections. To understand the variability of flows among different sections, interested readers are invited to consult the WebGIS platform, where data is provided for more measuring stations in each corridor.

Indicator "Road traffic volumes" – Monthly data 2019-2022

To investigate in more detail the impacts of the Covid-19 pandemic on the road traffic volumes along the iMONITRAF! corridors, monthly data have been collected from the same sources used to complete annual data. This ensures consistency between annual and monthly values and allows providing more details on the fluctuation of road traffic flows in the years from 2019 (pre-Covid condition) to 2022 (years affected by the Covid-19 pandemic).

Indicator "Transalpine freight transport rail and road"

The analysis of the tons transported per year is largely affected by the difficulties in finding reliable and consistent data. However, thanks to the information collected and provided by the Swiss Federal Office of Transport - Observatory for Road and Rail Freight Traffic in the Alpine Region (France, Switzerland, Austria; FOT[12]), data for all corridors has been collected until 2022.

Indicator "Transalpine freight transport rail and road" – Monthly data 2019-2022

Also the analysis of the tons transported per month during the years 2019-2022 is largely affected by the difficulties in finding reliable and consistent data. Even in this case, the information collected by the Swiss Federal Office of Transport - Observatory for Road and Rail Freight Traffic in the Alpine Region (France, Switzerland, Austria), has allowed the collection and analysis of such data.

[12] The FOT report with the 2022 figures is expected to be available online at: https://www.bav.admin.ch/bav/de/home/verkehrsmittel/eisenbahn/gueterverkehr/verlagerung/berichte-und-zahlen.html (German version).

Indicator "Air pollution concentrations measured"

Some details regarding the measurement stations have to be mentioned. First, the South Tyrolean station of Velturno/Feldthurns was deactivated at the end of 2016 and the station of Bressanone sud/Brixen süd (located 1.5 km northward from Velturno/Feldthurns, south of Bressanone/Brixen) has replaced it since 2018. South Tyrol is thus described by the stations of Velturno/Feldthurns (years 2005-2016), Bressanone sud/Brixen süd (years 2018-2021) and Ora/Auer (years 2007-2021). On the Austrian side of the Brenner, the station of Mutters in not active anymore since 2022. The new station of Vill/Zenzenhof A13 replaces it with data starting from 2021. Since NO_2 is not monitored at Tolmezzo since 2019, it is flanked with the station of Ugovizza-Tarvisio. This station was activated at the end of 2014 and data is available from 2015. Finally, data for the station of Vallée de la Maurienne is not available since 2019 and from that moment replaced by Maurienne Trafic.

Indicator "Air pollution concentrations measured" – Monthly data 2019-2022

It has been possible to collect monthly data only for some of the measurement stations considered in the annual analysis. Specifically, monthly data are available from 2019 to 2022 for the stations of Quiliano (Ventimiglia), Susa (Fréjus), La Thuile and Entreves (Mont Blanc), Altdorf and Camignolo (Gotthard), Rothenbrunnen (San Bernardino), Ora/Auer and Bressanone Sud/Brixen Süd (Brenner), and Ugovizza-Tarivisio (Tarvisio).

Indicator "Noise"

A comparison between the values (L_{den} **and** L_{night}) registered in different corridors may be not appropriate due to different distances between the microphones and the streets. However, the variations along the individual corridors are consistent throughout the years. Gotthard and Mont Blanc are the only corridors with continuous data collection for the period 2005-2022 (measuring stations of Camignolo, Reiden and Courmayeur), whereas noise is not monitored along Brenner and Ventimiglia. Only partial data is available along San Bernardino (Rothenbrunnen), Tarvisio (Camporosso), Fréjus (Bardonecchia) and Mont Blanc (Châtillon). Regarding the first station, data collection started in 2012 and is currently ongoing; in Camporosso and Bardonecchia, updated values are not available: the monitoring period was limited to 2011-2017 in the former case and to 2010-2014 in the latter. In Châtillon, data collection is available for 2010-2022.

Indicator "Toll prices"

The origins and destinations for the calculation of toll prices have been defined as follows:

- Ventimiglia: from Marseille (FR) to Genova (IT) via Ventimiglia (381 km)
- Fréjus: from Lyon (FR) to Torino (IT) via Fréjus road tunnel (298 km)
- Mont Blanc: from Bellegarde-sur-Valserine (FR) to Ivrea (IT) via Mont Blanc road tunnel (228 km)
- Simplon: from Brig (CH) to Gravellona Toce (IT), via Simplon pass (99 km)
- Gotthard: from Basel (CH) to Chiasso (CH) via Gotthard road tunnel (288 km)
- San Bernardino: from Chur (CH) to Chiasso (CH) via San Bernardino road tunnel (169 km)
- Brenner: from Munich (DE) to Verona (IT) via Brenner pass (415 km)
- Tarvisio: from Salzburg (AT) to Udine Nord (IT) via Villach (313 km)

The calculated prices refer to the prices for a single passage (in direction north-south). This holds for the Fréjus and Mont Blanc tunnels, the Austrian highway vignette and the separate Brenner highway toll on the A13 in Austria as well as for the Swiss highway toll (passenger cars). For these corridors, return tickets and yearly subscriptions are also available, which would lower the cost for a single passage. For Switzerland, only a yearly ticket is available for passenger cars,

meaning that only the first passage costs, while all subsequent passages within the same year are free.

Indicator "Alternative Fuels per corridor"

The EU transport sector still heavily relies on fossil fuels. In particular, road transport accounts for the largest share of oil-derived fuels and was responsible for 71% of total EU energy consumption in 2017[13]. In this framework, the diffusion of sustainable fuels and renewable energy sources is highly encouraged by the EU[14]. Alternative fuels (AFs), by alleviating the dependence on fossil fuels, have prominent advantages for reducing the emission of greenhouse gases (GHG) and air pollutants. However, their use requires the development of adequate AF charging infrastructures. For each corridor, the AFs stations located in the service areas and in the parking areas of the toll gates as well as those stations located in the autoports and at the entrance/exit of the road tunnels are identified. The only exception is made for hydrogen: due to its limited diffusion, the stations located close to the road corridors have also been included. The main source for data collection is the European alternative fuel station map[15], which has been integrated in other web-platforms at national and international level.

Indicator "Unitary pricing components"

Four unitary pricing components are observed each year for France[16], Switzerland[17], Italy, Austria and Germany[18]:

- the *purchase tax*, expressed in % of the one-only purchase cost of vehicle (equals value added tax, VAT);
- the *registration tax*, expressed in Euros, to be paid one time only with the purchase of vehicle;
- the *ownership tax*, expressed in Euros, to be paid yearly;
- the *insurance tax*, expressed in % of the yearly insurance costs.

Considered regions: In France, Switzerland and Italy, the unitary pricing components vary from region to region. Therefore, sample regions are considered: the Department 73 – Savoie in France, Ticino for Switzerland, Lombardy for Italy.

Considered vehicles: Additionally, the unitary pricing components depend on the type of vehicle considered and its specific characteristics (like weight, powertrain and CO_2 emissions). Four sample vehicles are thus selected: a petrol car, electric car, diesel HGV, and electric HGV. In particular, we focus on the top-sold car models in EU in the last three years (2020-2022), and on the most diffused and typical kinds of HGVs. They are: 1) VW Golf; 2) Tesla Model 3; 3) Volvo FH; 4) Volvo FH Electric. The characteristics of these models are reported in Table A-1.

Aggregation of the unitary components: The four pricing components are aggregated in order to obtain a synthetic figure of the yearly cost of the purchase and ownership of a vehicle (€/year during the vehicle lifetime). Since the components have different units of measures, a series of

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[13] *European Environment Agency, 2020*. Transport, increasing oil consumption and greenhouse gas emissions hamper EU progress towards environment and climate objectives. Online at: https://op.europa.eu/it/publication-detail/-/publication/20388700-577f-11ea-8b81-01aa75ed71a1/language-en/format-PDF

[14] DIRECTIVE 2014/94/EU of the European parliament and of the council of 22 October 2014 on the deployment of alternative fuels infrastructure. Online at: https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A32014L0094

[15] https://alternative-fuels-observatory.ec.europa.eu/interactive-map

[16] Additional sources for France regard the online calculation of the registration tax. Available at: https://www.service-public.fr/simulateur/calcul/cout-certificat-immatriculation

[17] Additional sources for Switzerland regard the online calculation of the registration tax. Available at: https://www4.ti.ch/di/sc/veicoli/immatricolazioni/immatricolazione-di-un-veicolo-nuovo

[18] Additional sources for Germany regard the online calculation of the ownership tax. Available at: https://www.bundesfinanzministerium.de/Web/DE/Service/Apps_Rechner/KfzRechner/KfzRechner.html

information is needed to allow the conversion and aggregation. First, the purchase price of the vehicles is needed for the conversion of the purchase tax. Data is collected from the model producers in each observed country, and an average purchase price is established for each model. Second, the annual insurance premium is necessary to convert the insurance tax. In this case, data is obtained thanks to market calculators in each country and the average is derived. Finally, the vehicle lifespan allows the conversion of the purchase and registration tax. In this case, average data per country are provided by the ACEA, and an overall average across the considered countries is obtained. Table A-1 summarises the conversion factors calculated for each vehicle type (column "Average", cells in light blue), based on the data collected for each country.

Petrol car						
	France	***Switzerland***	***Italy***	***Austria***	***Germany***	**Average**
Model	VW Golf (top sold petrol car in EU in the 3 years 2020-2022: almost 670,000 vehicles)					
Characteristics	81 kW; 110 cv / 1000 cc; 6 Puissance fiscale in France; 122 g CO_2/km; 1,770 kg					
Purchase price	€ 32,195	€ 33,500	€ 29,400	€ 29,776	€ 31,145	**€ 31,203**
Insurance premium	€ 620	€ 265	€ 545	€ 775	€ 535	**€ 548**
Lifespan	10.5 years	12.0 years	12.2 years	8.7 years	10.1 years	**10.7 years**
Electric car						
	France	***Switzerland***	***Italy***	***Austria***	***Germany***	**Average**
Model	Tesla Model 3 (top sold electric car in EU in the 3 years 2020-2022: almost 320,000 vehicles)					
Characteristics	225 kW; 306 cv; 19 Puissance fiscale in France; 0 g CO_2/km; 1,836 kg					
Purchase price	€ 41,990	€ 43,275	€ 41,490	€ 42,990	€ 41,990	**€ 42,347**
Insurance premium	€ 915	€ 310	€ 635	€ 554	€ 730	**€ 629**
Lifespan	10.5 years	12.0 years	12.2 years	8.7 years	10.1 years	**10.7 years**
Diesel HGV						
	France	***Switzerland***	***Italy***	***Austria***	***Germany***	**Average**
Model	Volvo FH (Volvo is one of the five EU most popular players for selling diesel trucks)					
Characteristics	309 kW; 420 cv; 30 Puissance fiscale in France; Euro 6; NA g CO_2/km					
Purchase price	NA	NA	NA	NA	NA	**€ 155,000**[1]
Insurance premium	NA	NA	NA	NA	NA	**€ 5,500**[1]
Lifespan	9.2 years	14.2 years	19.0 years	6.6 years	9.7 years	**11.7 years**
Electric HGV						
	France	***Switzerland***	***Italy***	***Austria***	***Germany***	**Average**
Model	Volvo FH Electric (Volvo is one of the leading companies selling electric trucks. In 2022, Volvo kept the highest market share in EU: 32% of new sold HGVs)					
Characteristics	490 kW, 666 cv, 64 Puissance fiscale in France, 0 g CO_2/km					
Purchase price	NA	NA	NA	NA	NA	**€ 400,000**[1]
Insurance premium	NA	NA	NA	NA	NA	**€ 5,500**[2]
Lifespan	9.2 years	14.2 years	19.0 years	6.6 years	9.7 years	**11.7 years**

Notes:

[1] Country-level data on the purchase price and insurance premium not available. Only average EU values available, derived from non-country-specific sources.

[2] Data on the insurance premium of electric HGVs not available. We assume the same premium as diesel HGVs.

Table A-1: Factors for the conversion and aggregation of the unitary pricing components (column "Average", cells in light blue), based on country-level data.