ALBATRAS

Alignment of the heavy traffic management instruments ACE, AETS and TOLL+ on a comparable scientific, technical and operational level taking into account the introduction of different thresholds in order to analyze transport flow impacts on Alpine routes

Final Report submitted by the consortium:

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HERRY Verkehrsplanung / Consulting — Analyse – Beratung – Forschung

7th January 2011

Publication Data

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Title

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Awarding Authority

Steering Committee "Transport Safety and Mobility in the Alpine Region" within the framework of the Common Declaration of Zurich

Date

7th January 2011

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COMMENTS

of the Steering Committee "Transport Safety and Mobility in the Alpine Region"

to the final report of 7 January 2011 on the study

"Alignment of the heavy traffic management instruments ACE, AETS and Toll+ on a comparable scientific, technical and operational level taking into account the introduction of different thresholds in order to analyze transport flow impacts on Alpine routes" (ALBATRAS)

According to the tender specifications the main aim of the tender was aligning ACE, AETS and Toll+ on the same scientific and operational level and defining thresholds in order to analyze the impact of those instruments on the transport flow on Alpine routes. The contractor has aligned the instruments in a scientific way especially by bringing up AETS and Toll+ on the same level. Furthermore the impacts on alpine routes have been tested with the TAMM model.
The contractor delivered in due times the requested reports and inserted, to a certain extent, the numerous substantial remarks of the Steering Committee into the reports concerned.

However, the delegations of France, Germany and Italy still have pending remarks to the final version of the report. In short, they address e.g. some methodological elements like the definition and calculation of thresholds, the design of the ACE application or the balance of the national role of the alpine countries. In particular the study inter alia leaves the following perplexities:

- *Conversion of Alpine Crossing Units into Alpine Crossing Rights in the case of local and short-distance transport and in relation to the thresholds;*
- *Need for in-depth specification and objective justifications on the definition and calculation of thresholds;*
- *Focus on the impacts of the application of the various systems on the number of vehicle trips on different passes;*
- *Further elaboration of the method of fixing prices for the certificates for the crossing of alpine passes and the specifications on the functioning of the structure of the market; additional synthesis work and complementary scenario studies for a more thorough comparison of the effects of the systems (particularly in terms of traffic and CO_2 emission levels, modal shift and transport costs);*
- *Economic assumptions and traffic forecasts are not shared, in particular for the French-Italian corridors. This study shall not be considered as a freight traffic forecasts study. Its main goal is to compare the effects of the three systems studied.*

Accompanying investigations especially on legal compliance and economic effects have to be launched for a better understanding and plausibility of the results. Special attention has to be paid on the borders of the systems and the scope of their applications in order not to overlook by-pass effects;

The assumptions of the report also for the display of the scenarios, shall not predetermine future political decisions. Furthermore, those assumptions and the results obtained should be read in a comparative way; no concrete statement regarding the development of traffic in the Alpine region should be derived from reading any of the scenarios alone. The report represents a basis for subsequent studies to be undertaken in the framework of the Follow up - Zurich Process to support the decision making process for the Ministers of Transport.
This report will be published together with this comment from the Steering Committee as a foreword (integral part).

Zurich-Airport, 9 February 2011

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Summary

Starting point and objectives of the ALBATRAS-study

Within the Zurich process the management and regulation of transalpine road freight transport is gaining importance. Therefore, the Steering Committee "Transport Safety and Mobility in the Alpine Region" of the Zurich process decided to carry out the study "ALBATRAS: Alignment of the heavy traffic management instruments ACE, AETS and TOLL+ on a comparable scientific, technical and operational level taking into account the introduction of different thresholds in order to analyze transport flow impacts on Alpine routes".

Although the instruments of the Alpine Crossing Exchange (ACE), the Alpine Emission Trading System (AETS) and TOLL+ could be applied for the whole Alpine region, the Steering Committee decided to limit the geographical scope of this study to the Alpine passages in the Alpine region "B+", i.e. the Alpine arch between Ventimiglia and Tarvisio, including the Tauern-axis. However, the study will also take into account the effects on transport in the region covered by the Alpine arch "C".

Focus of the study

The ALBATRAS-study report is structured in three parts with an Annex.

- Part I consists of a detailed description of the three instruments including an analysis of the operational aspects and the costs of their implementation.
- In Part II thresholds are defined, i.e. caps for the number of lorries (ACE), caps for the amount of CO_2-emissions (AETS) and for toll levels (TOLL+). As a basis, business as usual scenarios for the years 2020 and 2030 are developed, showing the consultants' estimates of expected growth of transalpine freight transport in the next 10 to 20 years.
- In Part III the impacts of the different instruments on transalpine freight transport are analysed in detail. The basis for this analysis is the TAMM - Trans Alpine Multimodal Model developed by NEA and Ecoplan.

The ALBATRAS study contributes to the ongoing discussion about a common policy for transalpine freight transport. The study does not make explicit recommendations with respect to the three instruments. To do that, additional information outside the scope of this study (economic impacts of the instruments, legal questions) would be needed.

ALBATRAS consortium

The ALBATRAS-study was carried out by a consortium of four consultancies: Ecoplan, HERRY, NEA and RappTrans. Ecoplan was the overall leader of the study, carrying out the main work for Part II and III of the study in cooperation with NEA who conducted the modeling part for the different scenarios. RappTrans and HERRY were responsible for Part I of the study.

Part I: Alignment of the instruments

S-1: Description of the Instruments

a) ACE

The idea of an Alpine Crossing Exchange (ACE) was launched in 2002 as a possible solution for the future requirement of the Swiss government to shift transalpine freight transport from road to rail and to balance the capacity of transalpine road corridors in the Alpine region, as determined by the 1994 referendum.

The ACE would make use of the available capacity of the Alpine crossings (tunnels, mountain passes) for road freight transport by requiring every heavy goods vehicle to have an Alpine Crossing Permit (ACP) when crossing the Alpine passages. ACPs would be limited in number and purchased using Alpine Crossing Units (ACU). The Exchange would periodically auction Alpine Crossing Units (ACU), which could then be bought and sold on an electronic ACE platform. These ACU would be converted at a given rate to ACP, depending on the vehicle's characteristics (size, emission class etc.) and on the length of the trip (local trips pay less ACU). At every journey over the Alpine crossing, an ACP would automatically be validated.

b) AETS

The Alpine Emission Trading System (AETS) is based on policy targets for reducing selected emissions and thus indirectly limiting the available capacity on transalpine road corridors. In addition to this, one main initiative for AETS is the Austrian policy target to reduce long distance road freight transport crossing the Austrian Alps.

Emission certificates have to be purchased depending on standard emissions per vehicle class in g/km. It is suggested to take CO_2 as the relevant emission indicator for deriving the certificates. Thus, the focus of the AETS is on the CO_2-emissions of trips crossing the Alps. The emissions depend on the distance driven in the Alpine region which is defined according to the borders of the Alpine convention.

For each unit of CO_2 emitted (e.g. one kg) one certificate has to be obtained. The basic principle is similar to the emission trading concept which is applied in other contexts (e.g. CO_2 trading for industrial CO_2-emissions; planned CO_2 trading for the air transport sector). All of the CO_2 certificates available for the full range of liable crossings and regions would be released in a single auction.

c) TOLL+

The concept of differentiated toll systems (TOLL+) is based on two characteristics: the internalisation of the external effects of road freight transport in terms of air pollution, noise and congestion, by implementing the "polluter pays" principle as described in the amendment of the Directive 1999/62/EC on charging of heavy goods vehicles for the use of infrastructure (Eurovignette), and, the optimisation of the use of the road network with differentiated toll rates according to the time of day. Similar to the ACE and AETS concepts, the TOLL+ concept requires a passage right to cross the Alpine passage. Whereas the “currency” for the ACE and AETS have been ACP or emission certificates, in the TOLL+ concept, the price of the “passage permit” is the charged toll rate. Within this concept, the toll may be charged as one (modulated) rate or in addition to the already existing toll schemes (such as the new HGV charging scheme for France, GO-Maut in Austria, heavy vehicle fee in Switzerland) for the passage over or through the Alps. The passage over the Alps is defined by the section which needs to be crossed and its length.

S-2: Operation of the Instruments

a) European Electronic Toll Service building the foundation

The **E**uropean **E**lectronic **T**oll **S**ervice (EETS) will enable road users to easily pay tolls throughout the whole European Union (EU). It will be mandatory to offer the service in all EU Member States according to the EU Directive 2004/52/EC from October 2012. EETS is a model for service provision which can be applied for the Alpine Crossing concepts and will have the advantage that a large number of vehicles will be equipped for it. These vehicles which enter a charging scheme on the Alpine corridors will already have compatible on board equipment and will not require additional equipment for the three instruments.

b) Debiting, compliance and implementation

The **debiting** of the crossing rights (be it TOLL+, ACE or AETS) is done with On Board Units (OBU) which are already common for road user charges for heavy goods vehicles. Since a huge number of heavy goods vehicles will be equipped with interoperable OBU due to the EETS, and various national road user charging schemes require a mandatory OBU, it can be assumed that almost every heavy goods vehicle crossing the Alpine arch will be equipped with an OBU which is compatible with the three instruments ACE, AETS and TOLL+. The debiting concept is very simple: specific roadside equipment reads out the Personal Account Number (PAN) of the OBU in order to identify the vehicle. Afterwards, the booking/debiting of the passage is done in the central back office where every haulier has an own account for its vehicles and “passage rights”.

The basis for a strong **compliance** is an adequate legal basis covering all the involved countries and a system of compliance checking to ensure the prosecution of those that do not comply with the system. In a first step, non-compliant users need to be identified by the roadside equipment which is also used for debiting the passage. In a second step, when the non-compliant vehicle is identified, a fine will be sent to the identified user. Mobile enforcement staff on the road side can aussure further compliance, performing compliance checking and prosecution at the same time.

The individual national governments have the overall responsibility over the entire system on their territory. For the ACE and AETS, a mix between public and private **implementation** with a concentration on very few offices seems to be suitable. The supervision is done by a state committee. The assignment of ACU / CO_2-certificates, the register and system management along with the roadside implementation should be a task of private companies that compete for these functions. A transnational management of the register would certainly simplify a possible solution regarding the whole Alpine arch B+. However, a precise definition of political responsibility would be necessary.

In the case of TOLL+, each toll operator of an Alpine crossing has the complete responsibility over his system.

c) Implementation and operation costs

In order to assess the costs of the three instruments, four alternative deployments were calculated: one cost calculation for each single instrument introduced on the whole Alpine arch B+ (e.g. TOLL+ on the whole Alpine arch B+) and one calculation for the parallel use of the instruments on the whole Alpine arch B+ (e.g. TOLL+ in France/Italy, ACE in Switzerland/Italy and AETS in Austria/Italy/Slovenia).

The **implementation costs** are estimated to range between 33 million € (TOLL+) and 76 million € (ACE and AETS) and the **operational costs** range between 17 million € (TOLL+) and 27 million € (ACE and AETS) per year. The implementation costs for the parallel use of the instruments (scenario 4) are 73 million € and the operational costs 23 million €.

The **total costs** range from an estimated amount of 230 Mio. € for the TOLL+ concept up to 410 Mio. € for the ACE and AETS concepts. The TOLL+ concept is easier to be implement on already existing toll roads and tunnels in France, Italy and Austria. However, TOLL+ does not stipulate an upper limit of passage rights or foster a marketplace for trading Alpine crossing rights, which are very important aspects for both Switzerland and Austria.

The parallel use of an ACE, AETS and TOLL+ results in total costs of 360 Mio. €. It will take the nationally developed concepts of the ACE and AETS into account and leaves the TOLL+ concept to be applied on the French/Italian corridors.

Part II: Scenarios

S-3: Forecasting transalpine freight transport

a) Assumptions

A forecast of transalpine freight transport serves as a basis for the analysis of the impacts of the introduction of an ACE, an AETS or a TOLL+ strategy. This forecast is produced for the years 2020 and 2030 with the help of the Transalpine Multimodal Model (TAMM) developed by NEA and Ecoplan. In comparison with other studies forecasting transalpine freight transport the TAMM can produce the most detailed results (differentiated on NUTS3-level, for ten different NSTR freight groups, by road and three rail modalities).

Whereas in ALBATRAS the three different instruments ACE, AETS and Toll+ are analysed for the Alpine Region "B+" level (from Ventimiglia to the Tauern-Tarvisio-corridor) the forecast of transalpine freight traffic as well as the impact analysis in Part III of this study are carried out for the Alpine Region C (the whole Alpine Region between Ventimiglia and Wechsel).

TAMM is calibrated on the CAFT 2004 data. Of course, it would be very desirable to calibrate TAMM on the CAFT 2009 data, but as this data set is not yet available, this has to be done at a later stage.

Three business-as-usual (BAU) scenarios are produced, a trend scenario for 2020 and a high growth as well as a low growth scenario for 2030. The most important assumptions are:

- Country-specific projections of growth rates according to the EU iTREN-2030 project
- General productivity effects: Lower cost factors for rail freight transport, due to a multitude of productivity improvements and an increase of the average load per HGV on Swiss corridors (in 2004 the 40t-limit was not yet introduced).
- Introduction of new rail base tunnels (Lötschberg and Gotthard before 2020, Brenner and Mont Cenis before 2030) with corresponding additional productivity effects
- Step by step abolishment of rail freight transport subsidies (partly in 2020, fully in 2030)

b) Recent development of transalpine freight transport

To start with it has to be mentioned that recent figures for the Alpine arch "C" show growth up to 2004, continuing in 2006, reaching a highpoint in 2007, followed by a marked downturn in 2009. The 2009 volumes are some 8.2% lower than 2004 and 15.8% lower than the 2007 peak.

- On the French-Italian routes, despite a background of economic growth, transalpine volumes have been falling over the medium term. In 1999, French corridors recorded 49.6 million tonnes, falling to 47.2 million by 2004, followed by recovery to 48.1 million in 2007, falling to 38.1 million in 2009 with the financial crisis.
- On the Swiss-Italian routes, growth has been steady, albeit from a lower starting point. Between 1999 and 2004, volumes grew from 26.8 million tonnes to 35.4 million, rising thereafter to 39.9 million in 2008. In 2009 the volume was dropping to 34.2 million.

- Austrian-Italian/Slovenian traffic has also been growing steadily, and also from a higher starting point, so the absolute volume growth within Austria accounts for most of the change seen in the Alpine Convention region. With the adjustment made to include the Tarvisio route with the Alpine Arch C, volumes were recorded to grow from 107 million tonnes in 1999 to 133.7 in 2004 and 145.2 in 2008. These volumes dropped back to 124.7 million in 2009.

Conclusion: Recent traffic growth patterns would therefore suggest a return to moderate growth following the recession period, with highest growth expected on the Central and Eastern routes of the Alpine arch.

c) Base case 2004 and the BAU-scenarios 2020 and 2030

The results for the base case 2004 and the BAU-scenarios 2020 and 2030 are presented in much detail chapter 4.3 and in the Annex (chapter 12) of this study. Figure S-1 summarises the results for the scenarios according to countries and transport modes.

Figure S-1: Overview total transalpine freight transport volumes per country, in 1'000 tons

		road	Δ %	UCT	WL	RM	rail	Δ %	total	g total	Δ %
base case 2004	A - I / SLO	93'029		6'808	23'242	3'111	33'162		126'191		
	CH - I	12'453		11'819	9'018	1'669	22'507		34'959		
	F - I	39'740		2'653	4'274	-	6'927		46'667	207'817	
BAU 2020	A - I / SLO	107'763	15.8%	11'789	36'052	4'290	52'132	57.2%	159'895		26.7%
	CH - I	17'007	36.6%	16'407	17'749	2'042	36'198	60.8%	53'206		52.2%
	F - I	36'418	-8.4%	4'504	5'154	568	10'226	47.6%	46'643	259'744	-0.1%
BAU 2030 low	A - I / SLO	115'001	23.6%	11'933	42'888	3'849	58'670	76.9%	173'671		37.6%
	CH - I	17'623	41.5%	12'460	18'054	738	31'252	38.9%	48'875		39.8%
	F - I	34'026	-14.4%	5'182	5'341	871	11'394	64.5%	45'419	267'966	-2.7%
BAU 2030 high	A - I / SLO	133'498	43.5%	14'110	49'584	4'591	68'285	105.9%	201'783		59.9%
	CH - I	20'781	66.9%	14'784	21'298	889	36'971	64.3%	57'753		65.2%
	F - I	40'795	2.7%	6'218	6'407	1'044	13'670	97.4%	54'464	314'000	16.7%

Figure S-1 shows that transalpine rail freight transport will grow more strongly than road transport. In BAU 2020 there is a marked growth on Swiss rail corridors which is mostly due to the opening of the new Gotthard base tunnel. On the other hand, in 2030 growth on Austrian- and French-Italian rail corridors is dominant, following the opening of the new Brenner and Mont Cenis base tunnels. The relatively strong growth of road freight transport on Swiss-Italian corridors between 2004 and 2020 is a consequence of the assumed productivity effects on Swiss road corridors (2004 the 40t-limit was not yet introduced in Switzerland).[1]

[1] Perhaps the model overestimates this effect. In a next step the TAMM should therefore be calibrated on the 2009 CAFT data set in order to include already this effect.

Perhaps most interesting is the expected development of transalpine freight transport volumes between different regions. This is shown in Figure S-2 which shows transport volumes for the most important relations between southern and the northern regions.

Figure S-2: Transalpine freight transport volumes between countries in 2004 and the expected development in the BAU-scenarios (in Mill. tons/a)

	2004		2020		2030 low		2030 high		30high/04
	Ton (m)	Shares	Ton (m)	Shares	Ton (m)	Shares	Ton (m)	Shares	Growth
DE-IT	26.1	12%	30.6	12%	25.9	10%	31.1	10%	19%
AT-AT	20.7	10%	26.3	10%	29.3	11%	29.3	9%	42%
IT-DE	19.1	9%	23.0	9%	22.5	8%	27.0	9%	41%
FR-IT	18.1	9%	23.2	9%	21.3	8%	25.6	8%	42%
IT-FR	13.2	6%	12.3	5%	10.4	4%	12.5	4%	-6%
AT-IT	13.0	6%	11.4	4%	8.6	3%	10.4	3%	-20%
IT-AT	6.5	3%	7.9	3%	7.0	3%	8.4	3%	29%
BE-IT	5.2	2%	6.0	2%	5.6	2%	6.8	2%	30%
ES-IT	4.6	2%	5.5	2%	5.0	2%	6.0	2%	32%
IT-ES	4.6	2%	4.2	2%	4.0	1%	4.8	2%	4%
NL-IT	4.3	2%	4.1	2%	2.9	1%	3.5	1%	-18%
AT-DE	4.2	2%	5.3	2%	5.4	2%	6.5	2%	55%
DE-AT	3.9	2%	5.9	2%	6.1	2%	7.3	2%	85%
IT-BE	3.4	2%	3.5	1%	3.8	1%	4.6	1%	34%
CH-CH	3.0	1%	3.9	2%	4.3	2%	4.3	1%	44%
PL-IT	2.1	1%	3.6	1%	3.2	1%	3.8	1%	82%
IT-PL	1.9	1%	4.4	2%	5.3	2%	6.3	2%	222%
CZ-IT	1.8	1%	3.0	1%	3.6	1%	4.3	1%	139%
IT-CZ	1.5	1%	3.4	1%	4.5	2%	5.3	2%	246%
TR-DE	1.1	1%	2.5	1%	3.6	1%	4.4	1%	288%
Total	**158.4**	**76%**	**189.7**	**73%**	**182.5**	**68%**	**212.2**	**68%**	**34%**
Others	50.9	24%	70.0	27%	85.4	32%	101.8	32%	100%
Grand Total	**209.4**		**259.7**		**268.0**		**314.0**		**50%**

The overall pattern is that the share of these large trade flows, compared to the total diminishes over time from 76% in 2004 to a forecast 68% in 2030, so that most of the larger country pairs also reduce their share over time. Although some of the smaller base year flows are forecast to grow at a rapid rate, they do not overtake the largest country pairs. Most of the re-ordering takes place at the foot of Figure S-2. Throughout the time series, the main core of trade relations remains unchanged, revolving around Germany, Italy and France, with Austrian domestic flows also prominent.

According to iTREN-2030 GDP for the EU15 countries (a definition including all of the main Alpine cargo generators) is expected to grow by 34% between 2005 and 2030. Bearing in mind the mix of traffic, the trade growth figures applied in this study can be seen as comparable. ITREN-2030 is a post-crisis forecast taking into account future raw material shortages, greater degrees of inter-continental trade (higher proportions of European trade with Asian countries), a demographic shift towards non-working population segments and an economic shift towards service industries. Taken together, most of these "mega-trend" assumptions are consistent with moderate to low Alpine traffic growth. The expectation of growth of external trade flows via Italian, Slovenian and Croatian seaports is the main exception to this rule.

Finally, Figure S-3 summarises the forecast of the number of lorries in transalpine freight transport within the BAU-scenarios. The total number of lorries increases from 11.4 Mill./a in 2004 to 12.5 Mill./a in 2020 (+9%) and 12.9 – 15.1 Mill./a in 2030 (+13% - +32%). In general, growth of the number of lorries is higher on the eastern corridors than the western corridors (shifting of the transport relations from west to east).

Figure S-3: Number of Lorries in transalpine freight transport in Alpine arch C 2004, 2020 and 2030 (low and high), in 1'000/a

base case / BAU country	base case 2004	BAU 2020	BAU 2030 low	BAU 2030 high
number of lorries				
A - I / SLO	7'325	8'485	9'055	10'512
CH - I	1'258	1'361	1'410	1'662
F - I	2'818	2'583	2'413	2'893
total	**11'401**	**12'429**	**12'878**	**15'067**
in % of base case 2004				
A - I / SLO	100%	116%	124%	144%
CH - I	100%	108%	112%	132%
F - I	100%	92%	86%	103%
total	**100%**	**109%**	**113%**	**132%**

S-4: Thresholds and scenarios

The three policy measures Alpine Crossing Exchange (ACE), Alpine Emission Trading System (AETS) and TOLL+ all aim at limiting road freight transport and shifting transport activities to rail. In order to analyse the effects of these different policy measures, operable thresholds have to be defined. This is done in a pragmatic way. Of course, the internalisation of external costs and the coverage of infrastructure costs are important objectives, but they are not directly transferable to the instruments looked at in this study. In fact, it is rather a political question how restrictive a threshold should be, with the Swiss policy to achieve annual HGV crossings of 650,000 as the most tangible benchmark. We have therefore set forth a long list of 21 scenarios that are covering possible tolerant and restrictive thresholds. These are computed according to a consistent modelling methodology allowing comparisons to be made and discussed. None of them represents a policy consensus, commitment or objective, and no single scenario should be considered more or less likely than another.

Figure S-4: Overview of scenarios with names and thresholds

		2020 (with GBT) trend growth	2030 (with BBT and MCBT) for low growth / high growth*
ACE	**Restrictive**	**ACE^{R}_{2020}** (see p. 144) Caps in terms of numbers of HGVs per country: CH: 650'000 trips/a (52% reduction) A: 4 Mill. trips/a (26% reduction in Alpine arch B+) F: 1.9 Mill. trips/a (26% reduction)	**ACE^{R}_{2030}** (see p. 153) Caps in terms of numbers of HGVs per country: CH: 650'000 trips/a (54-61% reduction)** A: 2.5 Mill. trips/a (54-61% reduction in Alpine arch B+) F: 1.1 Mill. trips/a (54-61% reduction)
		$ACE^{R}_{2020\ A+CH+F}$ (see p. 147) Variant: One cap for all countries (sum of the above limits): 6.6 Mill. trips/a (total 30% reduction)	**$ACE^{R}_{2030\ high\ A+CH+F}$** (see p. 156) Variant: One cap for all countries (sum of the above limits): 4.3 Mill. trips/a (total 54-61% reduction)
	Tolerant	**ACE^{T}_{2020}** (see p. 150) Caps in terms of numbers of HGVs per country: CH: 900'000 trips/a (34% reduction) A: 4.5 Mill. trips/a (17% reduction in Alpine arch B+) F: 2.1 Mill. trips/a (17% reduction)	**ACE^{T}_{2030}** (see p. 159) Caps in terms of numbers of HGVs per country: As 2020: 900'000 trips/a (37-46% reduction) A: 3.5 Mill. trips/a (37-46% reduction Alpine arch B+) F: 1.6 Mill. trips/a (37-46% reduction)
AETS	**Restrictive**	**$AETS^{R}_{2020\ A+CH+F}$** (see p. 164) 20% reduction of CO_2-emissions ***	**$AETS^{R}_{2030\ A+CH+F}$** (see p. 172) 40% reduction of CO_2-emissions
	Tolerant	**$AETS^{T}_{2020\ A+CH+F}$** (see p. 166) 10% reduction of CO_2-emissions	**$AETS^{T}_{2030\ A+CH+F}$** (see p. 175) 20% reduction of CO_2-emissions
		$AETS^{T}_{2020}$ (see p. 168) Variant: country specific limits	**$AETS^{T}_{2030\ high}$** (see p. 177) Variant: country specific limits
TOLL+	**Restrictive**	**$TOLL+^{R}_{2020}$** (see p. 183) Prices are in between the Prices resulting for **** ACE^{R}_{2020} and $AETS^{R}_{2020\ A+CH+F}$	**$TOLL+^{R}_{2030}$** (see p. 186) Prices in between the Prices resulting for ACE^{R}_{2030} and $AETS^{R}_{2030\ A+CH+F}$
MIX	**Tolerant**	**MIX^{T}_{2020}** (see p. 190) ***** CH: 900'000 trips per year A : 10% reduction of CO_2-emissions F: The lower price of ACE^{T}_{2020} and $AETS^{T}_{2020}$	**$MIX^{T}_{2030\ high}$** (see p. 193) CH: 900'000 trips per year A : 20% reduction of CO_2-emissions F: The lower price of ACE^{T}_{2030} and $AETS^{T}_{2030}$

* If indicated with "$_{high}$", the scenario is only calculated for the 2030 high growth case.

** The reduction is depending on the BAU 2030 high or low transport level.

*** Of concern are the CO_2-emissions within the Alpine area according to the perimeter of the Alpine Convention. A reduction of 20% of the CO_2-emissions corresponds to approx. 20% of the HGV vkm compared to the *BAU-2020* case in this area. As a basis for each crossing, the kilometres that occur within the Alpine Convention area are modelled. It is important to note that different Alpine crossings involve different journey lengths through the Alpine Convention region.

**** In TOLL+ a pre-set distance based charge is applied according to the distances per corridor within the perimeter of the Alpine Convention.

***** In the MIX-scenarios the three different pricing instruments are modelled simultaneously and in parallel (TOLL+ on France-Italian corridors, ACE on Swiss-Italian corridors and AETS on Austrian-Italian corridors).

Part III: Impacts of the policy instruments

S-5: The TAMM – Transalpine Multimodal Model

The three policy instruments, ACE, AETS and TOLL+ represent different approaches, aimed at common policy objectives for managing transalpine heavy goods transport. At this exploratory stage of the process, many variants and combinations could potentially be applied. It is therefore necessary to develop a framework within which such variations can be compared, based on accepted traffic flow data and transparent assumptions. The inclusion of instruments such as ACE and AETS where end-user prices for heavy goods vehicle (HGV) permits are determined through a market mechanism rather than a top-down process requires an explicit treatment within the model methodology. The ability to use a model to solve for permit prices also serves the purpose of comparing volume thresholds between different instruments.

All results are derived from the TAMM model are based on identical exogenous assumptions.

TAMM is a multimodal assignment model, based on the traffic flows contained in the 2004 AQGV survey, forecast according to the iTREN-2030 study. By expressing policy and industry changes in terms of transport costs, the model can react by switching traffic flows between different route and mode (including multimodal) options. If volume-related thresholds are set for road transport, the model iterates to solve for a set of trip-based or kilometre-based prices by which the volume-related thresholds might be achieved. Thus it attempts to simulate an auctioning process whereby road supply and demand are balanced by route and mode shifts.

The greater the difference between the assumed threshold and the business-as-usual volume, and the fewer possibilities for detouring to avoid the pricing instrument, the higher the resulting price(s) will be. In this sense the model provides an indicator for the tolerance or restrictiveness of any given proposal.

Essentially two forms of pricing are considered in TAMM:

- Charges per trip across the Alpine ridge, with or without associated traffic caps.
- Charges per unit of distance, again with or without associated traffic caps.

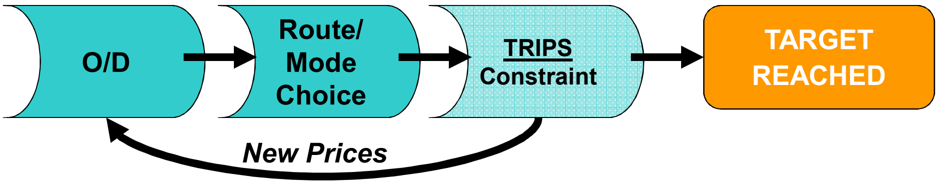
In the second category it is possible to address CO_2 related targets, or more straightforward charges per HGV kilometre.

If traffic limits are not set, a scenario can be constructed with preset charges per crossing or per kilometre within the Alpine Convention region. These can produce impacts in terms of:

- Route switching, from one Alpine crossing to another.
- Mode switching.
- Traffic suppression (relatively small effect compared to the others).

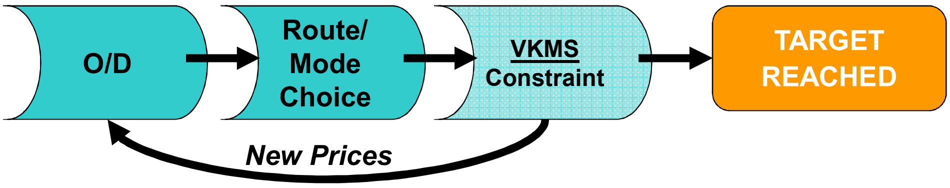
For **ACE**, caps are set in terms of vehicle trips, using the existing Swiss limit as the main benchmark for the restrictive variants. Outside Switzerland, the caps are set according to the business as usual volumes for the B+ arch.

Figure S-5: Construction of ACE Scenario in TAMM



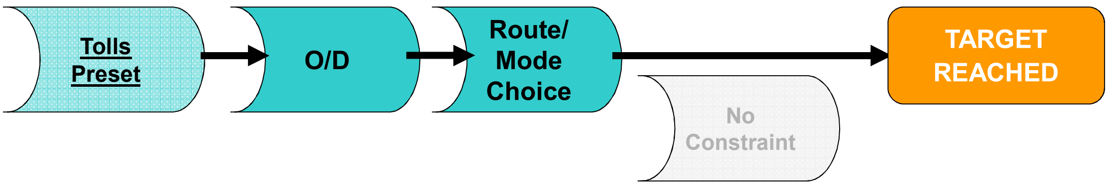
For **AETS**, caps are set in terms of vehicle kilomtres through the Alpine Convention (AC) region. The levels of the caps are set as a reduction relative to the forecast volume of traffic (2020 BAU or 2030-low) measured in heavy goods vehicle (HGV) kilometres within the Alpine Convention area. Distance based measures require an accompanying definition of the sensitive distance inside the AC region per Alpine crossing point. It is assumed that the HGV Km reductions, either 10%, 20% or 40%, also encapsulate technological changes which would result in lower carbon dioxide emissions per kilometre.

Figure S-6: Construction of AETS Scenario in TAMM



TOLL+ is similar to AETS, but the model is run in a more conventional way, with the prices being set exogenously, and the model calculating the resulting traffic shifts without iteration. No caps are set, but the tolls are applied per vehicle kilometre within the AC region. No time of day or day of week modulation is explicitly modelled.

Figure S-7: Construction of TOLL+ Scenario in TAMM



In the **MIX** scenarios, the three forms of pricing are modelled to operate in parallel.

In all cases the pricing schemes are only assumed to apply to the B+ range. This means that any vehicle detouring to the Eastern (Arch C) routes does not pay an additional crossing charge or consume one of the fixed number of permits. It does not count towards the preset volume thresholds.

Potentially there is a need to align the definition of the sensitive routes with the definition of the Alpine Convention region. Also to arrive at a policy recommendation it would be necessary to evaluate changes occurring in regions bordering the Alpine Convention.

S-6: Effects on transport volumes

In chapter 8.1 the impacts of the 21 different scenarios on transalpine freight transport volumes are presented in detail. In order to keep the summary reasonably short only the results for the scenarios 2030 high growth are summarised. The results for the other scenarios (2020 and 2030 low growth) in principle show the same structure but at different levels.

In the 2030 high growth scenarios, the strongest effects occur in the restrictive ACE scenario with country specific caps: Regarding the whole Alpine arch C around 65 Mill. tons/a are shifted from road to rail ("ACE R 2030 high"). In contrast, the lowest shifting effects occur in the scenario with a tolerant AETS system with a common reduction target for CO_2-emissions (around 36 Mill. tons/a). The TOLL+ scenarios lie in between the ACE and AETS scenarios whereas the MIX scenarios are closer to the AETS scenarios (but still higher than AETS regarding shifting effects from road to rail).

The policy instruments tend to result in a general shift of transalpine road freight transport from F – I corridors towards CH – I rail corridors. For some F – I road transport it is more attractive to shift towards CH – I rail corridors than on their own ones. There may be several reasons for this pattern:

- F – I corridors have a comparably high modal split for road. Therefore it is not surprising that the traffic shifts on the F – I rail corridors give rise to the highest growth rates for transalpine rail transport (see Figure S-9). But for some of the road freight traffic originally using F – I corridors it seems to be more attractive to shift on a Swiss rail corridor (e.g. traffic from the North-Eastern part of France or from the UK).
- Additionally, the Gotthard base tunnel rail corridor seems to attract rail freight traffic that was originally using more western corridors. It seems that despite the assumed opening of the new Mont Cenis base tunnel, especially the Gotthard rail corridor can attract additional transport.

In general, AETS leads to a higher relative reduction of vkm than of transalpine HGV trips within the area of the Alpine convention. This can be exemplified with the transport volumes on the Brenner-corridor (430 km distance within the Alpine Convention area) and the Tauern-corridor (301 km distance). Whereas in the scenario "ACE R 2030 high" 14.7 Mio. tonnes are transported on the Brenner road corridor it is noticeably less in the scenario "AETS R 2030 high" with 11.3 Mio. tonnes. At the Tauern corridor on the other hand 5.2 Mio. tonnes are transported in the scenario "ACE R 2030 high" but this figure rises to 7.1 Mio. tonnes in the scenario "AETS R 2030 high". So, for almost 2 Mio. tonnes a detour effect can be observed away from the Brenner- to the Tauern-axis. Overall, this detouring causes longer trips outside the Alpine area which increases again total CO_2-emissions. This effect is the consequence of restricting the CO_2-certificates to the distance driven within the Alpine Convention area, and not to the entire door-to-door trip.

Figure S-8 and Figure S-9 show the changes in transalpine road and rail freight transport in the 2030 high growth scenarios in absolute values and in % with respect to "BAU 2030 high" for the three considered groups of corridors within the Alpine arch C:

- The **A – I/SLO** corridors observe the lowest percentage reduction in transalpine road freight transport. This is due to the possibility of detouring via the three easternmost A – I/SLO corridors for which the instruments are not assumed to be applied.
- On **CH – I** corridors the percentage reduction in transalpine road freight transport is generally highest.
- The percentage reduction in transalpine road freight transport on **F – I** corridors lies below the reductions on CH – I but above A – I/SLO crossings. The reduction is clearly higher with country specific reduction targets compared to the introduction of a common cap.
- Regarding the changes in absolute values the reduction are highest on A – I/SLO corridores followed by CH – I and F – I crossings.

Figure S-8: Scenarios 2030 high: Δ in Mill. tons/a to BAU 2030 high for transalpine road and rail freight transport

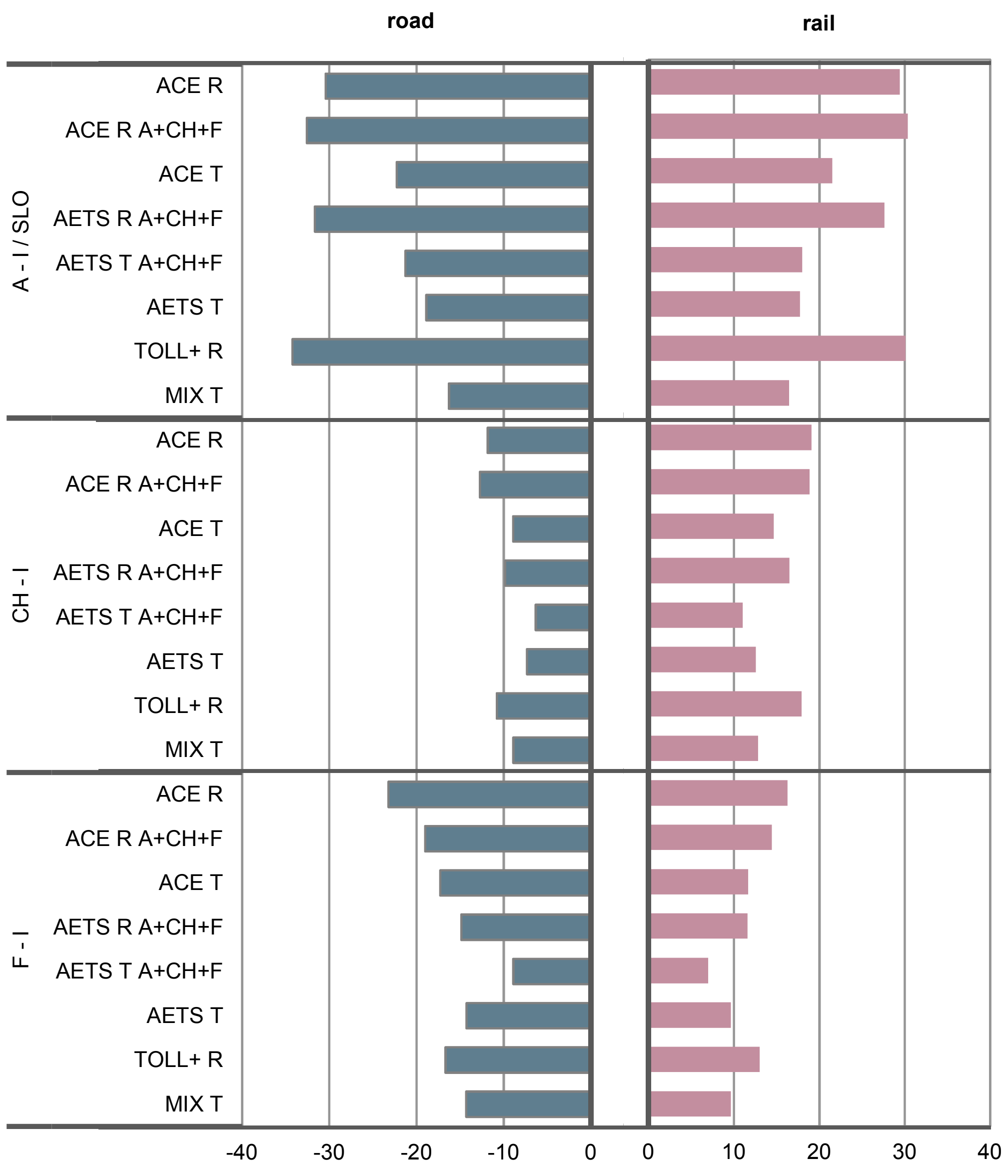
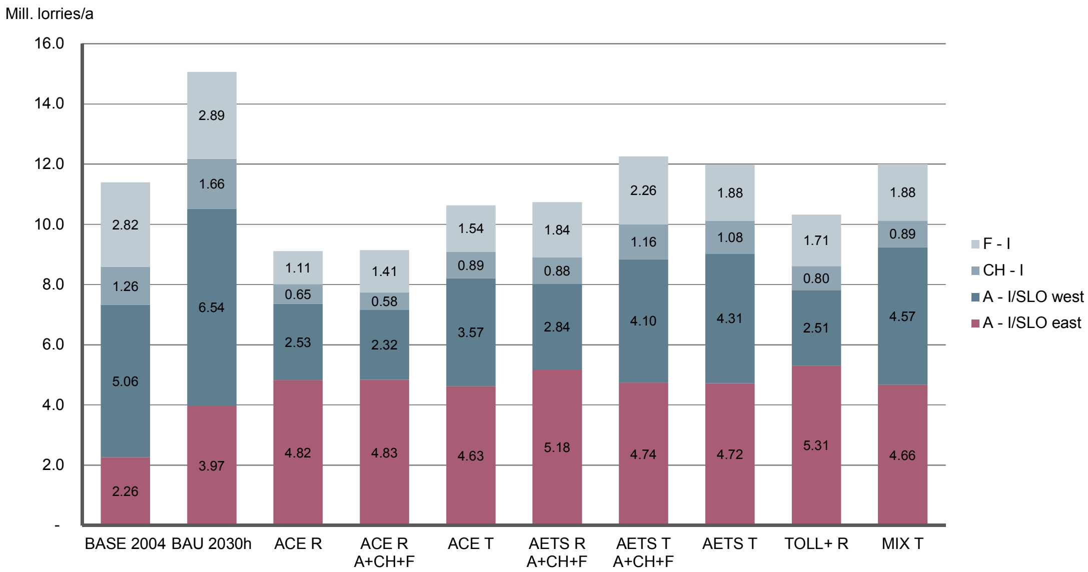


Figure S-9: Scenarios 2030 high: Δ in % to BAU 2030 high for transalpine road and rail freight transport

It is important to mention that for all analyzed policy instruments the shifts of transalpine freight transport from road to rail in Alpine arch C would be higher if the measures would include all corridors within Alpine arch C. Because of the **limitation on Alpine arch B+** the exclusion of the three easternmost A – I/SLO corridors leads to a marked detouring effect and consequently more road freight transport on those corridors. This is clearly shown by Figure S-10 which presents a summary of the results for the number of transalpine lorry trips for each of the scenarios for 2030 high growth. In order to distinguish between the crossing points for which the pricing instruments are applied (B+) and those which are excluded, volumes through Austria are split into two blocks – the Eastern (unaffected) routes, which see a rise in the number of lorries and the Western (affected) B+ routes, which see a decrease in the number of lorries.

Figure S-10: Transalpine lorry trips for the 2030 high scenarios, in Mill. lorries/a



Remark: The scales are measured in millions of lorries crossing the Alps per annum. The BASE 2004 column on the left hand side of the chart shows the observed volumes in 2004.

S-7: Road transport prices

Depending on the strength of the applied policy instrument and the observed year (2020 or 2030 low / high) the prices for transalpine HGV-trips per corridor increase by the following amounts (for all prices see chapter 8.2):

- **2020**: From 27 EUR/trip/corridor at the Tauern and Tarvisio corridors (scenario AETS T 2020) to 160 EUR/trip/corridor at CH – I corridors (scenario ACE R 2020).
- **2030 low**: From 56 EUR/trip/corridor at the Mont Blanc corridor (scenario AETS T 2030 low A+CH+F) to 281 EUR/trip/corridor at F – I corridors (scenario ACE R 2030 low).
- **2030 high**: From 102 EUR/trip/corridor at the Tauern and Tarvisio corridors (scenario MIX T 2030 high A+CH+F) to 345 EUR/trip/corridor at F – I corridors (scenario ACE R 2030 high).

For AETS and TOLL+, prices per corridor depend on the length of the corridor. Thus, for some transalpine HGV trips it may be cheaper to accept a detour via a corridor with a shorter distance within the area of the Alpine Convention.

S-8: Costs and revenues for the public sector

In this study the analysis of the impacts on costs and revenues is restricted to

- the calculation of the direct revenues generated by ACE, AETS or TOLL+
- the calculation of the operating costs of the policy instruments

A wider analysis would have to take into account a number of further impacts as e.g. reduced revenues from road tolls and petroleum taxes as well as less costs for rail subsidies or additional revenues from railway track access charges.

Generally, it can be observed that the revenues are higher the more restrictive an instruments is. But on the other hand, the most restrictive scenarios do not always generate the highest revenues as in these scenarios the shifting effect from road to rail outweighs the higher price per road freight trip.

Overall, the expected direct revenues are in the following range for the different instruments:

- ACE: 519 Mill. EUR/a (T 2020) to 1’224 Mill. EUR/a (R 2030 high)
- AETS: 275 Mill. EUR/a (T 2020 A+CH+F) to 1’255 Mill. EUR/a (R 2030 high A+CH+F)
- TOLL+: 682 Mill. EUR/a (R 2020) to 1’292 Mill. EUR/a (R 2030)
- MIX: 385 Mill. EUR/a (T 2020) to 1’018 Mill. EUR/a (T 2030)

The estimated operating costs are about 37 Mill. EUR/a for ACE- and AETS-scenarios, around 21 Mill. EUR/a for TOLL+ -scenarios and about 32 Mill. EUR/a for MIX-scenarios.

S-9: Analysis of rail capacities

Finally, the analysis of the capacity use shows that railway capacities in 2030 are large enough to absorb the large shifting effect of transalpine freight transport from road to rail. It can be clearly shown that in the BAU-scenarios the degree of capacity utilisation of the new transalpine rail base tunnels will be comparatively low. In other words: The construction of new rail base tunnels at the Mont Cenis/Fréjus-, Lötschberg-, Gotthard- and Brenner-corridor asks directly for the the implementation of an ACE- / AETS or TOLL+ -scenario in order to use these new capacities to a good degree.

Conclusion

This study delivers an analysis of three different transport policy instruments, the Alpine Crossing Exchange (ACE), the Alpine Emission Trading System (AETS) and TOLL+. All instruments aim at limiting transalpine road freight transport and shifting transport activities to rail. In the first part of the report, the instruments are described in detail. It is also shown how these instruments can be implemented and operated as well as what their costs would be.

The analysis of the impacts is based on a transport model – the TAMM – that was developed as a dedicated transalpine freight transport model and that is diffentiated according to all transalpine corridors, to road and rail freight transport including three different rail modes and to NSTR types of goods. The base year results of the model are calibrated according to 2004 data. It would be preferable to update the base year as soon as the new 2009 data set is available (which is not already the case).

The forecast in the business as usual scenarios for 2020 and 2030 corresponds to recent trends and is based on EU iTREN-2030 forecasts of trade volumes between European countries. It shows that growth of transalpine freight transport is shifting gradually towards the more easterly corridors. Of course, the assumptions used for the business as usual scenarios may be subject for discussion. In our view, given short and medium term uncertainties, the assumptions are well founded and are based on the most actual trends. In the business as usual (BAU) scenarios, forecast growth of transalpine rail freight transport is stronger than road freight transport. This is due to the introduction of new rail base tunnels (Mont Cenis and Brenner until 2030, Gotthard and Lötschberg before 2020) and other factors that cause noticeable productivity effects in the rail sector. On the other hand it is assumed that existing subsidies in rail transport (mainly for unaccompanied combined transport) are phased out.

As basis for the impact analysis a total of 21 scenarios for the ACE, the AETS and TOLL+ instruments were defined, run, and analysed. The thresholds used are derived in a pragmatic way in order to cover the implementation of the instruments from tolerant to more restricitive versions. The study shows the impacts of these scenarios on volumes and prices of transalpine freight transport. Additionally the direct effects on costs and revenues for the public sector and on capacities for transalpine rail freight transport are analysed. The results for the different scenarios are plausible. The more restrictive a scenario, the more transport volumes are shifted away from road to rail transport. Different per-trip prices via different crossings (as in the case of the AETS-scenarios) cause detouring effects towards corridors with lower price increases. The extent to which the instruments can be balanced by corridor across the whole region determines the extent to which they lead to desirable rather than perverse incentives.

The study delivers a basis for the governments of the Alpine countries to decide if one or a combination of these instruments should be established. The study produces no explicit recommendation with respect to the three instruments. All of these instruments could be introduced. In any case a co-ordinated introduction over the whole Alpine arch and not only a part of it is preferable in order to avoid unwanted detouring effects. Nevertheless, for a concrete implementation certain aspects such as the distribution of revenues between countries, the explicit organisation of auction procedures and questions of enforcement have to be determined in more detail.

1 Introduction

1.1 Background

The centrally located Alps have always been an important feature of European transport. Since Europe has consolidated as a single economic area, the transit routes through the Alps have gained in importance. Over the years, the continued growth of transalpine transport has led to a significant increase of transport-related problems, such as ecological damage, safety risks and noise. Congestion is also a recurrent problem. Reducing bottlenecks by merely building new (road) infrastructure is not considered a sustainable solution. This would reinforce the ecological problems and the resistance of the population in the affected regions. Furthermore, new infrastructure projects in mountainous regions are particularly expensive.

There is no explicit European Alpine transport policy. Instead, there are elements affecting transalpine traffic such as the promotion of Combined Transport, the trans-European network for transport (TEN-T) including some priority projects crossing the Alps, and the attempts to harmonize weight limits, working hours and pricing/financing. The White Paper on the Common Transport Policy contains some specific provisions for sensitive areas like the Alps. In the mid-term review of the European Commission's 2001 Transport White Paper, other forms of capacity allocation in environmentally sensitive and urban areas are suggested such as market exchanges of transit rights.

1.2 Scope of the study

Within the Zurich process "the management and regulation of transalpine road freight transport" is gaining importance. A first study "Best Research on Traffic Management Systems for Transalpine Road Freight Transport" has been finished with a final report at the end of 2008[2], giving first insights for a transnational policy for transalpine freight transport.

In the study three appropriate instruments of traffic management systems for transalpine road freight transport have been identified:

- **ACE**: Alpine Crossing Exchange
- **AETS**: Alpine Emission Trading System
- **TOLL+**: Differentiated toll systems

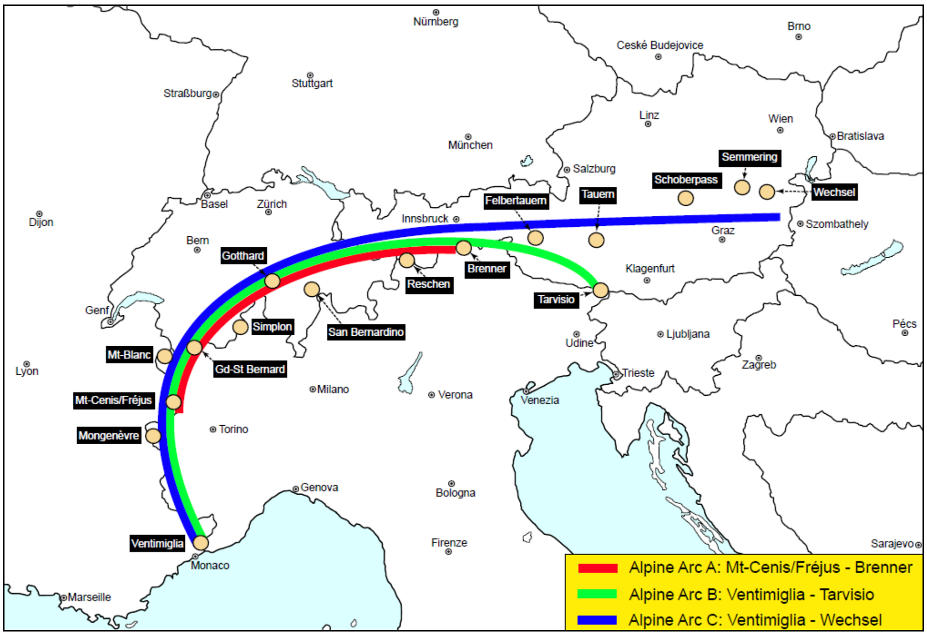
However, these instruments have been studied at different levels of detail and thus are not comparable yet. Therefore, ACE, AETS and TOLL+ have to be elaborated in more detail, defined and aligned on a common scientific, technical and operational level. Building on that, the instruments have to be thoroughly analysed at different defined thresholds regarding their practicability and applicability in the Alpine countries and the study has to answer fundamental questions with respect to the feasibility and the impacts of different possible instruments. Therefore, within the Zurich process, the Steering Committee "Transport Safety and Mobility

[2] TNO, ICCR und TML (2008), Best research on "Traffic management Systems for Transalpine Road Freight Transport"

in the Alpine Region" decided to carry out the follow-up study "ALBATRAS: Alignment of the heavy traffic management instruments ACE, AETS and TOLL+ on a comparable scientific, technical and operational level taking into account the introduction of different thresholds in order to analyze transport flow impacts on Alpine routes".

Although the instruments of the ACE, AETS and TOLL+ could be analysed for the whole Alpine region, the geographical scope of this study is limited to the Alpine passages in the Alpine region "B+", i.e. the Alpine arch "B" between Ventimiglia and Tarvisio, including the Tauern-axis (therefore "B+"). However, the study will also take into account the effects on transport on the region covered by the Alpine arch "C".

Figure 1-1: Alpine crossings within the Alpine arch



Source: BMVIT (see: www.zuerich-prozess.org/de/statistics/faq/).

1.3 Overview of the three instruments

Following earlier research, the "Alpine Crossing Exchange" (ACE), the "Alpine Emission Trading System" (AETS) and TOLL+ traffic management measures were selected as potentially the most suitable for regulating road freight transport in a sustainable way, i.e. reducing the environmental effects of road transport, enabling a modal shift and improving transport safety.[3]

This chapter provides a brief overview of these three instruments to highlight the similarities and differences between them regarding their basic attributes, possible technical implementa-

[3] Conclusions of the Transport Ministers within the Framework of the Follow-up Process to the Declaration of Zurich, presented in Vienna on the 7th May 2009.

tion and potential operational system before describing and aligning them on a more detailed technical, procedural and financial level in the subsequent chapters of this report.

1.3.1 Instruments

The concepts of an ACE, the AETS and TOLL+ are based on the common initial fact that every Alpine mountain pass and tunnel has a limited traffic capacity which is based on different characteristics.

Every road or tunnel has a physical capacity which is determined by different factors such as the number of traffic lanes. This means that at a certain speed, a maximum number of vehicles can pass this road or tunnel within a given time. Safety aspects such as the maximum speed and the level of traffic separation (density on the road) determine the maximum traffic flow on a road and tunnel. Furthermore, environmental aspects such as noise or pollution may have an influence on the capacity (e.g. night ban for heavy goods vehicles in Switzerland or speed limits on motorways in Austria during night time). And finally, political and economic aspects such as weight limits or toll rates have further influence on the capacity, thus leading to an individual "available" capacity for a specific road or tunnel on the Alpine corridor (see Figure 1-2).

Figure 1-2: Starting-point for the three concepts – road and tunnel capacity

The ideas for the concepts of an ACE, the AETS and TOLL+ have been developed in different countries (ACE in Switzerland, AETS in Austria and TOLL+ in France) with a different national transport policy on the traffic using the Alpine crossings. Therefore, the available capacity of an Alpine crossing mountain pass or tunnel strongly depends on the application of national policy, which can reduce the maximum possible physical capacity of the Alpine crossing to a lower available capacity due to the given restrictions.

Although there are different aspects to the capacities, a basic commonality of the ACE, AETS and TOLL+ is the management of the heavy goods traffic over the Alpine corridor with the granting of individual "rights" to pass an Alpine mountain pass or tunnel. These passage permits are mandatory for every vehicle passing a waypoint or section of the Alpine corridor and can be purchased by paying a certain "currency". The basic difference in these concepts is the required "currency" for the purchase of the passage right. The "currency" relates to the aspects limiting the capacity as defined in the national transport policy as shown in Figure 1-2, e.g. safety, environmental or economic reasons.

Alpine Crossing Exchange (ACE)

The roots of the Alpine Crossing Exchange go back to the year 1994, when the Swiss citizens voted in favour of an initiative with the objective to protect the Alps from the negative effects of transit traffic. The legal basis was set in article 84 of the Swiss Constitution, requiring the Swiss government to shift transit traffic from road to rail and levelling the capacity of the transit routes in the Alpine region within 10 years.[4] In order to transpose this constitutional policy, the Swiss government introduced a Heavy Vehicles Fee (LSVA) on all Swiss roads in 2001, resulting in a reduction of commercial traffic on the Alpine passages.

In the same year, a severe fire in the Gotthard tunnel caused its full closure for two months. After the reinstatement work, additional safety measures for the separation of trucks and cars were introduced. Since then, a metering system for heavy vehicles ensures an adequate separation of the vehicles by limiting the capacity for trucks to 60-150 vehicles per hour, depending on the amount of passenger traffic.

In order to reduce the Alpine transit traffic according to the Constitution and to allocate the limited capacity on the Alpine passages by economic incentives, the idea of an Alpine Crossing Exchange was launched in 2002 by the "Alpine Initiative" association, the initiators of the public voting in 1994. The feasibility of such an Alpine Crossing Exchange was evaluated in the research study 2002/902 "Alpentransitbörse, Abschätzung der Machbarkeit verschiedener Modelle einer Alpentransitbörse für den Schwerverkehr" and the concept refined in a study of the Federal Office of Spatial Development "Alpentransitbörse, Untersuchung der Praxistauglichkeit" in 2007.[5] Although the concept of an Alpine Crossing Exchange is feasible for the whole Alpine arch, both studies were limited to the four Swiss Alpine passages, i.e. the Gd. St. Bernard tunnel, the Simplon mountain pass, the Gotthard tunnel and mountain pass and the San Bernardino tunnel and mountain pass.

The concept of an ACE is based on the limited "available" capacity of the Swiss Alpine crossings due to political aspects (constitutional requirements) and environmental aspects (protection of the Alpine ecosystem).

The ACE concept distinguishes between Alpine Crossing Units (ACU), which can be bought and sold on the ACE platform, and Alpine Crossing Permits (ACP) which are required for the specific passage over an Alpine crossing. A defined number of ACU would be periodically auctioned and can be freely traded. ACU can be exchanged at a given conversion rate to ACP. The standard conversion rate is: 10 ACU equal 1 ACP. An ACP is assigned to a specific vehicle and is not tradable. At every journey over an Alpine crossing which is subject to the ACE, an ACP will be automatically validated. The separation between the tradable ACU and non-tradable ACP allows an additional degree of flexibility e.g. differentiation by trip length or vehicle type, if necessary.

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4 Article 84 of the Swiss Constitution on the Alpine transit traffic and Article 196 (1) Transitional provision to Art. 84 (http://www.admin.ch/ch/e/rs/101/index.html)

5 Ecoplan, Rapp Trans (2004), Alpentransitbörse. Abschätzung der Machbarkeit verschiedener Modelle einer Alpentransitbörse für den Schwerverkehr and Ecoplan, Rapp Trans and Kurt Moll (2007), Alpentransitbörse: Untersuchung der Praxistauglichkeit.

Alpine Emission Trading System (AETS)

One of the main aims of the Austrian transport policy since the early nineties was the reduction of road freight transport crossing the Alps in order to limit the of negative effects on the Alpine population and environment. This aim resulted in the Eco-point system which was in force from 1992 until end of 2003. This system aimed at reducing the NOx emissions and the number of trips through Austria.

The Eco-point system and other developments (e.g. European directives for emissions standards of engines; toll tariffs differentiation per EURO-classes) have influenced the reduction of NOx in the past and the remaining regulations and toll tariffs contribute to further NOx-reductions in the future. Therefore, an additional system should support the reduction of air pollution but does not have to be explicitly be aligned on NOx or other air pollutants.

On the other hand, no instrument exists that is directly related to CO_2 emissions of road transport and specifically Alpine crossing road freight transport in Austria. To make a contribution from this road haulage sector to the CO_2 emission reduction targets (due to the Kyoto protocol) a system reducing CO_2 emission of this sector is desired by Austrian policy. The Alpine Emission Trading System (AETS) is one possible solution to meet this policy aim. It takes over the idea of the industry CO_2-trading system.

In the AETS concept, a certain number of emission certificates are necessary for a single "passage right" across the Alps. For each Alpine crossing and every liable vehicle, a certain number of emission certificates would need to be presented in order to cross the waypoint or section where the Alpine crossing is charged. A fixed number of emission certificates are issued in every period reflecting a politically set maximum threshold of emissions. These emission certificates are then traded on the market (a kind of emission certificate trading exchange). The vehicle owner who wants to cross the Alps has to buy such emission certificates according to the emission category of the vehicle and the distance travelled within a defined Alpine region.

The AETS is based on policy reduction targets for selected emissions (mainly CO_2) which limits indirectly the available capacity on transalpine road corridors. In addition to this, one main driver is the Austrian policy target to reduce long distance road freight transport crossing the Austrian Alps.

Differentiated Toll Systems (TOLL+)

The concept of differentiated toll systems (TOLL+) is based on two characteristics: the internalisation of external effects of road freight transport in terms of air pollution, noise and congestion by further implementing the “polluter pays” principle as described in the amendment of the Directive 1999/62/EC on charging of heavy goods vehicles for the use of infrastructure, (Eurovignette). Furthermore, the TOLL+ concept would take into account the toll modulation scheme on some French motorway sections, optimizing the use of the road network with differentiated toll rates according to the time of day. The concept of toll modulation has been applied in France since 1992 on certain sections of the motorway A1 north of Paris, where the motorway operator SANEF levies higher tolls on Sunday afternoons to moderate the weekend traffic in direction of Paris.

The toll rate is reduced by 25% from 14.30 until 16.30 and from 20.30 until 23.30 (tarif vert), and increased by 25% between 16.30 and 20.30 (tarif rouge). In 1996, this concept was also tested with a higher level of modulation on the motorways A10 and A11 south of Paris during 8 months. Recently, the toll modulation concept was tested on the motorways A7 and A9 (Rhone valley/southern France). A similar toll modulation is in use on the Brenner Alpine crossing motorway in Austria (double tariff during the night for heavy goods vehicles). Other roads where a toll modulation has been applied for several years are the State Route 91 in Riverside County, California (USA) and Highway 407 in Toronto (Canada).

Thus, the concept of TOLL+ is based on the internalisation of external costs *and* the demand management of the limited capacity of a motorway, tunnel or mountain pass. Therefore, the measures to reach the available capacity are the modulated toll rate (economic aspect) as well as the addition of the internalised costs to the toll rate (environmental aspect) according to the amendment of the Eurovignette Directive 1999/62/EC.

Similar to the ACE and AETS concepts, the TOLL+ concept requires a passage right to cross the Alpine passage. Whereas the “currency” for the ACE and AETS have been ACP or emission certificates, in the TOLL+ concept, the currency is simply money, i.e. € or CHF. Within this concept, the toll may be charged as one (modulated) rate or in addition to the already existing toll schemes (such as the new HGV charging scheme for France, GO-Maut in Austria, LSVA in Switzerland) for the passage over or through the Alps. The passage over the Alps is defined by the section which needs to be crossed and its length.

Since one part of the TOLL+ charge is demand management, the rate charged for the passage can vary according to time. Therefore, it is important that these rate variations are transparent and are known by the drivers in advance in order to be able to react on the different rates.

1.3.2 Operations

The discussion on the operations system of a traffic management concept based on a system with individual passage rights can be divided into three parts:

- the acquisition of the passage rights,
- the debiting of the passage rights,
- the compliance to the system.

From an operational point of view, the ACE and AETS resemble each other regarding the operations system, whereas the TOLL+ concept can be seen as an extension of a current toll regime upgraded with internalised external costs and a modulation of the tariff.

a) Acquisition of the passage rights

The acquisition of the passage rights is very easy in the **TOLL+** concept: the passage right is paid at the toll plaza or charging point of the Alpine passage (e.g. Mont Blanc tunnel), either manually if a toll plaza is available, or electronically if the user has an On Board Unit (OBU) which can handle such payments. There will be a surcharge to the regular toll covering the external costs as described above, and due to the toll modulation, the tariff varies according to the demand, i.e. it is higher during peak hours and lower during calm hours. This modulation may be during the day, but also include only specific days such as Sundays or holiday seasons.

The **ACE** and **AETS** concepts require a more sophisticated acquisition system for the passage rights, i.e. an exchange platform where the "currency" for the passage rights is traded and can be purchased by the hauliers. The concept of the **ACE** is allotted to the trading of "Alpine Crossing Units" (ACU), which can be converted in individual "Alpine Crossing Permits" (ACP). The use of ACU improves the tradability and differentiation of the ACP on the exchange platform. The impersonal ACU can be traded unimpeded until it is converted into an ACP, which is specific for the vehicle using the Alpine passage. Furthermore, the conversion rate may depend on different factors such as the size of the vehicle, its emission class, the privileged handling of local and short term passages and so forth.

For the purchase of ACU the buyers have to register themselves in the owner register. A specific account with information about the company and the contact person will be created. In a second step, an account must be created in the ACU register. All assigned ACU from the initial assignment and later all purchased ACU will be registered on this account. ACU exist only in electronic form and can be identified according to their serial number. For an Alpine crossing, the ACU must be assigned to a specific vehicle. For this assignment, the haulier must register all his vehicles which he intends to use for Alpine crossings. ACP are created through the assignment of a certain number of ACU for a specific vehicle. ACP which are not used can be converted back into ACU.

ACU are traded off-market, i.e. there is no central platform on which the ACU transaction can be carried out. Hauliers, financial institutes and intermediate may trade ACU directly with each other, be it through personal contact, by telephone or by other media. At least three market participants act as market makers. They must purchase a minimum amount of ACU at the auctions and are committed to offer a certain amount of ACU for purchase or sale at any time. The market makers finance themselves from three sources: the difference between bid and asked, a commission for “last-minute” purchases as well as possible discount on the auctioned price. If private institutions do not assume the function of the market maker, public authorities have to administrate this function.

The concept of **AETS** is rather similar. A differentiation between units and permits is not necessary. Emission certificates have to be purchased depending on standard emissions in g/km). The number of certificates needed for one passage depends on the vehicle class and the distance driven in the region of the Alpine convention and the vehicle class.

b) Debiting of the rights

Similar to the chapter about the acquisition of the passage right, the debiting of these rights is very simple in the TOLL+ concept using existing technology, whereas for the debiting scheme of the ACE and AETS, additional electronic interfaces are required. All these concepts have again in common that the rights necessary for a passage over the Alps are due when crossing a defined waypoint or section.

In the **TOLL+** concept, debiting of the rights takes place directly at the toll plaza when the toll is paid manually. With already existing electronic tolling schemes, the debiting takes place at the same installation where the toll is already charged for the passage through a tunnel or over a mountain pass. These tolling schemes are normally based on microwave technology (Dedicated Short Range Communication DSRC[6]), but some schemes (e.g. in Germany) use also satellite technology for the determination of the chargeable waypoint.

In the **ACE and AETS** concept, the debiting of the passage rights is processed similar to the electronic payment in the TOLL+ concept. The only additional requirement is an interface between the operating system to the passage right exchange platform which requires as well a concept to link the identification of the vehicle’s OBU with its personal account number (PAN) to the ACE or AETS system. The ACE and AETS concepts benefit from the fact that currently most of the heavy vehicles are already equipped with OBU which have a DSRC interface for paying road tolls, which could be used in addition for the ACE and AETS. Due to the future possibility of having one single OBU for the payment of all road tolls in Europe, the amount of equipped vehicles will increase significantly. This will save operational costs as

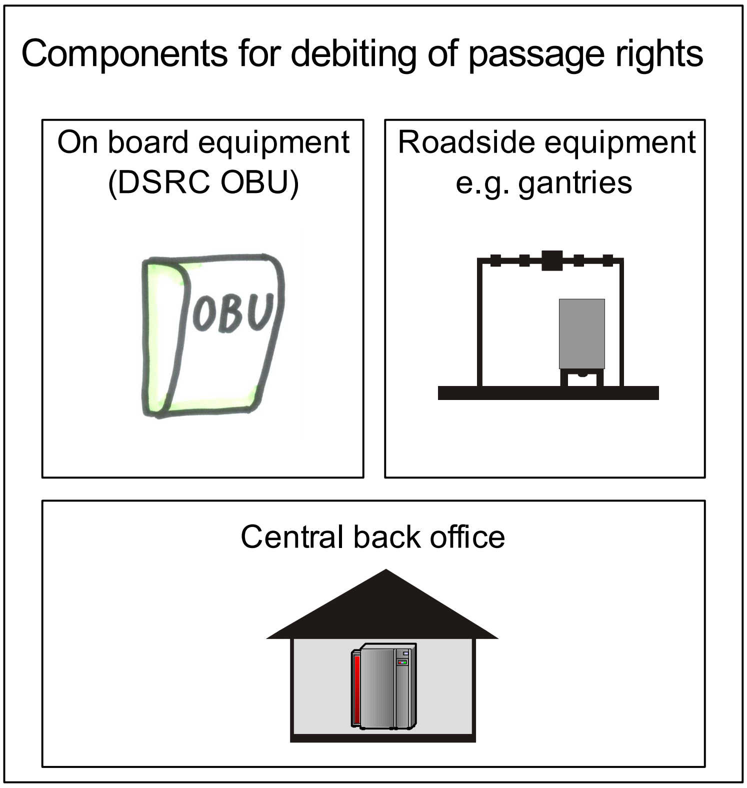
[6] Dedicated Short Range Communication (DSRC) is a wireless communication channel specifically designed for automotive use. There are different microwave technologies around or still under development. In this report the European DSRC version using microwave technology at 5.8 GHz is meant, which is widely used in European Electronic Fee Collection (EFC) services. European standards (EN) addressing the different layers in the OSI model as well as a set of protocols are available.

only a very small number of new DSRC OBU are necessary for vehicles not yet equipped with OBU.

For the debiting of the passage right of an ACE or AETS, and for the payment in the TOLL+ concept, three basic components are required:

- **On Board Equipment** (e.g. DSRC OBU): The On Board Equipment contains the Personal Account Number (PAN) which is necessary to identify a user.
- **Roadside equipment**: The passage rights are debited when the users crosses the roadside equipment (DSRC equipment on gantries) which identifies the OBU in the vehicle and the vehicle itself (number plate).
- **Central back office**: Each user has a back office account where the acquisition and debiting of the passage rights are processed and where the toll is charged from the user account (TOLL+).

Figure 1-3: Components for debiting of passage rights



For the debiting of the passage with TOLL+ the same procedure can be applied as for debiting the applied regular tolling scheme.

c) Compliance

In order to operate a credible instrument for the management of HGV over the Alpine passages, it is necessary that the users have an incentive to stay compliant with the rules. It is a general principle that a charging system is only as good as the compliance of the users. The basis for strong compliance is an adequate legal basis covering all the involved countries and a system of compliance checking to ensure the prosecution of those that do not comply with the system.

To ensure compliant users, a two-step approach is necessary:

- In a first step, non-compliant users need to be identified. This can be done automatically with gantries equipped with scanners for the identification of the vehicle's category, communication beacons for the identification of the vehicle's PAN and a camera for number plate recognition.
- In a second step, when the non-compliant vehicle is identified (compliance checking), a fine can be sent to the identified user (prosecution). Since this automated process would require enhancement and further international cooperation in identification (access to other number plate databases) and prosecution (international legal assistance), it is necessary to have additional roadside compliance checks. Mobile enforcement staff on the road side can assure further compliance, performing compliance checking and prosecution at the same time. With mobile enforcement, the prosecution of foreign users is much easier and has a signalling effect to all users on the road.

In the TOLL+ concept, the same procedure can be applied for compliance checking as for the regular tolling scheme already applied.

1.3.3 Basic attributes of the three instruments

The main attributes and principles of the three instruments ACE, AETS and TOLL+ in terms of their basic attributes are summarised in the Annex in chapter 9. The attributes are:

- definition of passage right
- validity
- spatial scope
- quantitative targets
- local and short distance transport
- supervision
- allocation
- trading
- layout and operations

P A R T I: Alignment of the instruments

The main objective of Part I is to harmonise the ACE, AETS and TOLL+ according to a common scientific, technical and operational level. Whereas the ACE concept needs to be adapted from a national level to the Alpine arch B+ level, the AETS and the TOLL+ concepts need to be elaborated and defined. The technical, procedural and financial scheme for the ACE, AETS and TOLL+ concept is elaborated, with the procedural scheme covering the organisational, operational and administrative aspects.

Part I is structured as follows:

- Chapter 2 deals with the definition of the instruments and provides an in-depth analysis on the concept of each measure, its passage rights, validity and exceptions.
- Chapter 3 is about the operations of a common ACE, AETS or TOLL+. After a short introduction to the European Electronic Toll Service (EETS) and the considerations of the expected impacts of such a service, more details are given on the acquisition and debiting of rights as well as compliance and implementation of the three instruments. Last but not least the estimated costs are presented.

2 Definition of the instruments

After the overview of the instruments in chapter 1.3, this chapter will define the three instruments ACE, AETS and TOLL+ in detail and compare the different concept approaches in terms of operations, transferability across the Alpine arch B+ and reciprocal acceptability.

The general principle of all three concepts is the same: the management and regulation of transalpine road freight transport with a relevant traffic management instrument, regulating the demand and/or supply of transalpine crossings.

In chapter 1.3.1, the relation between the physical capacity of an Alpine tunnel or mountain pass and the restricting aspects was shown. Based on the restricting aspects of the physical capacity (i.e. safety, environmental, political and economic aspects), which are related to the national transport policies, the instrument of ACE, AETS and TOLL+ are defined.

2.1 Alpine Crossing Exchange (ACE)

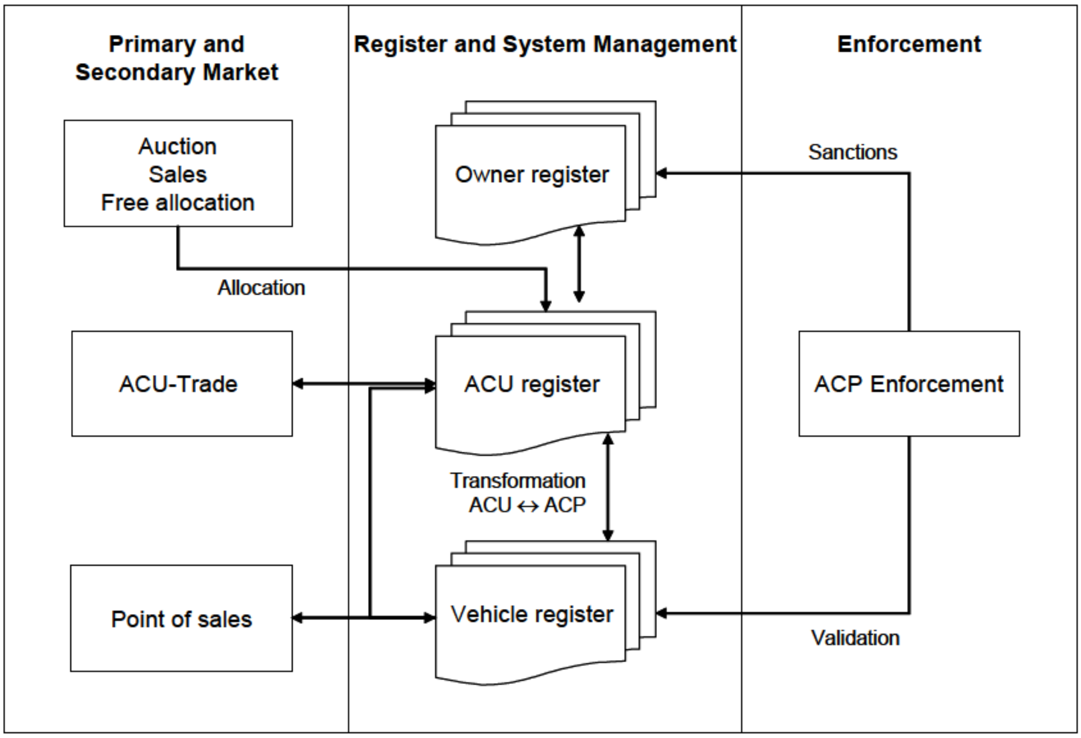
2.1.1 Concept of the measure

The capacity of the Alpine crossings is limited by safety, environmental and political aspects. The following table shows how the passage right is defined as well as which vehicles and which trips are liable.

Alpine Crossing Exchange (ACE)		
Capacity limitations		Safety, Environment, Politics
Liable passages		In Switzerland: Gotthard, San Bernardino, Simplon, Grosser St. Bernhard, but the concept should not be limited to the Swiss Alpine passages solely.
Liable vehicles		All HGV above 3.5 t
Variations	Vehicle	None
Variations	Distance / passage	None
Variations	Time	None
Variations	Emission	None

Figure 2-1 gives an overview on the concept of the ACE and the three system parts, i.e. the concepts for the acquisition of the passage right (primary and secondary market), the debiting process of those rights (register and system management) and the compliance checking (enforcement) as described in the research study on the ACE from 2007.[7]

Figure 2-1: Primary- and secondary market, register and system-management, supervision



Source: Ecoplan, Rapp Trans and Kurt Moll (2007).

In the first part of the “primary and secondary market”, the passage rights are traded. The second part of the concept is the “register and system management”, which can be seen as the operating system of the ACE. The third part is the “enforcement” of the compliance to the regulation for the ACE.

2.1.2 Passage rights

The basic principle of the ACE is the concept of tradable certificates already used in other contexts related to emission trading. Similar to the emission trading concept which is applied for various means (e.g. Kyoto Protocol, Acid Rain Program), the concept of the ACE would be applied to individual HGV passages over the Alpine corridors, which can be traded..

7 Ecoplan, Rapp Trans and Kurt Moll (2007): Alpentransitbörse: Untersuchung der Praxistauglichkeit.

In the concept of the Alpine Crossing Exchange the focus is on the acquisition of so called **Alpine Crossing Permits** (ACP). One ACP refers to one particular vehicle and entitles its owner to make one Alpine crossing in one direction within a certain period of time. The acquisition of ACPs is achieved by using **Alpine Crossing Units** (ACU). The actual number of ACU necessary for one ACP could be made dependent on the vehicle type (e.g. emission category). Local as well as short distance traffic can be treated separately concerning the number of ACUs needed per passage. The differentiation between ACU and ACP therefore allows for a price differentiation per vehicle type and road usage.

Auction

The previous study of the ACE evaluated three possibilities for the allocations of the ACU in detail: auction, free allocation and sale at fixed price. As a result, it suggests the auctioning of the ACU as the best solution for the distribution. Auctions are easy to implement, ensure an efficient result and set the right incentives.[8]

ACU are auctioned at regular intervals (e.g. once a year). The proposed procedure “simultaneous clock auction” is as follows:

1. The auctioneer quotes a price for one ACU.
2. The bidders indicate the number of ACU they would like to purchase at that price.
3. At the end of the round the auctioneer announces the aggregate demand. If it exceeds the available units, the price is increased.
4. The bidders again indicate the number of ACU they would like to purchase at that new price. They can also indicate the number of ACU they would purchase at prices in between.
5. The auction ends if supply and demand corresponds.

The described procedure allows for a price-setting process. The risk of large companies using their market power can be alleviated by appropriate information and price rules, but also because of the additional rule that a single market participant cannot acquire more than 25% of all available ACU. As every year ACU are auctioned, companies with a large market share cannot prevent other market participants to enter the market. Auctions therefore support competition and prevent incentives to build an oligopolistic situation. The auction is open for the hauliers as well as to financial institutes and other potential intermediaries.

In an auction, ACU for the current year would be auctioned, as well as units which could be used only in future years. Such a principle makes it possible for the market participants to develop long-term strategies and to evaluate the market prices of ACU for future years. In order to create the highest possible investment security and planning certainty, the number of available ACU in the future should be announced.

8 For a detail analysis of the assignment process of ACU see Ecoplan, Rapp Trans and Kurt Moll (2007), Alpentransitbörse: Untersuchung der Praxistauglichkeit, p. 111 – 120.

Trade [9]

ACU can be traded in two different ways.

- **Off order book** in an over-the-counter (OTC) market can be handled in written form, by phone or electronically. Transactions are concluded directly between buyers and sellers. Transfer of the ownership rights in the ACU register is achieved by a registration form.
- The other possibility would be an electronic **exchange market**. Trading of ACU would be based on an internet-based central platform. The exchange market could (but would not have to) include a standardised **clearing** mechanism (transactions are carried out between buyers / sellers and the operator of the exchange market). We expect that the trading volume is not large enough for such an integrated clearing mechanism.

The most efficient way to organise the trading process is a **combination of an over-the-counter market and an electronic exchange market without clearing**. The most important features of such a solution are:

- There is no central platform on which the ACU transaction can be carried out. Hauliers, financial institutes and intermediate may trade ACU directly with each other. Most of the trade will take place on internet platforms. "Last minute" purchase of ACU will take place on so-called Points of Sale (POS) along the transalpine corridors. Market makers (see next bullet point) are obliged to offer ACU on the internet terminals of the POS at any time.
- At least three market participants act as market makers. They must purchase a minimum amount of ACU at the auctions and are committed to offer a certain amount of ACU for purchase or sale at any time. Market makers ensure permanent accessibility for market participants. They finance themselves through three sources:
  1. Bid/offer spread: difference between the price quoted by a market maker for an immediate sale (bid) and an immediate purchase (ask);
  2. Fee for "last-minute" orders by vehicles without an ACP;
  3. Discounts on the auction price.

  Market makers are obliged to buy on every auction of ACU a minimum amount of ACU. We propose that this minimum amount is 10% of the ACU being auctioned. The maximum amount is limited to 25%. The public authorities close a contract with companies that fulfil these conditions. At every auction a minimal amount of ACU is automatically reserved for market makers. If an insufficient number of private companies (less than three) are interested to take over the function of a market maker public authorities themselves would have to fulfil this role.[10]

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[9] For a much more detailed description of the trading process and the role of the different actors see Ecoplan, Rapp Trans and Kurt Moll (2007), Alpentransitbörse: Untersuchung der Praxistauglichkeit, p. 123 – 128.

[10] In a more in-depth study this point has, of course, to be discussed in more detail. In an ACE-solution for the whole Alpine arch, the different countries have to work together. For instance, with respect to the French-Italian Alpine corridors, France and Italy would have to build a corporate public authority that would be responsible to administrate all public duties.

The proposed solution has the following advantages:

- Market participants can buy or sell ACU at any time. Therefore, the market has always a certain liquidity.
- The transparency is higher than with a pure OTC-solution because market makers have to publish their buying and offered rates for ACU.
- No additional infrastructure is necessary for "last-minute" orders of ACU. They can be placed at point of sales and then converted into ACP. In doing so, a fee becomes due.
- The solution is flexible and expandable. High starting investments are not necessary. Market makers and brokers are competing for the most attractive and cost-effective offer.

Excursus: *Several members of the Advisory Board asked questions about the risks of the ACE and the AETS with respect to the right functioning of the market for ACU and AETS-certificates. In the following excursus we discuss such questions as far it is possible in the framework of this study.*

Is it possible that ACU run short before the end of the year?

From the point of view of a haulier the problem can be structured as follows:

- *Before the auction the price of an ACU is not known. Therefore strategies for different prices have to be developed.*
- *During the auction the haulier will make different bids depending on the price of an ACU. At the end of the auction the haulier gets the amount of ACU that he bought for the then established auction price.*
- *After the auction the haulier makes an annual plan how to use the ACU he bought. If he didn't acquire enough ACU he will buy additional ACU on the market (most probably on one of the electronic platforms to trade ACU).*

There is no reason to expect that ACU run short before the end of the year as additional demand for ACU will result in an increasing price for ACU. In this case those freight operators that have the best (least cost) opportunities to switch to other modes (rolling motorway, combined transport) will sell some of their ACU on the market. The sine qua non for an efficient market is that the overall available amount of ACU is not changed during the year.

Will ACU be offered on the market?

The first allocation of ACU after the auction will most probably be not the definitive one as supply and demand for transalpine freight transport changes during time. Therefore it is most probable that ACU will be traded on the market. The liquidity of the market is uncertain and depends on the number of market participants, the degree of changes of supply and demand as well as the level of transaction costs. If market makers are involved in the ACU-market (as proposed) ACU will be offered on the market at any time.

The experiences on existing markets for certificates show that already with a relatively low number of market participants robust and liquid markets emerge.[11]

Is there a risk of strong price fluctuations on the market for ACU?

The price of ACU is influenced by several factors. If the demand for or the offer of transalpine freight transport services changes, the price for ACU will react. Apart from these fundamental factors also the expectations of market participants as well as their degree of risk aversion influences the price level of ACU. A certain fluctuation of ACU prices has therefore to be expected, in fact is inherent to the system. But these fluctuations will be limited. Especially, transalpine road freight transport is in a strong competition with transalpine rail freight transport. The higher the prices of an ACU, the stronger the incentive to switch the transport mode will be. Overall, after having established a market for ACU strong price fluctuations are not to be expected.
Additionally, the experiences in other markets show, that market participants can handle well price fluctuations. If the price would fluctuate more strongly than expected, products would be offered that limit price risks (e.g. options).

Is there a risk of abuse of market power?

It cannot be excluded that some actors will try to influence the price of ACU. But for several reasons it is very unlikely that they will be successful:
Market prices can only be influenced by such actors if they could buy the bigger part of all ACU (so called "cornering"). This would require such an actor to invest a lot of money (more than 100 Mill. €) – a very unlikely scenario. Of course, banks and other financial institutions would have the financial power needed but there are several reasons that such a speculative investment will not occur.

- *The maximum permissible amount of ACU that can be purchased at the auction by one company is limited to 25%. Additional ACU can only be bought on the free market with corresponding price increases.*
- *Price manipulations by an artificial shortage of the ACU-supply are limited because of the existing substitutes on the market (e.g. transalpine rail transport services). In a sense the rail price sets a kind of ceiling for the price of an ACU. Therefore it is certainly important to have a competitive rail freight market. If this would not be the case, e.g. having a rail operator with monopolistic market power, such an operator would have an incentive to buy ACUs and to ration its supply in order to push up his own rates. On the other hand, the possible influence of such a rail operator on the price of ACUs is limited through the presence of market makers.*
- *Price agreements are very unlikely because of the big number of market participants. Together, Germany, France, Italy, Switzerland, Austria and the Netherlands have more than 2000 hauliers operating in international freight transport services.*[12]

[11] See e.g. CCX - Chicago Climate Exchange (2004) or EPA (2003), Tools of the trade.

Is there a risk of hoarding ACU?

There is no economic incentive to hoard ACU and correspondingly we do not expect this:

- *It is not necessary to hoard because every year is a new auction of ACU that enables transport companies to meet their demand. During the year additional ACU can always be bought from other hauliers or from market makers.*
- *It would be costly to tie up capital that would otherwise produce good profits.*
- *Price manipulations caused by extensive hoarding are very unlikely as shown above.*

2.1.3 Validity / Exceptions

Territorial validity

Alpine Crossing Permits (ACP) can be used for all Alpine routes within the assigned area / countries. The aim of the Alpine Crossing Exchange is not traffic management between the different Alpine routes, i.e. the ACP's are valid for all Alpine crossings of one country (or – as an alternative – for all Alpine crossings of all Alpine countries) and not restricted to certain specific passages. Whenever severe and long lasting disturbances in the traffic system occur, it can be negotiated that the ACP can temporary also be used on Alpine crossings in other countries.

Temporal validity

Alpine Crossing Units (ACU) and ACP are valid over a defined time period (e.g. 15 months). The longer the validity of units the higher is the flexibility concerning the time of their use. The drawback of a long validity is a reduction in controllability of the Alpine crossings. The annual number of trips and therefore the accuracy of the system can only be managed if the validity lasts one year. But then again the planning of the trips toward the end of the year is difficult. Without any overlap of the validity, miscalculations by transport companies regarding their need of ACU or short-term changes in demand for transport could lead to price fluctuation.

The number of Alpine crossings may fluctuate over the months, but in total not more vehicles can cross the Alps than ACU were handed out each year. With the objective of the shift of road traffic and the decrease of Alpine crossings, short temporal validity has clear advantages over long validity. The problem of volatile prices can be overcome by creating ACU with short overlapping validity (e.g. 3 months).

When ACU are transformed into ACP, the permit would adopt the exact same validity that the units had.

[12] EC (2006), EU Energy and Transport in Figures.

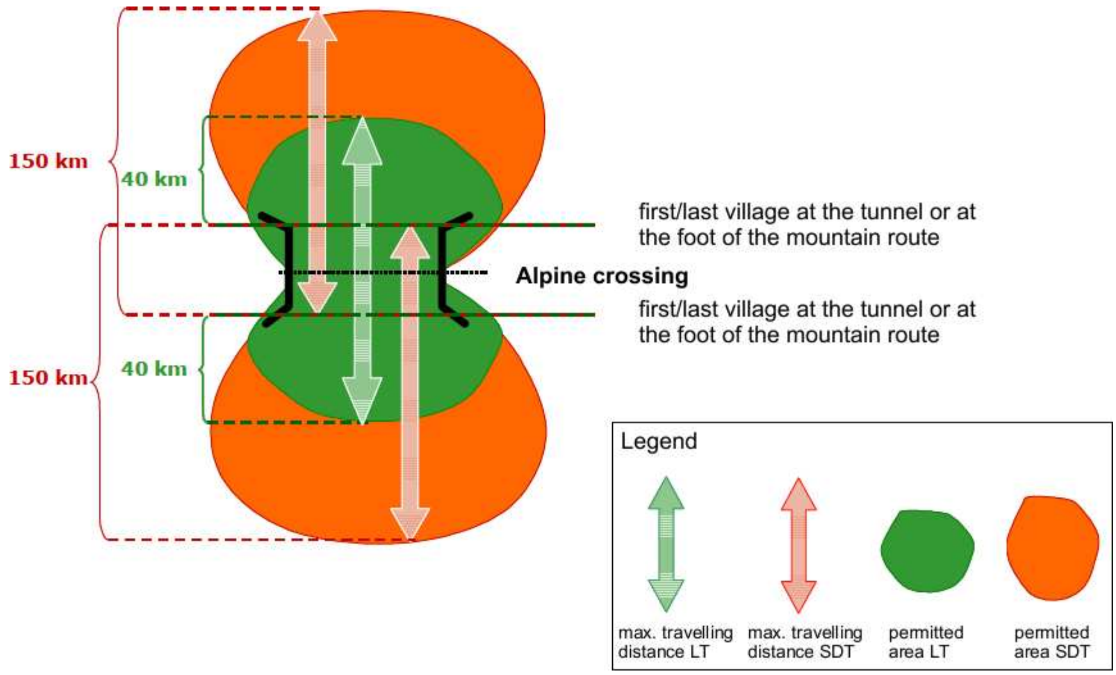
Conclusion: In order to ensure the consistency of the system and the scheduling for the transport companies, the period of validity of the ACU shall be limited to 12 plus 3 months. The overlap of 3 months between two ACU of a different year will reduce the variation of the price at the end of the calendar year.

Exemption

There are special exemptions for local and short distance traffic, which can be given preferential treatment in order to avoid traffic obstruction between nearby economic areas on both sides of the Alps. The exemption for local traffic (LT) would need to be stronger than for short distance traffic (SDT).

Both local and short distance traffic are defined by their Alpine crossing distance. The maximal travelling distance is 40 km on both sides of an Alpine crossing. For SDT the maximum travelling distance is 150 km including tunnel length or length of the mountain route (see Figure 2-2).

Figure 2-2: Maximum travelling distance for local traffic (LT) and short distance traffic (SDT)



Source: Ecoplan, Rapp Trans and Kurt Moll (2007).

For the acceptance of a vehicle as LT or SDT the load carried over an Alpine crossing is relevant (not the vehicle type) as well as the following empty trip. The vehicles would be clearly marked as local or short distance traffic (similar to the "S-traffic" in Switzerland) and mobile compliance checks would ensure the proper use of this exemption.

2.2 Alpine Emission Trading System (AETS)

2.2.1 Concept of the measure

Based on the initial description of the system set out in chapter 1.3, this chapter describes the concepts of the AETS in detail. As already discussed in chapter 1.3 it is possible to select different emissions as basis for the deduction of the emission certificates. Air pollution emissions (e.g. NOx or particular matters), noise and CO_2 are the most common emission categories that could be used for setting the capacity limitation due to emissions.

- Instruments to reduce NOx emissions already exist (toll tariffs differentiated by emissions classes; directives for introduction of EURO 5 and 6 vehicles) – an additional instrument focusing only on the reduction of this emission is helpful but not really necessary.
- Instruments to reduce noise (night driving ban in Austria for non-low noise vehicles, higher toll on Brenner for low noise vehicles) are in operation. A noise trading system is difficult to be connected to specific vehicle classes. Noise maps do not exist for all regions currently. Furthermore, perception of noise is non linear; an additional HGV is hardly noticed above other traffic on a busy link so there may be variable marginal costs.
- Currently, there is no instrument (except fuel tax) to reduce CO_2 emissions of (Alpine crossing) transport implemented yet. An Alpine Emission Trading System based on CO_2 emission offers an additional contribution by the transport sector to CO_2 reduction targets. CO_2 is strongly linked to fuel consumption and with it also to transport performance. Fuel consumption can also be seen as a close proxy for the motor emission of other air pollutants. The selection of CO_2 as relevant emission for certificates also contributes to the (Austrian) policy target to reduce Alpine crossing freight transport.

Due to these reasons it is suggested to take CO_2 as the relevant emission indicator for deriving the certificates. The following table shows which trips and vehicles are liable and on which parameters the number of certificates needed for an Alpine crossing trip depend.

Alpine Emission Trading System (AETS)		
Capacity limitations		Environment, Politics
Liable passages		In Austria: Tauern / Tarvisio, Felbertauern, Brenner, Reschen, but the concept should not be limited to the Austrian Alpine passages solely
Liable vehicles		All HGV above 3.5 t
Variations	Vehicle	standard CO_2 emission (g/km)
	Distance / passage	Distance within the region of the Alpine convention area
	Time	None
	Emission	Variation comprises from vehicle differentiation and distance

Due to the fact that CO_2 is selected as relevant emission, vehicles have to be distinguished by their CO_2 emissions. CO_2 emissions more or less conform to fuel consumption. CO_2 emissions and fuel consumption depend mainly on:

- Dimensions and aerodynamics of the vehicle
- Loading weight
- Engine power
- Driving mode
- Road topography
- Velocity
- (% of bio diesel)

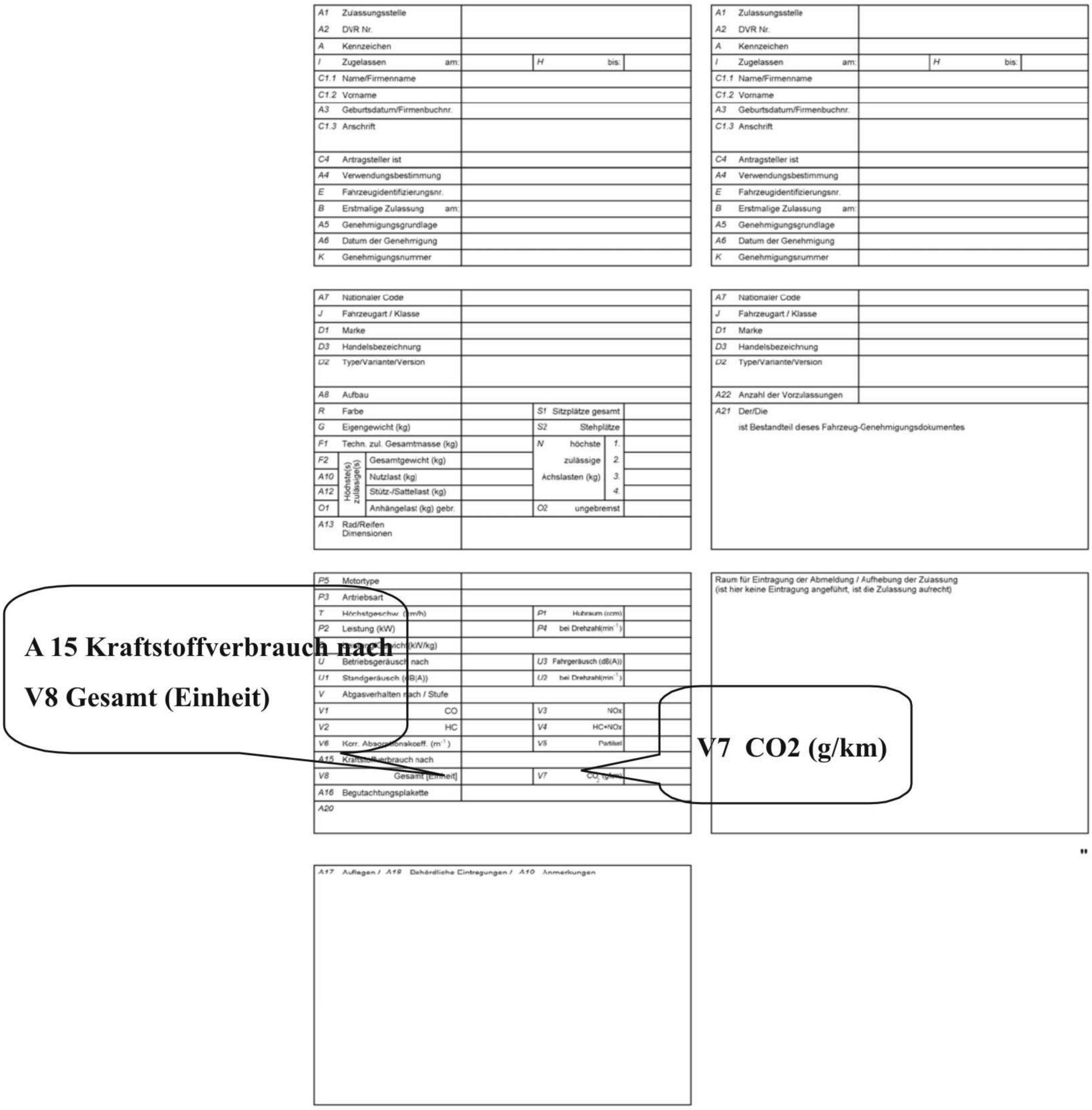
It is not possible to use all these factors for categorisation. This would lead to a non-user friendly and not enforceable system. To enable the enforcement of the system, the attributes for vehicle categorisation should be enforceable **automatically** as much as possible. The following variations are possible: number of axles and (standard) CO_2 emission or fuel consumptions classes within the axle classes.

The number of axles can be enforced with automatic systems (as used in existing road toll systems) but axles are only loosely related to CO_2.

Fuel consumption and CO_2-emissions can be translated into each other using physical formula. Since the measure aims at CO_2, clearly standard CO_2-emissions should be in the focus. The standard CO_2-emission is not automatically enforceable. To be able to validate this feature for every vehicle that is registered in the system the standard CO_2 emission is registered in the system and in the on board unit (OBU) that is used for the contact between the vehicle and AETS system. The information on this standard CO_2 emission can be found in the vehicle registration documents. Directive 2003/27/EC[13] regulates the content of the registration documents for vehicles. Due to this directive registration documents for vehicles with more than 3.5 ton gross vehicle weight (GVW) have to include standard CO_2 emission (and also standard fuel consumption). The following picture shows the vehicle registration document for Austria (as an example).

[13] COMMISSION DIRECTIVE 2003/127/EC of 23 December 2003 amending Council Directive 1999/37/EC on the registration documents for vehicles

Figure 2-3: Registration document for vehicles more then 3.5 t gvw (Example for Austria)



A1 Zulassungsstelle
A2 DVR Nr.
A Kennzeichen
I Zugelassen am: H bis:
C1.1 Name/Firmenname
C1.2 Vorname
A3 Geburtsdatum/Firmenbuchnr.
C1.3 Anschrift
C4 Antragsteller ist
A4 Verwendungsbestimmung
E Fahrzeugidentifizierungsnr.
B Erstmalige Zulassung am:
A5 Genehmigungsgrundlage
A6 Datum der Genehmigung
K Genehmigungsnummer

A7 Nationaler Code
J Fahrzeugart / Klasse
D1 Marke
D3 Handelsbezeichnung
D2 Type/Variante/Version
A8 Aufbau
R Farbe
S1 Sitzplätze gesamt
G Eigengewicht (kg)
S2 Stehplätze
F1 Techn. zul. Gesamtmasse (kg)
N höchste zulässige Achslasten (kg) 1. 2. 3. 4.
F2 Höchste(s) zulässige(s) Gesamtgewicht (kg)
A10 Nutzlast (kg)
A12 Stütz-/Sattellast (kg)
O1 Anhängelast (kg) gebr.
O2 ungebremst
A13 Rad/Reifen Dimensionen

A22 Anzahl der Vorzulassungen
A21 Der/Die
ist Bestandteil deses Fahrzeug-Genehmigungsdokumentes

P5 Motortype
P3 Antriebsart
T Höchstgeschw. (km/h)
P1 Hubraum (ccm)
P2 Leistung (kW)
P4 bei Drehzahl(min⁻¹)
Leistungsgewicht (kW/kg)
U Betriebsgeräusch nach
U3 Fahrgeräusch (dB(A))
U1 Standgeräusch (dB(A))
U2 bei Drehzahl(min⁻¹)
V Abgasverhalten nach / Stufe
V1 CO
V3 NOx
V2 HC
V4 HC+NOx
V6 Korr. Absorptionskoeff. (m⁻¹)
V5 Partikel
A15 Kraftstoffverbrauch nach
V8 Gesamt (Einheit)
V7 CO2 (g/km)
A16 Begutachtungsplakette
A20

Raum für Eintragung der Abmeldung / Aufhebung der Zulassung (ist hier keine Eintragung angeführt, ist die Zulassung aufrecht)

A17 Auflagen / A18 Behördliche Eintragungen / A19 Anmerkungen

This combination of validation and enforcement procedure is the same as for the existing toll system in Austria where the EURO classes (registration and implementation in the OBU) exist. Therefore, the enforcement and validation concepts in operation for the Austrian toll system can be used for the enforcement and validation of the AETS system, too.

Using CO_2-emissions and distances one CO_2-certificate is defined as one unit (eg. 1kg) CO_2 emission. So some lorries will thus need one certificate per km others one certificate per 4 km depending on the standard CO_2 emission. For calculating the needed certificates the standard CO_2 emission and the distance has to be used. It is not necessary to define specific classes. That gives the possibility to the user to precalculate easily the needed certificates per alpine crossing trip.

To facilitate trade with CO_2-certificates it might be necessary not to trade 1kg-certificates, but bundles of 100 or 1000 certificates (to be analysed).

In contrast to the ACE system, where the passage is the relevant unit, the focus of the AETS is on the CO_2 emission of the trip crossing the Alps. The CO_2-emission depends on the distance driven, i.e. a certificate is related to the distance driven in a defined Alpine. The region of the Alpine convention is an accepted definition for the Alpine region and should be used for the AETS system.[14]

The following figure shows the region on the Alpine convention (and its road network).

Figure 2-4: Region of the Alpine convention (and its road network)

Source: Alpenkonvention (2007), Online im Internet: http://www.alpconv.org (18.08.2010).

With this system of considering the driven distance instead of defining average distances (within a country or for the whole Alpine arch) a form of competition between different crossings is introduced because the number of certificates required for any given trip would de-

[14] This would call for the inclusion of the eastern Austrian corridors into the system. Our task, however, is the analysis of instruments in the Alpine Arch B+.

pend upon the crossing point chosen due to different distances driven in the Alpine region. This can lead to re-routings. It has to be kept in mind that CO_2 is a global pollutant, i.e. the damage from global warming in the Alps does not simply depend on the emissions in the Alpine area, but on total global emissions. Therefore detour traffic can increase total CO_2-emissions (including those outside the Alpine area) which is counterproductive. Thus if the reduction of CO_2 is the only aim, distance dependency (within the Alps) should not be used. However, the policy measure has additional aims: it should help to reduce air pollution and noise in the Alps where external costs are clearly higher than in flat areas.[15] With respect to these effects, distance dependency (within the Alps) has favourable incentives since it leads to re-routing: Those routes with the shortest distance through the Alpine regions are chosen more often which reduces the overall transport performance within the Alpine regions. Furthermore, we would like to analyse different policy measures in this report. Therefore we include distance dependency which is a clear distinction from the ACE.

This and the user fairness (the longer a trip within the Alps the more certificates are needed) are the reasons for suggesting this variation per actual distance. The implementation of this distance based system via EETS (European Electronic Toll Service) is easily possible: every distance can easily be recorded with the standard set by EETS. Moreover, by using GPS it is no problem to identify when a truck enters or leaves the Alpine area.

If only one country (e.g. Austria) starts to implement the AETS system, it is possible to reduce the liable region from the whole region of the Alpine convention to the parts of the Alpine convention within this one country.

The system enables the contribution of Alpine countries that do not have Alpine crossings (e.g. Germany and Slovenia). Trips crossing the Alps and passing the Alpine regions of more than one country have to use certificates for the distance driven in the Alpine region of all contributing countries. Via EETS it is possible to allocate the revenues of the certificates to the respective countries.

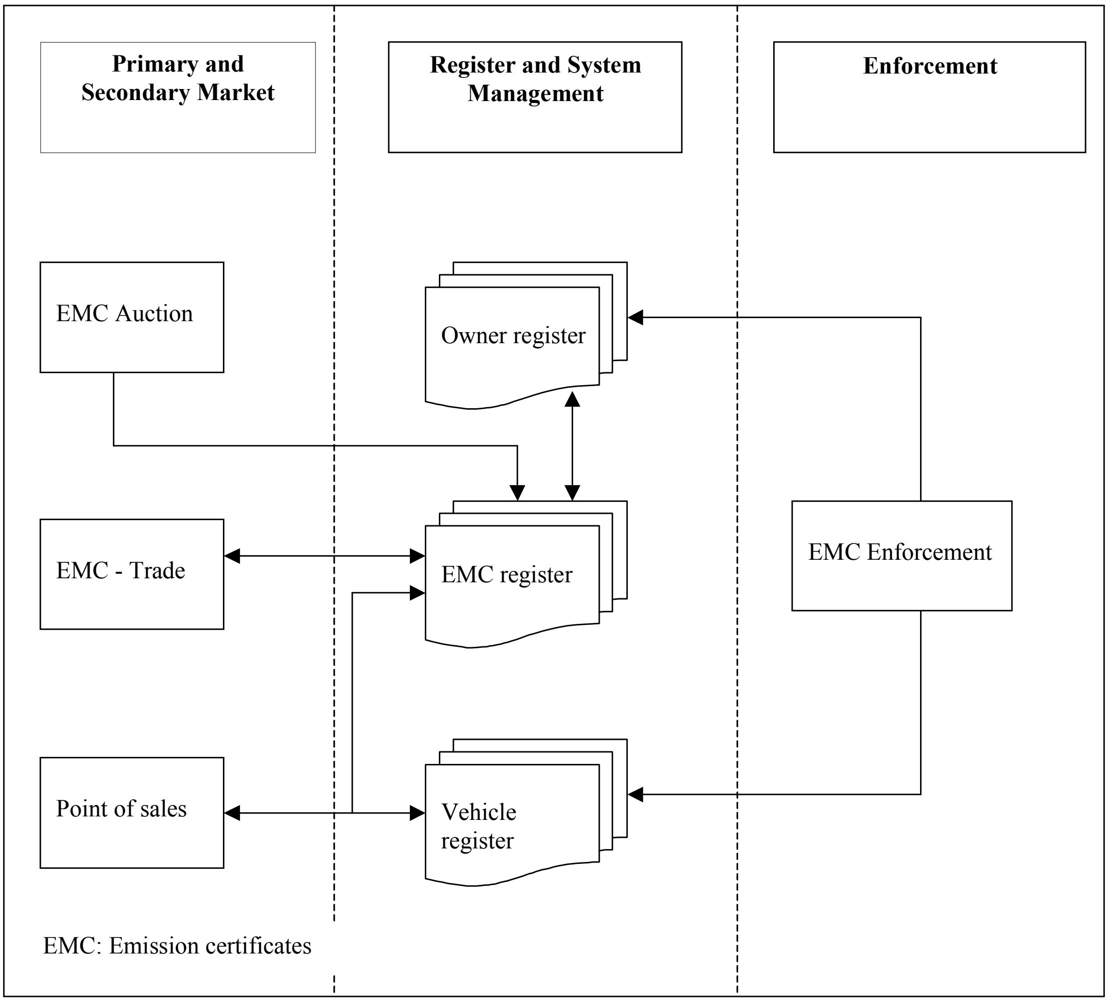
AETS has the same three systems parts like ACE:

- acquisition of the passage right (CO_2 certificates)
- debiting process of the certificates
- compliance checking

Due to the fact that there is no distinction between crossing units and crossing permits required (the CO_2 certificates are the only units – they are the trading units and they are needed for the Alpine crossing depending on the vehicle emissions and the distance) the transformation from units to permits is not necessary.

[15] Ecoplan (2006), Environmental costs in sensitive areas. The costs are mainly higher due to gradients, temperature inversions etc. which are both fostered by the Alpine topography. However, one might be critical about the usefulness of the Alpine convention area which includes areas which are rather flat (e.g. Southern Ticino). However, there are no real alternatives available.

Figure 2-5: Concept of the Alpine Emission Trading System (AETS)



2.2.2 Passage rights

The right to pass an Alpine crossing is linked to the emission of CO_2 during the crossing trip within the Alpine region. For each unit of CO_2 emitted (e.g. kg) one certificate has to be used.

The basic principle to get such certificates is similar to the emission trading concept which is applied for various other means (e.g. CO_2 trading for industry CO_2 emissions; planned CO_2 trading for the air transport sector).

One CO_2 certificate enables the emission of one unit (e.g. kg) of CO_2. Vehicles are classified according their standard CO_2 emission per km. To cross the Alps once (in one direction) it is necessary to use a specific number of CO_2 certificates depending on the vehicles standard emissions and the distance driven on this trip within the Alps. This enables an emission based price differentiation of the different Alpine crossing and includes also a different treatment of long – and short distance trips.

Following the suggestions for the allocation of Alpine crossing units within the ACE system, the allocation of the CO_2 certificates should be auctioned regularly (e.g. once a year).

The auctioning procedure is the same as for the ACE system (see chapter 2.1.2).

All of the CO_2 certificates available for the full range of liable crossings and regions would be released in a single auction. This guarantees one final price per certificate over the whole system and high route flexibility for the transport companies. In addition, this reduces the coordination efforts between corridors and especially between countries (if more than one country is involved). However, a single threshold for the whole Alpine arch has the disadvantage that country-specific reduction aims cannot be reached. In particular, the map in Figure 2-4 shows that the Austrian corridors are much longer than the Swiss ones such that some detour traffic through Switzerland will ensue. Therefore the reduction in Austria will be larger than in Switzerland. However, since CO_2 is a global pollutant it makes sense to use only one threshold for the whole Alps which is then met efficiently (see also section 5.1.2).

During the auction period certificates can be traded on an exchange market (in an organized trading centre). This is done over one central platform. Sub-platforms are allowed but they have to be linked to the central platform to guarantee one price at one point of trading time in all countries. Also market makers can organize the trading, again linked to the central platform to guarantee one price. The advantages of this system and the details are described already for the ACE system (see chapter 2.1.2).

2.2.3 Validity / Exceptions

Territorial validity

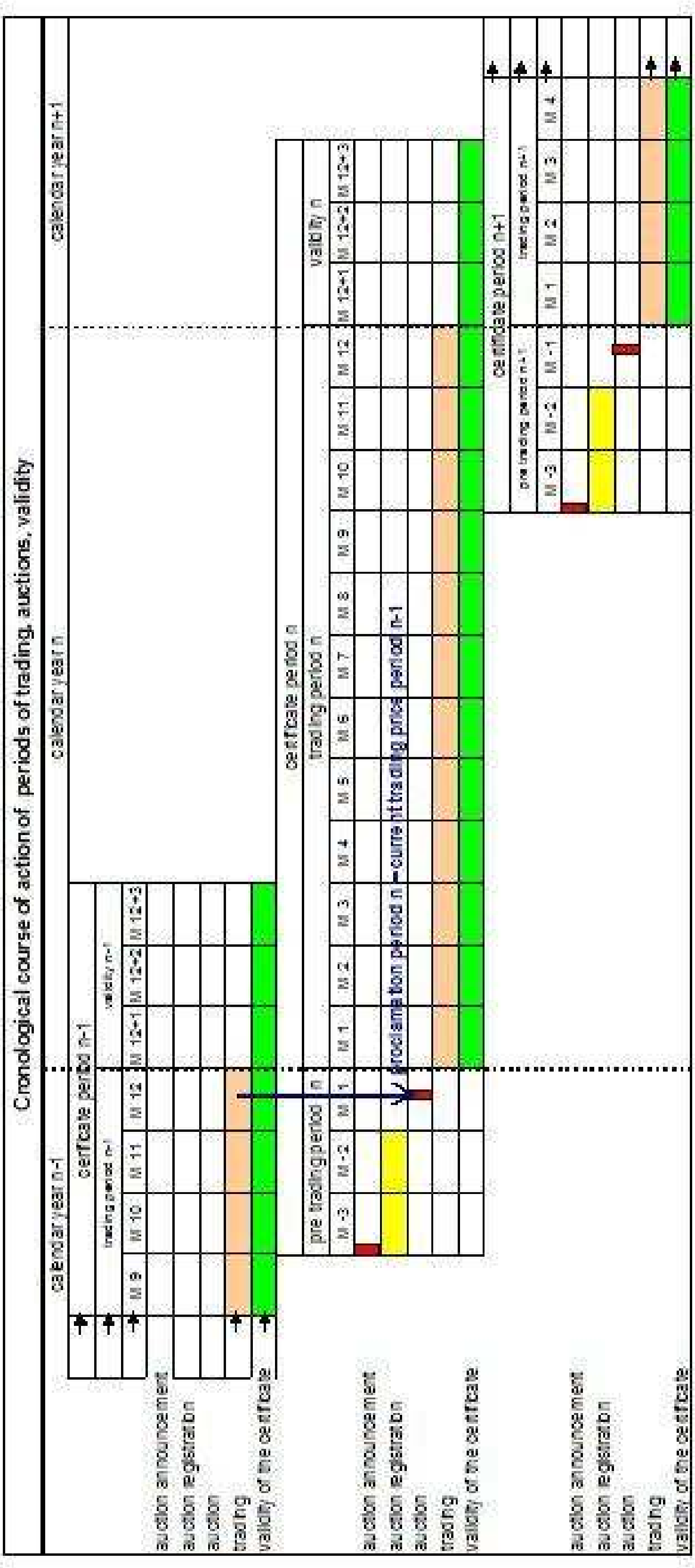
CO_2 certificates are valid and can be used for all crossings within the system. The auctioning has to auction all certificates of the system at once. One final auction price for all certificates will be generated during this auction. Because the number of certificates needed is dependent on the distance of the Alpine corridors, this principle of “one price per certificate” causes a re-routing effect in favour of the corridors with the shortest distance within the Alpine region. This re-routing effect supports the reduction of road transport performance within the Alpine region.

One advantage of having only one type of certificate which is valid for all liable crossings in all countries is that, if a traffic disturbance on one crossing or even in one country occurs, all users can switch to other Alpine crossings without any changes and additional efforts.

Temporal validity

The CO_2-certificates are valid over a defined time period. This should not be longer than one year (a new auction of certificates starts once a year). Otherwise it will become difficult to control the number of valid certificates. That would mean losing control over the achievement of the annual CO_2 reduction targets.

Figure 2-6: Chronological course of action of periods of trading, auctions, validity



Certificates auctioned should have a limited time of validity per trading period (e.g., in our example: one year). This time of validity should be longer than the respective trading period in order to have a degree of overlap.

Certificates auctioned per trading period have a suggested period of validity of one year.

As seen in the The CO_2-certificates are valid over a defined time period. This should not be longer than one year (a new auction of certificates starts once a year). Otherwise it will become difficult to control the number of valid certificates. That would mean losing control over the achievement of the annual CO_2 reduction targets. The CO_2-certificates are valid over a defined time period. This should not be longer than one year (a new auction of certificates starts once a year). Otherwise it will become difficult to control the number of valid certificates. That would mean losing control over the achievement of the annual CO_2 reduction targets.

Figure 2-6 as an example, each trading period n has a pre trading period which contains

- the announcement of the auction, at the beginning of the third month before of the trading period n
- the auction registration during the third month and the second month before the trading period n
- the auction itself during the month before the trading period n

To give the users the possibility for longer planning, the numbers of total certificates that will be auctioned are published some years in advance (e.g. 4 years). With this action the validity time period can be held rather short (e.g.15 month).

It should be taken care that there are certificates with different prices (one price for certificates of the ending period, and another price for certificates of the new starting trading period). Taking that into account, the certificates can be traded during the trading time, only (that means, one year). After that time, the certificate are valid for use, 3 months later on.

Exemption

All liable vehicles and all liable trips are included in the AETS system. In comparison to the ACE system no exemption for short distance transport is necessary. All trips are treated according to the trip distance within the Alpine region. Short distance transport need fewer certificates then long distance transports. Moreover, short distance trips are usually done with smaller HGVs than long distance trips. Small HGVs normally also have lower CO_2-emissions (but are less CO_2 efficient per tonne km).

AETS is linked to CO_2 emissions. Therefore the use of a higher percentage of bio-diesel leads to a reduction of CO_2 emission and therefore a reduction of needed certificates. The treatment of this issue within a trading scheme is not possible with existing available information. The vehicle registration document does not include the information on the (possible) usage of bio diesel. And the possible usage of bio diesel does not ensure that the Alpine crossing trip is actually done with bio diesel. The only way to control the usage of bio diesel is chemical control of the fuel used by the truck. This is a very expensive and time consuming task – the control density on this issue cannot be very high. For this reason it would be better not to foresee such a bio diesel exemption. But one has to be aware that the call for such an exemption will arise from transport lobbies and there is no argument against this (except the mentioned cost and complexity of the handling of such an exemption).

Other exemptions are not in line with the non-discriminatory principle so no further exemptions are foreseen.

AETS Validity Problem:

As mentioned above, the focus of the AETS is on the CO_2 emission **of the trips crossing the Alps.** That means, the amount of the respective charge is defined by the number of vehicle km driven in the region of the Alpine Convention. The problem is how to validate the different routes and freight trips in order to define which km of them are relevant for the Alpine crossing.

- At first, yes, this validity problem exists, but: The real problem is not the wrong declaration or the reorganization of the trips within the catchment area, with the effect of the minimization of the charge of the Alpine crossing trips to be charged, which is more or less possible.
- Indeed, the problem is the fact of crossing the "Main Alpine Line", which decides "You have to pay or not".

As mentioned above, CO_2 is not a local but a global pollutant, it is "going in the region and space".

- Therefore, the **main solution** is the treatment of AETS for the Alpine Space as described above, that means including the rule of crossing the „Main Alpine Line". This solution reflects the state of the art discussion concerning this point.
- In order to take into account that this main solution can be „undermined" by interim stops (intentional or not intentional), there are **extensibilities** of the AETS system, in the **long run**:

  One possible counter-measure could be a time limit of 24 hours (1 day), that means, crossing the Main Alpine Line you have to pay for all trips made in the region of the Alpine Convention within 24 hours.

  As **long-time goals**, there are the following further possibilities:

  – Away from the "rule of crossing the Main Alpine Line" towards the principle of the "area of the Alpine Convention" (all trips in the region of the Alpine Convention are subject to the km-dependent payment - independently of crossing the "Main Alpine Line".)
  – Extension to Europe „as a whole" (not necessary crossing the Alps. Trips are subject for payment for each km driven "in Europe".)

Discussion of points raised by members of the Advisory Board:

- Additionally to the point raised above, the question has been put that the report does not specify per-unit CO_2 emissions, the CO_2 emissions calculation method and traffic-generated CO_2 emissions by country.

  The answer is that the CO_2 emission system is fundamentally based on two milestones:

  – on the one hand, an Alpine Emission **Trading** System based on CO_2 emission ensures a contribution of the transport sector to CO_2 reduction targets,

  – which consists, at first on a sale on auction, and followed then by a trading system.

  That is the type of market specified to that system.

- Furthermore, the question raised by the French specialists speculate as to the most worthwhile AETS type system: "open", i.e. that would authorise permit trading with immovable industrial facilities covered by the European Union ETS; or "closed", i.e. exclusively concerning transalpine goods transit. Is it not likely that an "open" system, entailing a single CO_2 rate, would have little effect on local traffic-related problems in the Alps? On the other hand, is it not likely that a "closed" system would result in the coexistence of very different prices per ton of CO_2 across Europe, and that this could give rise to difficulties, especially of a legal nature.

  The answer is that the permit trading system with immovable industrial facilities covered by the European Union, and the (transport) emission trading system cover two completely different markets. Within these different markets different prices can exist! In the (transport) emission trading system, there is always one price for the emission trading units (at a certain time). So, it is not useful to have a common system for both these trading facilities.

- Further questions have been raised concerning the following statement that one advantage of an AETS, identified by the authors, compared with an Alpine crossing exchange is that ceilings could be defined without complicated political negotiations because they would flow logically from international and Community commitments (Kyoto, directive on national emission ceilings). However, that benefit should be qualified. Even though national emission targets have been defined for a number of pollutants, an emission ceiling applying to a single sector (road transport), in a single region (the Alps), could not be automatically deduced from them.

  The answer is that general CO_2 goals can be translated very well to limited territorial and with regard to contents sectors (Motto: All should contribute similarly.)

- Concerning the questions for specifying per-unit CO_2 emissions (e.g. by type of road, rail or maritime vehicle) for the various road and rail modes or their trends over time, the same **answer** as at the beginning of these remarks is given:

  The only regulator for that is the base of the trading emission system: the sale on auction, followed then by a trading system. These rules are the determining “actors” behind the scene. So, no additional method for CO_2 calculation has to be defined.

Furthermore, questions raised concerning the treatment of different kind of trips:

- As for instance with trips inside the Alpine region, but **not crossing the Alpine region**: **The answer is:** Alpine transport within the Alpine region and not crossing it does **not pay** within the AETS system.
- What is with the **empty** trips:
  The answer is: Empty trips crossing the Alps are subject to payment in the AETS system, too.
- Finally, how the **distances** of the trips can be **measured** within the Alpine region:
  The answer is, as mentioned above, the implementation of a distance based system via EETS (European Electronic Toll Service) is easily possible: every distance can be recorded with the standard set by EETS. Moreover, by using GPS it is no problem to identify when a truck enters or leaves the Alpine area or drives within this region.

2.3 TOLL+

2.3.1 Concept of the measure

In the TOLL+ concept, there is neither an allocation nor a market for passage rights. The operator of the Alpine passage solely sets the price for the passage through the tunnel or the mountain pass individually according to his system concept and according to the possibilities for the internalisation of external costs and capacity constraints, which will be defined in the amendment of the “Eurovignette” Directive 1999/62/EC[16][17].

In principle, there are two characteristics of the TOLL+ concept:

- The first and important characteristic of the TOLL+ concept is the objective to internalise external costs (accidents and environment) of road freight transport, to support a modal shift from road to rail and/or to cover above-average costs of Alpine road infrastructure cost. In order to realise this objective, a mileage-dependent toll in the Alpine region would have to be introduced.
- The second characteristic of the TOLL+ concept is to use the available physical capacity (including safety aspects) more efficiently. In order to reach this objective, congestion should be minimised by modulated toll rates depending on the exact conditions at the time of driving (higher prices at peak times should give incentives to hauliers to plan their journeys at other times).

[16] The proposed Directive enables Member States to integrate in tolls levied on heavy goods vehicles an amount which reflects the cost of air pollution and noise pollution caused by traffic. During peak periods, it also allows tolls to be calculated on the basis of the cost of congestion imposed upon other vehicles. The amounts will vary with the travelled distance, location and time of use of roads to better reflect these external costs.

[17] In October 2010, the the amendment of Directive 1999/62/EC reached political agreement in the Council and should pass the 2nd reading in the European Parliament’s plenary sitting in May 2011 (status January 2011).

In the TOLL+ concept, the more important characteristic of these two principles is the principle of the internalisation of external costs. As a basis to implement this principle the external costs of road freight transport have to be estimated. The numbers used are normally based on a general estimation of external costs caused by road transport, i.e. the respective unit values per cost components, which have been calculated, as an example, in Germany for the year 2000 (see Figure 2-7).

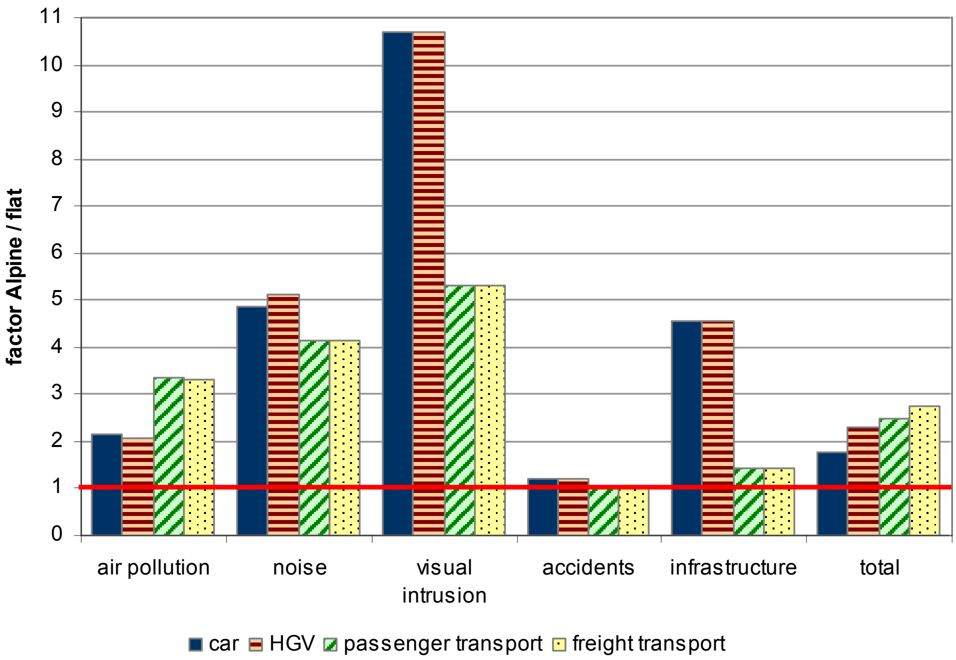
Figure 2-7: Exemplary unit values per cost component in €ct/vehicle-km for Germany (2000) for road transport[18]

Cost component		***Passenger car***	***Heavy duty vehicle (HDV)***
€ct/vkm		*Unit costs (bandwidths)*	*Unit costs (bandwidths)*
Noise	Urban, day	0.76 (0.76 - 1.85)	7.01 (7.01 - 17.01)
	Urban, night	1.39 (1.39 - 3.37)	12.8 (12.8 - 31)
	Interurban, day	0.12 (0.04 - 0.12)	1.1 (0.39 - 1.1)
	Interurban, night	0.22 (0.08 - 0.22)	2 (0.72 - 2)
Congestion	Urban, peak	30 (5 - 50)	75 (13 - 125)
	Urban, off-peak	0 (-)	0 (-)
	Interurban, peak	10 (0 - 20)	35 (0 - 70)
	Interurban, off-peak	0 (-)	0 (-)
Accidents	Urban	4.12 (0 - 6.47)	10.5 (0 - 13.9)
	Interurban	1.57 (0 - 2.55)	2.7 (0 - 3.5)
Air pollution	Urban, petrol	0.17 (0.17 - 0.24)	(-)
	Urban, diesel	1.53 (1.53 - 2.65)	10.6 (10.6 - 23.4)
	Interurban, petrol	0.09 (0.09 - 0.15)	(-)
	Interurban, diesel	0.89 (0.89 - 1.8)	8.5 (8.5 - 21.4)
Climate change	Urban, petrol	0.67 (0.19 - 1.2)	(-)
	Urban, diesel	0.52 (0.14 - 0.93)	2.6 (0.7 - 4.7)
	Interurban, petrol	0.44 (0.12 - 0.79)	(-)
	Interurban, diesel	0.38 (0.11 - 0.68)	2.2 (0.6 - 4)
Up- and downstream processes	Urban, petrol	0.97 (0.97 - 1.32)	(-)
	Urban, diesel	0.61 (0.61 - 1.05)	3.1 (3.1 - 6.9)
	Interurban, petrol	0.65 (0.65 - 1.12)	(-)
	Interurban, diesel	0.45 (0.45 - 0.92)	2.7 (2.7 - 6.7)
Nature & landscape	Urban	-	0 (0 - 0)
	Interurban	0.4 (0 - 0.4)	1.15 (0 - 1.15)
Soil & water pollution	Urban/Interurban	0.06 (0.06 - 0.06)	1.05 (1.05 - 1.05)
Total			
Urban	Day, peak	36.7 (7.1 - 61.1)	109.8 (35.5 - 192)
	Day, off-peak	6.7 (2.1 - 11.1)	34.8 (22.5 - 67)
	Night, off-peak	7.4 (2.8 - 12.7)	40.6 (28.2 - 80.9)
Interurban	Day, peak	13.3 (1 - 25.2)	54.4 (13.3 - 109)
	Day, off-peak	3.3 (1 - 5.2)	19.4 (13.3 - 39)
	Night, off-peak	3.4 (1 - 5.3)	20.3 (13.6 - 39.9)

For **sensitive areas** such as the **Alpine region**, the following figure shows the factors for the different effects for road and rail transport.

[18] Source: Internalisation Measures and Policies for All external Cost of Transport – IMPACT (2008), Handbook on estimation of external costs in the transport sector.

Figure 2-8: Factors Alpine/flat for the different effects for road and rail transport[19]



With the help of these two sets of figures, the internalisation of the concrete external costs can be estimated. Thereby, future reductions of emissions (e.g. cleaner lorries) have to be considered as well.

In the TOLL+ concept, the external costs would be added as a surcharge on the already existing toll rate. This rate would then be based on the internalisation of the above mentioned external effects and would increase the toll rate[20].

The **second aim** of the TOLL+ concept is to use the available physical capacity (including safety aspects) efficiently. In order to reach these aims, congestion should be minimised by modulated toll rates depending on the exact conditions at the time of driving (higher prices at peak times should give incentives to hauliers to plan their journeys at other times). Since this second objective of the TOLL+ concept is to reach the available (efficient) capacity by economic measures, the operator will set the toll rate lower during times with low demand and higher during times with higher demand, thus optimising the physical capacity of the road and the demand of road usage. That leads to congestion reduction at the toll plazas which also results in a lower number of accidents, in time savings, less fuel consumption and emissions as well as a better travel comfort in general.

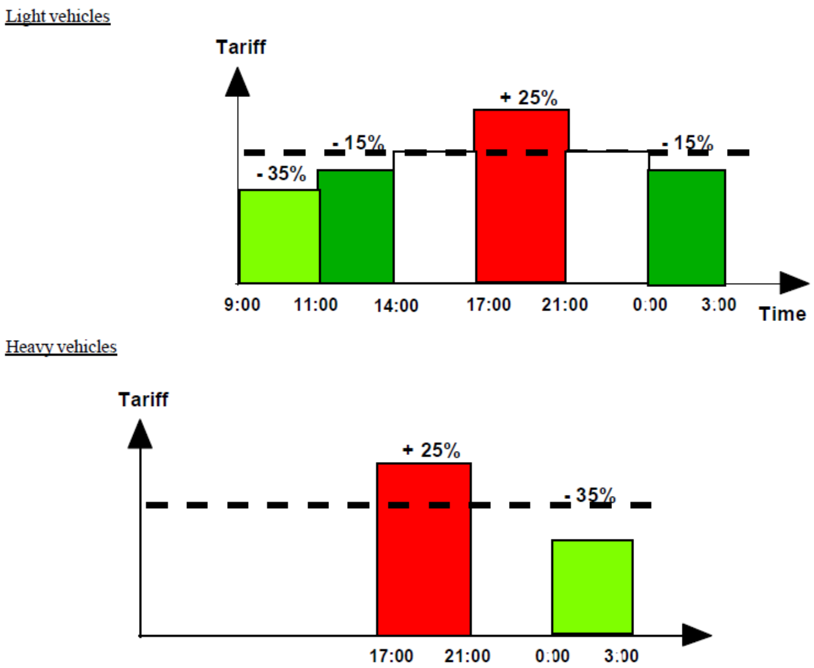
[19] GRACE (2006), Environmental costs in sensitive areas, p. 17.

[20] Please keep in mind that this consideration is depending on the Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructures!

The modulation of toll levels is in use or has been trailed in France on some motorways, e.g. on the A1 in the north of Paris during weekends since 1992 and is still ongoing. The toll modulation is and was mainly focusing on light vehicle peak flows. Further applications or experiments are on the following motorways in France:[21]

- A14: Tariff reduction for off-peak time around Paris during the weekend.
- A86 : Modulate tariff reduction on the second motorway ring around Paris for off-peak days and time.
- A5-A6: Experiment on tariff modulation for light vehicles on the motorways heading east-wards from Paris (1995 – 1997)
- A10-A11: Experiment on tariff modulation for light and heavy vehicles on the motorways heading southwards from Paris (March to November 1996). Figure 2-9 shows the result of this tariff modulation experiment.
- A7-A9: Modulated tariff schedule on the motorways in the Rhone valley towards Italy and Spain.

Figure 2-9: Tariff Modulation according to time on A10/A11 in 1996



Source: Delache & Alibert (2003).

[21] TRT (2008), D8.3 – D9.2 Report on Impacts of Charge Differentiation for HGV and Motorway Toll Differentiation to Combat Time Space Congestion.

ASFA, the association of French motorway companies, has put forward a set of policy proposals to regulatory authorities, where the main tariff modulation methods identified are[22]:

- temporal modulation "peak day/off-peak day" for all vehicles, that requires a national coordination and an important information system for French and foreign drivers;
- temporal modulation of "return weekend" for all vehicles, on the basis of the pilot project already in place on the A1 since 1992;
- temporal modulation of "urban or peri-urban areas", whose aim is to prevent the overlapping of traffic and transit commute. Its implementation requires a case-by-case basis depending on the nature of the section and traffic profiles;
- temporal modulation specific for "HGV" - Heavy Good Vehicles - , aimed at encouraging the use of the highway by HGV during off-peak periods. Its implementation should be studied on a case-by case basis, depending on network and taking into account the social acceptability. The magnitude of this modulation may itself be modulated according to the Euro classes of vehicles;
- "ecological pricing for HGV" on the basis of their Euro class, based on the one that exists since 2002 for the Mont Blanc and Frejus tunnels; within the framework of the Eurovignette EU directive, its implementation can be possible under the HGV telematic toll.

Figure 2-10: Heavy vehicle tariffs at Mont Blanc tunnel in EURO

			COTE FRANCE		COTE ITALIE	
			Course simple	Aller-retour (1)	Course simple	Aller-retour (1)
3	Euro 2-3-4	Véhicule à deux essieux dont la hauteur totale est supérieure à 3 m	127,10	203,90	127,50	204,60
3	Euro 1		134,40	215,70	134,90	216,40
4	Euro 2-3-4	Véhicule à trois essieux ou plus dont la hauteur totale est supérieure à 3 m	255,30	413,50	256,20	414,90
4	Euro 1		270,20	437,50	271,10	439,00
D	Euro 2-3-4	Transport exceptionnel "A" (frigorifique)	270,30	-	271,20	-
D	Euro 1		285,20	-	286,10	-
E	Euro 2-3-4	Transport exceptionnel "B"	703,70	-	706,00	-
E	Euro 1		744,50	-	746,60	-

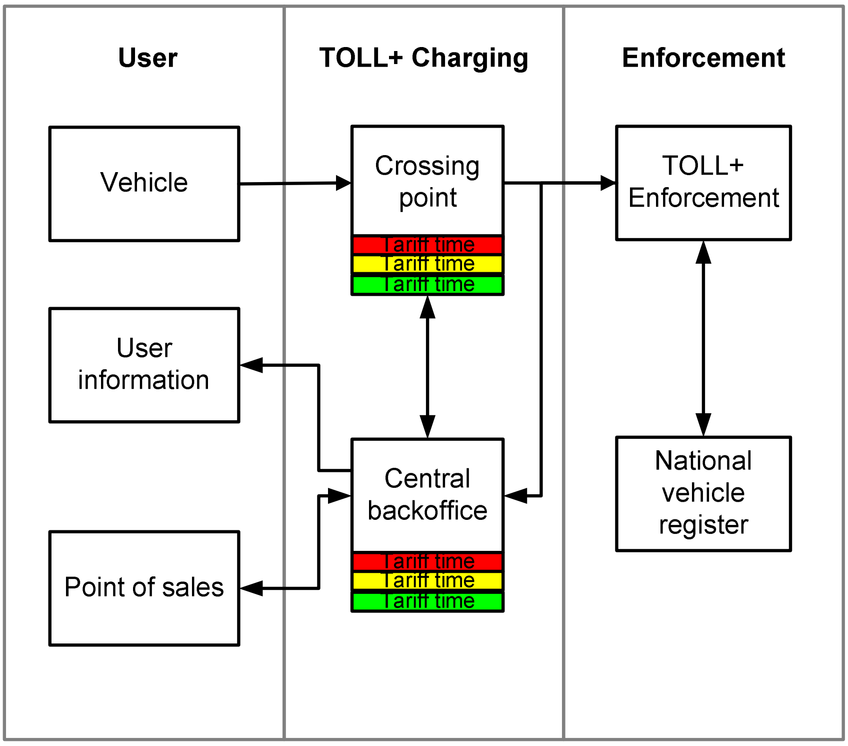
Source: Autoroutes et Tunnel du Mont Blanc supporteur d'Annecy 2018: http://www.atmb.net (18.08.2010).

In order to influence the behaviour of the hauliers, it is important that the modulation of the toll rate for the passage is known in advance. According to the set toll rate, the hauliers will then dispatch their trucks for the route over the Alpine crossings.

[22] TRT (2008), D8.3 – D9.2 Report on Impacts of Charge Differentiation for HGV and Motorway Toll Differentiation to Combat Time Space Congestion; ASFA, Dossier de presse – 23 janvier 2007

Differentiated toll systems (TOLL+)		
Capacity limitations		Environment, Technical
Liable passages		Not yet defined
Liable vehicles		All HGV above 3.5 t or 12 t
Variations	Vehicle	Total weight, number of axles (already used in France and Austria in order to determine the level of the toll, but not for the modulation due to congestion)
	Distance / passage	Depends on passage (tunnel or mountain pass) and distance
	Time	Higher tariff during peak hours, lower during hours with low traffic
	Emission	Depending on the amendment of Directive 1999/62/EC.

Figure 2-11: Concept of TOLL+



2.3.2 Passage rights

In the TOLL+ scheme, every operator of an Alpine crossing (tunnel or mountain pass) can have its own tariff regime. Every crossing has a different traffic capacity of the tunnel/road which should be used in the most efficient way by modulating the toll rate. In addition, the operator may levy an environmental toll surcharge depending to the possibilities given (when legally in force) by the amendment of the "Eurovignette" Directive 1999/62/EC as laid down in Annex IIIA.

Since the tariff regime might differ not only for the various passages, but also depending on the time of day, it is important that the price modulations are transparent to the hauliers. They must know the price of a passage at a certain crossing at a certain point of time before they start their journey. However, the flexibility in road freight transport is rather limited as hauliers have their obligations to deliver on time and at a defined place and therefore the possibility of adaption in time for them is rather limited.

2.3.3 Validity / Exceptions

Territorial validity

The territorial validity is limited to the Alpine passage which is used. Since the "passage right" is a modulated toll, it will be charged at the specific Alpine passage and differs from the other passages by the price. Additionally the environmental surcharge might differ from passage to passage depending on the length of the Alpine passage.

Temporal validity

The toll modulation is applied for a specific time (e.g. morning, night) or day (e.g. Sundays, week-end). It is charged directly when the HGV is crossing the toll gate.

Exemption

Whether exemptions or special regulations for the local traffic or short distance travel are necessary, must be analysed more deeply. For instance, emergency vehicles and vehicles in connection with relief aid are exempt from the motorway toll in Austria. In France, there is as well a list of vehicles which are exempt from the motorway toll such as emergency vehicles.

3 Operations of a common ACE, AETS or TOLL+

In the previous chapters, the ACE, AETS and TOLL+ concepts have been described on an individual level in detail. In this chapter, they are aligned in order to evaluate if these concepts can be used for the whole Alpine arch B+ as one single or combined concept, i.e. an ACE, AETS or TOLL+ is developed individually for each country or the ACE, AETS *or* TOLL+ is chosen as *the only* concept to be used on the whole Alpine arch B+.

The ACE, AETS and TOLL+ concepts are aligned on the Alpine arch B+ which stretches from Ventimiglia (Alpine crossing between France and Italy at the shore of the Mediterranean sea) to Tarvisio (Alpine mountain pass between Italy and Austria), including also the Alpine crossings Felbertauern and Tauern. 13 major Alpine crossings within the Alpine arch B+ are considered for the analysis (see figure 3-1):

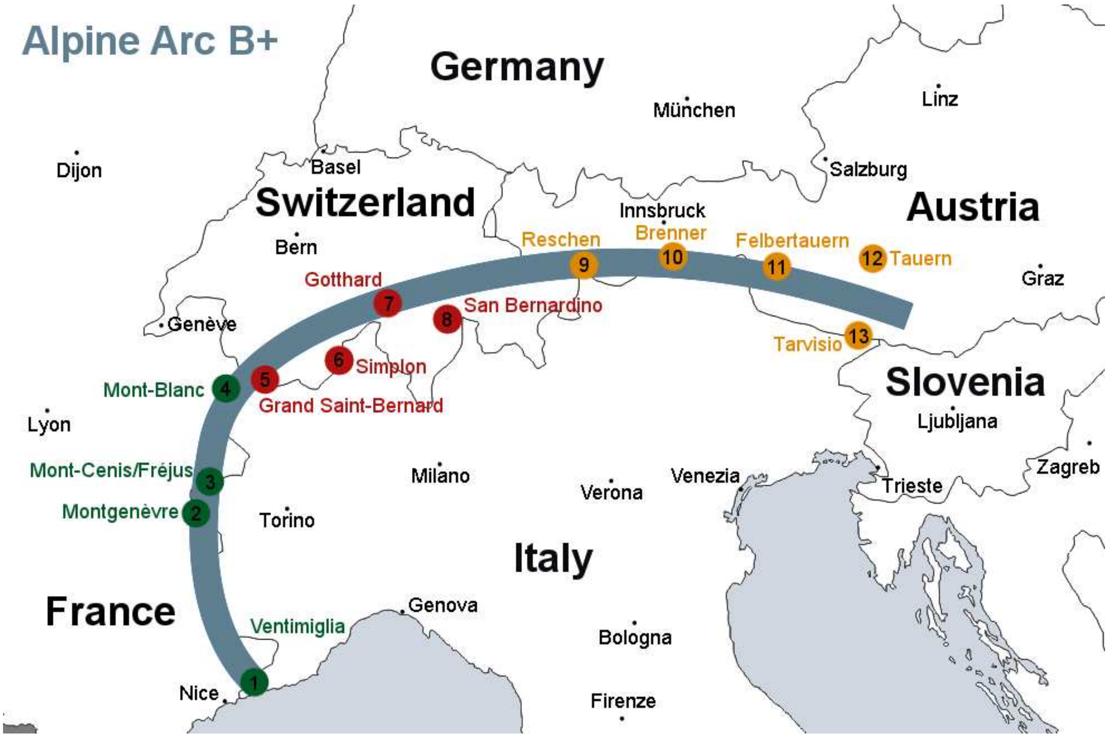
- **Ventimiglia**[23]: coastal road (motorway and road) along the Mediterranean sea, FR/IT
- **Montgenèvre**: mountain pass, FR/IT
- **Mont-Cenis/Fréjus**: tunnel, FR/IT
- **Mont-Blanc**: tunnel, FR/IT
- **Grand-St-Bernard**: tunnel, CH/IT
- **Simplon**: mountain pass, CH/IT
- **Gotthard**: tunnel and mountain pass, CH
- **San Bernardino**: tunnel and mountain pass, CH
- **Reschen**: mountain pass, AT/IT
- **Brenner**: mountain pass, AT/IT
- **Felbertauern**: tunnel, AT
- **Tauern**: tunnel, AT
- **Tarvisio**: mountain pass, AT/IT

For the alignment of the concepts four scenarios are being viewed and evaluated:

- **Scenario 1**: Alpine Crossing Exchange (ACE) on whole Alpine arch B+
- **Scenario 2**: Alpine Emission Trading System (AETS) on the whole Alpine arch B+
- **Scenario 3**: TOLL+ on the whole Alpine arch B+
- **Scenario 4**: Parallel use of ACE, AETS and TOLL+ on the whole Alpine arch B+

[23] Due to its geographical location, the area around the "Alpine" corridor of Ventimiglia at the Mediterranean Sea is densely populated and connected with various local roads. Two major roads (D6007 and D6327 (France)/SS1 and SS1 dir (Italy)) and one motorway (A8 (France)/A10 (Italy)) connect France and Italy. Whereas the concept of TOLL+ would be based on an existing motorway charging scheme, the concepts of ACE and AETS require a deeper analysis of the feasibility of these two concepts in this specific area, especially concerning local and short distance transport.

Figure 3-1: Alpine crossings within Alpine arch B+



Source: Rapp Trans (2010).

3.1 Existing road charging systems in the Alpine arch B+

As mentioned before, all three instruments considered in this report are basically payment systems for obtaining the right of crossing the Alps. From an operational point of view there is quite a strong similarity to the operation of electronic road charging systems which are widely spread in European countries and have been implemented in different ways and styles. The diversity of systems in that field and the harmonization efforts undertaken shall be briefly explained in the following chapters, since this is helpful for the derivation of the operational model for the ACE, AETS and TOLL+.

In the countries covered by the Alpine arch B+ road charging systems for HGVs have been working successfully for many years. A lot of experience has been gained in each country not only in the technical implementation of those systems, but also in the service provision and operation for the particular system. Before focusing on the potential operational layout of the instruments ACE, AETS and TOLL+ a short overview on the road charging systems in Austria, France, Italy and Switzerland shall be given.

3.1.1 Austria

The Austrian motorway tolling system for heavy vehicles was introduced on 01.01.2004. All vehicles with max gross vehicle weight > 3.5 tons are subject to distance related tolling when travelling on the Austrian motorways network and dedicated expressways with a total length of above 2'000 km. The system is designed as an open, multi-lane free-flow tolling system and the use of the electronic fee collection system (EFC) is mandatory by means of a DSRC OBU (tag) compliant to the CEN TC 278 standards. The OBU are distributed via a dense point of sales network in close vicinity to the motorway network. The system is operated by the state owned company ASFINAG which acts as full service provider with respect to the tolling.

3.1.2 France

In France all vehicles are subject to tolling for travelling the 8'500 km of French tolled motorways plus dedicated bridges and tunnels. The electronic toll collection system for light vehicles and motorcycles is in operation since 2000. The system was extended to heavy vehicles in 2007. The technology used for electronic toll collection is a DSRC OBU (tag) compliant to the CEN standards. The use of the electronic toll collection system is voluntary.

The overall system is a mixture of closed and open tolling and operated by a total of 13 private/public concessionaires. The concessionaires are applying different tolls for using their infrastructure based on their cost model.

The tariffs are calculated per (toll motorway) kilometre, and depend on the measured vehicle class: the lane is able to define automatically or manually the vehicle class (no. of axles and total height).

Furthermore, France will introduce a new road user charging scheme for heavy goods vehicles (Taxe Poids Lourds Nationale TPLN). The toll is not only charged on motorways, but also on major roads and therefore requires the mandatory use of an OBU.

3.1.3 Italy

Italy was the first European country to apply the use of motorway tolls on a 50km motorway section near Milan in 1924. Today, 5'700 km of Italy's 6'600 km network of motorways are tolled for all vehicles and operated by 24 concessionaires. Electronic toll collection was introduced in 1989, using the Telepass OBU which is based on DSRC communication, but using the UNI-10607 standard instead of the common CEN-DSRC standard used for most European OBU. The use of the electronic toll collection system is voluntary.

The overall system is a mainly closed network and the concessionaires are applying different tolls for using their infrastructure based on their cost model. The tariffs are calculated per (toll motorway) kilometre and are based on the measured vehicle class depending on the height of the vehicle and the number of axles.

3.1.4 Switzerland

The Swiss nationwide heavy goods vehicle fee (LSVA) was introduced on 01.01.2001. All heavy goods vehicles with a max gross vehicle weight > 3.5 tons are subject to this distance related tolling, which incorporates all public roads. The use of the *electronic* fee collection system is mandatory to Swiss HGVs and is an option for foreign HGVs.

The tariffs are calculated per kilometre, and depend on the emission class and on the declared vehicle class (max gross vehicle weight of the vehicle combination).

The technology used for the system comprises a dual approach: The OBU (mandatory to Swiss users) records the kilometres driven on Swiss and the Principality of Liechtenstein territory from the tachograph, supervised by a satellite positioning system (GPS) and a movement sensor. A CEN Standard DSRC link (5.8 GHz) is used to switch the recording of the driven kilometres on or off when passing the border and for reading out the data stored on-board for equipped foreign vehicles. Swiss users declare their on-board data by sending in a chip card or by internet. Foreign users declare their mileage and vehicle characteristics at self-service clearance terminals using a chip card (with the verified static data of the tractor vehicle) issued upon first arrival.

The Swiss Customs Administration is in charge of the operation of the LSVA system. In the LSVA scheme no issuing of customer-contracts is made, as the distance related fee is a legal duty.

The only major single infrastructure which is subject to a road toll in Switzerland is the Grand Saint-Bernard tunnel between Switzerland and Italy.

3.1.5 Conclusion

As briefly described above, the systems in France, Italy, Switzerland and Austria are in successful operation and working properly, but all of them have been developed under different political and legal constraints and are operated by different entities. This makes it quite difficult to harmonise them from an operational point of view, since a huge effort would have to be made by the operators regarding system adaptation. However, the European Electronic Toll Service (EETS) has been defined in the European Union to allow the use of different existing road charging scheme in Europe under one operational concept.

3.2 European Electronic Toll Service (EETS)

Before going into details, one important aspect in road user charging should be mentioned first: the future introduction of the **E**uropean **E**lectronic **T**oll **S**ervice (EETS), a service that will be mandatory to be offered in all EU Member States according to the EU Directive 2004/52/EC from October 2012.

The **E**uropean **E**lectronic **T**oll **S**ervice (EETS, not to be mixed up with the AETS) will enable road users to easily pay tolls throughout the whole European Union (EU) thanks to **one con-**

tract with **one service provider** and **one single on-board unit**. The EETS will be available on all infrastructure with electronic tolls such as motorways, tunnels, bridges, ferries, etc. It will ensure the interoperability of electronic road toll systems on the entire European Community road network, limit cash transactions at toll stations and eliminate cumbersome procedures for occasional users. This will improve traffic flow and reduce congestion.

Under this new system the three main partners are the **Road Users**, **Service Providers** and **Toll Chargers**. The Service Provider concludes contracts with Road Users and grants them access to the EETS in the entire EU. The Toll Charger levies tolls for the circulation of vehicles in an EETS domain, i.e. a part of the EU road network or a structure such as a tunnel, bridge or a ferry liable to toll. Tolling policies remain to be decided by the Member States in compliance with EU legislation. The EETS ensures interoperability between all the electronic road toll systems in the Community, which can use either: dedicated short-range communication (DSRC) and satellite positioning associated with mobile communications.

The legal basis for the EETS is the European Directive (2004/52/EC) on the interoperability of electronic road toll systems in the Community, which was adopted in April 2004. This Directive makes reference to the Commission Decision to further specify EETS and its technical elements. The Commission Decision 2009/750/EC was adopted in October 2009 and thus started the following timescales for implementation of EETS following the publication of the Decision:

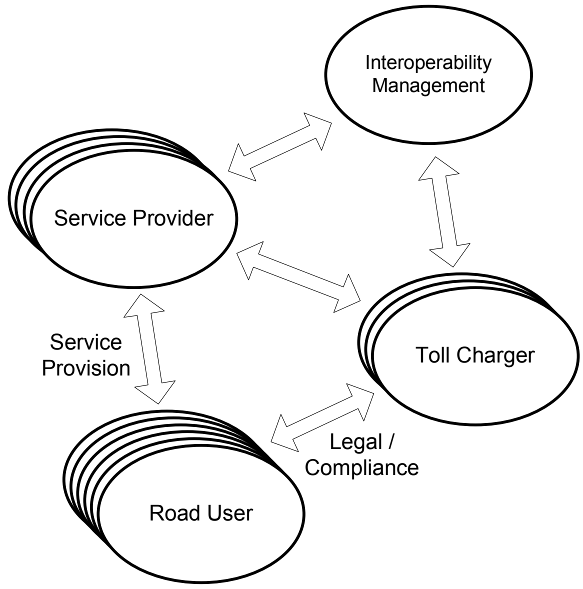
- 3 years for vehicles over 3.5 tonnes (i.e. October 2012)
- 5 years for all other vehicles (i.e. October 2014)

EETS leads to less effort for Toll Chargers in their charging scheme as some of the necessary tasks are outsourced to Service Providers. Service provision including the equipment (e.g. OBU), call centre support, invoicing and customer contact which were traditionally done by the Toll Charger, will be supported in the EETS concept by the Service Providers instead.

The system concept of EETS separates the functions of the service provision done by the service providers for the Road User, the clearing of the tolls between these Service Providers and the Toll Charges and the still remaining legal connection between the Toll Charger and the Road User for the compliant use of the toll road, including enforcement. The role of interoperability management is related to the governance of the system, i.e. the legislator and governmental institutions which are responsible for the roads, concessions, compliance etc. Figure 3-2 illustrates these roles and interactions between the different entities[24].

[24] See the Commission Decision 2009/759/EC for a more detailed description of the roles and requirements.

Figure 3-2: EETS concept



According to this EETS concept, a Road User (e.g. a haulier with a fleet of trucks) has a service contract with a Service Provider. The trucks of the haulier are equipped with EETS OBU which have all necessary data stored for the use of tolled road. When the truck enters a tolled road, the electronic fee collection system of the Toll Charger recognizes the EETS OBU in the truck. Based to the data exchange between the Toll Charger's roadside equipment and the EETS OBU in the truck, the Toll Charger knows that a Service Provider will pay the toll for the Road User. Within the invoicing process, the Toll Charger invoices the toll to the Service Provider. The Service Provider itself collects all invoices related to the specific Road User and charges the accumulated tolls on a regular basis.

The interoperability management role describes the responsibility for the adherence of the EU and national law, both in relation to the Service Providers as well as to the Toll Chargers.

The **three most important properties of EETS** in the discussion of Alpine crossing instruments are the following:

1. The implementation of EETS has a **legal and binding basis on European Union level** and will be mandatory to be offered and accepted in all EU Member States. Thus, trucks using the EETS will be equipped with an EETS OBU which can be used for the Alpine Crossing concepts as well.
2. EETS is a **model for service provision** in which the service provision can be transferred to private entities, allowing to be applied as well for the Alpine Crossing concepts.
3. EETS has the advantage that a huge number of vehicles which enter a charging scheme are already equipped with on board equipment and will **not require additional equipment for the Alpine Crossing concepts**.

3.3 Acquisition of rights

3.3.1 Auction of rights

Scenario 1: Alpine Crossing Exchange ACE on whole Alpine arch B+

In the concept of the ACE, the extension to the whole Alpine arch has always been an option, if not even a necessity. Both concept studies[25] concluded that an ACE has to be coordinated with the other Alpine countries in order to avoid undesired detour traffic which tries to avoid the ACE.

Technically, the system concept can easily be enlarged from a national to an international level, covering the Alpine arch B+. As described in chapter 2.1.2, a certain amount of ACU would be auctioned. Whereas in the initial concept of an ACE the auctioned amount of ACU was set on a national level, in an ACE which spans over the Alpine arch B+, the amount of ACU can be

- set individually for each participating country and only valid in those countries, or
- set as one common amount of ACU valid in all participating countries.

Scenario 2: Alpine Emission Trading System (AETS) on the whole Alpine arch B+

Similar to the ACE, an AETS in solely one Alpine country is not advisable due to the undesired detour traffic. A coordinated approach for the introduction of such a system concept is necessary, and technically feasible for the whole Alpine arch B+.

This desired introduction on the whole arch B+ needs a concerted auction of all CO_2 certificates for all countries and all crossings. One CO_2 certificate has to have the same price at one point of trading time for all regions and crossings. Different reduction targets are still possible. They are summed up for the auction and form the total CO_2 capacity for the arch B+.

Scenario 3: TOLL+ on the whole Alpine arch B+

In the TOLL+ concept, there is no auctioning of passage rights over the Alpine corridors; each corridor sets its own modulated toll rate according to its requirement/traffic capacity and the possible internalisation of external costs from the (still to be) amended “Eurovignette” Directive 1999/62/EC. A TOLL+ concept on the indicated Alpine crossings on the whole Alpine arch B+ would be feasible, but requires additional technical solutions for the Swiss (and partly Italian) Alpine crossings Simplon, Gotthard and San Bernardino and the French/Italian and Austrian/Italian mountain pass Montgenèvre respectively Reschenpass since these crossings are not yet tolled (nr. 2 and nr. 5-9 in figure 3-1). In Switzerland, there is the Swiss heavy vehicles fee scheme which is levied on all Swiss roads and not specifically on certain roads, tunnels or mountain passes. All other indicated Alpine crossings in figure 3-1 are already individually tolled and have the necessary technical installations for charging the toll.

[25] Ecoplan, Rapp Trans (2004) and Ecoplan, Rapp Trans and Kurt Moll (2007).

For the scenario 3 it is important that the modulated tolls are set and published well in advance; this will allow the hauliers to dispatch their transports and make their calculations based on the different toll rates.

Scenario 4: Parallel use of ACE, AETS and TOLL+ on the whole Alpine arch B+[26]

In this scenario, all concepts are introduced individually, i.e. the TOLL+ concept on the French/Italian, the ACE on the Swiss/Italian and AETS on the Austrian/Italian mountain crossings. For the ACE and AETS, the auctioning of the passage rights, be it ACU or emission certificates, is necessary. The TOLL+ concept can run independently on the French/Italian Alpine corridors.

For the ACE and AETS, a common platform for the auctioning and trading of the passage rights is possible, and the available amount is set independently by each country. The auctioning is performed as described in chapter 2.1.2.

3.3.2 Trading of the rights

Scenario 1: Alpine Crossing Exchange ACE on whole Alpine arch B+

The trading of the ACU again depends on the initial allocation (see chapter 3.3.1 above).

For both options (individual or common allocation of ACU), the trading can take place on the same platform, however the price may vary for the different countries if the initial allocation is set by each country.

Scenario 2: Alpine Emission Trading System AETS on the whole Alpine arch B+

In difference to the ACE scenario the initial auction within the AETS system has to be one auction for all countries with one final price for one CO_2-certificate. This leads to the necessity that the trading has to take place on one central platform for all countries. This guarantees the same price for certificates for all countries and crossings at one trading point of time.

Scenario 3: TOLL+ on the whole Alpine arch B+

There will be no trading of crossing rights in the concept of TOLL+.

Scenario 4: Parallel use of ACE, AETS and TOLL+ on the whole Alpine arch B+

If the concepts of TOLL+, ACE and AETS are set-up individually, the TOLL+ will run individually on its assigned corridors, whereas the concept of ACE and AETS can be introduced for the other countries on the same platform. The trading of the passage rights will be individual for the ACE and AETS according to their initial concepts.

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[26] For scenario 4 we assume that the individual concepts are introduced in those countries where they were initially discussed, i.e. the ACE in Switzerland, the AETS in Austria and the TOLL+ between France and Italy. However, every combination is feasible.

3.4 Debiting

The debiting of the crossing rights (be it **TOLL+, ACE or AETS**) is done with an OBU and over DSRC communication. As described in chapter 3.2, there will be soon a huge number of heavy goods vehicles equipped with an interoperable OBU in Europe. Furthermore, on French and Austrian toll roads OBU with DSRC communication are already used for debiting the tolls; domestic Swiss heavy goods vehicles are all equipped with a Swiss OBU, and France will introduce a nationwide road tolling system (TPLN), requiring a mandatory OBU. Therefore, this **existing and future OBU equipment can easily be used for the debiting process of the ACE and AETS**. And due to the increasing penetration of such OBU in the fleet of heavy goods vehicles, it can be expected that **in a few years, almost every heavy vehicle driving on European roads, be it registered in an EU Member state or outside the EU, will be equipped with an OBU suitable for the ACE or AETS**. For TOLL+, the OBU must be interoperable according to the European Directive (see chapter 3.2.) since it is linked to an automatic payment process. It can be an EETS OBU, but could be as well an OBU which is already accepted on the TOLL+ corridors such as the French TIS-PL OBU.

The concept for **all three concepts** is very simple: specific roadside equipment reads out the **Personal Account Number (PAN) of the OBU** in order to identify the vehicle. Afterwards, the booking is done in the central back office. The Personal Account Number consists of two items: first it is possible to identify the service provider and second it is possible to identify the user account at the service Provider.

Debiting of the passage over the Alpine corridor will be done only once per corridor. The passage is linked to one single Alpine corridor in the Alpine arch B+ except for the Tarvisio-Tauern axis, where two Alpine crossings are involved for one passage. For this corridor, the ACE system will **charge a passage over the Tarvisio and Tauern corridor only once**, whereas a different amount of emission certificates is required depending on the route (i.e. from Italy via Tarvisio/Tauern to Germany will require more certificates than from Italy via Tarvisio to Klagenfurt only). In the TOLL+ concept, the toll depends as well on the distance of the Alpine passage and not on the number of passages.

Scenario 1: Alpine Crossing Exchange ACE on whole Alpine arch B+

The debiting of the passage rights of the ACE is similar to the existing electronic payment on toll roads throughout Europe, i.e. roadside equipment identifies an OBU and links the PAN to the registered owner. The only additional requirement is an interface between the operating system to the passage right exchange where the vehicle’s PAN can be linked to the ACE account of the haulier and the necessary amount of ACU is deducted for an ACP.

Roadside equipment already exists at the major toll roads on the Alpine corridors except in Switzerland, the Montgenèvre and Reschen mountain passes as well as on the local roads at the Brenner and Tarvisio mountain passes and the local roads at the Ventimiglia corridor (these three corridors are only equipped with roadside equipment on the motorways).

Scenario 2: Alpine Emission Trading System AETS on the whole Alpine arch B+

The same debiting system as for the ACE-system can be used.

Scenario 3: TOLL+ on the whole Alpine arch B+

The debiting process in the TOLL+ concept takes place at each individual charging point of the Alpine corridors (e.g. toll plaza or automatic charging point on the road). As written before, the TOLL+ concept needs additional roadside equipment on the Montgenèvre and Reschen mountain passes as well as on the three Swiss Alpine corridors.

Scenario 4: Parallel use of ACE, AETS and TOLL+ on the whole Alpine arch B+

Scenario 4 is a combination of the already existing toll road charging schemes on the French/Italian Alpine corridors and the ACE and AETS concepts on the Swiss/Italian and Austrian/Italian Alpine corridors. The TOLL+ concept does not need any interface to the ACE or AETS, whereas the ACE and AETS can use the same platform for the auctioning and trade of the passage rights as well as the debiting process as described above.

3.5 Compliance

Whereas the service provision can be outsourced, the compliance including compliance checking and prosecution rests still between the national authorities in the particular country and the road user. Furthermore, compliance checking and prosecution must be based on the national rules and law[27], taking EU law into account (e.g. cross-border enforcement of penalties).

Scenario 1: Alpine Crossing Exchange ACE on whole Alpine arch B+

The compliance checking and prosecution in case of an Alpine Crossing Exchange ACE on the whole Alpine arch B+ has to be performed in the country where the Alps are crossed. The compliance check whether a vehicle has the appropriate passage right or not takes place at the crossing points. For that reason the crossing points are equipped with facilities for automatic debiting (see chapter 3.4, Scenario 1) and for automatic compliance checking and evidence capturing in case of non-compliance. The functionalities are performed under free flow traffic conditions at the crossing points and can be grouped as follows:

- **DSRC communication:** The DSRC roadside equipment at the crossing point sets up a communication with the OBU in the vehicle passing by and reads out the Personal Account Number (PAN) for verification and debiting ACP from the respective user account in the central back-office.

[27] Policing measures (e.g. stopping a truck on the road for compliance checking) and the cession of these measures to private organisations such as the operator of an ACE or AETS is defined by national law which can be very different from country to country.

- **Vehicle classification:** The automatic vehicle classification aims on the distinction of ACE liable and non-liable vehicle (e.g. passenger cars) based on their dimensions. It is to identify those vehicles where a DSRC communication should be expected and those where not. A commonly used technology for classification is laser scanning. They provide high classification accuracy, up to 95 % of correct classification.
- **Video enforcement (image capturing):** In case of a vehicle was classified as ACE liable vehicle and the data retrieved from the OBU via DSRC communication was identified as non-compliant a digital video image will be taken, including the license plate number of the vehicle. Based on the information coming from DSRC communication, classification and image capturing a so called evidential record will be created and transferred to the central back-office for analysis and provision for prosecution.
- **Prosecution:** In case of obvious non-compliance based on the evidential record the violent vehicle is put on a black list for further prosecution. If the vehicle is a domestic one, the vehicle holder and registration is known and the holder can be forced to subsequent payments including paying a fine. In case of foreign registered vehicles the prosecution must take place either on the remaining subsection in the country or at the borders when leaving it. The allocation of these tasks to legal enforcement authorities differs from country to country. For the purpose of provision of evidential records it is necessary to have an interface in each country from the ACE compliance checking system in place to the enforcement authorities in that country. However, it must be analysed if the national or regional/cantonal law allows its authorities (e.g. police or customs) to act for the prosecution of sanctions related to the ACE since the administrative duties are defined in the law and might require and amendment for additional duties. In certain cases it might be necessary to adapt the law for legalising the prosecution for the ACE.

  In Switzerland, prosecution could be performed by police patrols which check the vehicles either in floating traffic or on parking lots. If a violator is identified the vehicle will be stopped and the fine is imposed directly. Furthermore, it could be possible to involve the Swiss Customs Administration, which is in charge of operation, compliance checking and prosecution of the Swiss heavy good vehicles fee, in the ACE prosecution process. The Swiss Customs Administration in any case carries out the compliance check for paying the heavy good vehicle fee at Swiss border crossings and therefore the ACE prosecution could happen here as well. In Austria the already in operation mobile enforcement units for the heavy vehicle fee on motorways can be used for ACE compliance prosecution as well. The vehicles are operated by ASFINAG and they are already provided with adequate equipment for prosecution of toll violation which is quite similar to the one needed for ACE. The vehicles would be either checked in floating traffic or dedicated checking areas (special parking lots). In France this role could be taken over by the Police.

As mentioned in chapter 3.4, Scenario 1, the roadside equipment for ACE debiting already exists at the major toll roads on the Alpine corridors except in Switzerland, the Montgenèvre and Reschen mountain passes as well as on the local roads at the Brenner and Travisio mountain passes and the local roads at the Ventimiglia corridor (these who passes are only equipped with road-side equipment on the motorways). Where the roadside equipment for

ACE debiting already exists, only the missing compliance checking infrastructure for classification and image capturing must be added, otherwise the infrastructure for ACE debiting as well.

Scenario 2: Alpine Emission Trading System AETS on the whole Alpine arch B+

The system enforcement is done automatically. This is the same as for the existing toll system in Austria. Therefore the enforcement system for the AETS system has to be similar to the enforcement system in operation for the Austrian toll system.

The automatic part can check only the principal existence of adequate CO_2 certificates.

The standard CO_2 emission cannot directly be checked with an automatic system. The validation of this item will be done at the registration process of the vehicle. The adequate category is implemented in the OBU at the point of time of registration of the vehicle in the system. This is similar to the validation process used for validating the EURO classes in the existing Austrian toll system.

The enforcement has to be done by the countries. Different strategies (enforcement frequency, etc.) can be used by different countries. A common strategy would be useful to avoid system differences that produce detour effects.

Scenario 3: TOLL+ on the whole Alpine arch B+

The compliance checking and prosecution in case of TOLL+ on the whole Alpine arch B+ has to be performed in the country where the Alps are crossed and the differentiated toll amount is due. The compliance check whether a vehicle has paid the correct toll due takes place at the Alpine crossing toll collection points. For that reason the TOLL+ collection points are equipped with facilities for automatic toll collection (see chapter 3.4, Scenario 3) and for automatic compliance checking and evidence capturing in case of non-compliance. The compliance checking is performed under free flow traffic conditions at the toll collection points and is similar to ACE. The same applies for the prosecution procedures and the infrastructure needed.

Scenario 4: Parallel use of ACE, AETS and TOLL+ on the whole Alpine arch B+

Compliance checking and prosecution in case of individual introduction of ACE, AETS and TOLL+ on the whole Alpine arch B+ would happen for each instrument separately as described for the 3 Scenarios above.

3.6 Implementation

Scenario 1: Alpine Crossing Exchange ACE on whole Alpine arch B+

In general, the individual national governments have the overall responsibility over the entire system on their territory. In case of serious problems of the ACE system, the federal governments can take appropriate measures to restore its functionality and shall ensure that the necessary functions for the operation of the ACE are perceived in the appropriate way.

In order to ensure this, the ACE functions need to be defined (see figure 3-3). The first function is the **supervision**. The supervisory committee is responsible for the legal operation of the ACE, which includes several aspects:

- Definition of the requirement for the various system components;
- Provision of information about changes to the overall system;
- Specification of criteria for market makers, operators and auctioneers;
- Regular reports to the federal government;

The **assignment of ACU** function covers the auction and the debt collection of auctioned units, which also includes the transfer of the revenue to the competent authority (appropriate for the intended use).

Trading as well as the **register and system management** was already introduced in previous chapters and is not going to be further described. The same applies to **roadside implementation** and **enforcement**, which is covered in chapter 3.5.

Figure 3-3: ACE functions

Main Function	Sub Function
Supervision	Responsible for the legal operation of the ACE
Assignment of ACUs	Auction, debt collection
Trading	Market makers, broker/OTC-trading, market participants
Register and system management	Implementation and operation of the register and system: • Registration of users • Registration of ACUs • Conveyance of ACUs • Transformation of ACUs into ACPs • Retransformation of ACPs into ACUs • Redemption of ACPs • Monitoring and statistics • Enforcement at the Alpine crossing • Compliance check • Impose sanctions
Roadside implementation	Enforcement at the Alpine crossing, Points of Sales (POS)
Enforcement	Compliance with ACP obligation, assignment of penalties, penalty debt collection, permission control of LT and SDT

Source: Ecoplan, Rapp Trans and Kurt Moll (2007): Alpentransitbörse: Untersuchung der Praxistauglichkeit.

Figure 3-3 shows that the planning, implementation and execution of the ACE requires a variety of functions. Depending on who is responsible for which function, a large number of organisational models is possible, but a reasonable selection must be made for several reasons:

- The organisational efficiency can only be improved if closely related administrative functions (e.g. assignment of ACUs and register management) are performed by the same office.
- From the perspective of dynamic efficiency (the incentive of an efficient service provision), an organisational model with several private market elements is preferable to a public or state-controlled organisation due to competition aspects.
- In order to receive widespread acceptance customer proximity, a transparent implementation and a clear system specification is necessary.

A mix between public and private implementation with a concentration on very few offices deems seems to be best most suitable. The supervision is done by a state committee. The assignment of ACU, the register and system management along with the roadside implementation should be a task of private companies that compete for these functions.

A transnational management of the register would certainly simplify a possible solution regarding the whole Alpine arch B+. However, a precise definition of political responsibility would be necessary.

Scenario 2: Alpine Emission Trading System AETS on the whole Alpine arch B+

The organisation and the allocation of responsibilities within the AETS equal that of the ACE. The main functions remain. More of a formal difference is the fact that CO_2-certificates are traded instead of ACUs.

Scenario 3: TOLL+ on the whole Alpine arch B+

In the TOLL+ Scenario the single toll operator has the complete responsibility over his system. That means in France and Italy, the concessionaires, in Switzerland either the Swiss Customs Administration as current operator of the Swiss Heavy Vehicle Fee (LSVA) or a new public/private entity and in Austria either the ASFINAG as operator of the current heavy vehicle motorway tolling scheme or a new public/private entity. The toll operator is responsible for the functional and technical specification and the respective implementation.

The main functions of each TOLL+ operator can be grouped as follows.

Figure 3-4: TOLL+ functions

Main Function	Sub Function
Supervision	Responsible for the legal operation of the TOLL+
Registration and system management	Implementation and operation of the TOLL+ system: • User registration and contract issuing • Issuing of OBU to users either directly or via certified issuers • Conclusion of contracts with future EETS providers • Invoicing and payment collection • User information about tariffs and changes • Monitoring and statistics • Maintenance and systems renovations • Compliance check at the Alpine crossing • Impose sanctions
Roadside implementation	DSRC beacon infrastructure for TOLL+ debiting at the Alpine crossing, Compliance checking infrastructure at the Alpine crossing, Points of Sales (POS) for OBU issuing
Central back-office implementation	For central data storage and processing, central customer service functions; provision of interfaces to roadside infrastructure, prosecution entities and future EETS providers

The functions mentioned above can either be performed by the toll operator directly or outsourced to third parties. There are already points of sales for DSRC OBU at petrol stations and roads leading to the TOLL+ Alpine crossing. Furthermore, customer service activities like call centres or website functionalities can also be provided by third parties.

Scenario 4: Parallel use of ACE, AETS and TOLL+ on the whole Alpine arch B+

The parallel use of ACE, AETS and TOLL+ requires the implementation as described above for each instrument but on a smaller scale.

3.7 Costs

For the ALBATRAS project a cost model for the four main scenarios mentioned above and three sub scenarios has been calculated with a cost model developed by Rapp Trans for similar calculations for road user charging projects throughout Europe.

The cost model reflects the **investment** needed during the implementation phase, the **reinvestments** in certain parts (which reached the end of their lifetime) as well as the **yearly operating costs**. The financing of the systems scenarios is not a part of the cost model since recent road user charging systems have been financed as a BOT (build-operate-transfer) and thus without costs for the government. Neither are the revenues included in the calculations.

3.7.1 Scenarios

The ACE, AETS and TOLL+ scenario and their parallel use are calculated with the Rapp Trans cost model for the whole Alpine arch B+ (scenario 4 as shown in figure 3-5 below). The four scenarios are in detail:

Scenario 1: Alpine Crossing Exchange ACE on whole Alpine arch B+

The Alpine Crossing Exchange concept was developed in Switzerland, including cost estimation. Based on that cost estimation, the implementation, reinvestment and operating costs for the Alpine Crossings Exchange (ACE) for the whole Alpine arch B+ (Ventimiglia–Tarvisio) are calculated.

Scenario 2: Alpine Emission Trading System AETS on the whole Alpine arch B+

The Alpine Emission Trading System is the concept which was initially developed in Austria. Scenario 2 reflects the costs for the implementation, reinvestments and operation of the Alpine Emission Trading System (AETS) for the whole Alpine arch B+ (Ventimiglia–Tarvisio).

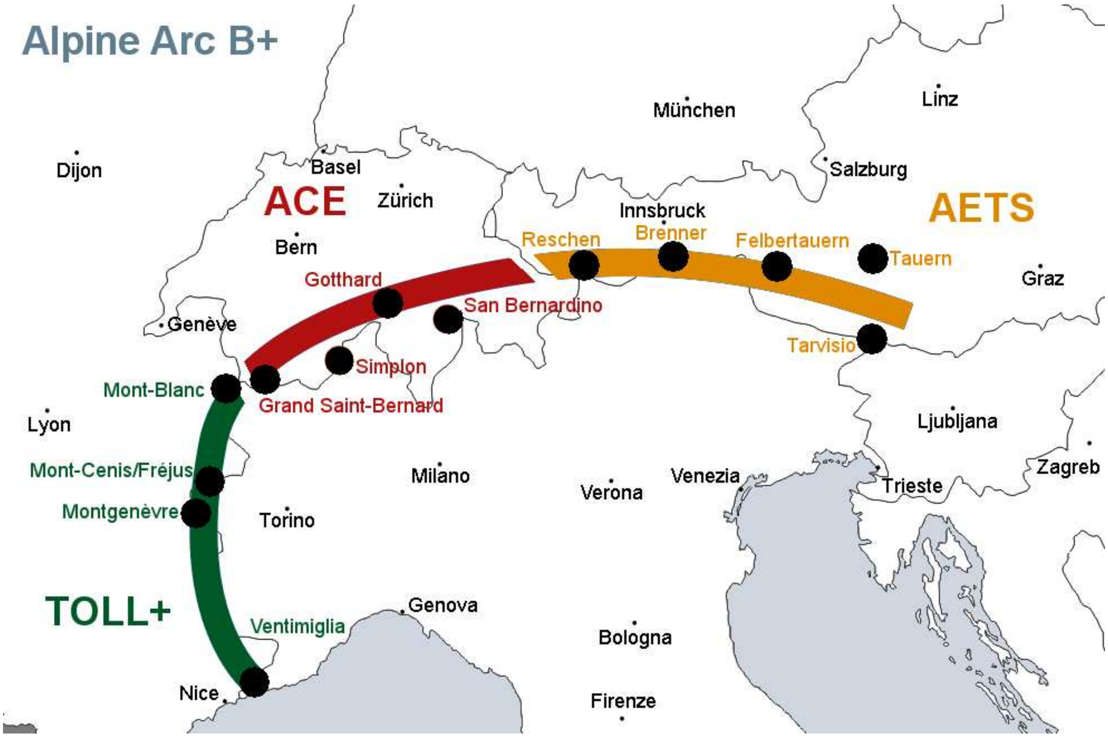
Scenario 3: TOLL+ on the whole Alpine arch B+

In the TOLL+ instrument the tariff varies according to time, environmental surcharge and specific Alpine crossing which is partly already in use on the French/Italian Alpine crossings. In scenario 3 it is assumed that the whole Alpine arch B+ (Ventimiglia–Tarvisio) will adopt the TOLL+ system.

Scenario 4: Parallel use of ACE, AETS and TOLL+ on the whole Alpine arch B+

In scenario 4 the costs of a parallel use of all the three instruments are calculated. Every country implements and operates a specific system. That is the Alpine Crossing Exchange for Swiss/Italian corridors, the Alpine Emission Trading System for Austrian/Italian corridors and the TOLL+ System for French/Italian corridor (see figure 3-5). The scenario takes into account the possible synergies (especially between the ACE and AETS system).

Figure 3-5: Scenario 4: parallel use of ACE, AETS and TOLL+



Source: Rapp Trans (2010).

3.7.2 Cost categories

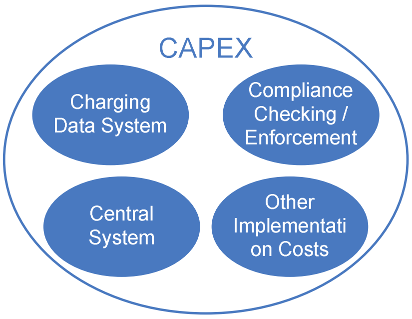
There are two types of cost to be considered:

1. **CAPEX** (Capital expenditure) comprises the investment (implementation of the system) and reinvestment costs. The capital expenditure is added to an asset account ("capital-ised"). As a consequence it needs to be depreciated over the life of the asset.
2. **OPEX** (Operating expenditure) is the on-going cost for running a product, business or system. OPEX may also include the cost of workers and facility expenses such as rent and utilities. OPEX costs are expensed in the year they occur.

3.7.3 CAPEX

There are four major cost pools for the investment in a road user charging scheme:

1. Charging Data System
2. Compliance Checking / Enforcement
3. Central System
4. Other Implementation Costs



Charging Data System

The major part of the charging data system is the necessary investment and reinvestment in the DSRC On Board Units of "not yet" equipped users[28], the road side charging system (DSRC gantries) as well as the point of sales (POS), where users can get their On Board Units (OBU) in case they are not yet equipped. Not only in the first year, but also in later years new OBU are necessary, as every year new vehicles are registered and some OBU have to be replaced because they reached the end of their lifetime.

Compliance Checking / Enforcement

In order to have a credible charging system, compliance checks and violator prosecution are necessary. Roadside compliance checking can be done by fixed enforcement stations and mobile enforcement units[29]. Depending on the desired compliance check density, a different mix of the possibilities is applied.

Central System

The central system is the backbone of each charging system. It consists of the central hardware and software, application modules (e.g. customer relationship management module or electronic back-office), DSRC specific modules and the compliance check back-office.

For the ACE and the AETS scenarios the central system software must enable the trading of passage rights. This causes high costs as the trading of such rights is still "virgin soil" and no state of art technology can be applied.

Other Implementation Costs

Other costs which occur during the implementation are the test environment, the training equipment as well as the costs for marketing and information (e.g. call centre activities, website configuration).

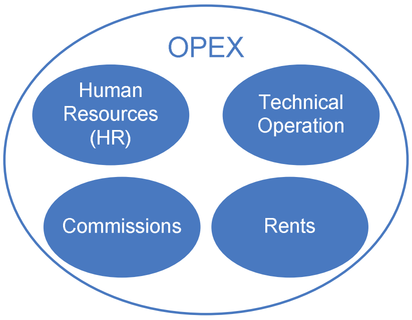
[28] Users that do not have an OBU with DSRC interface from another charging system such as the EETS, the Austrian or French OBU.

[29] Assumption: there are only fixed enforcement stations and mobile enforcement units, but no portable enforcement stations.

3.7.4 OPEX

There are four major cost pools for the operation of a scheme which are due every year:

1. Human Resources (HR)
2. Technical Operation
3. Commissions
4. Rents



Human Resources (HR)

Human resources are necessary for the set-up of the system as well as for the operation. Due to the complex system, it is assumed that the system will not be developed by the operator itself but purchased thorugh public procurement from a specialised system developer. Depending on the design of the scheme, the human resources required can vary. During operation especially the mobile enforcement units are very resource intensive.

Because HR costs are due every year of operation, it is more economical to invest in a reliable system (higher CAPEX during the implementation which is then depreciated over several years) than having lower CAPEX at the beginning but higher OPEX every year.

Technical Operation

The operating expenditure (OPEX) for the technical operation consist of the yearly costs necessary to maintain and operate the charging data system, compliance checking system, central system and other equipment (see CAPEX).

Commissions and other expenses

Commissions are due for the handling of the payment, the distribution of the OBU, the call centre operation, information and marketing, update of the internet platform and internal and external training. A significant expense cost factor in the ALBATRAS project is the cost item *“Lump sum for registration, trading of rights on the market, debiting etc.”*. This includes the yearly operating expenses necessary for the trading of the rights relevant for the ACE and the AETS instruments.

Rents

Rents need to be paid every year of operation as well as during the implementation period (for the central system and offices).

3.7.5 Cost items according to the instrument

The expenses will differ according to the complexity of the instrument. The **ACE and AETS instruments are more complex** because a limited amount of passage rights is auctioned and traded which is an entirely new concept. The TOLL+ approach is much simpler in terms of system design as there is no upper limit of passage rights to be traded and hence no necessity of “stock exchange” for passage rights. In the TOLL+ system, the tariff simply varies according to time and environmental surcharge as well as on the length of the Alpine passage. This realisation can be done with “state of the art” technology.

3.7.6 The Rapp Trans cost model

The cost analysis for the ALBATRAS project was conducted with the Rapp Trans cost model. It is based on the experience from cost calculations made for various international road user charging projects. The purpose of this cost model is to estimate total costs to understand the cost structure and compare different scenarios.

The cost model delivers a breakdown of the costs for the different phases in the lifetime of a road user charging scheme. The costs are calculated for the implementation year as well as the operation phase which is assumed to be 10 years. The different items in the cost model are grouped into categories and subcategories for a better overview.

The cost model can be used to estimate the total costs for the set-up and operation of the road user charging scheme based on reasonable assumptions for each cost element. By adapting the assumptions to the scenarios, a cost evaluation for the three instruments over a defined geographical area can be created.

The cost model is based on the best knowledge available from exisiting road user charging projects. However, instruments of an ACE and AETS have never been used in practice and some cost factors and volumes might change depending on the future development of traffic flows, political decisions and technological progress. **Therefore, the cost calculations include an uncertainty range of +/- 30%.**

3.7.7 Source of the model and values

The structure of the cost model as well as the assumptions used are based on several studies and the experience gained from the introduction of several road user charging schemes in Europe (Switzerland, Austria, France, Belgium (study), United Kingdom (study), Czech Republic, Slovenia (study), Finland (study), Slovakia and Hungary).

Furthermore, specific results out of the report “Alpentransibörse: Untersuchung der Praxistauglichkeit”, Chapter 8 “Costs”, from Ecoplan, Rapp Trans and Kurt Moll (2007) have been taken into consideration.

3.7.8 Structure of the cost model

The model can show the costs of ownership as well as the cash flows during the implementation and operation phase.

- The cash flows are calculated by adding CAPEX plus OPEX
- The costs of ownership are calculated by adding depreciation plus OPEX

In this report only the CAPEX and OPEX are shown in the results.

In the cost model a time horizon has been chosen for the purpose of the cost model only which does not reflect any actual, detailed time schedule. It is assumed that the implementation lasts only one year (starting in the preparation year 2014). The operational duration is assumed to be 10 years.

Implementation, Operating and Depreciation costs

In the cost model three different kinds of costs are differentiated:

- **Implementation and renewal costs (CAPEX):** First, the implementation costs are calculated. This is the capital expenditure necessary for the set-up of the charging system at the beginning of operation. For the implementation costs the unit cost are estimated in Euros. This cost factor is then multiplied by the units required in the system. During the 10 years of operation other capital expenditure (renewal) is necessary (e.g. new OBU, replacement of other technical components).
- **Operating costs (OPEX):** Based on the implementation costs the majority of operating costs is calculated as a percentage of the corresponding implementation costs which have to be paid every year. Some of them are calculated depending on volumetrics (e.g. communication costs are linked to the OBU population) whereas others are lump sums (e.g. yearly costs for call centre operation).
- **Depreciation costs:** In the cost model the depreciation is assumed to be linear. To stay on the safe side rather conservative estimates are used. The components are depreciated within 5 years (OBU, equipment for certified workshop and manual verification / post processing working stations), 7 years (e.g. central system) or within 10 years (normal depreciation). Some parts are even depreciated over 20 years (e.g. gantries). As the calculation is only performed for one year of implementation and 10 years of operation, there will be residual values (there is no extraordinary depreciation in the last year of operation).

3.7.9 Limitations of the cost model

The cost model is based on rough assumptions concerning the major cost items for each scenario, since no detailed information is available at this stage of the project. The results of the calculation allow for a relative comparison of the costs of the scenarios between each other.

All costs quoted exclude VAT. In addition, no inflation is included, i.e. the operating costs as well as reinvestment capital expenses during the operation are based on the price level at the start of operation.

The costs contain all the direct costs which occur in the road user charging scheme. As only direct costs are calculated, the time lost by users during the necessary procedures is not included. The model only shows the costs which are necessary in addition to already existing systems. In all the scenarios DSRC OBU are used. Most of these OBU have already been paid in other system (e.g. GO-Maut in Austria) and therefore cause only minor cost in the ALBATRAS cost calculation.

The costs calculation is an estimation of the costs over a time span in the future. Costs of major components can change due to technological improvements.

3.7.10 Assumptions

The assumptions concerning the major cost drivers are listed in the table below.

We estimate the **costs for a DSRC OBU** to be 20 €. However, most of the vehicles will have already an OBU from an other charging system or the EETS OBU with a DSRC interface, only a small number of vehicles have to be equipped with specific OBU for the Alpine crossings.

In Switzerland it is assumed that 30'000 DSRC OBU need to be provided to users not yet equipped at the start of operation. This represents the number of users that choose the manual solution in the Swiss LSVA and do not have any OBU with DSRC interfaces from other charging systems (e.g. the German LKW-Maut, Austrian GO-Maut, French TPLN, Czech DSRC Tags etc.). In Austria most vehicles (domestic and foreign) driving on motorways need to be equipped with a GO-Box which can be used for the Alpine crossings as well. In France the situation is similar: most vehicles (domestic and foreign) will already have an OBU for the TPLN (French road user charging scheme) or some already existing DSRC OBU used on French motorways. Even OBU with DSRC interfaces from other motorway operators like from from Spain can be used for the Alpine Crossing Scheme.

We estimate that every year, approximately 20'000 **new vehicles** need to be equipped with an OBU. 15'000 vehicles are assumed to leave the system and not to come back in the following year, thus most of these OBU are "lost", but some can be reused if they are returned to a point of sales (separate calculation in the cost model).

For the implementation as well as the operation of the system, **human resources** (HR) are necessary. HR are required for the back-office of the operations centre as well as for the mobile enforcement teams. The cost model works with two different assumptions: first there are HR necessary during the year for *implementation* of the system and second, there are HR necessary for the *operation* of the system. Due to its simplicity, the TOLL+ scheme requires less HR than the other schemes, both in the implementation as well as during operations.

The number of **charging points** reflects the points of Alpine crossings which need to be equipped with DSRC gantries in order to charge for the passages. These gantries are similar to those already used for charging electronic road tolls. One entity of gantries in the cost model reflects one driving direction. An average costs factor is used for both single and multi-lane.

The **Points of Sales** (POS) are the places where the users which are not yet equipped with a DSRC OBU can get their specific OBU for the Alpine Crossing Scheme. In Austria and the neighbouring regions in Germany and Italy, the existing POS for the GO-Maut can be used. In France, the POS for the existing road user charge or the (not yet) implemented TPLN can be used. The POS in Italy and Slovenia must be analysed, but we assume that existing POS can be used for the Alpine crossing schemes as well. Only for Switzerland new POS are necessary. We therefore assume that only 15 new POS must be equipped.

Every charging point is also equipped with the **roadside compliance check equipment** on the same gantries. In addition, some **mobile enforcement units** are patrolling on the streets in order to guarantee the prosecution of non- or “bad” payers. The staff of these mobile enforcement units is included in the HR section.

The **platform** which allows the trade of passage rights has a major impact through the implementation costs for the Central System Software in the Alpine Crossing Exchange and the Alpine Emission Trading System. The TOLL+ system requires a much lower effort due to the already existing system in France as well as the more state of the art technology necessary for this instrument (no trading of passage rights, only variation in tariff).

Figure 3-6: Assumptions for major cost drivers[30]

	Scenario 1 ACE	Scenario 2 AETS	Scenario 3 TOLL+	Scenario 4 Parallel use
Cost for DSRC OBU ("not yet" equipped vehicles)	20 €			
Number of "not yet" equipped vehicles at start of operation (HGV > 3.5 tonnes)	30'000	30'000	30'000	30'000
Operation: Number of "not yet" equipped vehicles which appear new in the system (per year)	20'000	20'000	20'000	20'000
Operation: Number of vehicles which disappear from the system (per year)	15'000	15'000	15'000	15'000
Total number of personnel necessary during implementation (12 months)[31]	90	90	14	72
Total number of personnel necessary during operation[32]	135	135	75	92
Number of charging points (one direction), lump sum for 1 and 2 lanes in one driving direction	34	34	24	24
Number of Point of Sales for "not yet" equipped users (for getting DSRC OBU)	15	15	15	15
Number of fixed roadside compliance check stations	34	34	24	24
Number of mobile enforcement units	28	28	18	18
Implementation costs central system hardware	10 M €	10 M €	1.5 M €	9 M €
Implementation costs central system software	24 M €	24 M €	3.6 M €	21.6 M €

Source: Rapp Trans (2010).

[30] The assumptions are based on figures from other road user charging cost calculations.

[31] Mainly back-office staff for the system integration and start-up.

[32] This number of personnel includes back-office staff as well as mobile enforcement staff.

3.7.11 Results

This section describes the following results based on the cost model:

- Implementation costs (CAPEX)
- Operation costs (OPEX)
- Implementation and reinvestment costs over lifetime
- Operating expenditure over lifetime
- Total costs over lifetime

3.7.12 Implementation costs

The total implementation costs over one year of preparation are shown in figure 3-7.

The cost for the ACE and the AETS are very similar. The major investment is in the central system which needs to be able to allow the trading of passage rights.

The TOLL+ instrument is much less complex than the other two instruments and no new applications need to be developed. It requires very little investment in France/Italy as most of the infrastructure already exists. To give an example: only at Montgenèvre there is currently no tolling station that could function as the charging point for TOLL+. When introducing the TOLL+ system over the Alpine arch B+ much higher investments are necessary due to the investments and adaptations of the systems in Switzerland and Austria/Italy. However, compared to the ACE and AETS systems over the Alpine arch B+, the investment costs for the TOLL+ are much lower due to the simplicity of the system.

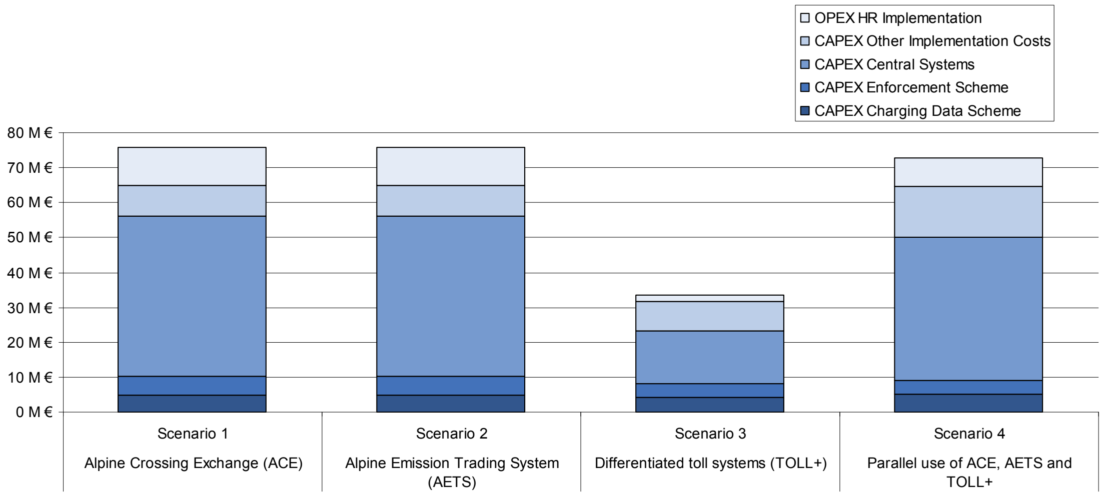
The introduction of a combination of all the three instruments leads to some synergies in comparison with the simple sums of the “stand alone scenarios”.

Remark: in the figure the OPEX HR[33] during implementation are also shown. All HR is calculated as OPEX in the Rapp Trans costs model. In order to give a better overview over the costs during implementation, these costs have been included in the graphic.

[33] Human Resources.

Figure 3-7: Total implementation costs in M € (preparation year)

	Scenario 1 ACE	Scenario 2 AETS	Scenario 3 TOLL+	Scenario 4 Parallel use
OPEX HR Implementation	10.9	10.9	1.8	8.3
CAPEX Other Implementation Costs	8.9	8.9	8.3	14.3
CAPEX Central Systems	45.7	45.7	15.2	41.2
CAPEX Enforcement Scheme	5.5	5.5	3.8	3.8
CAPEX Charging Data Scheme	4.9	4.9	4.4	5.3
Total	75.8	75.8	33.5	72.9



Source: Rapp Trans calculations (2010).

3.7.13 Operating expenditure

The following figure shows the operating expenditure (OPEX) during one randomly selected year of operation (example year 2017).

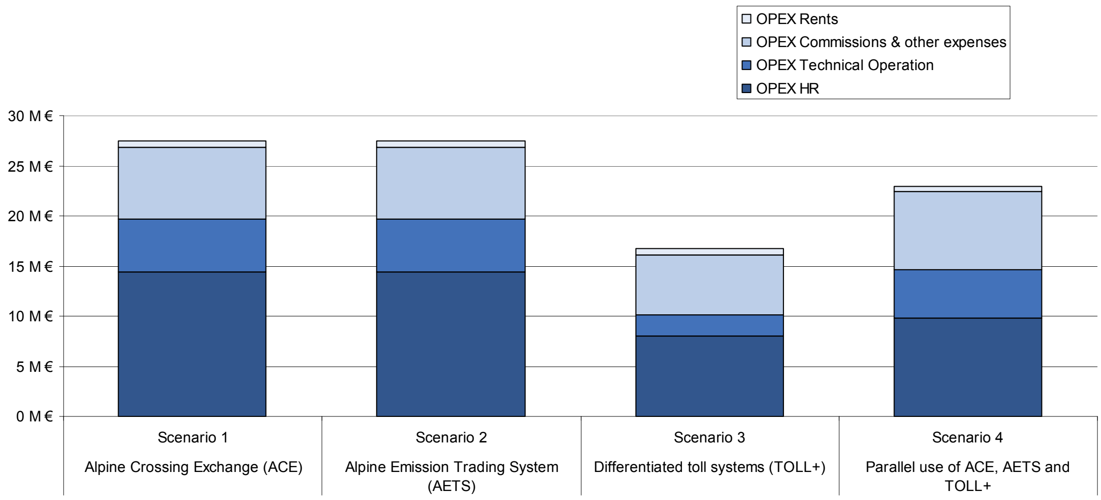
The operating expenditures during one year of operation behave in the same way between the different scenarios as the implementation costs do.

The major parts of the operating expenditures are human resources and commissions, which need to be paid in every year. For the human resources, especially the mobile enforcement units on the street are very resource intensive.

In “commission and other expenses”, the costs for payment means suppliers, the commission for the points of sales where “not yet” equipped HGV can purchase their DSRC OBU, the call centre operation and of course the **expenses for the registration and trading of passage rights** (ACE and AETS) are the major cost drivers.

Figure 3-8: Operating expenditure in M € (during example year 2017)

	Scenario 1 ACE	Scenario 2 AETS	Scenario 3 TOLL+	Scenario 4 Parallel use
OPEX Rents	0.6	0.6	0.6	0.6
OPEX Commissions & other expenses	7.2	7.2	6	7.7
OPEX Technical Operation	5.3	5.3	2.1	4.9
OPEX HR[34]	14.4	14.4	8	9.8
Total	27.4	27.4	16.7	23.0



Source: Rapp Trans calculation (2010).

[34] HR includes back-office staff as well as mobile enforcement staff.

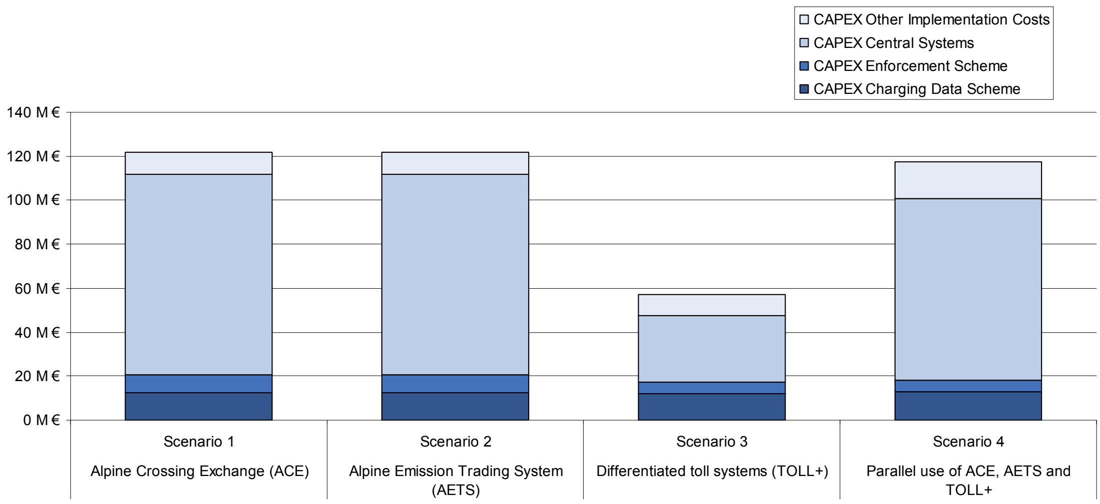
3.7.14 Implementation and reinvestment costs over lifetime

Figure 3-9 shows the total implementation and reinvestment costs (CAPEX) over one year of preparation and 10 years of operation which is the assumed lifetime of the system for the sake of the cost estimation.

In comparison to the implementation costs during the implementation year, the investment costs over lifetime also include the reinvestment of components which have reached the end of their lifetime. Most of the components have a lifetime of either 5 (e.g. equipment point of sales), 7 years (e.g. central system hardware and software) or 10 years (e.g. system concept). In addition, every year new DSRC OBU are necessary as new vehicles appear in the system.

Figure 3-9: Total implementation and reinvestment costs in M €
(one year implementation and 10 years of operation)

	Scenario 1 ACE	Scenario 2 AETS	Scenario 3 TOLL+	Scenario 4 Parallel use
CAPEX Other Implementation Costs	9.9	9.9	9.3	16.8
CAPEX Central Systems	91.3	91.3	30.4	82.4
CAPEX Enforcement Scheme	8.2	8.2	5.5	5.5
CAPEX Charging Data Scheme	12.3	12.3	11.8	12.7
Total	121.6	121.6	57.0	117.4



Source: Rapp Trans calculations (2010).

3.7.15 Operating expenditure over lifetime

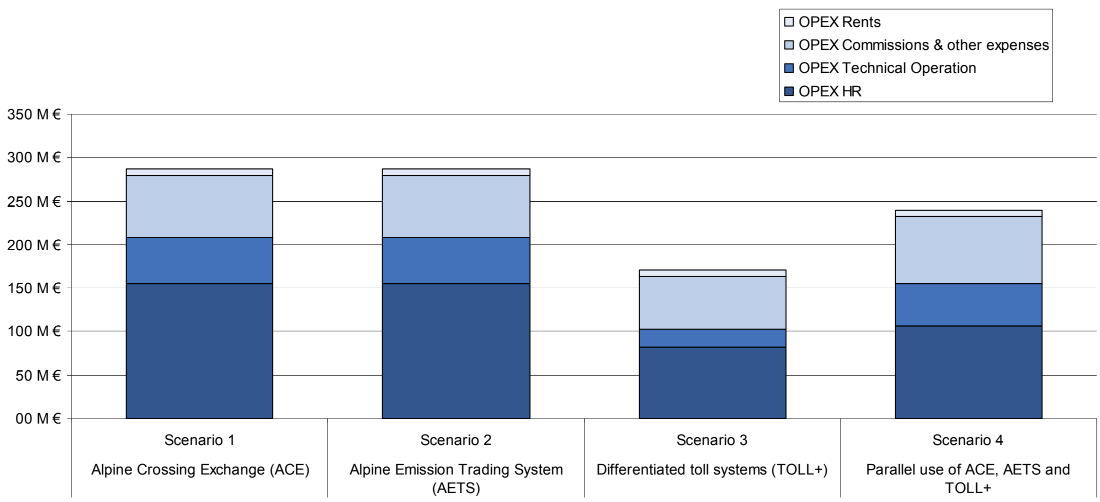
The following figure shows the operating expenditure (OPEX) during 10 years of operation. Please note that some operating expenditures already occur during the year of implementation (rents and human resources).

During the whole lifetime of the system, the human resources are the major cost factor in operating expenditures. The ACE and AETS systems are more complex and hence result in higher OPEX than the TOLL+ system.

Over the Alpine arch B+, a combination of the three instruments (scenario 4) is more expensive than TOLL+, but cheaper than ACE and AETS, because the French/Italian TOLL+ system will still be simpler and therefore cheaper than installing the more complex systems ACE or AETS also on the French/Italian Alpine corridors.

Figure 3-10: Operating expenditure in M € (over lifetime)

	Scenario 1 ACE	Scenario 2 AETS	Scenario 3 TOLL+	Scenario 4 Parallel use
OPEX Rents	6.6	6.6	6.6	6.6
OPEX Commissions & other expenses	72.2	72.2	61.0	77.7
OPEX Technical Operation	53.0	53.0	21.1	48.9
OPEX HR	154.9	154.9	81.9	106.2
Total	286.6	286.6	170.6	239.5



Source: Rapp Trans calculations (2010).

3.7.16 Total costs over lifetime

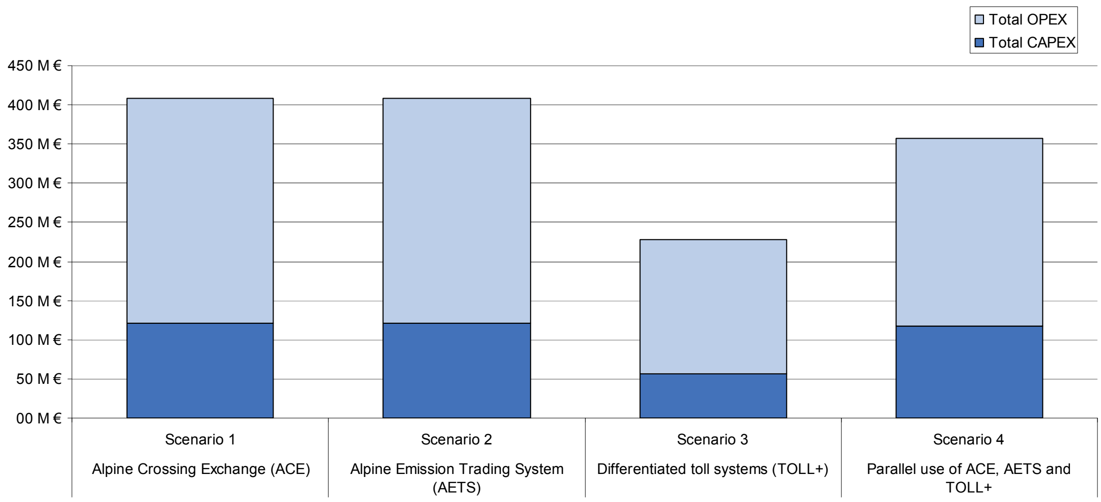
The following table shows the total cash outflows (CAPEX + OPEX) over one year of implementation and 10 years of operation.

Over the Alpine arch B+, the ACE and AETS are assumed to be similar as the two approaches have many commonalities.

The costs of a combination of the three instruments in scenario 4 causes higher costs than TOLL+ over the Alpine arch B+, but lower costs than one of the much more complex ACE or AETS instruments over the Alpine arch B+.

Figure 3-11: Total costs in M € (over lifetime)

	Scenario 1 ACE	Scenario 2 AETS	Scenario 3 TOLL+	Scenario 4 Parallel use
OPEX	286.6	286.6	170.6	239.5
CAPEX	121.6	121.6	57.0	117.4
Total	408.3	408.3	227.6	356.9



Source: Rapp Trans calculations (2010).

3.7.17 Conclusions on costs

The total costs range from an estimated amount of **230 Mio. € for the TOLL+** concept up to **410 Mio. € for the ACE and AETS** concepts. The TOLL+ concept is easier to be implemented on already existing toll roads and tunnels in France, Italy and Austria. However, TOLL+ does not meet an upper limit of passage rights or a market for trading Alpine crossing rights, which is a very important aspect for both Switzerland and Austria.

The **parallel use of an ACE, AETS and TOLL+** as calculated in scenario 4 results in total costs of **360 Mio. €**. It will take the nationally developed concepts of the ACE and AETS into account, but leaves the TOLL+ concept to be applied on the French/Italian corridors.

These cost results give a rough estimation on the costs (+/- 30 % uncertainty range [35]) over the implementation and operation phase for the different instruments over certain geographical areas. The cost factors are based on the experience from already existing road users charging schemes. The application for the trading of passage rights in the ACE and AETS scenarios is a totally new concept in the European transportation policy and therefore includes an uncertainty range for the implementation costs.

[35] See chapter 3.7.6.

P A R T II: Thresholds

The three policy measures ACE, AETS and TOLL+ all aim at limiting road freight transport and shifting transport activities to rail. It is one of the objectives of this study to analyse the effects the different policy measures have (in Part III). To this end, operable thresholds for the three policy measures have to be defined. In Part II of this study we define thresholds, i.e. caps for the number of trucks (ACE), caps for the amount of emissions (AETS) and toll levels (TOLL+). The thresholds should be defined on a well-founded approach, taking into account existing policy aims, economic and traffic forecasts as well as the capacities of road and rail infrastructure.

Several thresholds will have to be defined for each instrument: on the one hand the analysis will be done for 2020 and 2030, so that it must be considered whether or not thresholds should be adjusted over time. On the other hand, two variants of each policy measure will be proposed, a more restrictive one and a more tolerant one. In the more restrictive case the thresholds are more binding, so that less trucks or truck emissions are allowed (ACE and AETS) or road transport charges are higher (TOLL+).

Part II is structured as follows:

- Chapter 4 (Forecasting transalpine freight traffic) provides the basis for the impact analysis in Part III of this study. For 2020 and 2030 business as usual scenarios are derived, one for a “low growth” case the other for a “high growth” case. The scenarios are quantitatively computed with the help of the TAMM (TransAlpine Multimodal Model). TAMM is described in detail in chapter 10.
- Chapter 5 includes first a discussion of possible criteria to derive thresholds for the three different instruments followed by a specific proposal for „restrictive“ and „tolerant” thresholds for every of the three instruments.
- Chapter 6 includes a short discussion about possible accompanying measures.

4 Forecasting transalpine freight traffic

4.1 Overview of existing economic and traffic forecasts

In a first step we will analyse existing economic and traffic forecasts at national and European level. To this end, we will analyse the following studies and transport models:

- TAMM (TransAlpine Multimodal Model), a freight transport model used in the EU-project ASSET[36] and further developed in an ACE-study for the FOT[37]. The model system includes an interface for a trade model to make detailed projections of trade tonnages between countries and differentiated according to the type of goods.
- TRANS-TOOLS, a comprehensive European transport network model for DGTREN (now DG-MOVE). TRANS-TOOLS calculates the flows of freight and passenger transport up to 2030 on the complete, multi-modal, European network.[38]
- Swiss Perspective Study, Perspektiven des alpenquerenden Güterverkehrs, for Switzerland,[39] including existing updates as far as they are available.

TAMM and TRANS-TOOLS are related in many respects, including important components such as the transport networks and methodological steps derived from EC research, but TAMM has been optimized for the Alpine transport system, using specialized data inputs, and designed to allow complex pricing options to be tested. It is not a pan-European model and it only considers freight flows.

The following figures summarize these forecasts for transalpine freight transport as well as the underlying socioeconomic parameters (GDP and population, if available). They are compared and discussed below and will be used to validate the results as well as the crucial assumptions driving the forecasts of the updated TAMM which is applied in the present study.

36 Ecoplan, NEA (2009), Case Study Alpine Crossing. EU-Projekt ASSET (Assessing Sensitiveness to Transport).

37 Ecoplan, NEA (2010b), Auswirkungen verschiedener Varianten der Alpentransitbörse.

38 TNO, ICCR und TML (2008), Best research on “Traffic management Systems for Transalpine Road Freight Transport”.

39 INFRAS (2005), Perspektiven des alpenquerenden Güterverkehrs.

Figure 4-1: Overview forecasts for transalpine freight transport

	Austria			Switzerland			France			Total Alpine Arch "C"[1)]		
Alpinfo 2004 / 2008 [2)]	**2004**	**2008**		**2004**	**2008**		**2004**	**2008**		**2004**	**2008**	
Mill. tonnes / year												
Road	*94.50*	*101.20*		*12.50*	*14.40*		*40.30*	*40.10*		*147.30*	*155.70*	
Rail	*39.20*	*44.07*		*22.90*	*25.50*		*6.90*	*5.20*		*69.00*	*74.77*	
Total	***133.70***	***145.27***		***35.40***	***39.90***		***47.20***	***45.30***		***216.30***	***230.47***	
Share of total	*61.8%*	*63.0%*		*16.4%*	*17.3%*		*21.8%*	*19.7%*		*100.0%*	*100.0%*	
TAMM 2009	**2004**	**2020**	**2030**	**2004**	**2020**	**2030**	**2004**	**2020**	**2030**	**2004**	**2020**	**2030**
Mill. tonnes / year												
Road	92.89	98.69	n.a.	12.50	14.73	n.a.	39.97	40.88	n.a.	145.36	154.29	n.a.
Rail	32.91	48.09	n.a.	22.71	39.32	n.a.	6.84	9.71	n.a.	62.46	97.12	n.a.
Total	**125.80**	**146.78**	**n.a.**	**35.21**	**54.05**	**n.a.**	**46.81**	**50.59**	**n.a.**	**207.82**	**251.41**	**n.a.**
Share of total	60.5%	58.4%	n.a.	16.9%	21.5%	n.a.	22.5%	20.1%	n.a.	100.0%	100.0%	n.a.
Growth from 2004 in %												
Road		6.2%	n.a.		17.8%	n.a.		2.3%	n.a.		6.1%	n.a.
Rail		46.1%	n.a.		73.2%	n.a.		41.9%	n.a.		55.5%	n.a.
Total		16.7%	n.a.		53.5%	n.a.		8.1%	n.a.		21.0%	n.a.
Modal Split												
Road	73.8%	67.2%	n.a.	35.5%	27.2%	n.a.	85.4%	80.8%	n.a.	69.9%	61.4%	n.a.
Rail	26.2%	32.8%	n.a.	64.5%	72.8%	n.a.	14.6%	19.2%	n.a.	30.1%	38.6%	n.a.
TRANSTOOLS	**2004**	**2020**	**2030**	**2004**	**2020**	**2030**	**2004**	**2020**	**2030**	**2004**	**2020**	**2030**
Mill. tonnes / year												
Road	97.17	119.00	n.a.	13.31	12.80	n.a.	38.51	48.50	n.a.	148.99	180.30	n.a.
Rail	33.30	63.70	n.a.	22.90	37.80	n.a.	6.80	11.60	n.a.	63.00	113.10	n.a.
Total	**130.47**	**182.70**	**n.a.**	**36.21**	**50.60**	**n.a.**	**45.31**	**60.10**	**n.a.**	**211.99**	**293.40**	**n.a.**
Share of total	61.5%	62.3%	n.a.	17.1%	17.2%	n.a.	21.4%	20.5%	n.a.	100.0%	100.0%	n.a.
Growth from 2004 in %												
Road		22.5%	n.a.		-3.8%	n.a.		25.9%	n.a.		21.0%	n.a.
Rail		91.3%	n.a.		65.1%	n.a.		70.6%	n.a.		79.5%	n.a.
Total		40.0%	n.a.		39.7%	n.a.		32.6%	n.a.		38.4%	n.a.
Modal Split												
Road	74.5%	65.1%	n.a.	36.8%	25.3%	n.a.	85.0%	80.7%	n.a.	70.3%	61.5%	n.a.
Rail	25.5%	34.9%	n.a.	63.2%	74.7%	n.a.	15.0%	19.3%	n.a.	29.7%	38.5%	n.a.
CH Perspective Study[3)]	**2004**	**2020**	**2030**	**2004**	**2020**	**2030**	**2004**	**2020**	**2030**	**2004**	**2020**	**2030**
Mill. tonnes / year												
Road				12.10	12.00	18.50						
Rail				22.00	38.70	45.30						
Total				**34.10**	**50.70**	**63.80**						
Share of total												
Growth from 2004 in %												
Road					-0.8%	52.9%						
Rail					75.9%	105.9%						
Total					48.7%	87.1%						
Modal Split												
Road				35.5%	23.7%	29.0%						
Rail				64.5%	76.3%	71.0%						

1) The whole Alpine arch from Ventimigla to Vienna.
2) The numbers shown in this table include the volumes of the Tarvisio crossing. Within **Alpinfo** the Tarvisio Crossing is excluded from the definition of Alpine arch C in order to avoid a double count (Tarvisio is linked via motorway to other passes e.g. Tauern and Wechsel, so transalpine flows crossing Tarvisio also use another crossing point).
3) For Swiss corridors only. The 2004- and 2020-values are based on the alternative scenario 1 (rail dynamics in Europe) in INFRAS (2005), Perspektiven des alpenquerenden Güterverkehrs. In deepening analyses within the future development of the Swiss railway infrastructure (ZEB 2030; Zukünftige Entwicklung der Bahninfrastruktur), the 2030-values from the Swiss Perspective Study have been updated. For the updates, 2007/2008 has been applied as base year (see UVEK (2009), Monitoring flankierende Massnahmen, 2. Semesterbericht 2008). Therefore, here we use the updated values for 2030.

Figure 4-2: Basic socioeconomic parameters

	Switzerland			European Union		
	2004	2020	2030	2004	2020	2030
TAMM 2009 (EU-27)[1)]						
GDP in bn EUR [2)]	345	442	497	10'573	12'926	14'445
Growth from 2004 in % p.a.		*1.67%*	*1.47%*		*1.35%*	*1.26%*
Population in mill.[2)]	7.40	7.49	7.32	488.59	496.27	494.33
Growth from 2005 in % p.a.		*0.08%*	*-0.15%*		*0.10%*	*0.05%*
TRANSTOOLS (EU-25)						
GDP in bn EUR [3)]						
Growth from 2000 in % p.a.					*2.14%*	*n.a.*
Population in mill.[3)]						
Growth from 2000 in % p.a.		*0.16%*	*n.a.*			
CH Perspective Study						
GDP in bn EUR [4)]	357	483	535			
Growth from 2002 in % p.a.		*1.70%*	*1.46%*			
Population in mill.[4)]	7.32	7.54	7.55			
Growth from 2002 in % p.a.		*0.16%*	*0.11%*			

1) The country specific GDP and population growth rates which are used in the trade model for TAMM (to produce future trade flows between two countries) are based on the iTREN-2030 project of the EU, see Schade W. et al. (2010), The iTREN-2030 Integrated Scenario until 2030. For lack of space here we only show the average growth rate for EU-27 (e.g according to the iTREN data the average GDP-growth for France between 2005 and 2030 is 0.75%, for Italy 0.78%, both countries clearly below the EU-average; on the other hand, for eastern EU-states like Poland, Slovenia, Slovakia or the Baltic states the yearly average growth is estimated to 2.5 – 3.5%, clearly above the EU-average growth). It is clear that other (or more detailed country specific) forecasts can produce different per country growth rates than the iTREN-2030. But with respect to equal methods of forecasting and a similar treatment of all countries we decided to base the TAMM on the iTREN-2030 forecasts.
2) Base year 2005.
3) Base year 2000.
4) Base year 2002.

4.1.1 Discussion of the forecasts and the underlying assumptions

- Regarding the total volume of transalpine freight transport (road and rail) within the Alpine arch C, the TRANSTOOLS forecast for 2020 is about 40 mill. tons p.a. higher as the one with TAMM 2009. The modal split of total transport in 2020 is virtually identical with a share of 61.5% for road and 38.5% for rail. The same holds for the individual countries.
- The share of total transport of France is almost identical in the two studies. In contrast, Austria and Switzerland show a difference of around 4% in their shares of total transport in 2020: In TAMM 2009 the share of total transalpine freight transport through Switzerland is growing, through Austria it is decreasing, whereas in TRANSTOOLS the shares of the two countries stay more or less the same.
- The comparison of the results for transalpine freight transport through Switzerland in TAMM 2009 and the Swiss Perspective Study shows a higher growth in total transport in TAMM 2009 from 2004 to 2020 (around 3 mill. tons more than in the Swiss Perspective study). This difference is mainly due to a higher growth of road transport in TAMM 2009.

Accordingly, the modal split for road in 2020 is higher in TAMM 2009 (27.2%) than in the Swiss Perspective Study (23.7%).

- The assumptions for population growth in Europe and Switzerland are all very low and similar in all three studies. The same holds for GDP-growth in Switzerland: TAMM 2009 and the Swiss Perspective study both assume comparable annual growth rates till 2030. For the GDP-growth in Europe, TRANSTOOLS assumes a higher annual growth than TAMM 2009.[40]
- An important difference between the three studies is the modeling of productivity effects and rail subsidies. Whereas in TRANSTOOLS neither productivity effects nor subsidies are taken into account, they are considered in TAMM 2009 and the Swiss Perspective Study. However, in the TAMM 2009 the productivity effects directly influence individual cost factors, whereas in the Swiss Perspective Study they are modeled through a decrease of total cost (for more detailed information about the modeling of productivity effects and subsidies in TAMM see the summary of the assumptions in chapter 4.2 and see chapter 11 in the Annex).

4.1.2 Conclusion

Overall, the three studies produce comparable forecasts for the transalpine freight transport for 2020 and 2030 respectively. Therefore, the again updated TAMM is a reasonable choice for modeling transalpine freight transport and the effects of the three policy instruments discussed in the present study. Moreover, the TAMM can produce the most detailed results for transalpine freight transport (differentiated on NUTS3-level, for ten different NSTR freight groups, by road, and three rail modalities). Furthermore, all the relevant assumptions for the calculation with TAMM have been discussed and verified in a workshop with experts in 2010.[41] The main updates within TAMM from the previous to the present study include a more recent trade forecast (based on the iTREN-2030 project of the EU[42]), a revised modeling of the productivity effects, rail subsidies and forecasts till 2030. The general expectation from the trade forecast is one of moderate growth, with a relative shift from West to East.

4.2 Assumptions

In order to provide the basis for the analysis of the impacts of the three instruments ACE, AETS and TOLL+ on transalpine freight transport flows, business as usual (BAU) scenarios for 2020 and 2030 have to be defined. Thereby, for 2030 we differentiate between a “low growth” case and a “high growth” case in order to carry out the analysis for a larger spectrum of possible future states. For 2020 we only model one “trend growth” BAU scenario.

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40 Further economic parameters are either missing or not comparable between the three studies.

41 Ecoplan, NEA (2010a), Alpentransitbörse: Plausibilisierung der Ergebnisse und Annahmen.

42 See Schade W. et al. (2010), The iTREN-2030 Integrated Scenario until 2030.

The quantitative calculation of these scenarios is carried out with the help of the TAMM (TransAlpine Multimodal Model). TAMM is described in detail in chapter10. In the present chapter we summarise the assumptions for the base case 2004 and the BAU scenarios (for more detailed information about the most crucial assumptions see chapter 11 in the Annex).

4.2.1 Relevant transport infrastructure

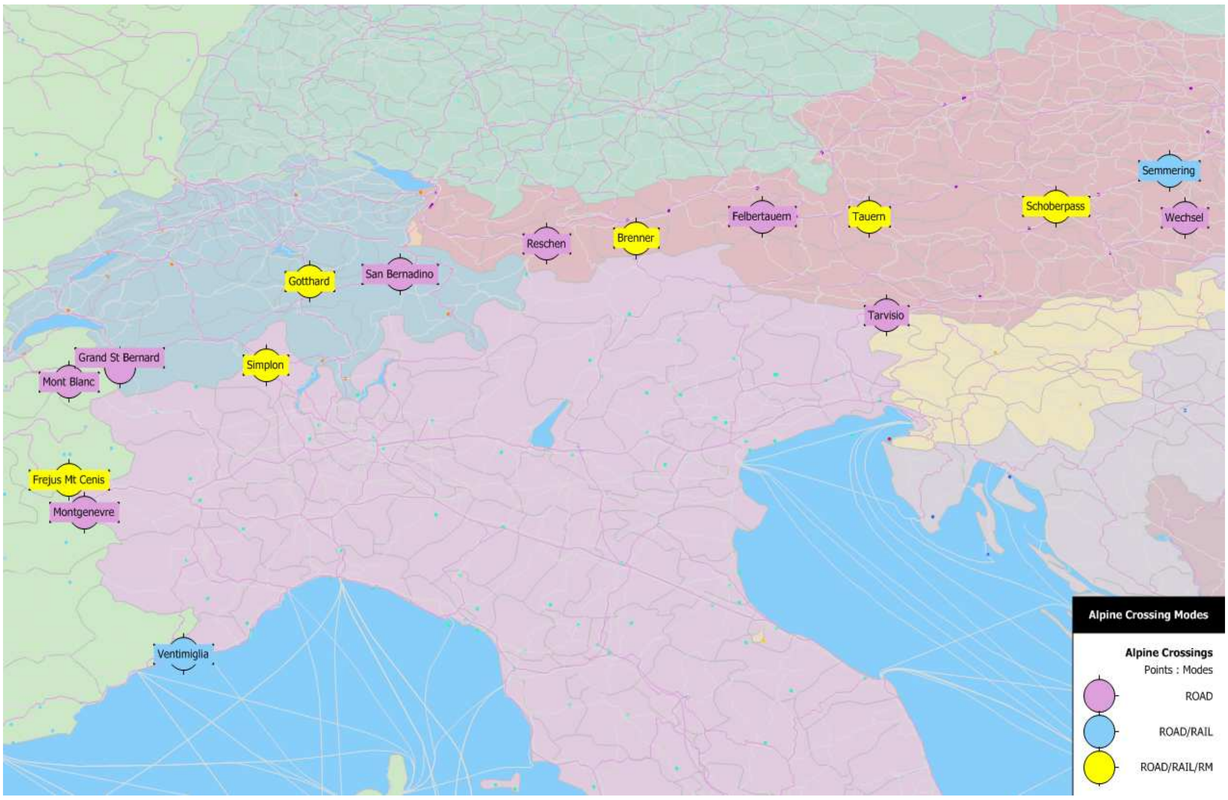
Figure 4-3 shows the relevant transport infrastructures for road and rail traffic in the Alpine arch. The relevant Alpine transport infrastructure contains 2’337 km of interurban motorways and 1’484 km of railways. The road infrastructure consists of eight Alpine corridors in Austria, four in Switzerland and four in France. The rail infrastructure consists of four corridors in Austria, two in Switzerland and two in France. The Semmering and the Ventimiglia rail corridors only have wagon load and unaccompanied combined transport, whereas the other corridors also offer a rolling motorway (RM) service.

Whereas in ALBATRAS the three different instruments ACE, AETS and Toll+ are analysed for the Alpine Region “B+” level (from Ventimiglia to the Tauern-Tarvisio-corridor) the forecast of transalpine freight traffic as well as the impact analysis in Part III of this study are carried out for the Alpine Region C (the whole Alpine Region between Ventimiglia and Wechsel, defined by the Alpine Convention).[43]

The analysis is restricted to **transalpine freight transport**, as the focus of this study is on transalpine freight transport and for which a coordinated policy of all countries belonging to the Alpine Convention is searched for.

[43] Alpine Convention (http://www.alpconv.org/theconvention/index_en).

Figure 4-3: Transalpine corridors (Road and rail)



4.2.2 Assumptions for the base case 2004 and BAU scenarios 2020 /2030

Figure 4-4 further below shows the most important assumptions for the analysed base case 2004 and the business as usual (BAU) scenarios for 2020 and 2030. In brief, the reference cases can be described as follows:

a) Base case 2004

- The base case corresponds to the calibrated transalpine freight transport volumes with TAMM, based on CAFT 2004[44]
- The policy instruments and the transport services for road and rail represent the situation 2004 (e.g. no ACE, no rail base tunnel on the Gotthard or Lötschberg corridors etc.)
- In Switzerland, the total amount of subsidies for rail freight transport is 140 mill. EUR: Around 110 mill. EUR for unaccompanied combined transport (UCT) and around 30 Mill. EUR for rolling motorway (RM). The rates for subsidies amount to 90 € per shipment and 850 – 1'940 € per train for UCT (depending on the origin of the train) and 109 € per ship-

[44] Crossalpine Freight Transport 2004.

ment and 2'048 € per train for RM.[45] In Austria the subsidies are 35 € per shipment for UCT and 75 – 85 € per shipment for RM (depending on the Alpine crossing). In France 24 € per shipment are paid for UCT and RM.[46]

b) BAU 2020

- For 2020, regarding transport growth, **a trend BAU scenario** is modelled. "BAU 2020 trend" is based on the TAMM trade and transport forecast for 2020 (based on the projection in the EU-project iTREN-2030[47]), assuming that for several reasons the growth of transalpine freight transport will be not as high as projected in the past. Main reasons are:
  – the economic crisis crisis 2008/09 (permanent shift in demand for Alpine crossing transport) instead of a steady recovery towards the (pre-crisis) long term trend-line
  – medium to long term limits to the growth of visible trade within the region, due to income/transport decoupling effects, scarcer fuel resources, and de-materialisation of the economy.
- **No new policy instruments** have been implemented since 2004
- **Productivity effects**:[48]
  – Between 2004 and 2020 **rail freight transport** on the whole European network observes productivity effects due to concerted policy actions (e.g. TEN-T priority investments) resulting in greater service frequencies, lower fixed costs per shipment because of better equipment and terminal utilization related to higher volumes, less delays for cross border transports, progress and standardization within IT Technologies etc., which are modeled through lower cost factors (see chapter 11 in the Annex)
  – For **road freight transport** the average load per HGV increases on the Swiss corridors from 9.9 tons/HGV in 2004 to 12.5 tons/HGV in 2020, to account for the (already implemented) relaxation of HGV weight limits
- The **Lötschberg and Gotthard rail base tunnels** are operating, whereas at the Brenner and Mont Cenis corridor the new base tunnels for rail are still under construction and not open for traffic yet.
  – The new Gotthard base tunnel leads to reduced distances and higher cargo speed that decrease the duration of the routes affected.[49] Moreover, due to the lower slope of the base tunnels, the number of necessary locos can be reduced from two to one for UCT

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[45] BAV (2005-2009), Offertverfahren kombinierter Verkehr 2005 – 2009. Due to a change in the regime for subsidies in Switzerland 2010 (conversion of the track cost subsidies into subsidies per shipment and train; the total amount remains unchanged) we implement for the situation 2004 the subsidies as they are in 2010.

[46] For all calculations within the present study (assumptions and runs with the TAMM) the following exchange rate for conversion of CHF to EUR and vice versa is used: 1.5625 CHF/EUR. If not indicated elsewise, all values and costs are given in EUR with 2004 as the base year (see also chapter 11.1.2 in the Annex).

[47] Schade W. et al. (2010), The iTREN-2030 Integrated Scenario until 2030.

[48] Those productivity effects "over time" from 2004 to 2020 occur on the whole transport network.

[49] The new Gotthard base tunnel (57 km) is currently under construction and is expected to be opened in 2017. The base tunnel leads to higher capacities and shorter travel times (1h for passenger, 1h for freight traffic).

and WL, which leads to lower traction costs per train. In the case of RM the base tunnels allow longer trains. All those effects are modeled as improvements in productivity on the affected transport relations.

– The new Lötschberg base tunnel leads to reduced distances only and therefore only to a small decrease in the duration for rail transport. Therefore, productivity effects are smaller than on the Gotthard corridor.[50]

- **Rail subsidies**
  - In Switzerland, the rates of subsidies are reduced step by step and by 2020 amount to 45€ per shipment (forty foot container unit equivalent (FEU)) and on average 425 € per train for trains from/to the Netherlands and 815 € per train for trains from/to the rest of Europe for UCT (this corresponds to a reduction of 50% compared to the subsidies 2010). For RM the subsidies are 98 € per shipment and 1’843 € per train (corresponding to a reduction of 10% compared to 2010). Two thirds of the omitted subsidies are shifted towards the prices (see chapter 11 in the Annex).
  - In Austria, the subsidies are assumed to be reduced in the same way as in Switzerland till 2020 (50% for UCT, 10% for RM). For UCT the subsidies amount 2020 to 18 € per shipment (no subsidies per train). For RM, the subsidies per shipment lie between 68 and 77 € depending on the Alpine corridor.
  - For France, the rail subsidies are assumed to be abolished in 2020.
- **Rolling motorway**: The RM services in Switzerland and Austria remain unchanged (in Switzerland around 100’000 RM trips per year). In France a new RM line is operating between Orbassano and Aiton. The prices for RM decrease due to the productivity effects for rail but also increase because of the reduction in subsidies between 2004 and 2020 (see above).
- **UCT / WL**: The UCT and WL services remain unchanged (expect for the productivity effects and reduction in subsidies mentioned above).

c) BAU 2030

For 2030, again **two BAU scenarios** are modeled regarding transport growth (“BAU 2030 high growth” and “BAU 2030 low growth”; extrapolation of the implied growth trends), which differ to the 2020 BAU scenarios in the following points (see also above):

- From 2020 to 2030 there are no more productivity effects, neither for rail, nor for road freight transport
- The **Brenner and Mont Cenis rail base tunnels** are operating and lead to similar effects as the Gotthard base tunnel
- The **subsidies** for rail freight transport (UCT and RM) are completely abolished in all three countries

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[50] The Lötschberg base tunnel (34.6 km) is in operation since 2007 and also led to higher capacities and reduced distances but no significant reduction in travel times or lower traction costs (mainly due to the Simplon tunnel)..

Figure 4-4: Assumptions for base case 2004 and business as usual scenarios 2020 / 2030

	Base case 2004 and BAU 2020 / 2030			
	2004	2020	2030	
growth	2004	iTREN-2030 projection	low	high
economic / transport growth	AQGV 2004	NEA/TAMM trade forecast, GDP growth EU-27: 1.35% p.a. (based on iTREN-2030 forecast)	Reduced NEA/TAMM trade forecast: 7% lower growth rate than TAMMref, to account for stronger effects of economic crisis 2008/09	High NEA/TAMM trade forecast: 9% higher than TAMMref, based on iTREN-2030 (GDP growth EU-27: 1.26% p.a.)
Lötschberg / Gotthard base tunnel	no	open	open	open
Brenner /Mont Cenis base tunnel	no	no	open	open
further extensions	none			
UCT service	as 2004			
WL service	as 2004			
RM service	situation 2004	new RM in France (Orbassano-Aiton)		
subsidies AT (UCT and RM)	situation 2004	reduced	abolished	
subsidies CH (UCT and RM)	situation 2004	reduced	abolished	
subsidies F	situation 2004	abolished	abolished	
productivity effects road 2004-2020/30	9.9 tons/HGV average load	12.5 tons/HGV average load	none	
productivity effects rail 2004-2020/30 (due to harmonisation / new investments)	situation 2004	reduced preparation hours, wagon, terminal and headquater costs	no additional productivity effects, same figures as 2020	
productivity effects rail due to new base tunnels	situation 2004	reduced distance, higher cargo speed, reduced time, less locos (traction costs) on GBT; reduced distance and time only on LBT	reduced distance, higher cargo speed, reduced time, less locos (traction costs) on GBT and BBT/MCBT; reduced distance and time only on LBT	
policy instruments (ACE, AETS, TOLL+)	none	none	none	

4.3 Results

4.3.1 Alpine Trade and Traffic Growth: A preliminary note

The two principal data sources providing insight into traffic growth for the transalpine traffic are trade data (COMEXT and national sources) and the Alpinfo data /AQGV survey. In Alpinfo, the recent figures for the Alpine arch “C”, show growth up to 2004, resuming in 2006, reaching a highpoint in 2007, and then a marked downturn in 2009. The 2009 volumes are some 8.2% lower than 2004 and 15.8% lower than the 2007 peak.

On the French routes, despite a background of economic growth, volumes have been falling over the medium term. In 1999, French corridors recorded 49.6 million tonnes, falling to 47.2 million by 2004, followed by recovery to 48.1 million in 2007, and 38.1 million in 2009. Apart from the 2008/9 recession, the recent trend does not exhibit growth.

On the Swiss routes, growth has been steady, albeit from a lower starting point. Between 1999 and 2004, volumes grew from 26.8 million tonnes to 35.4 million, rising thereafter to 39.9 million in 2008, which is so far the high point. In 2009 the volume was 34.2 million. The trend therefore exhibits moderate growth from a relatively low base.

Austrian traffic has also been growing steadily, and also from a higher starting point, so the absolute volume growth accounts for most of the change seen in the Alpine Convention region. With the adjustment made to include the Tarvisio route with the Alpine Arch C, volumes were recorded to grow from 107 million tonnes in 1999 to 133.7 in 2004 and 145.2 in 2008. These volumes dropped back to 124.7 million in 2009.

At face value, therefore the recent traffic flows would suggest a return to moderate growth following the recession period, with highest growth expected on the Central and Eastern routes of the Alpine Arch.

Using the forecasting model to derive growth rates for the traffic flows, and applying these to the AQGV 2004 data, it is possible to break down the forecast volumes according to pairs of trading countries. A selection of the most important country pairs, accounting for 75% of total traffic in the base year is shown below. In each year the volumes and the share of total traffic are visible.

Figure 4-5: Key Trade Origin/Destination-matrix (in Mill. tons)

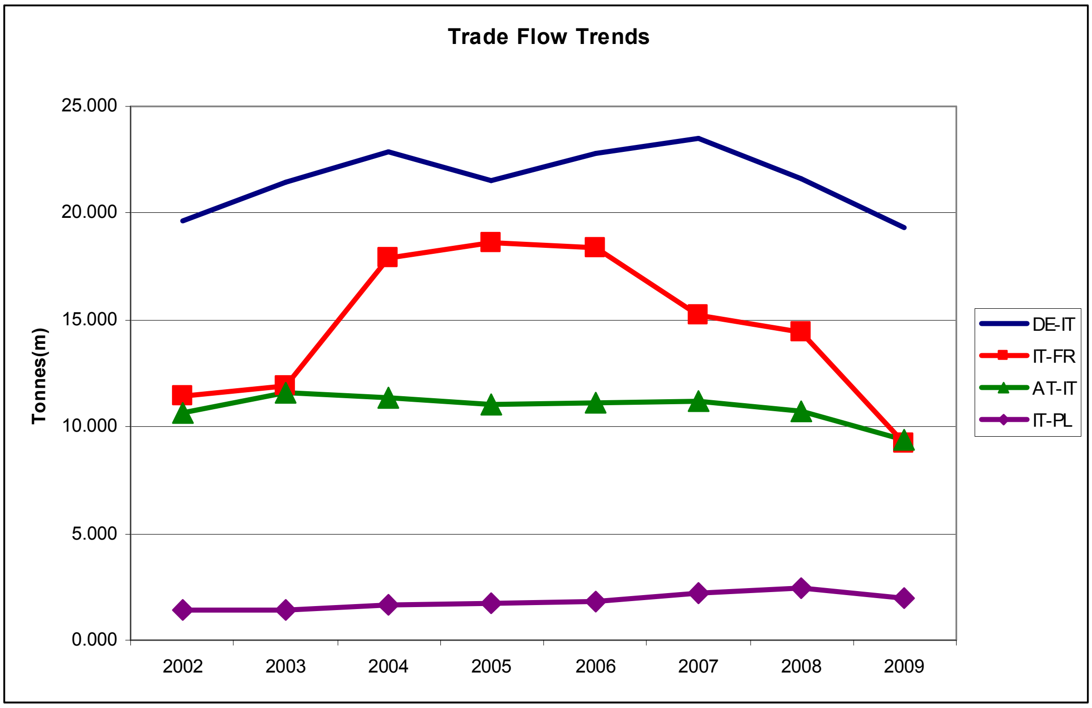
	2004		2020		2030 low		2030 high		30high/04
	Ton (m)	Shares	Ton (m)	Shares	Ton (m)	Shares	Ton (m)	Shares	Growth
DE-IT*	26.1	12%	30.6	12%	25.9	10%	31.1	10%	19%
AT-AT	20.7	10%	26.3	10%	29.3	11%	29.3	9%	42%
IT-DE	19.1	9%	23.0	9%	22.5	8%	27.0	9%	41%
FR-IT	18.1	9%	23.2	9%	21.3	8%	25.6	8%	42%
IT-FR*	13.2	6%	12.3	5%	10.4	4%	12.5	4%	-6%
AT-IT*	13.0	6%	11.4	4%	8.6	3%	10.4	3%	-20%
IT-AT	6.5	3%	7.9	3%	7.0	3%	8.4	3%	29%
BE-IT	5.2	2%	6.0	2%	5.6	2%	6.8	2%	30%
ES-IT	4.6	2%	5.5	2%	5.0	2%	6.0	2%	32%
IT-ES	4.6	2%	4.2	2%	4.0	1%	4.8	2%	4%
NL-IT	4.3	2%	4.1	2%	2.9	1%	3.5	1%	-18%
AT-DE	4.2	2%	5.3	2%	5.4	2%	6.5	2%	55%
DE-AT	3.9	2%	5.9	2%	6.1	2%	7.3	2%	85%
IT-BE	3.4	2%	3.5	1%	3.8	1%	4.6	1%	34%
CH-CH	3.0	1%	3.9	2%	4.3	2%	4.3	1%	44%
PL-IT	2.1	1%	3.6	1%	3.2	1%	3.8	1%	82%
IT-PL*	1.9	1%	4.4	2%	5.3	2%	6.3	2%	222%
CZ-IT	1.8	1%	3.0	1%	3.6	1%	4.3	1%	139%
IT-CZ	1.5	1%	3.4	1%	4.5	2%	5.3	2%	246%
TR-DE	1.1	1%	2.5	1%	3.6	1%	4.4	1%	288%
Total	**158.4**	**76%**	**189.7**	**73%**	**182.5**	**68%**	**212.2**	**68%**	**34%**
Others	50.9	24%	70.0	27%	85.4	32%	101.8	32%	100%
Grand Total	**209.4**		**259.7**		**268.0**		**314.0**		**50%**

The overall pattern is that the share of the largest trade flows diminishes over time from 76% in 2004 to a forecast 68% in 2030 for the higher growth scenario, so that most of the larger country pairs reduce their share over time. Although some of the smaller base year flows are forecast to grow at a rapid rate, they do not overtake the largest country pairs. Most of the re-ordering takes place at the foot of the table. Throughout the time series, the main core of trade relations remains unchanged, revolving around Germany, Italy and France, with Austrian domestic flows also prominent.

Four flows are selected, so that their trade flows between 2002 and 2009 can be compared. They are *asterisked* in the previous table:

- DE-IT: was selected because it is the largest single trade flow, expected to grow by a moderate 19% by 2030. In the following graph it can be seen that this forecast represents a continuation of the trend up to 2007. Also the trade figures (derived from COMEXT) agree well with the AQGV figures in the 2004 column above, i.e. between 22 and 26 million tonnes per annum.
- IT-FR: was selected because it is the largest flow expected to show a net decrease. Historical figures show that volumes peaked in 2005 (before the recession) and that the recent trend has been decreasing, accelerated by the recession. Because 2004 was close to the peak volume for this flow, the traffic must increase quite significantly from the 2009 figure in order to reach the forecast for 2020 and 2030. Note also that the trade volume in COMEXT (18m in 2004) is somewhat higher than the AQGV volume (13m in 2004), even after certain bulk traffics are excluded, suggesting (and it is difficult to conclude the reason) that part of the trade flow moves by sea.
- AT-IT: was selected because it is the largest Southbound flow showing a net decrease. According to the trade figures, this trade flow peaked in 2003 and has streadily decreased up to and including the recession. This pattern is extrapolated into the forecast. Unlike the previous case (IT-FR) the decrease forecast between 2004 and 2020 is based on a steady year on year decrease, and not a slow recovery from a low 2009 figure, hence the difference in the rate of decrease. COMEXT and AQGV agree well for this case, suggesting that the land-based survey captures most of the relevant volume.
- IT-PL: was selected because it is one of the largest flows for which a large relative increase is expected, with volumes expected to treble (from a low base) from 2004. Between 2002 and 2009 the trade flow had been growing rapidly, peaking at 2.6 million tonnes in 2008, close to a 75% increase in six years. Deeper analysis indicates that this growth can be found in most product sectors. Again, the COMEXT and AQGV data validate each other, suggesting that future trade growth expectations might well be translated into traffic volumes across the Alpine Arch.

Figure 4-6: Historical time series of trade data for key Alpine O/Ds.



Source: COMEXT (Eurostat), and consultants' estimates.

Beyond these highlighted examples, the pattern is more uniform, with the majority of O/Ds forecast to grow by 30-40% by 2030 compared to their 2004 levels. In ITREN-2030 (DG-MOVE, 2009), GDP for the EU15 countries, a definition including all of the main Alpine cargo generators was expected to grow by 34% between 2005 and 2030. For the EU12 countries, mainly affecting the Eastern Alpine corridors GDP growth of 95% was forecast. Bearing in mind the mix of traffic, the trade growth figures applied in this study can be seen as comparable. ITREN-2030 is a post-crisis forecast taking into account future raw material shortages, greater degrees of global trade (higher proportions of European trade with Asian countries), a demographic shift towards the non-working population and an economic shift towards service industries. None of these "mega-trend" assumptions immediately suggest Alpine traffic growth, except perhaps the growth of external flows via Italian, Slovenian and Croatian seaports.

4.3.2 Overview of results

The following tables include the results for transalpine freight transport for the base case 2004, BAU 2020 and BAU 2030 (low and high) within Alpine arch C and thus give an overview of the assumed demand for transalpine freight transport in the future and represent the basis for the modeling of the scenarios analyzed in the present study (for the underlying assumptions for the reference cases and the scenarios see chapter 5 and 11). The results are presented in the following way:

- In 1'000 tons/a per Alpine crossing
- Growth from 2004 to the respective BAU scenario in 1'000 tons/a and in %
- Annual growth from 2004 to the respective BAU scenario
- Number of lorries for road and rail

The results for base case 2004 and the BAU scenarios 2020/30 as well as the scenarios to analyze the considered policy instruments in more detail can be found in chapter 12 in the Annex.

With a view on the **whole Alpine arch** the results can be summarized as follows:

- Total transalpine freight transport volume increases from 208 Mill. tons/a in 2004 to 260 Mill. tons/a in 2020 (+25%) and to 268 – 314 Mill. tons/a in 2030 (+29 – +51%, low and high growth) (see Figure 4-7).
- The A – I/SLO corridors (corridors between Austria and Italy / Slovenia) by far have the highest share of total transalpine freight transport for road and rail (see Figure 4-8)
- Annual overall growth rates of transalpine freight transport from 2004 till 2020 and 2030 respectively are highest on CH – I corridors (corridors between Switzerland and Italy), followed by the A – I/SLO corridors (see Figure 4-9). On F – I crossings annual growth rates are clearly lower due to the lower growth of transalpine road freight transport on those corridors (for an explanation for the lower growth rates on F – I corridors see the comments on the respective BAU scenarios further below). Overall, annual growth is noticeably higher on rail than on road crossings (on all corridors). CH – I RM services are decreasing from 2020 till 2030 due to the abolishment of the total amount of subsidies that is paid today.
- In general, growth in transalpine freight transport is higher on the eastern corridors than the western corridors (shifting of the transport relations from west to east). The share of A – I/SLO corridors is increasing while the share of F – I corridors (corridors between France and Italy) is decreasing (road transport).[51] To account for different growth projections we additionally model two BAU scenarios for 2030, one with a lower (annual growth of total transport 2004-2030 is 1.6%) and one with a higher growth rate (annual growth of total transport 2004-2030 is 2.6%).
- The reduction / abolishment of the subsidies leads to a lower or even negative growth for UCT and RM (especially from 2020 – 2030 as there occur no more productivity effects to compensate for the abolishment of the subsidies).

[51] We are aware of the fact that other (perhaps more detailed country specific) forecasts can produce different per country growth rates and forecasts for transalpine freight transport between two countries than the TAMM BAU scenarios do (for the annual growth rates of Alpine crossing transport for the BAU scenarios see Figure 4-9). But with respect to equal methods of forecasting and a similar treatment of all countries the TAMM is based on the iTREN-2030 forecasts throughout the EU (see Schade W. et al. (2010), The iTREN-2030 Integrated Scenario until 2030).

- The total number of lorries on road increases from 11.4 Mill./a in 2004 to 12.5 Mill./a in 2020 (+9%) and 12.9 – 15.1 Mill./a in 2030 (+13% - +32%, low and high growth) (see Figure 4-10).
- The modal split of road in the whole Alpine arch C decreases from approx. 70% in 2004 to approx. 62% in 2020/30.

Figure 4-7: Total transalpine transport volumes base case 2004 and BAU 2020 / 2030 in Alpine arch C

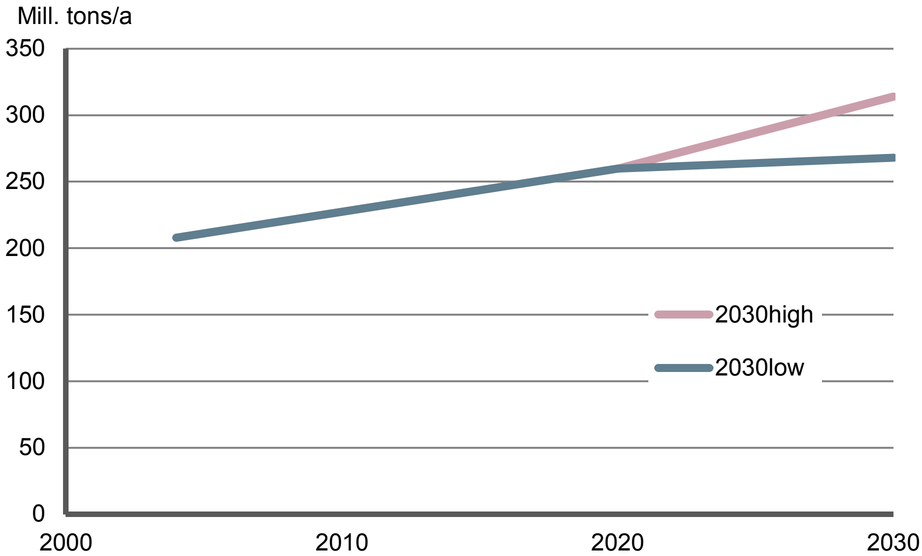


Figure 4-8: Transalpine freight transport for road, UCT, WL and RM in Alpine arch C for base case 2004 and the BAU-scenarios 2020 / 2030

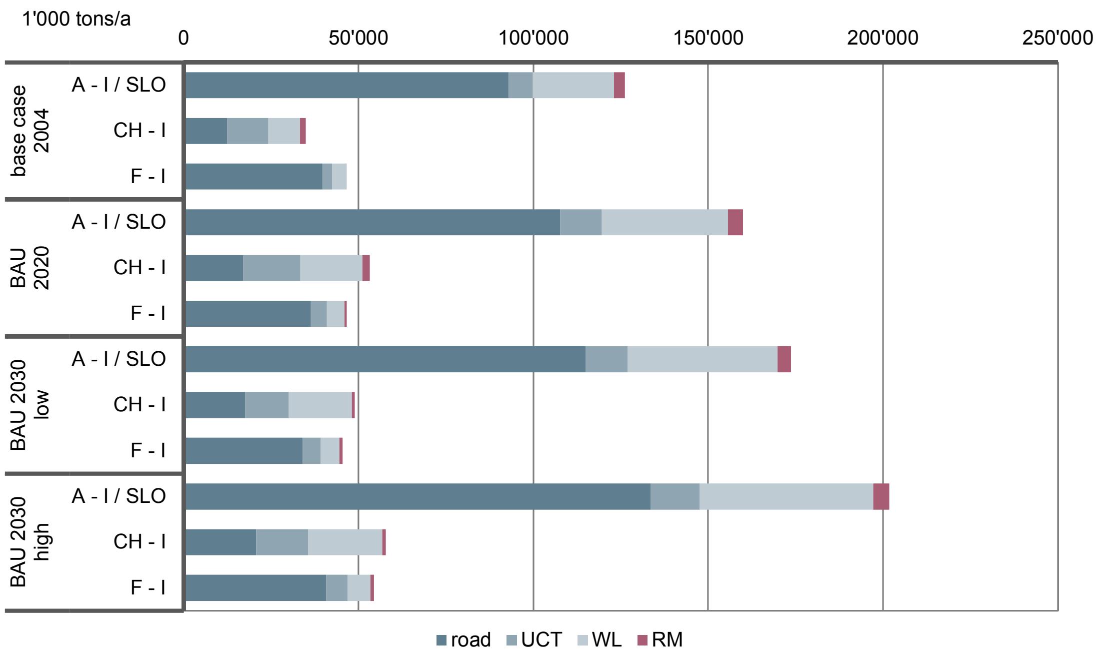


Figure 4-9: Annual growth rates in transalpine freight transport volumes in Alpine arch C 2004-2020, 2004-2030 low and 2004-2030 high

country	rail				road	share	total	share
	UCT	WL	RM	total				
Annual Growth 2004 - 2020								
A - I / SLO	3.5%	2.8%	2.0%	2.9%	0.9%		**1.5%**	
CH - I	2.1%	4.3%	1.3%	3.0%	2.0%		**2.7%**	
F - I	3.4%	1.2%		2.5%	-0.5%		**0.0%**	
total	**2.7%**	**3.0%**	**2.3%**	**2.9%**	**0.7%**		**1.4%**	
Annual Growth 2004 - 2030low								
A - I / SLO	3.6%	3.9%	1.3%	3.6%	1.3%		**2.0%**	
CH - I	0.3%	4.4%	-5.0%	2.1%	2.2%		**2.1%**	
F - I	4.3%	1.4%		3.2%	-1.0%		**-0.2%**	
total	**2.1%**	**3.8%**	**0.8%**	**3.1%**	**0.9%**		**1.6%**	
Annual Growth 2004 - 2030high								
A - I / SLO	4.7%	4.8%	2.5%	4.6%	2.3%		**3.0%**	
CH - I	1.4%	5.5%	-3.9%	3.2%	3.3%		**3.2%**	
F - I	5.5%	2.6%		4.3%	0.2%		**1.0%**	
total	**3.2%**	**4.8%**	**2.0%**	**4.1%**	**1.9%**		**2.6%**	

Figure 4-10: Number of Lorries in transalpine freight transport for road and RM in Alpine arch C 2004, 2020 and 2030 (low and high) , in 1'000 HGV

road				
base case / BAU **country**	**base case 2004**	**BAU 2020**	**BAU 2030 low**	**BAU 2030 high**
number of lorries				
A - I / SLO	7'325	8'485	9'055	10'512
CH - I	1'258	1'361	1'410	1'662
F - I	2'818	2'583	2'413	2'893
total	**11'401**	**12'429**	**12'878**	**15'067**
in % of base case 2004				
A - I / SLO	100%	116%	124%	144%
CH - I	100%	108%	112%	132%
F - I	100%	92%	86%	103%
total	**100%**	**109%**	**113%**	**132%**

rolling motorway				
base case / BAU **country**	**base case 2004**	**BAU 2020**	**BAU 2030 low**	**BAU 2030 high**
number of lorries				
A - I / SLO	185	238	214	255
CH - I	99	113	41	49
F - I	-	32	48	58
total	**285**	**383**	**303**	**362**
in % of base case 2004				
A - I / SLO	100%	129%	115%	138%
CH - I	100%	114%	41%	50%
F - I				
total	**100%**	**135%**	**107%**	**127%**

4.3.3 Base case 2004

Figure 4-11 shows the transalpine freight transport volume for 2004. Compared with the original data of the census AQGV 2004, the base case 2004 corresponds to a very good reproduction of the transalpine freight traffic (the shares of the several corridors are virtually unchanged and the total traffic volume is only around 1% lower; AQGV 2004: 209.91 Mill. tons p.a.).[52]

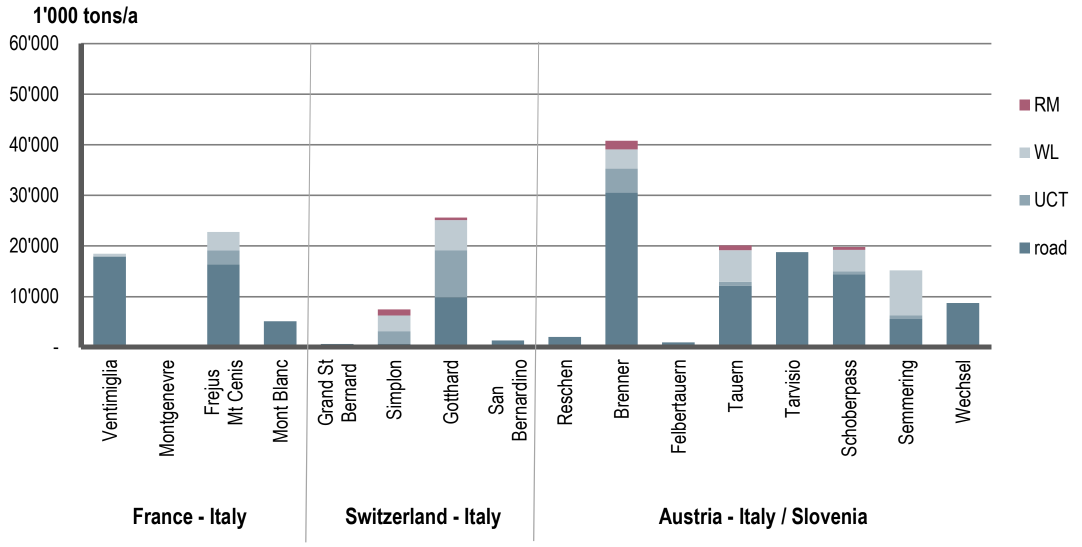
Overall, 30% of the total freight transport volumes are transported on rail, 70% on road. Within rail, 10% are transported with UCT, 17% with WL and 2% with RM. However, the modal splits differ between the countries with Alpine crossing corridors (France – Italy, Switzerland – Italy, Austria – Italy / Slovenia): Whereas the share of road on the A – I/SLO (corridors between Austria and Italy / Slovenia) and F – I crossings (corridors between France and Italy) is 74% and 85% respectively, on the CH – I crossing (corridors between Switzerland and Italy) it is only 36%.

The number of lorries on road amount to 7.3 Mill./a on A – I/SLO, 1.3 Mill./a on CH – I and 2.8 Mill./a on F – I crossings (total of 11.4 Mill./a, see Figure 4-10). With RM only around 285’000 HGV are transported through the Alps (A – I/SLO and CH – I corridors only).

Furthermore, Figure 4-11 shows the transalpine freight transport volumes on the different corridors (from East to West). Thereby, the Brenner corridor clearly sees the highest volume with more than 40 Mill. tons/a. Moreover, one can see the relative high significance of the Swiss corridors for transalpine rail freight transport.

52 See Crossalpine Freight Transport Data Base for the year 2004 (CAFT 04).

Figure 4-11: Base case 2004: Transalpine freight transport 2004 in Alpine arch C, in 1'000 tons/a



country / corridor	rail				road	share of road	total	share of total
	UCT	WL	RM	total				
A - I / SLO	6'808	23'242	3'111	33'162	93'029	73.7%	**126'191**	60.7%
Reschen	-	-	-	-	1'987	100.0%	**1'987**	1.0%
Brenner	4'750	3'848	1'622	10'220	30'539	74.9%	**40'759**	19.6%
Felbertauern	-	-	-	-	907	100.0%	**907**	0.4%
Tauern	794	6'222	959	7'974	12'109	60.3%	**20'083**	9.7%
Schoberpass	599	4'260	530	5'389	14'408	72.8%	**19'797**	9.5%
Semmering	665	8'913	-	9'578	5'581	36.8%	**15'160**	7.3%
Wechsel	-	-	-	-	8'740	100.0%	**8'740**	4.2%
Tarvisio	-	-	-	-	18'758	100.0%	**18'758**	9.0%
CH - I	11'819	9'018	1'669	22'507	12'453	35.6%	**34'959**	16.8%
Gr. St. Bernard	-	-	-	-	595	100.0%	**595**	0.3%
Simplon	2'525	3'045	1'204	6'773	668	9.0%	**7'441**	3.6%
Gotthard	9'294	5'973	466	15'734	9'868	38.5%	**25'602**	12.3%
San Bernardino	-	-	-	-	1'321	100.0%	**1'321**	0.6%
F - I	2'653	4'274	-	6'927	39'740	85.2%	**46'667**	22.5%
Mont-Blanc	-	-	-	-	5'112	100.0%	**5'112**	2.5%
MtCenis/Fréjus	2'645	3'737	-	6'381	16'417	72.0%	**22'798**	11.0%
Montgenerve	-	-	-	-	331	100.0%	**331**	0.2%
Ventimigla	8	537	-	545	17'880	97.0%	**18'425**	8.9%
total	**21'280**	**36'534**	**4'780**	**62'595**	**145'222**	**69.9%**	**207'817**	100.0%
share	10.2%	17.6%	2.3%	30.1%	69.9%		100.0%	

4.3.4 BAU-scenarios

a) 2020

Figure 4-12 presents the expected transalpine freight transport volumes for 2020 (BAU 2020). From 2004 till 2020 the total annual freight volumes increase by 25% (52 Mill. tons/a, see also Figure 12-4 and Figure 12-5 in the Annex). For the transalpine corridors the TAMM predicts a growth of 27% on A – I/SLO, 52% on CH – I and 0% on F – I crossings. The share of road decreases 7% on A – I/SLO and F – I and 4% on CH – I corridors. Overall, the modal split of road decreases from 70% to 62%. The reasons for the higher growth on rail modes are the assumed productivity effects for rail freight transport from 2004 till 2020, which outweigh the opposite acting reduction of subsidies for UCT and RM. On the CH – I corridors the additional **productivity effects due to the new Gotthard base tunnel** even outweigh the additional negative effects for rail due to the allowance of 40 tons HGV (2004 only 34 tons HGV were allowed on CH – I corridors). Therefore, the increase of rail freight transport is highest on CH – I corridors with 61%, followed by the A – I/SLO with 57% and the F – I corridors with 49%.

However, the main reason for the clearly lower growth of total freight transport volumes on the F – I corridors are not only the higher productivity effects on CH – I rail corridors, but additionally also the **productivity effects on CH – I road corridors (higher average load due to the allowance of 40 tons HGV)**. Therefore, all CH – I road crossings see a clear increase in transport volumes, whereas the neighboring F – I and to a lower extent also the Western A – I/SLO road corridors observe a decrease in road transport volumes (see the middle part of Figure 4-12).[53] The same reasons hold true for the 2030 BAU scenarios.

The number of transalpine lorries on road within Alpine arch C amount to around 8.5 Mill./a on A – I/SLO, 1.4 Mill./a on CH – I and 2.6 Mill./a on F – I crossings, which represents an overall increase of 9% (total of 11.4 Mill./a, see Figure 4-10). With RM only around 383'000 HGV are transported through the Alps (including the French-Italian RM).

Regarding the different Alpine corridors, especially the CH – I[54] and even more the Eastern A – I/SLO corridors observe an increase of road freight transport (for an explanation see above), whereas the increase of rail freight transport is distributed more evenly among the corridors (with the exemption of the Gotthard corridor, which sees an increase of more than 12 Mill. tons compared to 2004, as a consequence of the opening of the new Gotthard base tunnel line).

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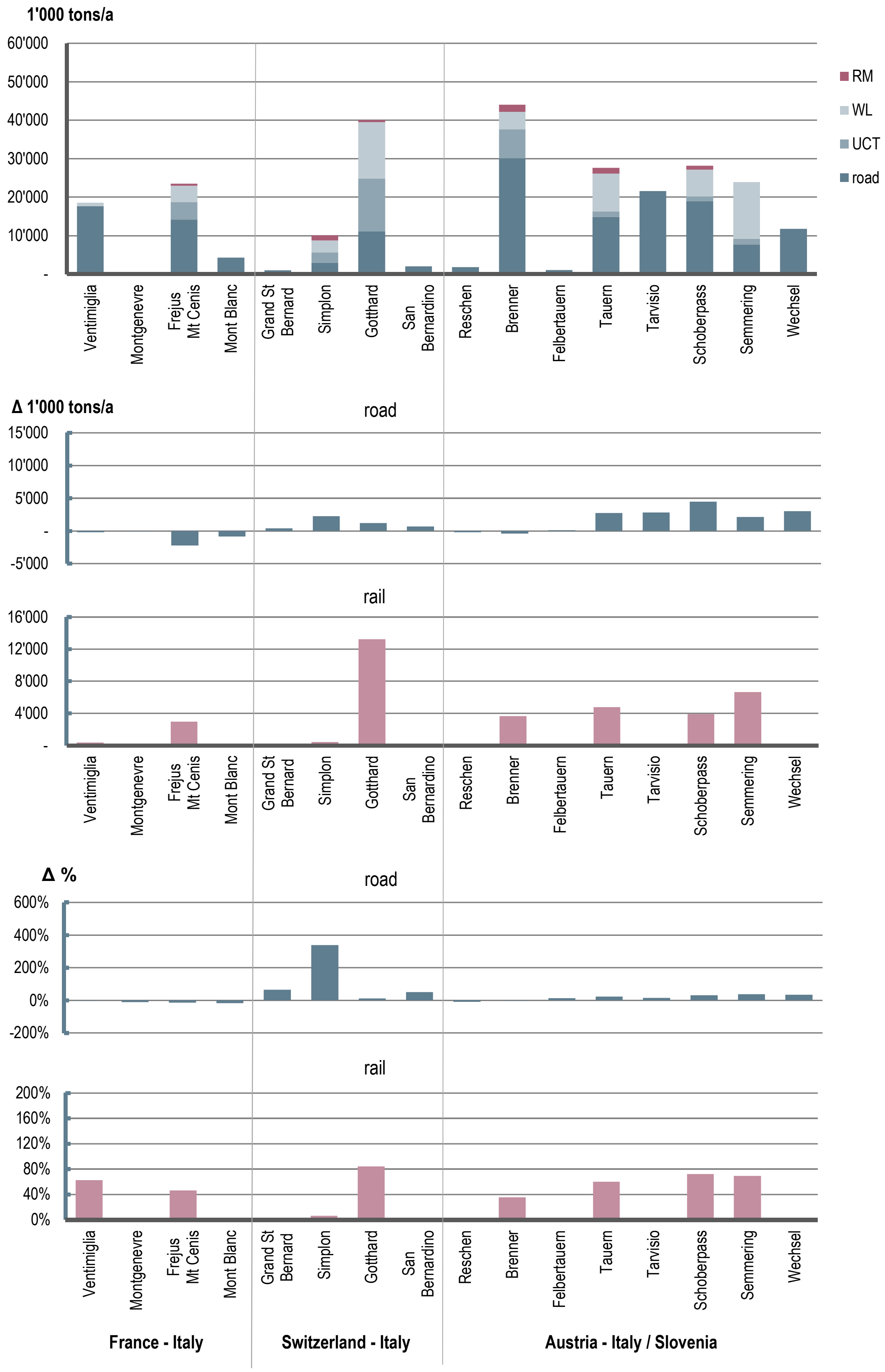
[53] The reason for the unusual high growth on the Simplon corridor has to do with the route choices underlying the TAMM. In fact, it seems more realistic that this growth will partly occur on the Grand St. Bernard instead of the Simplon corridor.

[54] Regarding the growth of transalpine road freight transport at the Simplon mountain pass it has to be said that the predicted growth on this corridor in TAMM tends to be too high as the road infrastructure is not build for such an increase in traffic (e.g. small roads, closed in winter time). But such factors cannot be taken into accout by the model.

Figure 4-12: BAU 2020: Transalpine freight transport 2020 in Alpine arch C, in 1'000 tons/a, Δ 2004-2020 in 1’000 tons/a and Δ 2004-2020 in %



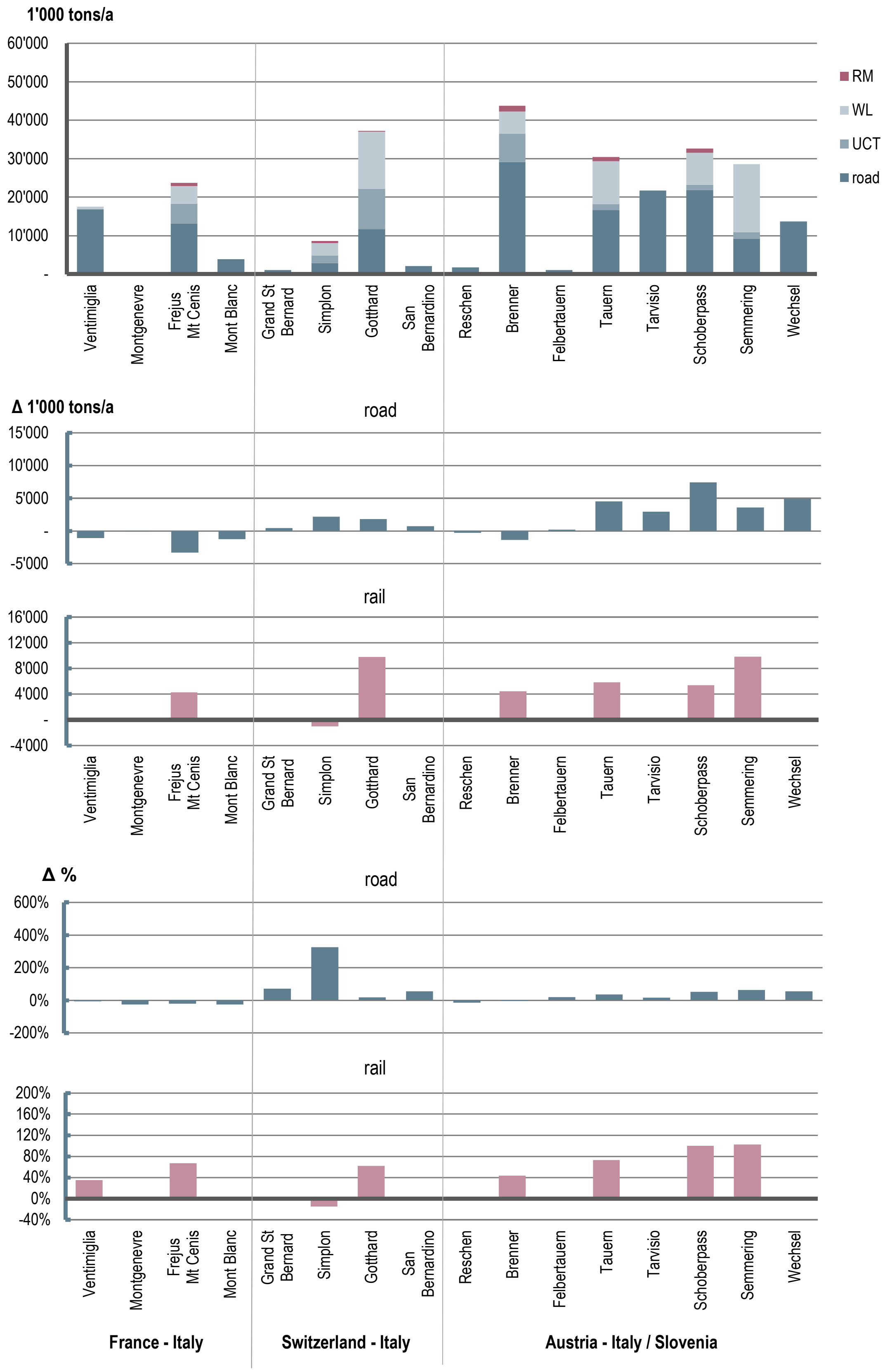
b) 2030 low

Figure 4-13 shows the expected transalpine freight transport volumes for BAU 2030 low. From 2004 till 2030 the total annual freight volumes increase by 29% (60 Mill. tons/a, see also Figure 12-6 and Figure 12-7 in the Annex). For the transalpine corridors the TAMM predicts a growth of 38% on A – I/SLO, 40% on CH – I and -3% on F – I crossings. The share of road decreases 8% on A – I/SLO, 10% on F – I and is virtually unchanged on CH – I corridors. Overall, the modal split of road decreases from 70% to 62%. The reason for the lower growth on CH – I crossings (compared to BAU 2020) is the abolishment of subsidies for UCT and RM in 2030 which leads to a reduction of rail freight transport. Therefore, the shares of rail are increasing on A – I/SLO and F – I corridors. Road shares on F – I and Western A – I/SLO corridors are decreasing due to the reason already explained in the previews chapter for BAU 2020 (allowance of 40 tons HGV on CH – I corridors in 2020).

The number of transalpine lorries on road amount to around 9.1 Mill./a on A – I/SLO, 1.4 Mill./a on CH – I and 2.4 Mill./a on F – I crossings, which represents an overall increase of 13% (total of 12.4 Mill./a, see Figure 4-10). With RM only around 303'000 HGV are transported through the Alps (lower than in 2020 due to the abolishment of the subsidies for UCT and RM).

Regarding the different Alpine corridors, as in 2020 especially the Eastern A – I/SLO and to a lower extent the CH – I corridors observe an increase of road freight transport (for an explanation see above), whereas the increase of rail freight transport is distributed more evenly among the corridors. The reduction of rail freight volumes on the Simplon corridor can be explained by the abolishment of the subsidies for transalpine rail freight transport. Additionally, the productivity effect of the new Lötschberg base tunnel is much lower than on the other corridors with new base tunnels (Gotthard, Brenner, Mont Cenis).

Figure 4-13: BAU 2030 low: Transalpine freight transport 2030 in Alpine arch C, in 1'000 tons/a, Δ 2004-2030 in 1'000 tons/a and Δ 2004-2030 in %



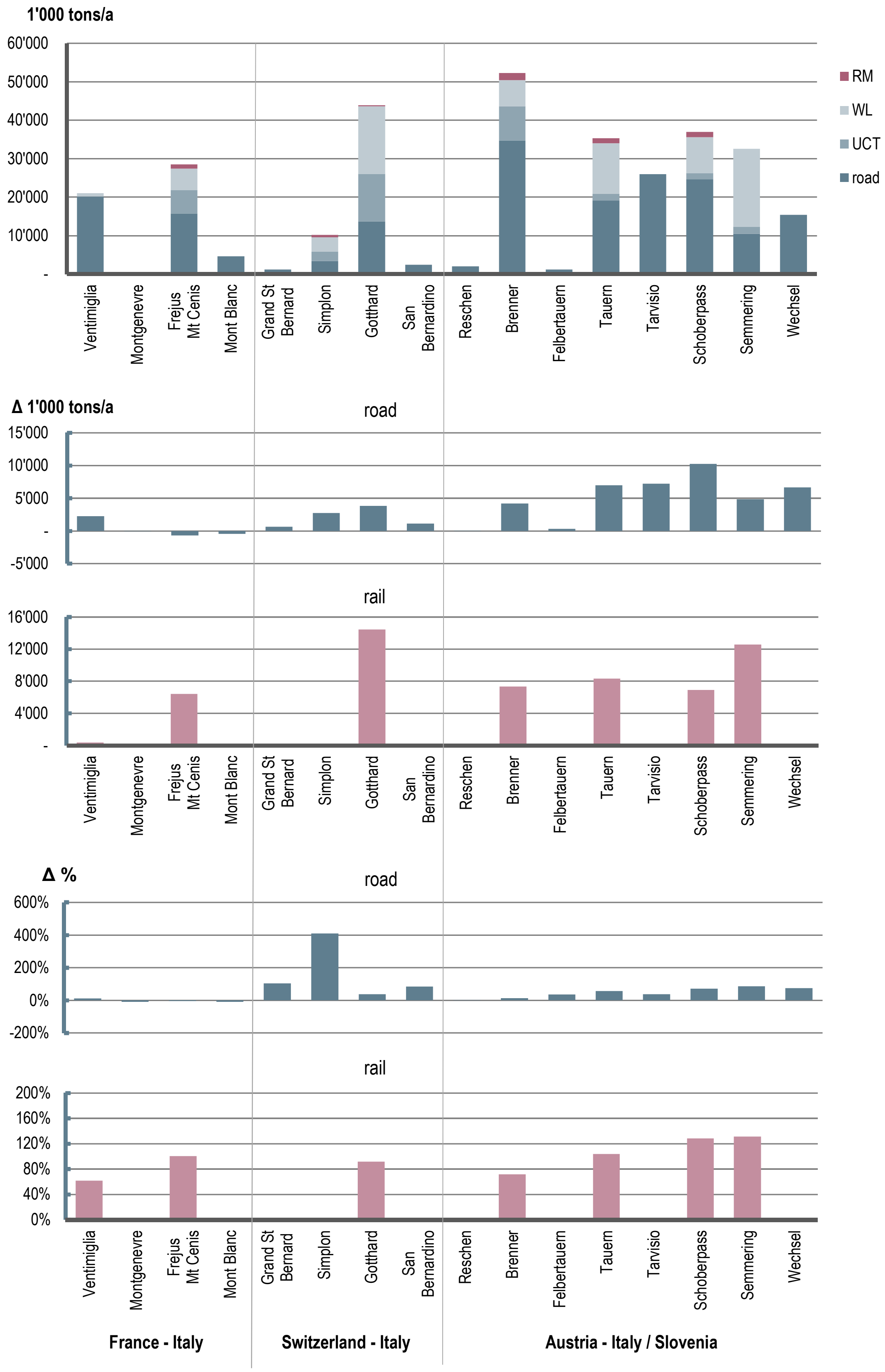
c) 2030 high

BAU 2030 high has a similar pattern of growth and shares as BAU 2030 low (see the more detailed explanations above). Figure 4-14 presents the expected transalpine freight transport volumes for BAU 2030 high. From 2004 till 2030 the total annual freight volumes increase by 51% (106 Mill. tons/a, see also Figure 12-8 and Figure 12-9 in the Annex). For the transalpine corridors the TAMM predicts a growth of 44% on A – I/SLO, 67% on CH – I and 17% on F – I crossings. The share of road decreases 8% on A – I/SLO, 10% on F – I and is virtually unchanged on CH – I corridors. Overall, the modal split of road decreases from 70% to 62%. Total road shares on F – I and Western A – I/SLO corridors are now increasing compared to BAU 2030 low due to the higher overall growth in transalpine freight transport (see also the explanation for BAU 2030 low above).

The number of transalpine lorries on road amount to around 10.5 Mill./a on A – I/SLO, 1.7 Mill./a on CH – I and 2.9 Mill./a on F – I crossings, which represents an overall increase of 32% (total of 15.1 Mill./a, see Figure 4-10). With RM only around 362'000 HGV are transported through the Alps (lower than in 2020 due to the abolishment of the subsidies for UCT and RM).

Regarding the different Alpine corridors, as in 2020 especially the Eastern A – I/SLO and to a lower extent the CH – I corridors observe an increase of road freight transport, whereas the increase of rail freight transport is distributed more evenly among the corridors.

Figure 4-14: BAU 2030 high: Transalpine freight transport 2030 in Alpine arch C, in 1'000 tons/a, Δ in 1'000 tons/a and Δ in % 2004-2030



5 Thresholds

5.1 Criteria to define thresholds

5.1.1 Definition of criteria

The three policy measures Alpine Crossing Exchange (ACE), Alpine Emission Trading System (AETS) and TOLL+ all aim at limiting road freight transport and shifting transport activities to rail. It is one of the aims of this study to analyse the effects the different policy measures have (in part III). To this end, operable thresholds for the three policy measures have to be defined. In this chapter we define thresholds, i.e. caps for the number of trucks (ACE), caps for the amount of emissions (AETS) and toll levels (TOLL+).

To select reasonable thresholds for the three policy measures, criteria have to be defined which the thresholds should fulfill. We differentiate between the following criteria:

- Capacity oriented criteria:
  - Physical capacity of existing and planned road and rail infrastructure: The initial limiting factor for traffic is the physical capacity of a road or tunnel which is determined by different factors such as the amount of existing road traffic lanes, the amount of available railway lines per day as well as the amount of individual traffic on the considered link.
  - Safety restrictions such as the maximum speed and the traffic separation (density) may restrict the maximum allowed traffic flow on a road and especially in road tunnels (e.g. “Tropfenzählersystem” (drop counter system) on the Gotthard corridor).
- Politically oriented criteria:
  - Objectives with respect to modal shift: The available capacity of transalpine road freight transport is restricted in order to achieve politically determined modal split targets. The most important example is the Swiss Constitution which asks in article 84 for a policy of shifting transalpine freight transport from road to rail. The implementation of this article is described more precisely in the so called “Güterverkehrsverlagerungsgesetz” (freight transport shift law), which limits the number of lorries passing one of the four main Swiss Alpine road corridors to 650’000 per year. This aim has to be reached from 2019 onward, i.e. two years after the opening of the new Gotthard railway base tunnel.
  - Provide attractive rail services, especially for transalpine freight transport and therefore support unaccompanied combined transport and the rolling motorway.
  - Emission targets: Targets with respect to noise, air pollution or greenhouse gases do have an influence on demand and the available capacity (e.g. night ban for heavy goods vehicles in Switzerland or speed limits on motorways in Austria during night time).
  - Political framework: Existing weight limits, freight traffic laws (night time and Sunday driving bans etc.) as well as road charges and tolls.

- Fairness criteria:
  - The thresholds have to be “fair” which means that all Alpine corridors should be treated equally. Especially, perverse incentives causing detour traffic between countries and Alpine corridors should be averted as far as possible. Thus the prices on all Alpine corridors should be equal unless there are scientifically based reasons to deviate from equality.
  - Special solutions have to be found for strongly affected transport categories. In particular, exemptions for short distance transport have to be considered. These exemptions are of great importance when putting the systems into practice. They are considered in more detail in chapter 6.

The concepts of an Alpine Crossing Exchange, the Emission Trading System and TOLL+ have been developed in different countries (ACE in Switzerland, AETS in Austria and TOLL+ in France) on the basis of their national transport policy. Although the nature of the ACE, the AETS and TOLL+ originates from different national transport policies they have an important commonality: The management of the transalpine road freight traffic is based on individual “rights” to pass an Alpine corridor. These passage rights are mandatory for every vehicle passing a waypoint or section of the Alpine corridor and can be purchased by paying a certain “currency”. The basic difference in the three instruments is the required “currency” for the purchase of the passage right.

5.1.2 Thresholds for corridors, countries or the whole Alpine arch?

An important question when defining thresholds is whether it is reasonable to define one threshold for the whole Alpine arch, three thresholds for the different countries (France, Switzerland and Austria) or a threshold for each Alpine corridor. In the following the advantages and disadvantages of these three possibilities are discussed. We first turn to the question of three thresholds (one per country) or one threshold for the whole Alpine arch.

Advantages of thresholds per country (instead of for the whole Alpine arch):

- The local, specific conditions can be better taken into account, e.g exemption rules for local and short distance traffic.
- With its own threshold each country keeps more sovereignty, i.e. it has more influence on the transport flows in its own territory as changes are more easily feasible. It also allows countries to select slightly different levels of stringency (although too different levels should not be chosen due to fairness considerations).
- If one country introduces a new policy measure or changes its level (e.g. lower or higher tolls), this has a more direct effects on the other countries when there is only one threshold. The neighbours will oppose this.
- If the actual effects of a new threshold are not as expected, there is more room for quick adjustments.
- The three countries currently have very dissimilar modal splits (in particular, the rail share in Switzerland is much higher). If only one threshold was chosen, these differences cannot be sufficiently taken into account.

- Explicit policy aims in one country (e.g. the maximum of 650'000 lorries per year through Switzerland) are difficult to reach with only one threshold for the whole Alps.
- The successful achievement of a given road transport threshold, particularly under a more restrictive scenario, depends upon the availability of suitable alternatives, especially RM. The perception of the "correct" balance of road and RM shares may differ per country, depending upon available capacities, and the rate at which RM can be expanded.

Disadvantages of thresholds per country (instead of for the whole Alpine arch):

- One threshold assures that the price for an "Alpine crossing permit" is identical in all countries. This can be considered as very fair as no detour traffic will ensue.
- If one aims at a shift of transalpine freight transport from road to rail one single threshold is enough.
- When "Alpine crossing rights" are traded on a market, only one market is necessary (instead of three). This might allow saving costs of implementation and operation.
- Potentially, each haulage company needs to purchase permits for each country, in order to allow short term route changes to be made, if for example, the return trip destination is changed. Instead of simply predicting the number of permits required per time period, the operator also has to predict the routing.
- In case of the AETS the instrument aims at reducing a global pollutant (CO_2). Therefore an efficient way of doing so is using one threshold for the whole Alpine arch.

Conclusion

Due to these advantages and disadvantages we conclude that a solution with one threshold per Alpine country has to be preferred to one single threshold for the whole Alpine arch – with the exception of the AETS, which focuses on a global pollutant. It might be interesting to compare the effects of three different thresholds with the one single equivalent threshold (e.g. an ACE or an AETS with thresholds A, B and C in the three countries compared to a combined threshold of A+B+C).

Next, we discuss whether it makes sense to define thresholds for each Alpine corridor.

Advantages of thresholds per corridor (instead of per country):

- The local, specific conditions can be taken into account. In France, it might make sense to have a different price level and price differentiation for the Ventimiglia corridor (at the border of the Mediterranean) compared to the typical Alpine corridors Fréjus, Mont Blanc and Mongenevre. In Austria, there are Alpine corridors outside the considered Alpine arch B+ where no additional policy measure is implemented. It is expected that some traffic will be rerouted to these unpriced corridors. Therefore it might make sense to lower the price level towards the east in order to lower the incentives for a detour (this will, however, lead to some detours within the priced corridors).
- If the aim of the higher prices is to internalise external costs, the prices should in principle be different between the different corridors as the external costs depend on the local con-

ditions (frequency of inversions, profile of the valleys, predominant wind directions, location of villages and cities along the corridor etc.).[55]

Disadvantages of thresholds per corridor (instead of per country):

- If Alpine crossing permits are only valid for one single corridor, the market where the permits are traded is not large enough (especially for the smaller corridors).
- Very differentiated price levels are difficult to comprehend. Furthermore, they urge firms to plan their journey in great detail to be able to buy the right amount of permits. It is also possible that detours are accepted in order not to be forced to sell a permit for one crossing and buy one for another.
- Implementation and operation costs would be higher.
- To reach a certain target for modal shift it is not necessary to differentiate thresholds per corridor.
- The definition of corridor specific thresholds is often difficult to justify as many data are not available for single corridors (especially external costs).

The first two disadvantages are in our view No-Go-criteria for the ACE (and AETS). With tolls these problems are much smaller.

Conclusion

To simplify the analysis, we will not consider corridor specific thresholds in the following. Corridor specific thresholds are only plausible for TOLL+. In the actual implementation of TOLL+ some corridors will possibly be higher or lower priced, if the necessary data and reasons for the differentiation are available.

5.2 Proposal for „restrictive“ and „tolerant” thresholds

5.2.1 Overview of Scenarios

The main scenarios to be analysed are the following:

- Alpine Crossing Exchange (ACE) on whole Alpine Arch B+
- Emission Trading System (ETS) on the whole Alpine Arch B+
- TOLL+ on the whole Alpine Arch B+

For most of these three scenarios we will define a more restrictive and a more tolerant variant. In the more restrictive case the thresholds are more binding, so that less trucks or truck emissions are allowed (ACE and AETS) or road transport charges are higher (TOLL+). For

[55] However, because of partly missing data it is difficult to calculate external costs along the whole corridor as a basis for higher prices.

the purpose of this study we assume that there will be no changes in the existing road tolls due to the introduction of new instruments (i.e. an ACE, AETS or TOLL+ would be introduced on top of the existing mechanisms).

Furthermore, the analysis will be done for 2020 and 2030, so that it must also be considered whether or not thresholds should be adjusted over time.

When deriving thresholds for the different scenarios we will not differentiate between low and high growth rates.

Before deriving the thresholds possible additional scenarios are shortly discussed:

- It is also possible that the three countries introduce different policy measures, but that the introduction and the choice of the thresholds are coordinated. Due to the political framework and the history of transport policy it seems most plausible to assume that on Swiss-Italian corridors an ACE will be introduced, on Austrian-Italian/Slovenian corridors an AETS and on French-Italian corridors a TOLL+ system. With three different policy measures the costs of implementing the measures might be higher than with only one single measure. Furthermore, the three measures do not have exactly the same incentives, so that some detour traffic is possible:
  - The most polluting trucks will tend to drive through Switzerland (instead of Austria) while the least polluting prefer passing through Austria. Thus, HGVs crossing Switzerland will tend to be more polluting that those crossing Austria.
  - Trips which would be crossing the French-Italian corridors during highly priced peak time will tend to detour through Switzerland. On the other hand, trips outside peak hours will tend to use lower priced French-Italian corridors. Hence, HGVs crossing Switzerland will tend to come at the least convenient, congested time intervals.
- The ACE is normally defined as a limit for the number of HGVs allowed to cross the Alps. A variant would be that not the **number** of HGVs is limited, but the **tonnage** transported through the Alps, i.e. the maximal allowed gross vehicle weight.[56] This has the advantage that short distance traffic is less affected by the new policy instrument as short distance traffic is mostly done with smaller vehicles than long-distance traffic. The disadvantage is that the number of HGVs crossing the Alps is not directly limited. As the overall tonnage is a good proxy for the total CO_2 emissions we can reject this variant and postulate that it is covered by the AETS.
  Another possible solution would be to limit the number of HGVs and to differentiate the price of an Alpine Crossing Permit according to weight categories. This would again affect short distance traffic much less than long-distance traffic. Again, the AETS is already a system that is very close to such a solution as CO_2 emissions are very closely related to the weight of a lorry.

[56] In principle, we might want to limit the tonnage of the transported freight or of the actual HGV. In practice, this is hardly possible as this would mean that each HGV has to be weighted when crossing the Alps. Therefore, a practical solution is to limit the maximal allowed gross vehicle weight which is well known and independent of the actual vehicle weight.

- As discussed in section 5.1.2 a further scenario could be the introduction of one single threshold for the whole Alpine arch (B+), instead of three thresholds for the three countries.

Conclusion: It would be interesting to analyse a combined scenario ACE-AETS-TOLL+ or the difference between a single threshold for the whole Alps and country specific thresholds, but at the same time the number of scenarios should be kept at a reasonable level.

5.2.2 Deriving thresholds

a) ACE thresholds (ACE^R_{2020}, ACE^R_{2030}, ACE^T_{2020}, ACE^T_{2030})

The Swiss “Güterverkehrsverlagerungsgesetz” (freight transport shift law) is a starting point for the definition of a threshold: The law aims at shifting freight traffic from road to rail and contains a threshold of 650’000 HGVs per year crossing the Swiss Alps. As the current number of HGVs is about double this amount, the threshold is restrictive.

Since this threshold is political, it is impossible to define a scientifically based threshold for a more tolerant variant of the ACE. In several studies,[57] a more tolerant version for the ACE has used a threshold of 900’000 HGVs. With this threshold the shift from road to rail is about half as large as with the restrictive threshold. This threshold is also used in this report. And as a rule of thumb we can conclude that the tolerant variant should correspond to approximately half the reduction of the restrictive variant.

For Austria and France, no political aims are available to determine possible ACE-thresholds.[58] Therefore we propose to derive the thresholds from the Swiss threshold. Two possibilities exist:

- If road freight transport has to be reduced by X% in Switzerland, the same percentage of the road freight transport reduction is used in the other two countries.
- If X% of total freight transport is shifted from road to rail in Switzerland, the same percentage of total freight transport reduction is used in the other two countries.

Since the Swiss share of road freight transport is much smaller than in Austria and France the second version leads to much less restrictive thresholds.[59]

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[57] Ecoplan, NEA (2009), Case Study Alpine Crossing and Ecoplan / NEA (2010), Auswirkungen verschiedener Varianten der Alpentransitbörse.

[58] In France there is an aim to increase rail freight by 25% between 2008 and 2012 (Alpifret (2009), Observatoire des Trafics Marchandises Transalpins, p. 47). But since rail only has a share of about 15% of total freight traffic through the French Alps, this only calls for a relatively small reduction in road traffic of less than 4% of total freight traffic. Moreover, no aims for 2020 or 2030 are available.

[59] The Swiss share of road transport is about one third and since the restrictive threshold calls for about halving road freight transport, this means that road transport in Austria and France must either be halved or that one sixth of total traffic must be shifted to rail. As Austrian and French road shares are about 75% and 85%, this means that these shares must be reduced to either 37.5% and 42.5% or to about 58% and 68%. The difference between these two possibilities is large as the second possibility calls for a reduction which is only less than half as large.

However, Ecoplan and NEA[60] have shown that the first possibility leads to similar prices per Alpine crossing permit on A – I/SLO, F – I and CH – I crossings (actually the Swiss price lies in between the French and Austrian price). Since the second possibility leads to much less restrictive thresholds on A – I/SLO and F – I corridors it is to be expected that the second possibility leads to considerably lower prices in Austria and France. This would violate our fairness criterion for the definition of thresholds (see section 5.1.1) and lead to considerable detour traffic. Therefore we propose to use the first possibility to transfer the Swiss threshold to Austria and France. This transfer method is used for both the restrictive and the tolerant version of the Swiss thresholds.[61]

Finally, it has to be discussed whether the threshold changes between 2020 and 2030. The Swiss "Güterverkehrsverlagerungsgesetz" calls for a maximum of 650'000 HGVs after 2018. No change over time is prescribed. There is also no obvious reason why the threshold should be changed over time.[62, 63]

b) AETS thresholds ($AETS^{R}_{2020\ A+CH+F}$, $AETS^{R}_{2030\ A+CH+F}$, $AETS^{T}_{2020\ A+CH+F}$, $AETS^{T}_{2030\ A+CH+F}$)

The principal aim of the AETS is to reduce CO_2-emissions in the Alpine area. The threshold is therefore clearly politically oriented and there is no obvious scientifically correct threshold. Nevertheless, we need to determine a reduction target for CO_2-emissions from freight transport for 2020 and for 2030 for the restrictive and the tolerant version of the AETS. In order to do so it is helpful to consider different targets for greenhouse gas reductions:

- The 20-20-20-target of the EU involves a reduction of 20% of greenhouse gas emissions until 2020 compared to 1990 (and a 20% share of renewable energy). To reach this aim the emission trading system (EU ETS) has started operation in 2005.[64] However, transport is not part of the EU ETS. In sectors not covered by the ETS – such as buildings, transport, agriculture and waste – emissions are to be reduced by an average of 10% below 2005 levels by 2020.[65] In principal, there are also individual targets for each Member State.[66]

[60] Ecoplan / NEA (2010), Auswirkungen verschiedener Varianten der Alpentransitbörse.

[61] Since the rule to transfer the limit from Switzerland to Austria and France would lead to different thresholds for the low and high growth BAU-scenarios we calculate the thresholds for the BAU high growth in Austria and France (based on the percentage reduction of road transport in Switzerland) and use the same absolute thresholds for BAU low growth.

[62] Of course, the introduction should be gradual, with a steady and predictable reduction of the threshold until the final aim is reached.

[63] Since the rule to transfer the limit from Switzerland to Austria and France would lead to different thresholds in 2020 and 2030 we calculate the threshold for 2020 and use the same threshold for 2030.

[64] EU-Homepage (http://ec.europa.eu/environment/climat/emission/index_en.htm 19.8.2010).

[65] EU-Homepage (http://ec.europa.eu/environment/climat/campaign/actions/whatiseudoing_en.htm 19.8.2010).

[66] EU-Homepage (http://ec.europa.eu/environment/climat/campaign/actions/euinitiatives_en.htm 19.8.2010).

- France has stated the aim of reducing greenhouse gases by 20% between 2008 and 2020.[67] However this target is not linked to the EU, but to the French policy of reducing long-distance road freight transport.
- The EU is willing to reduce greenhouse gases even by 30% instead of 20% between 1990 and 2020, if other developed countries agree to do the same in a global agreement.[68] At least, this was the EU-position for the Climate Conference in Copenhagen (end 2009).
- The same targets are also found in Switzerland: The Swiss Federal Council wants to reduce greenhouse gases by at least 20% until 2020,[69] or even by 30% together with other countries. Moreover, there is a running citizens' initiative in Switzerland which wants to prescribe the 30% reduction until 2020.[70]
- Concerning longer term targets the EU calls for a coordinated reduction of greenhouse gas emissions until 2050 by 80% to 95% compared to 1990.[71] In Switzerland the Federal Council aims at a reduction of at least 50% by 2050.[72]

Before deriving targets for the AETS from these targets, it is important to note that the greenhouse gas emissions in 2004 were nearly identical to the greenhouse gas emissions in 1990.[73] 2004 is the base year for our calculations with the TAMM in part III. The targets between 1990 and a certain year can approximately be considered as targets between 2004 and the same future year. Therefore the Swiss targets of a reduction of 20% until 2020 or 50% until 2050 correspond to a yearly reduction of 1.5% starting in 2004.

Most of the targets considered above are general targets, not specific to transport. Only the EU-target of a 10% reduction until 2020 is transport specific and the French aim of 20% is even specific to road freight transport. In general, it has been difficult to reduce CO_2-emissions of transport due to transport growth, so that we would expect that specific targets for transport are somewhat lower than general targets.

For **2020** we therefore propose to use the **10%-reduction of emissions** as the **tolerant variant** and the **20%-reduction** as the **restrictive variant** (these aims might correspond to a 20%- or 30%-reduction of general greenhouse gas emissions, respectively).

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67 Alpifret (2009), Observatoire des Trafics Marchandises Transalpins, p. 47.

68 EU-Homepage (http://ec.europa.eu/environment/climat/campaign/actions/euinitiatives_en.htm 19.8.2010).

69 BAFU-Homepage (http://www.bafu.admin.ch/dokumentation/medieninformation/00962/index.html?lang=de&msg-id=17400 19.8.2010).

70 BAFU-Homepage (http://www.bafu.admin.ch/dokumentation/medieninformation/00962/index.html?lang=de&msg-id=28680 19.8.2010).

71 Die Presse Homepage (http://diepresse.com/home/panorama/klimawandel/516554/index.do 19.8.2010).

72 BAFU-Homepage (http://www.bafu.admin.ch/dokumentation/medieninformation/00962/index.html?lang=de&msg-id=17400 19.8.2010).

73 The emissions of the EU-15 have decreased by 0.9% (EEA-Homepage, http://www.eea.europa.eu/pressroom/newsreleases/GHG2006-en (19.8.2010)), the Swiss emissions slightly increase or decrease depending on the in- or exclusion of the emissions by land use and land-use change and forestry (BAFU 2006, Switzerland's Greenhouse Gas Inventory 1990–2004, p. 12).

For the **tolerant variant in 2030**, we use the relatively tolerant aim of Switzerland for 2050 which corresponds to a reduction 1.5% per year. We therefore use a **20% reduction.**[74] For the **restrictive variant in 2030**, we propose to use a **40% reduction**. This proposal is based on a general reduction of 30% until 2020 and a target of an 80%- to 95%-reduction until 2050. To reach the 2050-target the yearly reduction after 2020 must lie between 4% (target 80%) and 8% (target 95%). Starting with the 20% reduction for road freight transport for 2020 and assuming a yearly 4%- or 8%-reduction between 2020 and 2030 we arrive at a target between 35% and 53% for 2030. We propose 40% which lies in the lower part of this interval and which is again double the aim of the tolerant variant.

Technically, we assume that the CO_2-reduction targets can be translated into a similar reduction of HGV vehicle kilometres compared to the BAU-scenarios for 2020 and 2030. The relevant distance per transalpine corridor in km is derived from the Alpine Convention area for Alpine arch B+. As a consequence, the distance varies from corridor to corridor (see Figure 5-1).

Figure 5-1: Distance per transalpine corridor within the relevant area of the Alpine Convention (AC) for Alpine arch B+

Corridor	km within AC area
A - I / SLO	
Reschen	443
Brenner	430
Felbertauern	387
Tauern	301
Tarvisio	301
CH - I	
Gr. St. Bernard	321
Simplon	375
Gotthard	269
San Bernardino	291
F - I	
Mont-Blanc	251
MtCenis/Fréjus	307
Montgenerve	305
Ventimigla	317

74 Mathematically, we would arrive at a 22.6% reduction, but we chose to round this.

c) TOLL+ thresholds (TOLL+ $^{R}_{2020}$, TOLL+$^{R}_{2030}$)

The **first possible aim** of the TOLL+ concept is to use the available physical capacity (including safety aspects) efficiently. In order to reach these aims congestion should be minimised by modulated toll rates depending on the exact conditions at the time of driving (higher prices at peak times should give incentives to hauliers to plan their journeys at other times).

However, congestion problems on the Alpine corridors are mainly due to school holidays (individual traffic to Italy and back), not due to HGVs:[75]

- In France, congestion before the main Alpine tunnels is low. The main times of congestion are the beginning of holidays and generally the weekends during main holiday times. Thus congestion is in general neither caused nor suffered by HGVs.
- In Switzerland, the congestion in the North of the Alpine crossings is concentrated on a few weekends (start of holidays). In the South the traffic patterns arising from return trips (people coming back from holidays) are less concentrated, so that there are longer hours with congestion, but the queues are shorter and thus less time is lost per trip. Overall, for only 6% to 9% of the year is the Gotthard congested.
- In Austria, data of minor quality was available which did not provide satisfactory insight into the main causes of congestion. However, it is observed that the main times for congestion are typical holiday months.

The modulated toll systems TOLL+ have so far been used to redirect individual traffic to different times of the day, and mainly in or near agglomerations (see section 2.2).

Even though tolls per se have an important potential to influence transalpine freight transport (especially mode and route choice) we conclude that tolls for HGVs need not to be modulated by time of day in the Alpine corridors: the main cause of congestion is individual traffic, so that a modulated toll system for HGVs will have only minor effects on congestion. For TOLL+ to be more effective in reducing congestion, individual traffic would have to be included. But even then the effects might be limited as congestion is relatively low in the alpine corridors and as it is well known that long queues emerge e.g. at the Easter weekend. Nevertheless, many drivers still choose to travel and wait for hours in the queue. Modulated tolls, especially for individual traffic, are more promising in or near agglomerations where some drivers can change their time of departure more easily than drivers on their way to holidays after finishing working. For transalpine freight traffic, however, we only expect minor effects of modulated tolls. Therefore we do not analyse modulated tolls in more detail here.

The **second possible aim** of TOLL+ is to internalise external costs (e.g. accidents and environment) of road freight transport, in order to cover over-average cost of alpine road infra-

[75] Alpifret (2009), Observaroire des Trafics Marchandises Transalpins, p. 80-85.

structure cost or to support a modal shift from road to rail.[76] In order to do that, a mileage dependent toll along the transalpine corridors would have to be introduced.

The thresholds for such TOLL+ scenarios cannot be defined in a scientific way in the framework of this study. Basically, for every transalpine road corridor a calculation of the specific external costs and of the additional alpine-specific infrastructure costs would be needed.

On the other hand, we have to ensure that the assumed TOLL+ charges differ from prices that will be calculated with the TAMM for the AETS scenarios. If the TOLL+ charges would not differ much from the AETS prices the calculated effects on the transalpine road traffic volumes would be more or less the same. In other words, from the point of view of the transport model such scenarios would not differ in a noticeable way. We therefore propose the following pragmatic procedure:

- Step 1: Calculate the ACE and AETS-scenarios
- Step 2: Define a TOLL+ scenario with TOLL+ charges lying in between the prices that are resulting for the restrictive ACE and AETS-scenarios and calculate afterwards this TOLL+ scenario with the help of the TAMM.

This procedure makes sure that we will not calculate more or less the same scenario twice only under different headings.

d) Special cases

Mix: Coordinated ACE, AETS and TOLL+ (Mix^T_{2020}, $Mix^T_{2030\ high}$)

For the coordinated introduction of the ACE in Switzerland, the AETS in Austria and higher tolls in France, we propose to analyse a rather tolerant variant. To keep the number of scenarios at a reasonable level we will only analyse the high growth scenario for 2030.

For Switzerland the tolerant scenario from above is used, i.e. 900’000 HGVs per year for both 2020 and 2030. For Austria, we also use the tolerant AETS thresholds defined above (but only for Austria, instead of the whole Alpine arch).[77] For France, a toll rate must be determined. We propose to use the lower price which will ensue from either the ACE or AETS scenarios. These prices will be determined only in a later stage of this project.

These mixed scenarios contradict in some way our fairness criterion: They ask for different levels of efforts in the different countries and therefore may cause detour traffic. But if we wanted to analyse a fairer scenario we would end up with similar scenarios as the “pure”

[76] It is not the purpose of the present study to decide about which factors should be included in the external costs. This issue is still under discussion within the modification of the Eurovignette directive.

[77] We propose to use the whole distance in the Alpine Convention area for those trips crossing an Austrian crossing under the AETS, although part of these distance might be in Germany or Italy.

scenarios. The results will show what effects the setup would end up with (compared to the fairer scenarios with an ACE or an AETS).

ACE for the whole Alpine arch ($ACE^{R}_{2020\ A+CH+F}$, $ACE^{R}_{2030\ high\ A+CH+F}$)

For this special case we simply use the limits set out for the ACE and add them up for Switzerland, Austria and France and set only one limit for the whole Alpine arch B+. To keep the number of scenarios at a reasonable level we again only analyse the high growth scenarios and we only analyse the more restrictive variant.

AETS with country limits ($AETS^{T}_{2020}$, $AETS^{T}_{2020\ high}$)

The AETS with country limits allows the involved countries to better manage the amount of traffic using their crossings as detour traffic from one country to the other is limited. We use exactly the same limits as for the “normal” AETS, but the limits are now split up for the three countries. As for the ACE we only analyse the high growth scenarios and we restrict ourselves to the tolerant variant which seems more probable (EU-aim of 10% reduction).

e) Summary of the thresholds defined

Thus a total of 21 scenarios are analysed (see the following table – the table also shows the proposed names of the different variants, note that the thresholds do not depend on the traffic growth rate):[78]

- 8 scenarios for 2020
- 8 scenarios for 2030, high growth
- 5 scenarios for 2030, low growth

The scenarios are not exactly those that we expected at the outset, but we believe that chosen scenarios will allow more interesting insights than the analysis of the scenarios we had in mind at the beginning.

The results of the 21 scenarios will be compared to the three business as usual scenarios in Part III of this report.

[78] For more detailed information about the implementation of the scenarios in the used transport model TAMM please see chapter 7 as well as chapter 10 in the Annex.

Figure 5-1: Scenarios to be analysed with scenario names and thresholds

		2020 (with GBT) trend growth	2030 (with BBT and MCBT) for low growth / high growth*
ACE	Restrictive	**ACE^{R}_{2020}** (see p. 144) Caps in terms of numbers of HGVs per country: CH: 650'000 trips/a (52% reduction) A: 4 Mill. trips/a (26% reduction in Alpine arch B+) F: 1.9 Mill. trips/a (26% reduction)	**ACE^{R}_{2030}** (see p. 153) Caps in terms of numbers of HGVs per country: CH: 650'000 trips/a (54-61% reduction)** A: 2.5 Mill. trips/a (54-61% reduction in Alpine arch B+) F: 1.1 Mill. trips/a (54-61% reduction)
		$ACE^{R}_{2020\ A+CH+F}$ (see p. 147) Variant: One cap for all countries (sum of the above limits): 6.6 Mill. trips/a (total 30% reduction)	**$ACE^{R}_{2030\ high\ A+CH+F}$** (see p. 156) Variant: One cap for all countries (sum of the above limits): 4.3 Mill. trips/a (total 54-61% reduction)
	Tolerant	**ACE^{T}_{2020}** (see p. 150) Caps in terms of numbers of HGVs per country: CH: 900'000 trips/a (34% reduction) A: 4.5 Mill. trips/a (17% reduction in Alpine arch B+) F: 2.1 Mill. trips/a (17% reduction)	**ACE^{T}_{2030}** (see p. 159) Caps in terms of numbers of HGVs per country: As 2020: 900'000 trips/a (37-46% reduction) A: 3.5 Mill. trips/a (37-46% reduction Alpine arch B+) F: 1.6 Mill. trips/a (37-46% reduction)
AETS	Restrictive	**$AETS^{R}_{2020\ A+CH+F}$** (see p. 164) 20% reduction of CO_2-emissions ***	**$AETS^{R}_{2030\ A+CH+F}$** (see p. 172) 40% reduction of CO_2-emissions
	Tolerant	**$AETS^{T}_{2020\ A+CH+F}$** (see p. 166) 10% reduction of CO_2-emissions	**$AETS^{T}_{2030\ A+CH+F}$** (see p. 175) 20% reduction of CO_2-emissions
		$AETS^{T}_{2020}$ (see p. 168) Variant: country specific limits	**$AETS^{T}_{2030\ high}$** (see p. 177) Variant: country specific limits
TOLL+	Restrictive	**$TOLL+^{R}_{2020}$** (see p. 183) Prices are in between the Prices resulting for **** ACE^{R}_{2020} and $AETS^{R}_{2020\ A+CH+F}$	**$TOLL+^{R}_{2030}$** (see p. 186) Prices in between the Prices resulting for ACE^{R}_{2030} and $AETS^{R}_{2030\ A+CH+F}$
MIX	Tolerant	**MIX^{T}_{2020}** (see p. 190) ***** CH: 900'000 trips per year A : 10% reduction of CO_2-emissions F: The lower price of ACE^{T}_{2020} and $AETS^{T}_{2020}$	**$MIX^{T}_{2030\ high}$** (see p. 193) CH: 900'000 trips per year A : 20% reduction of CO_2-emissions F: The lower price of ACE^{T}_{2030} and $AETS^{T}_{2030}$

* If indicated with "$_{high}$", the scenario is only calculated for the 2030 high growth case.

** The reduction is depending on the BAU 2030 high or low transport level.

*** Of concern are the CO_2-emissions within the Alpine area according to the perimeter of the Alpine Convention. A reduction of 20% of the CO_2-emissions corresponds to approx. 20% of the HGV vkm compared to the *BAU-2020* case in this area. As a basis for each crossing, the kilometres that occur within the Alpine Convention area are modelled. It is important to note that different Alpine crossings involve different journey lengths through the Alpine Convention region.

**** In TOLL+ a pre-set distance based charge is applied according to the distances per corridor within the perimeter of the Alpine Convention.

***** In the MIX-scenarios the three different pricing instruments are modelled simultaneously and in parallel (TOLL+ on France-Italian corridors, ACE on Swiss-Italian corridors and AETS on Austrian-Italian corridors).

6 Accompanying measures

All instruments looked at in this study, the ACE, the AETS or the TOLL+ regime will make transalpine road freight transport more expensive. The magnitude of the price increase depends on the severeness of the scenario (restrictive or tolerant) and on the instrument looked at. In the following overview we discuss shortly possible accompanying measures that could be taken into account when introducing one of the above instruments.

6.1 Exemptions for short distance freight transport

Whereas AETS and TOLL+ will cause a higher price per km within the perimeter of the Alpine Convention area, the ACE sets a distance independent price for every transalpine road freight trip. As a consequence, for local and short distance transalpine road freight transport prices will raise much above average. This could cause a split of local small interdependent neighbouring economic areas at the Alpine crossings. Such a split would not be desirable due to economic, regional and socio-political dimensions, independent from country borders. Furthermore, with the exception of rolling motorway, rail transport is often not competitive on short distances. With the introduction of an ACE, a privileged handling of local supply transport between the areas of both sides of the Alpine crossing should therefore be taken into consideration. In Ecoplan, RappTrans and Kurt Moll (2007) a concrete proposal how to treat local and short distance transport is developed.

In a **first step** local and short distance transport are defined: Local transport can be defined as heavy goods vehicles which travel a maximum distance of 40 km on both sides of the Alpine crossing. Short distance transport trips exceed this limit of 40 km, but travel a total maximum distance of 150 km. This definition is independent of country borders and may be used in all Alpine countries in a similar way. It ensures that only the short and local transalpine journeys profit from a possible privileged handling. Less than 5% of the transalpine heavy goods vehicles journeys are counted as local or short distance transport.

In a **second step** the privileged handling of local and short distance transport is subject to an adjustment of the “conversion rate”. This is equivalent to a reduction of the tariff per ACP. The aim is not to exclude local and short distance transport from the increase of cost caused by the ACE, but to ensure that the price for local and short distance transport is not increased disproportionately. Calculations show that a reduction for local transport of 80% and for short distance transport of 50% should balance the disproportionate increase of price for short distance transport to the average. The suggested discount for local transport and short distance transport can be translated to the adapted conversion rates from ACU to ACP, e.g. if the standard conversion rate for one ACP corresponds to 10 ACU, local transport trips would only have to pay 2 ACU for one “local transport ACP”.

6.2 Subsidies

As a counterpart of the higher prices for transalpine road freight transport, subsidies for transalpine rail freight transport could be abolished. In fact, the scenarios defined in this study for 2020 and 2030 already adopt this idea. For the 2020 scenarios the subsidies for combined transport (UCT and RM) are reduced, and for the 2030 scenarios all subsidies are abolished.

6.3 Rolling Motorway

One reason for criticism against ACE, AETS and TOLL+ that was stressed by several members of the Advisory Board for this study is the following one:

- The introduction of ACE, AETS or TOLL+ causes an “artificial” constraint of transalpine road capacities. This is especially evident for the ACE which introduces a cap for transalpine road freight trips, but in fact is also the case for the two other instruments AETS and TOLL+ as every of the three instruments causes a substantial price increase for transalpine road freight trips.
- Furthermore, it is argued that such a capacity constraint will cause severe economic losses for the economies in the North respectively the South of the Alpine arch.

Therefore, to ease the shift from road to rail, the supply of the rolling motorway (RM) could be increased in order to take up the road freight traffic that is difficult to shift to the rail modes UCT and WL and for which the price increase for transalpine road trips is too strong. This would be done by introducing additional transalpine RM-links. Ecoplan and NEA have calculated such a scenario at the example of an additional RM-link for the Simplon-corridor between Basel – Domodossola. This new RM would offer a good service with a train every hour per direction.[79] The result shows as expected a marked increase of the demand from 2.1 Mill. tons for the scenario ACE R 2020 (Figure 12-12 in the Annex, chapter 12) to almost 6 Mill. tons with the additional supply of RM.

This result shows that transalpine freight transport reacts quite sensitive on supply changes. For a more in-depth discussion of the “capacity constraint” problem see chapter 8.4

[79] At the same time, with such an offer substantial economies of scale can be realised with a correspondingly relatively low price per RM-trip of 290€.

P A R T III: Traffic Study

In Part III of this study the impacts on transalpine freight transport of the different instruments and the scenarios respectively will be analysed in detail. The basis for this analysis is the TAMM - Trans Alpine Multimodal Model developed by NEA and Ecoplan.

Part III is structured as follows:

- Chapter 7 includes a short description of the Transalpine Multimodal Model (TAMM) and the model specific assumptions for the scenarios.
- In chapter 8 we present the results for the different scenarios. The main focus is on the effects on transport volumes. Additionally, we have a look at the impacts on road transport prices and public revenues.

7 Overview of TAMM – Transalpine Multimodal Model

7.1 Model description

Managing Alpine traffic flows in practice implies introducing policy instruments capable of influencing market behaviour in such a direction whereby perceived positive impacts can be achieved. In essence this process is manifested in terms of route and mode choice for the Alpine corridors. Following the previous discussions set out in this document, a series of model runs have been designed, and their results in terms of route and mode shares are presented. All of the scenarios, containing variations in the application of different pricing instruments have been estimated for this study using the Trans Alpine Multimodal Model (TAMM).

Owing to the complexity of the scenarios, a new model version has been created, TAMM v2.0. The main new feature is the ability to model different pricing instruments, and to allow these to be combined in a scenario, for example the simultaneous operation of TOLL+ in France, ACE in Switzerland and AETS in Austria. Previous model versions only considered ACE variants.

One of the important requirements for this application is the need to estimate how the prices of tradable HGV permits would react to given traffic thresholds, expressed either in the number of Alpine crossings or in the level of carbon dioxide emissions, translated into HGV kilometres. Thus the model needs to be iterative – it must be run repeatedly in order to find the set of prices at which the route and mode choice results achieve the preset constraints.

Compared to previous studies which have used TRANS-TOOLS (DG-Move's reference transport network model), this modelling approach has been to construct a system specifically for the Alpine region, using the AQGV Alpine freight survey data as the main reference.

The recent TNO study (Best Research on Traffic Management Systems for Transalpine Road Freight) undertook to analyse the feasibility of different pricing schemes, using the TRANS-TOOLS model suite. Several recent studies (see ITREN-2030 for example) have shown that despite software implementation problems, TRANS-TOOLS may be a suitable model for calculation of high level transport indicators (pan Europe, freight and passengers), but so far it is not suitable for corridor specific analysis without a high degree of modification.

Important weaknesses of TRANS-TOOLS in the context of transalpine freight pricing include:

- Representation of pure modes only – with no differentiation between different rail options, and the inability to include "road-like" rail services such as rolling motorway. Thus diversion potential is severely underestimated.
- Model execution speed – a typical TRANS-TOOLS model run takes several days to complete, making goal seeking analyses practically impossible. Thus it is not a suitable system for modelling cap-and-trade scenarios such as ACE and AETS, where the model needs to iterate to balance price and demand.

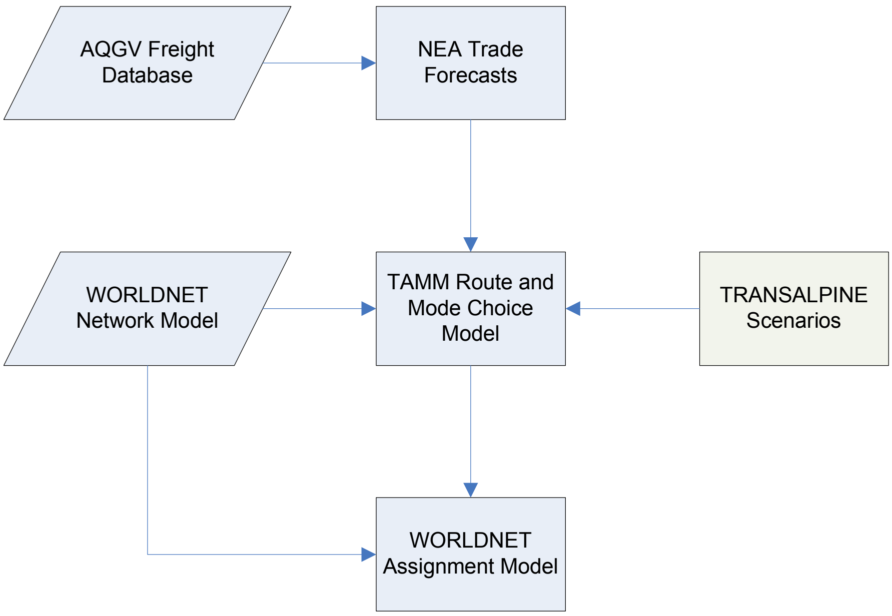
- Transport cost – TRANS-TOOLS is relatively limited in terms of how the user can set policy levers such as transport costs to divert traffic, and there is a single set of transport costs defined for the whole set of freight flows. More sophisticated cost calculations involving subsidies, tolls, base tunnels and weight limits are required to take into account the full range of factors influencing the route and mode shares on this corridor.

Within TAMM, the aim has been to selectively use existing inputs from different projects, and to add detail where necessary to represent the strategic environment more closely.

Inside, the model structure is broadly conventional. The origin/destination matrix is drawn from the AQGV survey of 2004 and can be projected using trade forecasts. The main function of the system is to assign traffic to multi-modal chains, using the methodologies originally developed by STEMM (DG-MOVE, FP4, 1997, MDS-Transmodal, Ecoplan, IWW et al.), and subsequently applied in the UK national freight model, GBFM (MDS-Transmodal, 2006) and WORLDNET (DG-MOVE, FP6, NEA, IWW et al.). Assignment to multi-modal chains is necessary for the Alpine region, due to the importance of combined transport.

More traditional freight modelling approaches share fixed sums of traffic between pure modes, but this is not ideal for long distance transport corridors. In practice this means that in TAMM 2.0, the traditional four stage (generation, distribution, mode split and assignment) operation is reduced to a two stages model (matrix estimation and multimodal assignment). More detailed assignment per mode is optional.

Figure 7-1: Overview of TAMM Model structure



The two principal data inputs are the AQGV survey database providing an accurate set of traffic flows for 2004, and the WORLDNET transport network, which is an update and extension of the TRANS-TOOLS network, covering road and rail for all European countries.

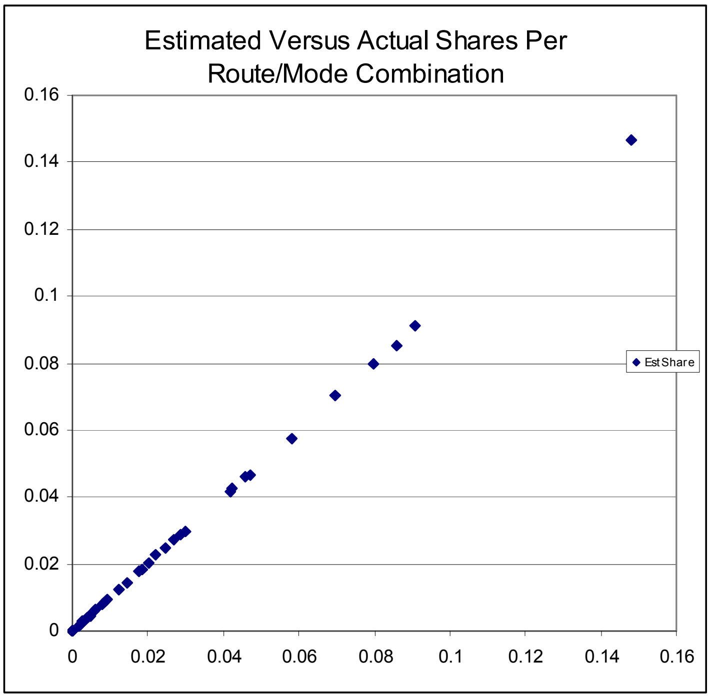
Freight flows were forecast in advance of the current study using an agent-based trade model developed at NEA for estimating long term trade growth within the ITREN-2030 project. It is a worldwide model, taking into account detailed historical trade development, and it is analysing simultaneously trade flows as financial and physical quantities. Thus, financial constraints such as the development of unsustainable trade deficits may act as limits to long term growth.

Route and mode choice modelling is carried out at two levels. The central TAMM model builds high level transport chains, routing the freight flows through a hyper-network constructed from its constituent sub-networks (road, and three forms of rail network). Scenarios including a wide range of relevant policies can be applied in TAMM, and the model can iterate quickly, since it operates at the level of the hyper-network to solve constraints such as quotas for HGV permits.

Outputs from TAMM can be fed into the traffic assignment model developed in the WORLDNET project, and in this way it is possible to calculate traffic performance indicators such as tonne and vehicle kilometres per link or per zone.

The availability of high quality survey data (AQGV 2004), and a fast model make it possible for the fit between the base year (2004) model results and the actual (AQGV 2004) to be very close. This is illustrated in the scatter plot below, where each dot is a single route/mode combination e.g. Brenner-wagonload, and the axes of the graph are the model estimates and the AQGV survey results. Errors would be seen as deviations from the diagonal.

Figure 7-2: Comparison of Estimated and Actual Shares per Route/Mode



Although the model application is constructed specifically for the Alpine region (it cannot be applied in any other setting) it uses several inputs from EU models, including the transport networks of TRANS-TOOLS (TNO et al. 2006), the trade forecasts from iTREN-2030 (ISI-Fraunhofer et al, 2009), and the updated and extended transport cost models of ETIS-Base (NEA et al. 2005). Thus most of the specialisation lies in the level of detail; the focus upon the Alpine crossing points, and the need to differentiate different rail segments; conventional wagonload, unaccompanied combined transport, and rolling motorway. Because there are established “road-like” rail options within this corridor and sufficient rail volumes to make it a viable option, the mode share within the Alpine corridor is not typically European.

Note that sea options are not included in either the AQGV survey or the TAMM model. Recently (2007), the Italian Government has taken the lead in promoting Italy-Spain ferry services, supported by the Eco-Bonus incentive. The impacts cannot be observed in the survey data, and future shifts between sea and land are not explicitly modelled.

In this study it has been necessary to focus upon the impact of pricing measures. Traditionally, network-based transport models store pricing information at the network link level. This approach works well for standard motorway tolls or for rail track charges, where a pre-set price is attached to a given stretch of road. The toll is set and the traffic shift is estimated. However, we now face the prospect of the traffic shift being pre-set, implying the need to estimate the price to which the toll must rise.

Essentially two forms of pricing are considered in TAMM 2.0:

- Charges per trip across the Alpine ridge, with or without associated traffic caps.

- Charges per unit of distance, again with or without associated traffic caps.

In the second category it is possible to address carbon dioxide related targets, or more straightforward charges per HGV kilometre.

If traffic limits are not set, a scenario can be constructed with preset charges per crossing or per kilometre within the Alpine Convention region. These can produce impacts in terms of:

- Route switching, from one Alpine crossing to another.
- Mode switching.
- Traffic suppression.

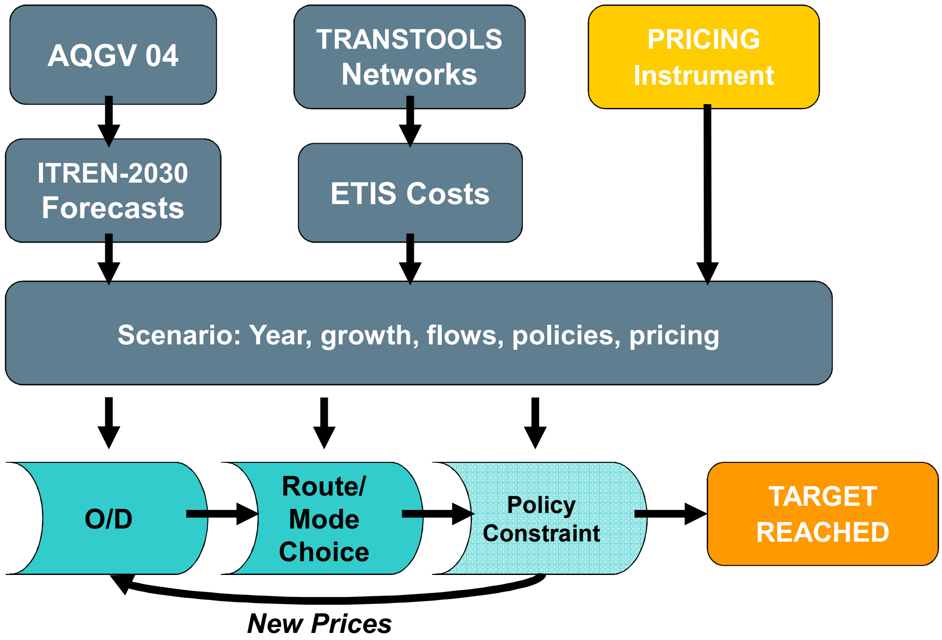
For realistic levels of transalpine charges, the third category is unlikely to show a big effect in TAMM because it uses a calculation based on changes to the cost of the delivered goods, and not simply to the transportation cost. One lorry load of goods might typically carry goods worth 10-15,000 Euros, and a complete journey from North to South Europe might cost 1,500 Euros, so raising the cost by a further 200 Euros would only change the delivered price by 2%. Nevertheless, traffic generation and suppression effects are included in the modelling.

When traffic limits are set, the model iterates, changing the levels of the charges at each step to find a solution whereby the constraints are met. Such charges and constraints can be set per country or for the whole Alpine region together.

7.2 Scenario Configuration

In the figure below the structure of the scenario-building process is illustrated. The boxes in the top half of the diagram show the main variables affecting traffic volumes, networks and basic costs. On the right hand side, the specification of the pricing instrument (TOLL+, ACE or AETS) is highlighted.

Figure 7-3: Building a Scenario



The model processing is shown at the bottom of the diagram. The flows are calculated, the scenario variables are used to determine the route and mode choice, the results are compared with (optional) traffic constraints, and if they agree with the targets the model run will stop, reporting the resulting prices. If the outcome does not meet the specified thresholds, new prices are calculated and the model iterates.

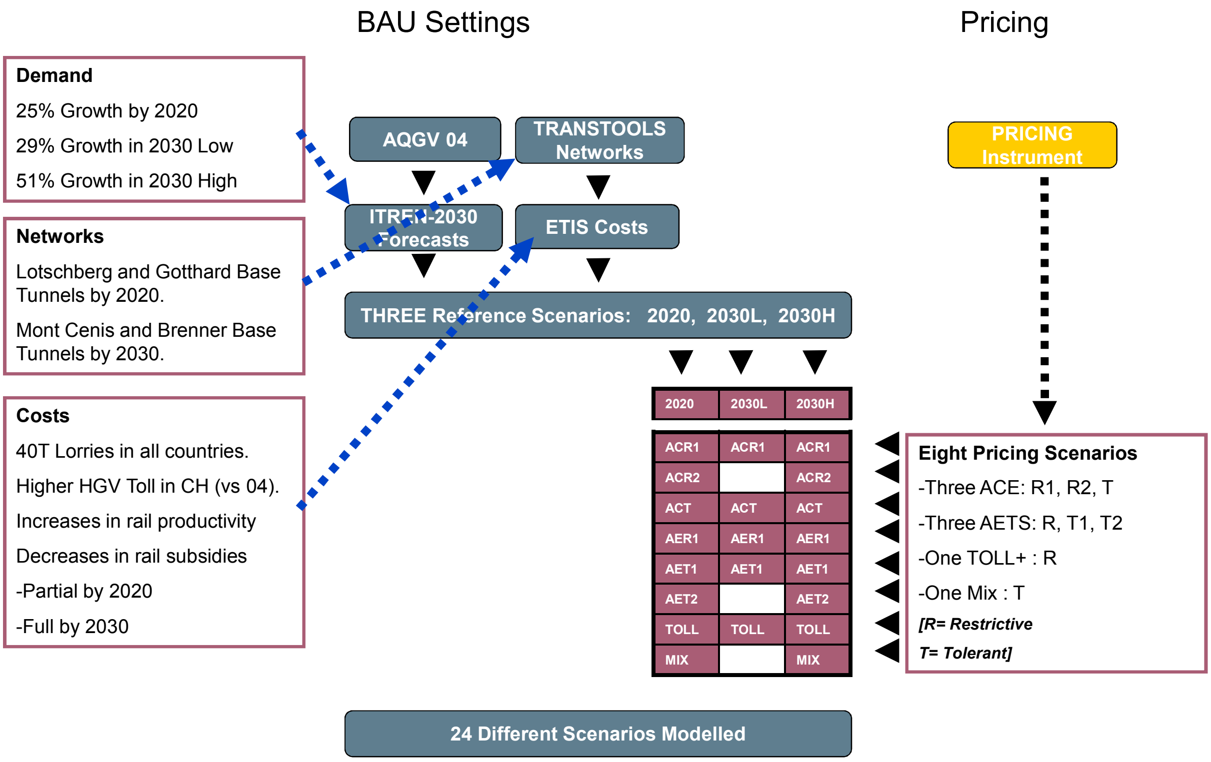
7.3 Overview of scenarios and assumptions

For this study, twenty one different future scenarios have been modelled. For all of the ACE, AETS and MIX scenarios, which involve iteration, several hundred model runs have been completed per scenario in order to estimate the resulting prices.

These scenarios have been split into three groups, each one associated with a different traffic demand level and a forecast year. One set of runs was calculated for 2020, and the two others contain the different 2030 volumes, one lower, one higher, to allow a range of uncertainty to be considered. Compared to the 2004 data, the 2020 traffic level is 25% higher, and the 2030 traffic levels are respectively 29% and 51% higher. Each forecast takes into account the impact of the economic crisis.

Since many of the cases considered involve specific traffic constraints, i.e. a given number of crossing permits or a specified level of carbon dioxide emission (expressed in absolute terms), the growth of the market by volume is a crucial variable because it determines the relative degree of behavioural change required to meet the preset constraint.

Figure 7-4: ALBATRAS Scenario Matrix



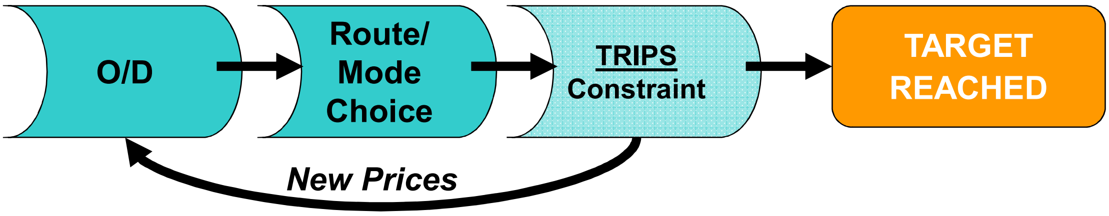
The model runs carried out for the study can be visualised as a matrix with three columns for the different years (and growth estimates) and eight rows for the different pricing instruments.

For each of the 2020, 2030-low and 2030-high sets of model runs a "Business as Usual" scenario has been prepared, indicating possible route and mode shares for circumstances where no new pricing measures are active. From these origin values, eight scenarios have been run for 2020, eight for the 2030 high case, and five for the 2030 low case. These cover each of the main pricing instruments, ACE, AETS, TOLL+, and involve either tolerant or restrictive constraints.

Previous studies using TAMM have focused upon the ACE instrument, and been applied to the full set of Alpine crossings (Alpine Arch C and Tarvisio) defined in the AQGV survey. For the current study which follows the Alpine Arch B+ definitions, only the Western crossings have been considered for the application of new heavy transport management instruments in Austria. The Eastern routes, Schober Pass, Semmering and Wechsel continue to exist in the transport network, but they are passive. For the entire modelling exercise therefore it should be noted that all the traffic constraints and AETS, ACE or TOLL+ charges applied relate only to the Western (B+ arch) crossings. There are no new charges on the remaining routes, and none of the constraints apply to traffic.

For ACE, the caps are set according to the business as usual volumes for the B+ arch. This means that anything detouring to the Eastern (Arch C) routes does neither pay the ACE crossing charge nor consume one of the (fixed number) of permits. Since the model handles tonnages and HGV numbers simultaneously, an assumption must be made about average lorry weights. These are based on the existing AQGV data (and Alpinfo), and importantly for ACE these are allowed to vary according to the ACE charge. Because these are per trip charges, a benefit can be realised by higher load factors, so this incentive is included as a model response.

Figure 7-5: Construction of ACE Scenario in TAMM



For AETS, the caps are set as a reduction relative to the forecast volume of traffic (2020 business as usual or 2030-low) measured in heavy goods vehicle (HGV) kilometres. It is assumed that these HGV Km reductions, either 10%, 20% or 40%, also encapsulate technological changes which would result in lower carbon dioxide emissions per kilometre. Unlike ACE, the average lorry weights are not allowed to change in the model runs because, everything else being equal, there would be a correlation between emissions per vehicle kilometre and average weights.

Figure 7-6: Construction of AETS Scenario in TAMM

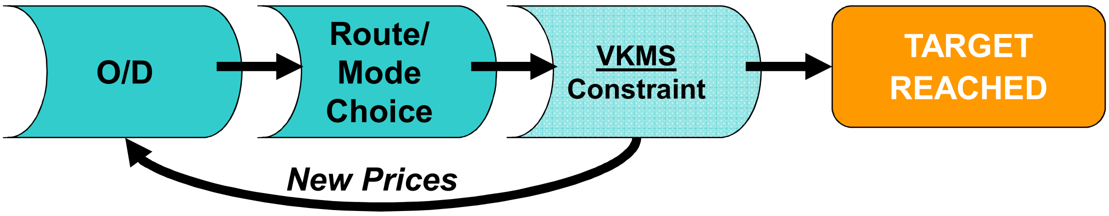


Figure 7-7: Definition of Chargeable Distances for AETS and TOLL+

In AETS and TOLL+ the model outcomes are influenced to a considerable degree by the assumptions relating to the distances through the Alpine Convention region[80]. In the above map, the red lines indicate the assumed chargeable distances for each of the crossings. Note:

- Each crossing point needs to be identified with a particular Alpine route. In certain cases different route options are available, which in practice could be monitored using electronic tracking devices. The modelling work however is based on a preset distance per route.
- Austrian routes to the East of Tarvisio (shown in purple) are excluded from the model analysis. Vehicle kilometres estimated on these Eastern (C) routes are not subject to pricing in the model, and they do not contribute to the threshold calculations. This creates an anomaly whereby an instrument to manage transport impact in a pre-defined region (Alpine Convention) essentially re-defines the environmentally sensitive region.
- Related to this, a judgement was made as to how far East to extend the Tarvisio corridor. In order to balance the sensitive distances per route, it was chosen to extend the route as far as Graz. This has the effect of reducing the potential for detouring from Tauern to Schoberpass+Tarvisio.
- A strict interpretation of the Alpine Convention area might also lead to a shorter distance being considered for the Ventimiglia route with the main E80 road route following the coast. Again however, a longer distance has been assumed in order to minimise detouring outside the defined region which would not be desirable in the context of a policy aiming to reduce carbon emissions.

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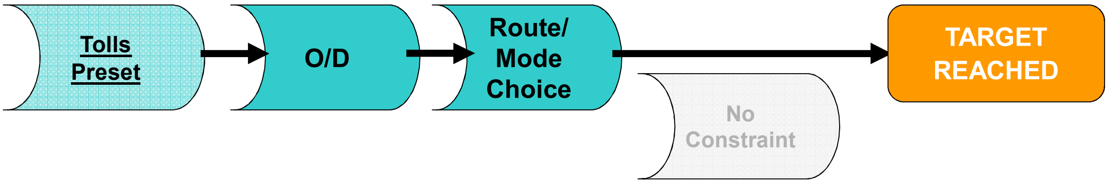
80 The map is based on a definition of Alpine administrative regions as listed on the link below. However, this interpretation extends the region somewhat compared to the maps also published on the website. See: http://www.alpconv.org/theconvention/conv05_en.htm.

- Like the ACE analysis, the traffic set being considered is based entirely on the AQGV survey, so it only includes Alpine transits (vehicles that cross the Alpine passes) and not the full set of traffic that might enter or travel within the Alpine Convention region.

TOLL+ is similar to AETS, but the model is run in a more conventional way, with the prices being set exogenously, and the model calculating the resulting traffic shifts without iteration.

Figure 7-8: Construction of TOLL+ Scenario in TAMM



A detailed description, showing the modelling approach for each of the eight pricing variants is set out in the tables below.

		Overview	Implementation
ACE	**Restrictive 1**	Restrictive ACE caps applied individually in France, Switzerland and Austria	A constraint is set in terms of numbers of HGVs per country. Each country offers a fixed number of permits, and these increase in price until the constraint is met. Different prices per country can arise, particularly if the available rail options are different in the different countries. In Switzerland, the constraints are set at 650,000 in line with Swiss policy, and the levels for France and Austria are set to produce a similar relative decrease in lorry numbers. Under these restrictive assumptions, the level of decrease is 54% (in the scenarios for 2030). In France and Switzerland this must be met by mode shifting, but in Austria, detouring is also possible.
	Restrictive 2 A+CH+F	Restrictive ACE cap applied jointly across the Alpine arch (B+)	Compared to ACE-R1, ACE-R2 involves a single HGV limit for the whole arch (B+) equal to the sum of the constraints in R1. Therefore a single ACE price will emerge from the iterative process, and there is greater potential for re-routing between countries. Here it is expected that the resulting price will be within the range of levels found in R1.
	Tolerant 1	Tolerant ACE caps applied individually in France, Switzerland and Austria.	Compared to ACE-R1, the only important difference is the level of the cap, which is raised to 900,000 HGVs in Switzerland, and – in the scenarios for 2030 – by an equivalent relative amount in Austria and France.
AETS	**Restrictive 1 A+CH+F**	Restrictive AETS applied jointly across the Alpine arch B+.	This has been modelled by defining for each crossing, the kilometres that occur within the Alpine Convention (AC) area, and thus the total HGV kilometres within the Alpine Convention area. These AC-sensitive distance definitions are fixed for all scenarios. Since the relevant AETS charges apply only to the B+ arch, it is therefore assumed that the HGVkm constraints also only apply to the B+. Traffic on the Eastern routes does not pay the charge nor count towards the targets. It is important to note that different Alpine crossings involve different journey lengths through the Alpine Convention (AC) region. Under this scenario, it is therefore possible for traffic to divert from one route to another in the same country with a lower sensitive distance, and under the model assumptions, this counts as a reduction in traffic relative to the constraint, even if it involves a detour adding HGV kms outside the Alpine Convention region. Because of these possibilities, the AETS constraints may be more tolerant for a given level of traffic reduction. When the 2030-High variant is run, the constraints for HGV kms are not simultaneously raised. This is to ensure compatibility with the ACE assumptions, which also do not change according the traffic volume realised. In practice, the number of permits would have to be set in advance of the traffic out-turn being known. Thus these constraints are all more restrictive in the high 2030 than the low 2030.
	Tolerant 1 A+CH+F	Tolerant AETS applied jointly across the Alpine arch B+.	As above, but with the constraint for the whole Alpine arch halved.
	Tolerant 2	Tolerant AETS applied per country.	Individual HGV-km constraints are defined for each country, summing up to the level used in AETS-T1. The proportions are set according to the levels reached in the respective BAU scenarios. Thus the tendency for traffic to detour from routes with longer AC-sensitive distances to shorter ones is reduced. However, within any given country it can still occur, and the option to detour outside the B+ arch is still present.
TOLL+	**Restrictive 1**	A fixed distance based charge is applied equally to all countries.	Here, a pre-set distance based charge is applied according to the AC-sensitive distances defined per corridor. As with the other instruments this only affects the Alpine B+ range, so any use of links in the Eastern (C) part of the region is not tolled.
MIX	**Tolerant 1**	Preset toll per km in France, ACE in Switzerland, and AETS in Austria, with tolerant levels.	Here, three different pricing instruments are modelled simultaneously and in parallel. In France a preset distance based toll is applied, creating a traffic shift. In Switzerland a HGV limit is applied so as the price rises to meet the constraint, there is an interaction with the French toll. In Austria there is a HGV-km constraint, which is also modelled interactively. As the tolls rise in Switzerland and Austria, eventually enough traffic is diverted to rail to allow the road constraints to be met.

		Threshold	2020 Threshold	2030 Threshold
ACE	**Restrictive 1**	TRIPS	Austria: 4,036,981 HGV Trips Switzerland: 650,000 HGV Trips France: 1,908,362 HGV Trips	Austria: 2,552,214 HGV Trips Switzerland: 650,000 HGV Trips France: 1,112,614 HGV Trips
	Restrictive 2 A+CH+F	TRIPS	All: 6,595,343 HGV Trips	All: 4,314,828 HGV Trips
	Tolerant 1	TRIPS	Austria: 4,538,949 HGV Trips Switzerland: 900,000 HGV Trips France: 2,145,653 HGV Trips	Austria: 3,533,834 HGV Trips Switzerland: 900,000 HGV Trips France: 1,540,542 HGV Trips
AETS	**Restrictive 1 A+CH+F**	Million HGV Kms in AC B+	All: 2,532 Million HGV Kms	All: 1,882 Million HGV Kms
	Tolerant 1 A+CH+F	Million HGV Kms in AC B+	All: 2,848 Million HGV Kms	All: 2,509 Million HGV Kms
	Tolerant 2	Million HGV Kms in AC B+	Austria: 1,780 Million HGV Kms Switzerland: 359 Million HGV Kms France: 710 Million HGV Kms	Austria: 1,590 Million HGV Kms Switzerland: 328 Million HGV Kms France: 589 Million HGV Kms
TOLL+	**Restrictive 1**	N/A		
MIX	**Tolerant 1**	CH: TRIPS AT: HGV Kms	Switzerland: 900,000 HGV Trips Austria: 1,780 Million HGV Kms	Switzerland: 900,000 HGV Trips Austria: 1,590 Million HGV Kms

8 Impacts

This chapter summarizes the results of the impacts on transalpine freight transport of the different policy instruments (ACE, AETS and TOLL+) and the scenarios respectively for Alpine arch C.[81] First, we will present the effects on Alpine crossing transport volumes. The second part analyses the effects on road transport prices. The estimated costs and revenues for the public sector are presented in the third part. The fourth part consists of a short analysis of the use of the transalpine railway capacities. The chapter closes with a summary of the impacts of the policy instruments and scenarios on transalpine freight transport (see chapter 8.5).

Obviously, in the present chapter we can only present a selection of the results on the following pages. This is mainly done by graphic illustrations of the results. The more detailed results for the scenarios as well as for base case 2004 and the BAU scenarios 2020/30 can be found in chapter 12 in the Annex (see Figure 12-1 - Figure 12-42 which show volumes per transalpine crossing and the prices for the instruments per country).

As presented above, for 2030 we modeled two BAU scenarios, one for low and one for high growth in transalpine freight transport. Because the patterns of shares and growth as well as the impacts of the policy instruments in the analyzed scenarios are very similar (stronger for high than for low growth), for the results for 2030 we focus in the following mainly on the effects in the 2030 high growth scenarios and only comment the 2030 low scenarios if there are any significant differences to the high growth scenarios.

For a description of the analyzed scenarios see chapter 5.2. The TAMM which is used to calculate the results for the present transalpine freight transport scenarios is briefly described in chapter 7 and in more detail in the Annex (chapter 10).

8.1 Effects on transport volumes

The effects on transport volumes of the four groups of scenarios (ACE, AETS, TOLL+ and MIX) for 2020 and 2030 low / high growth are presented as follows (one figure for each group of the four policy instruments showing transport volumes for the four considered modes on country level and one figure per scenario showing volumes, absolute and percentage growth on transalpine corridor level):

- In 1'000 tons/a per country and mode (road, UCT, WL and RM), including the respective BAU scenario
- In 1'000 tons/a per corridor and mode
- The absolute change in 1'000 tons/a to the respective BAU scenario for road and rail
- The change in % to the respective BAU scenario for road and rail

[81] Please note that all results are shown for Alpine arch C, while the instruments are introduced for Alpine arch B+ only (exclusion of the three easternmost A – I/SLO corridors).

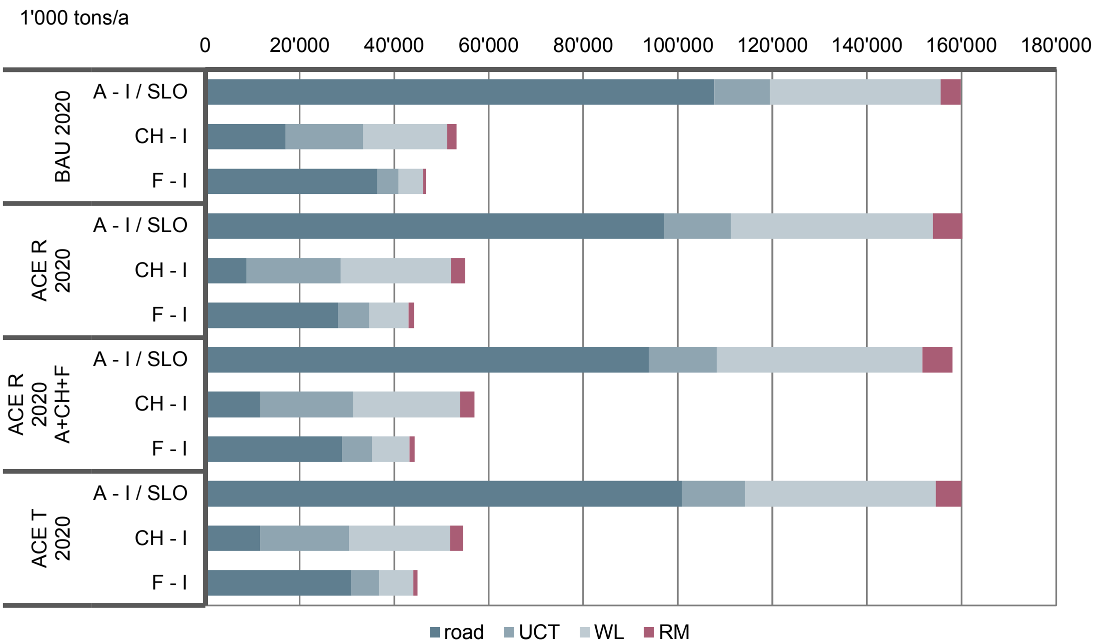
8.1.1 ACE

a) 2020

In 2020 the introduction of an ACE leads to a general shift of transalpine freight transport from road to rail, depending on the strength of the ACE caps chosen. In all three scenarios analyzed, total transalpine transport volume decreases by only 0.1% - 0.2% (not transported through the Alps anymore, e.g. shifted to East-West relations or freight transports on water). The results of the three ACE scenarios for 2020 (see Figure 8-1 for a general overview) are described more precisely on the following pages.

In general the effects on transport volumes cannot fully be compared between 2020 and 2030 because the implemented measures for A – I/SLO and F – I corridors are different to the ones for CH – I corridors (only half of the percentage reduction of CH – I corridors in 2020).

Figure 8-1: Transalpine freight traffic volumes for BAU and the ACE scenarios 2020, in 1'000 tons/a



ACE R 2020

In scenario “ACE restrictive 2020” the caps for transalpine HGV trips of the introduced ACE and the resulting prices for Alpine crossing permits (ACP) per trip are as follows (for the prices see also Figure 8-30):[82]

	Caps (incl. necessary reduction)	ACP prices
A – I/SLO	4 Mill./a (26% reduction of Alpine arch B+ volumes)	94 EUR/trip
CH – I	0.65 Mill./a (52% reduction)	160 EUR/trip
F – I	1.9 Mill./a (26% reduction)	126 EUR/trip

The introduction of the ACE leads to a reduction in total transalpine road freight transport volume of around 17% compared to BAU 2020 (see Figure 8-2 and the respective Figure in the Annex): From 161 to 134 Mill. tons/a. However, due to the different strength of the caps for CH – I and A – I/SLO / F – I corridors (only half of the reduction on CH – I corridors, see table above), the reduction of road transport volume is varying: 10% on A – I/SLO, 49% on CH – I and 23% on F – I corridors. On A – I/SLO the reduction is even lower than on F – I crossings because the ACE does not include the three easternmost transalpine A – I/SLO corridors (which leads to detouring on Schoberpass, Semmering and Wechsel). The number of transalpine lorries on those three corridors increases by 10%, whereas on the Western corridors their number decreases by 26%. Consequently, the relocation effects from road to rail are not as high as they would be with an equal percentage reduction of transalpine HGV trips and an application of the ACE on the whole Alpine arch C.

The same arguments explain the differences in the **prices for ACP** (see table above).

27 Mill. tons/a of the total reduction in transalpine road freight transport (27.3 Mill. tons/a) are shifted towards rail corridors. The residual 0.1% of total transport is shifted towards other transport modes not considered here (e.g. transports on water between the Iberian Peninsula and Italy) or not transported anymore. For the different transalpine crossings, the introduction of the ACE leads to the following changes:

- **A – I/SLO**: Transalpine road freight transport volume is reduced by 11 Mill. tons/a (10% of total road freight volume on A – I/SLO corridors). 11 Mill. tons/a are shifted towards A – I/SLO rail corridors.
- **CH – I**: Transalpine road freight transport volume is reduced by 8 Mill. tons/a (49%). 10 Mill. tons/a are shifted towards CH – I rail corridors.
- **F – I**: Transalpine road freight transport volume is reduced by 8 Mill. tons/a (23%). 6 Mill. tons/a are shifted towards F – I rail corridors.

[82] The basis for the caps is the number of transalpine HGV trips within Alpine arch B+ in 2020: CH – I: 1.36 Mill. trips/a, A – I/SLO: 5.46 Mill. trips/a, F – I: 2.60 Mill. trips/a. This holds true for all 2020 ACE scenarios.

Overall, **total transalpine freight transport volume** (road and rail) is shifted from F – I corridors (-5.3% of total transalpine transport in BAU 2020) towards A – I/SLO (+0.2%) and CH – I corridors (+3.4%) (see Figure 12-12 in the Annex). Thus, it can be assumed that especially for some F – I road transport it is more attractive to shift towards CH – I than on F – I rail corridors.

Modal split of road of total transalpine freight transport is reduced by the introduction of the ACE from 62% to 52%.

The **number of total transalpine HGV trips** on road decreases from 12.4 Mill./a to 9.9 Mill./a: -13% on A – I/SLO, -52% on CH – I and -26% on F – I crossings (see Figure 12-10). This decrease (-2.5 Mill. trips/a) is lower than the reduction one would expect according to the implemented caps within Alpine arch B+ (-2.8 Mill trips/a, see figure above). The reason for this difference lies in the fact that all the results are presented for Alpine arch C, whereas the measures are implemented for Alpine arch B+ only, which leads to the possibility of detouring via the three easternmost A – I/SLO corridors which do not belong to Alpine arch B+ (This holds true for all scenarios).

Figure 8-2: ACE R 2020: Transalpine freight transport 2020 in Alpine arch C, in 1'000 tons/a, Δ in 1'000 tons/a and Δ in %

ACE R 2020 A+CH+F

In scenario “ACE restrictive 2020 A+CH+F” the ACE is implemented with one single cap over the whole **Alpine arch B+**. This **common cap** of 6.6 Mill. transalpine HGV trips per year (sum of the individual caps in scenario “ACE R 2020”) leads to an **ACP price of 110 EUR/trip** for all corridors within Alpine arch B+. Compared to scenario “ACE R 2020” with country/corridor specific caps, this price is higher for A – I/SLO and lower for CH – I and F – I corridors.

The introduction of an ACE with a common cap also leads to a reduction in total transalpine road freight transport volume of around 17% compared to BAU 2020 (see Figure 8-3 and the respective Figure in the Annex): From 161 to 134 Mill. tons/a. In comparison with an ACE with country/corridor specific caps, the reduction of road transport volume is a little bit more equalized with a common cap for the whole Alpine arch B+, but remains varying (due to the different strength of the caps for CH – I and A – I/SLO / F – I corridors): 13% on A – I/SLO, 31% on CH – I and 21% on F – I corridors (the reduction increases on A – I/SLO crossings and decreases on CH – I and F – I crossings, because A – I/SLO crossings face a smaller ACP price with single caps). Again on A – I/SLO the reduction is even lower than on F – I crossings because the ACE does not include the three easternmost transalpine A – I/SLO corridors (which leads to detouring on Schoberpass, Semmering and Wechsel). The number of transalpine lorries on those three corridors now increases by 11%, whereas on the Western corridors their number decreases by 32% (compared to 26% with different caps). Thus, a common cap leads to more equalized relocation effects from road to rail within the Alpine area. But the effects would still be higher if the ACE would be introduced with an equal percentage reduction of transalpine HGV trips on all corridors and with an application of the ACE on the whole Alpine arch C.

26.4 Mill. tons/a of the total reduction in transalpine road freight transport (26.7 Mill. tons/a), are shifted towards rail corridors. The residual 0.2% of total transport is shifted towards other transport modes not considered here (e.g. transports on water between the Iberian Peninsula and Italy) or not transported anymore. For the different transalpine crossings, the introduction of the ACE leads to the following changes:

- **A – I/SLO**: Transalpine road freight transport volume is reduced by 14 Mill. tons/a (13% of total road freight volume on A – I/SLO corridors). 12 Mill. tons/a are shifted towards A – I/SLO rail corridors.
- **CH – I**: Transalpine road freight transport volume is reduced by 5 Mill. tons/a (31%). 9 Mill. tons/a are shifted towards CH – I rail corridors.
- **F – I**: Transalpine road freight transport volume is reduced by 7 Mill. tons/a (21%). 5 Mill. tons/a are shifted towards F – I rail corridors.

Overall, **total transalpine freight transport volume** (road and rail) is shifted from F – I (-5%) and A – I/SLO (-1.1% of total transalpine transport in BAU 2020) corridors towards CH – I corridors (+7.1%). Thus, in comparison with an ACE with single caps, the higher ACP price on A – I/SLO corridors necessary to reach the common cap mainly leads to a relocation of A – I/SLO road transport (-13% vs. -10% with single caps) towards CH – I rail corridors. Another reason for this impact is the opening of the Gotthard base tunnel and the corresponding productivity effects.

Modal split of road of total transalpine freight transport can be reduced by the introduction of the ACE with a common cap from 62% to 52% (same reduction as for an ACE with single caps).

The **number of total transalpine HGV trips** on road decreases from 12.4 Mill./a to 10.0 Mill./a: -17% on A – I/SLO, -34% on CH – I and -24% on F – I crossings (see Figure 12-10).

Thus, in comparison with an ACE with single caps, CH – I and to a lower extent also F – I benefit from the introduction of an ACE with a common cap from lower ACP prices and therefore from a lower necessity to reduce transalpine HGV trips. On the other hand, ACP prices and the reduction of transalpine road transport are higher on A – I/SLO corridors (esp. the Brenner corridor faces a higher reduction with a common cap).

Figure 8-3: ACE R 2020 A+CH+F (one limit): Transalpine freight transport 2020 in Alpine arch C, in 1'000 tons/a, Δ in 1'000 tons/a and Δ in %

ACE T 2020

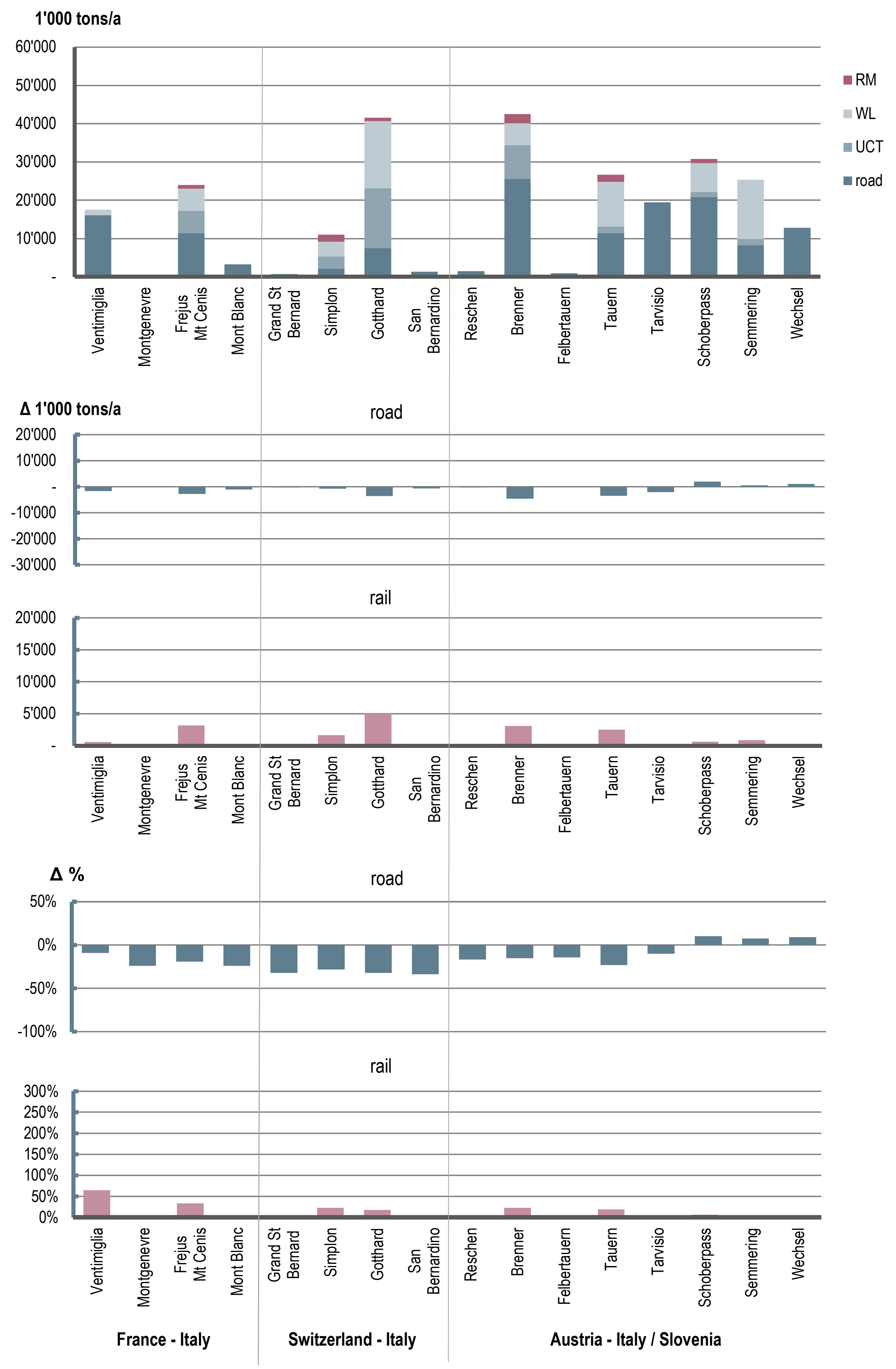
In scenario “ACE tolerant 2020” the caps for transalpine HGV trips of the introduced ACE and the resulting prices for Alpine crossing permits (ACP) per trip are as follows (for the prices see also Figure 8-30):

	Caps (incl. necessary reduction)	ACP prices
A – I/SLO	4.5 Mill./a (17% reduction of Alpine arch B+ volumes)	59 EUR/trip
CH – I	0.9 Mill./a (34% reduction)	93 EUR/trip
F – I	2.2 Mill./a (17% reduction)	79 EUR/trip

The introduction of the ACE with higher caps (900’000 HGV trips per year on CH – I corridors) leads to a reduction in total transalpine road freight transport volume of around 11% compared to BAU 2020 (see Figure 8-4 and the respective Figures in the Annex): From 161 to 143 Mill. tons/a.

The pattern of the shifting of transalpine transport between modes and corridors is very similar to the introduction of a more restrictive cap with 650’000 HGV trips per year on CH – I corridors (scenario “ACE R 2020”). Overall, the shifting effects are just smaller. Therefore, the results for scenario ACE T 2020 are not described in more detail. Instead we refer to the description of the results of the restrictive scenario and Figure 8-4.

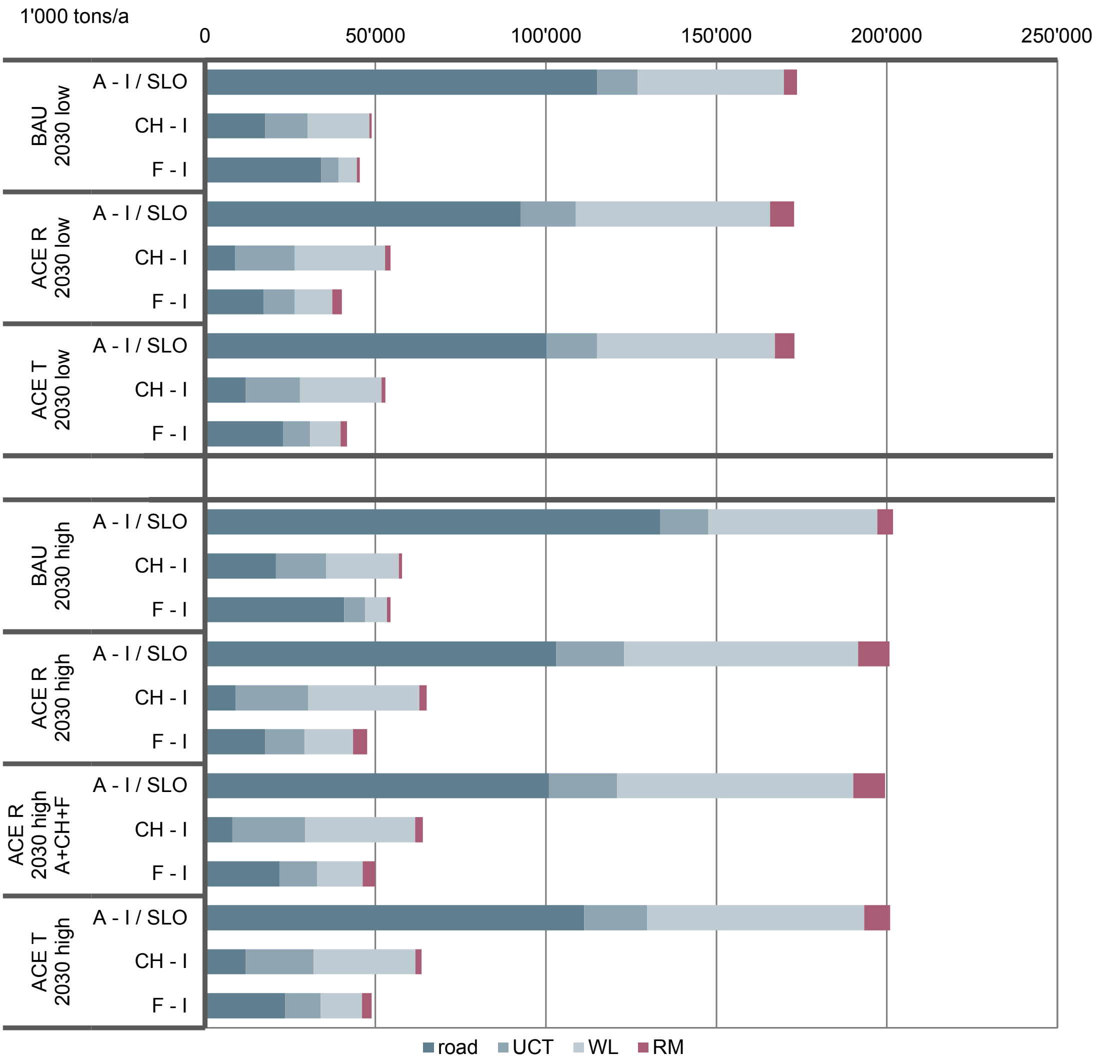
Figure 8-4: ACE T 2020: Transalpine freight transport 2020 in Alpine arch C, in 1'000 tons/a, Δ in 1'000 tons/a and Δ in %



b) 2030

In 2030 the introduction of an ACE also leads to a general shift of transalpine freight transport from road to rail. But the shifting is stronger due to the higher strength of the ACE caps chosen (same percentage reduction for all corridors). In all ACE scenarios for 2030, total transalpine transport volume decreases by only 0.2% (not transported through the Alps anymore, e.g. shifted to East-West relations or freight transports on water). The results of the ACE scenarios for 2030 (see Figure 8-5 for a general overview) are described more precisely on the following pages. However, the pattern of the shifting of transalpine transport between modes and corridors is very similar for 2030 high and 2030 low. Overall, the shifting effects are just smaller for 2030 with low growth in transalpine freight transport. Therefore, the results for the scenarios "ACE R 2030 low" and "ACE T 2030 low" are not described in more detail. Instead we refer to the description of the results of the 2030 high scenarios as well as Figure 8-9 and Figure 8-10 on page 161 and 162.

Figure 8-5: Transalpine freight traffic volumes for BAU and the ACE scenarios 2030 low and high, in 1'000 tons/a



ACE R 2030 high

In scenario "ACE restrictive 2030 high" the caps for transalpine HGV trips of the introduced ACE (same percentage reduction for all crossings) and the resulting prices for Alpine crossing permits (ACP) per trip are as follows (for the prices see also Figure 8-30):[83]

	Caps (incl. necessary reduction)	ACP prices
A – I/SLO	2.5 Mill./a (54% reduction of Alpine arch B+ volumes)	263 EUR/trip
CH – I	0.65 Mill./a (54% reduction)	269 EUR/trip
F – I	1.6 Mill./a (54% reduction)	345 EUR/trip

The introduction of the ACE leads to a reduction in total transalpine road freight transport volume on Alpine arch C of around 34% compared to BAU 2030 high (see Figure 8-6 and the respective Figure in the Annex): From 195 to 130 Mill. tons/a. The reduction of road transport volume on the different corridors is 23% on A – I/SLO, and 57% on CH – I and F – I corridors. Due to the same percentage reduction of transalpine road freight transport per country needed to reach the caps, the reduction is more equalized than in the 2020 scenarios (same percentage reduction on CH – I and F- I corridors). However, on A – I/SLO corridors the reduction is still a lot lower than on the other crossings because the ACE does not include the three easternmost transalpine A – I/SLO corridors (which leads to detouring on Schoberpass, Semmering and Wechsel). Compared to BAU 2030 high the number of transalpine lorries on those three corridors increases by 21%, whereas on the Western A – I/SLO corridors their number decreases by 61%. Nevertheless, road transport volume on the three A – I/SLO easternmost corridors remains increasing due to higher average lorry weight in 2030. In contrast, in case of lower growth in transalpine freight transport (scenario "ACE R 2030 low"), the number of transalpine lorries on the three easternmost corridors of Alpine arch C is still increasing by 18%, whereas on the Western A – I/SLO corridors it is decreasing by 54%. Consequently, even with an equal percentage reduction on all transalpine crossing in Alpine arch B+, the relocation effects from road to rail are not as high as they would be with an application of the ACE on the whole Alpine arch C.

Due to the higher road transport volumes and the stronger caps on A – I/SLO and F – I corridors compared to 2020 the **prices for ACP** are clearly higher in 2030 (see table above). Moreover, the prices are now highest on F – I crossings, followed by CH – I and A – I/SLO corridors with almost the same prices. The higher price for F – I corridors can be explained through their high modal split for road in the BAU scenarios (for BAU 2030 high: F – I: 75%, A – I/SLO: 66%, CH – I: 36%) and the possibility of A – I/SLO road freight transport to switch to the three free easternmost corridors. Additionally, it seems that road freight transport on F – I corridors is more inelastic than on CH – I and A – I/SLO corridors with respect to a modal shift from road to rail.

[83] The basis for the caps is the number of transalpine HGV trips within Alpine arch B+ in 2030 low: CH – I: 1.42 Mill. trips/a, A – I/SLO: 5.54 Mill. trips/a, F – I: 2.45 Mill. trips/a. This holds true for all 2020 ACE scenarios.

64.8 Mill. tons/a of the total reduction in transalpine road freight transport (65.5 Mill. tons/a) are shifted towards rail corridors. The residual 0.2% of total transport is shifted towards other transport modes not considered here (e.g. transports on water between the Iberian Peninsula and Italy) or not transported anymore. For the different transalpine crossings, the introduction of the ACE leads to the following changes:

- **A – I/SLO**: Transalpine road freight transport volume is reduced by 30 Mill. tons/a (23% of total road freight volume on A – I/SLO corridors). 29 Mill. tons/a are shifted towards A – I/SLO rail corridors.
- **CH – I**: Transalpine road freight transport volume is reduced by 12 Mill. tons/a (57%). 19 Mill. tons/a are shifted towards CH – I rail corridors.
- **F – I**: Transalpine road freight transport volume is reduced by 23 Mill. tons/a (57%). 16 Mill. tons/a are shifted towards F – I rail corridors.

Overall, **total transalpine freight transport volume** (road and rail) is shifted from F – I (-12.8% of total transalpine transport in BAU 2030) and A – I/SLO corridors (-0.5%) towards CH – I corridors (+12.6%). Thus, especially for some F – I road transport it is more attractive to shift towards CH – I rail corridors than on their own ones. It seems that despite the assumed opening of the new Mont Cenis base tunnel, especially the Gotthard rail corridor can attract additional traffic.

Modal split of road of total transalpine freight transport can be reduced by the introduction of an ACE with the same percentage reduction for all corridors within Alpine arch B+ from 62% to 41%.

The **number of total transalpine HGV trips** on road decreases from 15.1 Mill./a to 9.1 Mill./a: -30% on A – I/SLO, -61% on CH – I and -62% on F – I crossings (see Figure 12-10).

Figure 8-6: ACE R 2030 high: Transalpine freight transport 2030 in Alpine arch C, in 1'000 tons/a, Δ in 1'000 tons/a and Δ in %

ACE R 2030 high A+CH+F

In scenario "ACE restrictive 2030 high A+CH+F" the ACE is implemented with one single cap over the whole **Alpine arch B+**. This **common cap** of 4.3 Mill. transalpine HGV trips per year (sum of the individual caps in scenario "ACE R 2030 high") leads to an **ACP price of 280 EUR/trip** for all corridors within Alpine arch B+. Compared to scenario "ACE R 2030 high" with country/corridor specific caps, this price is higher for A – I/SLO and CH – I corridors and lower for F – I corridors.

The introduction of an ACE with a common cap leads to a similar reduction in total transalpine road freight transport volume as an ACE with single caps of around 33% compared to BAU 2030 high (see Figure 8-7 and the respective Figure in the Annex): From 161 to 131 Mill. tons/a. The reduction of road transport volume in case of a common cap for the whole Alpine arch B+ is still varying: 24% on A – I/SLO, 61% on CH – I and 47% on F – I corridors (compared to "ACE R 2030 high" the reduction increases on A – I/SLO and CH – I crossings and decreases on F – I crossings, because F – I crossing face a higher ACP price with single caps). Still on A – I/SLO the reduction remains lower than on F – I crossings because the ACE does not include the three easternmost transalpine A – I/SLO corridors (which leads to detouring on Schoberpass, Semmering and Wechsel). Compared to BAU 2030 high the number of transalpine lorries on those three corridors now increases by 22%, whereas on the Western corridors their number decreases by 64% (compared to 61% with country specific caps). Thus, a common cap leads to slightly more equalized relocation effects from road to rail within the Alpine area. But the effects would still be higher if the ACE would be introduced on the whole Alpine arch C.

63.6 Mill. tons/a of the total reduction in transalpine road freight transport (64.3 Mill. tons/a), are shifted towards rail corridors. The residual 0.2% of total transport is shifted towards other transport modes not considered here or not transported anymore. For the different transalpine crossings, the introduction of an ACE with a common cap leads to the following changes:

- **A – I/SLO**: Transalpine road freight transport volume is reduced by 33 Mill. tons/a (24% of total road freight volume on A – I/SLO corridors). 30 Mill. tons/a are shifted towards A – I/SLO rail corridors.
- **CH – I**: Transalpine road freight transport volume is reduced by 13 Mill. tons/a (61%). 19 Mill. tons/a are shifted towards CH – I rail corridors.
- **F – I**: Transalpine road freight transport volume is reduced by 19 Mill. tons/a (47%). 14 Mill. tons/a are shifted towards F – I rail corridors.

Overall, **total transalpine freight transport volume** (road and rail) is shifted from F – I (-8.4% of total transalpine transport in BAU 2030) and A – I/SLO corridors (-1.1%) towards CH – I corridors (+10.6%).

Modal split of road of total transalpine freight transport can be reduced by the introduction of the ACE with a common cap from 62% to 42% (similar reduction as for an ACE with single caps).

The **number of total transalpine HGV trips** on road decreases from 15.1 Mill./a to 9.1 Mill./a: -32% on A – I/SLO, -65% on CH – I and -51% on F – I crossings (see Figure 12-10). Thus, the introduction of an ACE with a common cap leads to a stronger reduction in the number of transalpine HGV on A – I/SLO and CH – I corridors. On the other hand, the reduction on F – I corridors is lower than with country/corridor specific caps. The reason for the lower reduction on F – I corridors is again their high modal split for road in the BAU scenarios (for BAU 2030 high: F – I: 75%, A – I/SLO: 66%, CH – I: 36%) and the possibility of A – I/SLO road freight transport to switch to the three free easternmost corridors.

Thus, in comparison with an ACE with single caps, F – I corridors benefit of the introduction of an ACE with a common cap from lower ACP prices and therefore from a lower necessity to reduce transalpine HGV trips. On the other hand, ACP prices and the reduction of transalpine HGV trips are higher on A – I/SLO and CH - I corridors.

Figure 8-7: ACE R 2030 high A+CH+F: Transalpine freight transport 2030 in Alpine arch C, in 1'000 tons/a, Δ in 1'000 tons/a and Δ in %

ACE T 2030 high

In scenario “ACE tolerant 2030 high” the caps for transalpine HGV trips of the introduced ACE and the resulting prices for Alpine crossing permits (ACP) per trip are as follows (for the prices see also Figure 8-30):

	Caps (incl. necessary reduction)	ACP prices
A – I/SLO	3.5 Mill./a (37% reduction of Alpine arch B+ volumes)	172 EUR/trip
CH – I	0.9 Mill./a (37% reduction)	178 EUR/trip
F – I	1.5 Mill./a (37% reduction)	229 EUR/trip

The introduction of the ACE with higher caps (900’000 HGV trips per year on CH – I corridors) leads to a reduction in total transalpine road freight transport volume of around 25% compared to BAU 2030 high (see Figure 8-8 and the respective Figure in the Annex): From 195 to 147 Mill. tons/a.

The pattern of the shifting of transalpine transport between modes and corridors is very similar to the introduction of a more restrictive cap with 650’000 HGV trips per year on CH – I corridors (scenario “ACR R 2030 high”). Overall, the shifting effects are just smaller. Therefore, the results for scenario ACE T 2030 high are not described in more detail. Instead we refer to the description of the results of the restrictive scenario and Figure 8-8.

Figure 8-8: ACE T 2030 high: Transalpine freight transport 2030 in Alpine arch C, in 1'000 tons/a, Δ in 1’000 tons/a and Δ in %

ACE R 2030 low and ACE T 2030 low

Figure 8-9: ACE R 2030 low: Transalpine freight transport 2030 in Alpine arch C, in 1'000 tons/a, Δ in 1'000 tons/a and Δ in %

Figure 8-10: ACE T 2030 low: Transalpine freight transport 2030 in Alpine arch C, in 1'000 tons/a, Δ in 1'000 tons/a and Δ in %

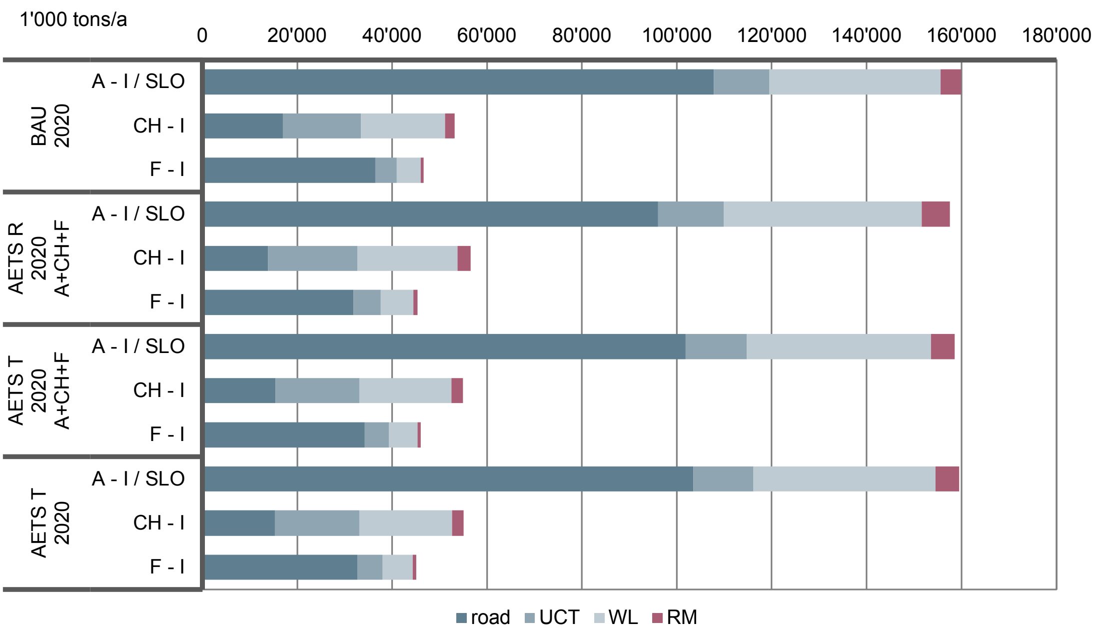
8.1.2 AETS

In TAMM, the reduction of CO_2-emissions due to the AETS is modeled as a percentage reduction of vehicle km (vkm) within the Alpine arch B+ (Alpine area according to the Alpine Convention). To reduce the vkm the TAMM calculates the necessary price of the AETS certificates per km within Alpine arch B+ that has to be paid by all transalpine HGV trips (see chapter 5.2 for a more detailed description of the modeling of AETS). The following chapters present the results for the analysed AETS scenarios for 2020 and 2030.

a) 2020

The introduction of an AETS system (reduction of CO_2-emissions through certificates) in 2020 leads to an overall shift of transalpine freight transport from road to rail, depending on the strength of the reduction target for CO_2-emissions chosen. However, the shifts are clearly lower than in the scenarios with an ACE (see chapter 8.1.1). In all three scenarios analyzed, total transalpine transport volume decreases by only 0.1% (not transported through the Alps anymore, e.g. shifted to East-West relations or freight transports on water). The results of the three AETS scenarios for 2020 (see Figure 8-11 for a general overview) are described more precisely on the following pages.

Figure 8-11: Transalpine freight traffic volumes for BAU and the AETS scenarios 2020, in 1'000 tons/a



AETS R 2020 A+CH+F

In scenario "AETS restrictive 2020 A+CH+F" the **20% reduction of CO_2-emissions** for transalpine HGV trips in Alpine arch B+ (corresponding to the respective area according to the Alpine Convention) leads to a price of AETS certificates of **0.23 EUR/km** (km within the Alpine Convention area in Alpine arch B+; for the prices per corridor see Figure 8-31).[84]

The introduction of an AETS system with 20% reduction of CO_2-emissions leads to a decrease in total transalpine road freight transport volume of around 12% compared to BAU 2020 (see Figure 8-12 and the respective Figure in the Annex): From 161 to 141 Mill. tons/a. The reduction of road transport volume is varying between corridors: 11% on A – I/SLO, 19% on CH – I and 13% on F – I corridors. On A – I/SLO the reduction is lower than on the other crossings because the AETS does not include the three easternmost transalpine A – I/SLO corridors (which leads to detouring on Schoberpass, Semmering and Wechsel). The number of transalpine lorries on those three corridors increases by 12%, whereas on the Western corridors their number decreases by 23%. Consequently, the relocation effects from road to rail are not as high as they would be with an application of the AETS on the whole Alpine arch C. Furthermore, the reduction on F – I corridors is lower than on CH – I corridors. Again it seems that road freight transport on F – I corridors is more inelastic than on CH – I and A – I/SLO corridors with respect to a modal shift from road to rail.

19.7 Mill. tons/a of the total reduction in transalpine road freight transport (19.4 Mill. tons/a) are shifted towards rail corridors. The residual 0.1% of total transport is shifted towards other transport modes not considered here or not transported anymore. For the different transalpine crossings, the introduction of the AETS leads to the following changes:

- **A – I/SLO**: Transalpine road freight transport volume is reduced by 12 Mill. tons/a (11% of total road freight volume on A – I/SLO corridors). 9 Mill. tons/a are shifted towards A – I/SLO rail corridors.
- **CH – I**: Transalpine road freight transport volume is reduced by 3 Mill. tons/a (19%). 7 Mill. tons/a are shifted towards CH – I rail corridors.
- **F – I**: Transalpine road freight transport volume is reduced by 5 Mill. tons/a (13%). 3 Mill. tons/a are shifted towards F – I rail corridors.

Overall, **total transalpine freight transport volume** (road and rail) is shifted from A – I/SLO (-1.5% of total transalpine transport in BAU 2020) and F – I corridors (-2.7%) towards CH – I corridors (+6.3%). Thus, it can be assumed that for some F – I and A – I/SLO road transport it is more attractive to shift towards CH – I rail corridors than on their own ones. This seems plausible as in 2020 the new Gotthard base tunnel is in operation.

Modal **split of road** of total transalpine freight transport can be reduced by the introduction of the AETS from 62% to 55%.

The **number of total transalpine HGV trips** on road decreases from 12.4 Mill./a to 10.9 Mill./a: -11% on A – I/SLO, -19% on CH – I and -13% on F – I crossings (see Figure 12-21).

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[84] For the relevant distances per transalpine corridor see chapter 5.2.2. As mentioned earlier (see chapter 5.2.1) we assume that there will be no changes in the existing road tolls due to the introduction of new instruments (i.e. an ACE, AETS or TOLL+ would be introduced on top of the existing mechanisms).

Figure 8-12: AETS R 2020 A+CH+F: Transalpine freight transport 2020 in Alpine arch C, in 1'000 tons/a, Δ in 1'000 tons/a and Δ in %

AETS T 2020 A+CH+F

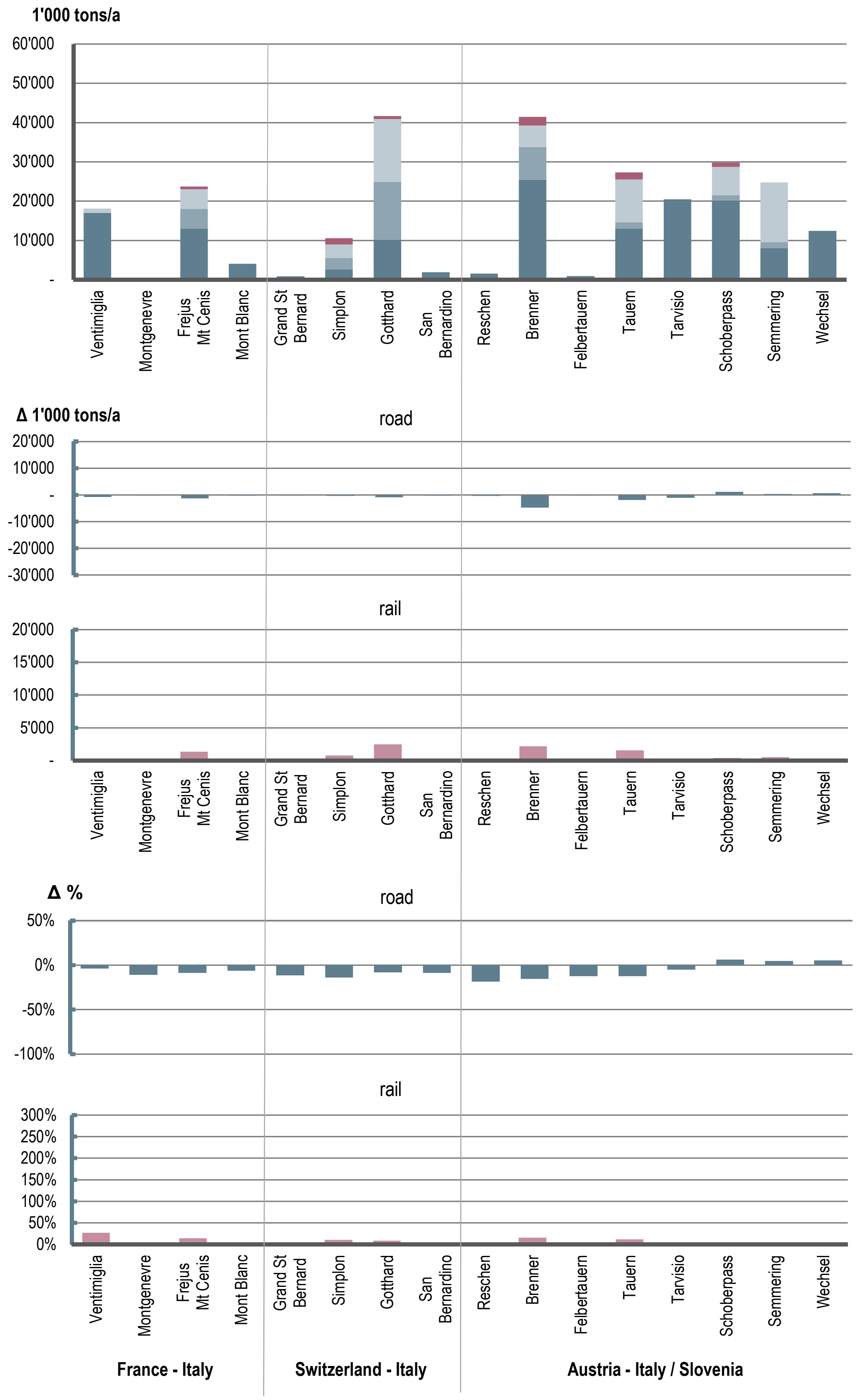
In scenario "AETS tolerant 2020 A+CH+F" the **10% reduction of CO_2-emissions** for transalpine HGV trips in Alpine arch B+ (corresponding to the respective area according to the Alpine Convention) leads to a price of AETS certificates of **0.11 EUR/km** (km within the Alpine Convention area in Alpine arch B+; for the resulting prices per corridor see Figure 8-31).[85]

The introduction of the AETS with a lower target for the overall reduction of CO_2-emissions leads to a reduction in total transalpine road freight transport volume of around 6% compared to BAU 2020 (see Figure 8-13 and the respective Figure in the Annex): From 161 to 152 Mill. tons/a.

The pattern of the shifting of transalpine transport between modes and corridors is very similar to the introduction of a more restrictive AETS system with a 20% reduction of CO_2-emissions (scenario "AETS R 2020 A+CH+F"). Overall, the shifting effects are just smaller. Therefore, the results for scenario AETS T 2020 A+CH+F are not described in more detail. Instead we refer to the description of the results of the restrictive scenario above and Figure 8-13.

85 For the relevant distances per transalpine corridor see chapter 5.2.2.

Figure 8-13: AETS T 2020 A+CH+F: Transalpine freight transport 2020 in Alpine arch C, in 1'000 tons/a, Δ in 1'000 tons/a and Δ in %



AETS T 2020

In scenario “AETS tolerant 2020” the AETS system is implemented with **country specific targets for the reduction of CO_2-emissions** (i.e. on each of the three groups of transalpine corridors (A – I/SLO, CH – I and F – I) CO_2-emissions have to be reduced by **10%**). This leads to the following prices for the country specific AETS certificates (km within the Alpine Convention area in Alpine arch B+; for the resulting prices per corridor see Figure 8-31):[86]

	AETS prices
A – I/SLO	0.09 EUR/km
CH – I	0.12 EUR/km
F – I	0.16 EUR/km

Compared to scenario “AETS T 2020 A+CH+F” with one single reduction target for Alpine arch B+, the AETS prices are lower for A – I/SLO and higher for CH – I and F – I corridors.

The introduction of an AETS with country specific reduction targets leads to a decrease in total transalpine road freight transport volume of around 6% compared to BAU 2020 (see Figure 8-14 and the respective Figure in the Annex): From 161 to 151 Mill. tons/a.

In comparison with a tolerant AETS with one single reduction target, the reduction of road transport volume is slightly higher (1 Mill. ton/a) but remains varying: 4% on A – I/SLO, 10% on CH – I and 10% on F – I corridors (the reduction decreases on A – I/SLO crossings and increases on CH – I and more significantly on F – I crossings, because A – I/SLO crossings face a lower AETS price with a single reduction target). Additionally, the reduction on A – I/SLO is also lower than on the other crossings because the AETS does not include the three easternmost transalpine A – I/SLO corridors (which leads to detouring of A – I/SLO road transport over Schoberpass, Semmering and Wechsel). The number of transalpine lorries on those three corridors now increases by 5%, whereas on the Western corridors their number decreases by 9% (compared to 12% with one single reduction target).

9.6 Mill. tons/a of the total reduction in transalpine road freight transport (9.8 Mill. tons/a), are shifted towards rail corridors. The residual 0.1% of total transport is shifted towards other transport modes not considered here (e.g. transports on water between the Iberian Peninsula and Italy) or not transported anymore. For the different transalpine crossings, the introduction of the AETS leads to the following changes:

- **A – I/SLO**: Transalpine road freight transport volume is reduced by 4 Mill. tons/a (4% of total road freight volume on A – I/SLO corridors). 4 Mill. tons/a are shifted towards A – I/SLO rail corridors..
- **CH – I**: Transalpine road freight transport volume is reduced by 2 Mill. tons/a (10%). 3.5 Mill. tons/a are shifted towards CH – I rail corridors.

[86] For the relevant distances per transalpine corridor see chapter 5.2.2.

- **F – I**: Transalpine road freight transport volume is reduced by 4 Mill. tons/a (10%). 2 Mill. tons/a are shifted towards F – I rail corridors.

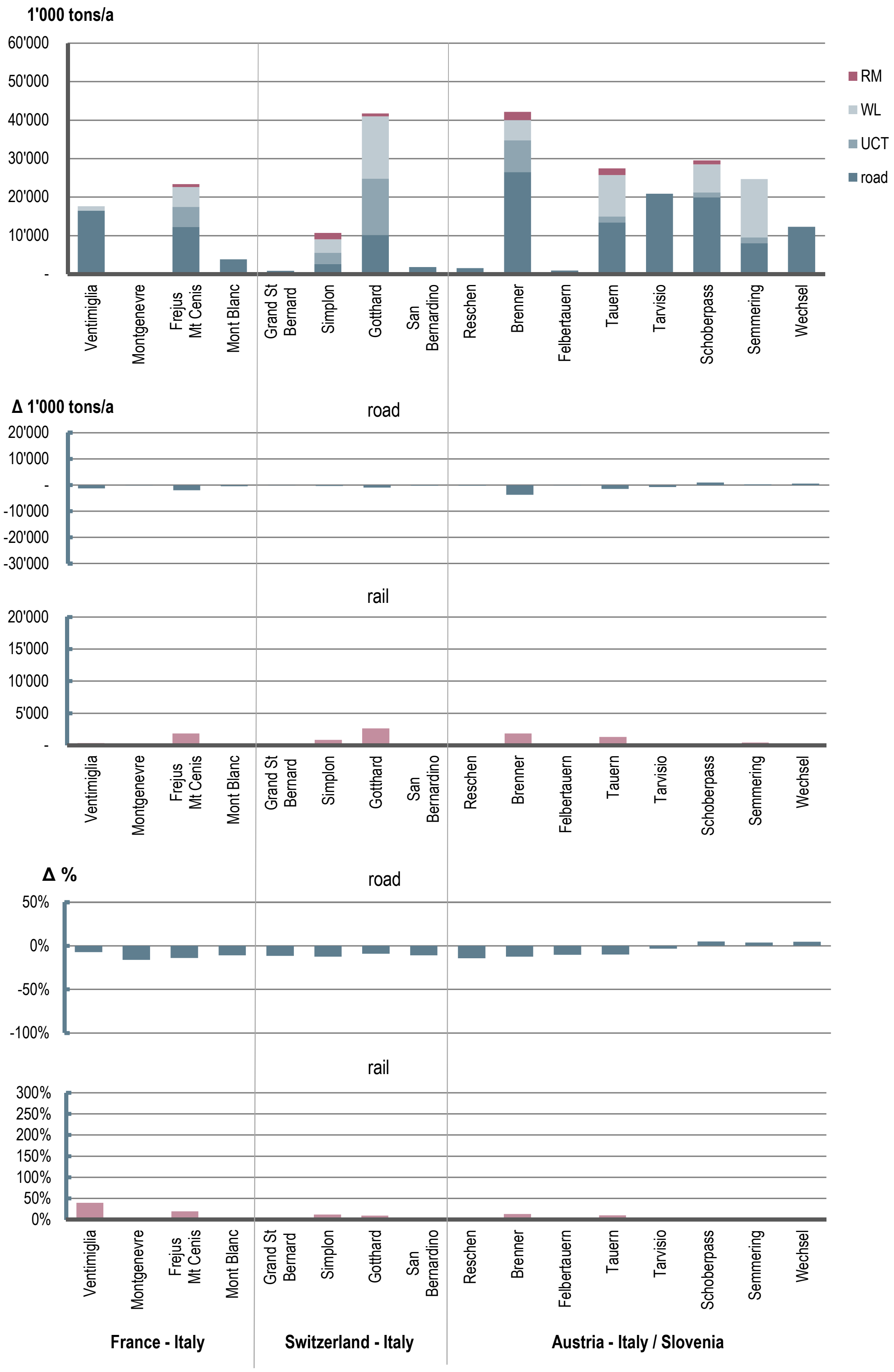
Overall, **total transalpine freight transport volume** (road and rail) is shifted from F – I (-3.4% of total transalpine transport in BAU 2020) and A – I/SLO (-0.3%) corridors towards CH – I corridors (+3.4%). With CO_2-reduction targets to be fulfilled by every country by itself, the relatively inelastic road freight demand on F – I corridors causes a higher price per km (from 0.11 EUR/km to 0.16 EUR/km) on these corridors and thus a higher shift from road to rail.

Modal split of road of total transalpine freight transport can be reduced by the introduction of the AETS with country specific caps from 62% to 58% (same reduction as for an AETS with a common reduction target).

The **number of total transalpine HGV trips** on road decreases from 12.4 Mill./a to 11.7 Mill./a: -4% on A – I/SLO, -10% on CH – I and -10% on F – I crossings (see Figure 12-21).

Thus, in comparison with an AETS with one common reduction target for CO_2-emissions, A – I/SLO corridors benefit of the introduction of an AETS with country specific reduction targets cap from lower AETS prices and therefore from a lower necessity to reduce transalpine HGV trips. On the other hand, AETS prices and the reduction of transalpine road transport are higher on CH – I and F – I corridors.

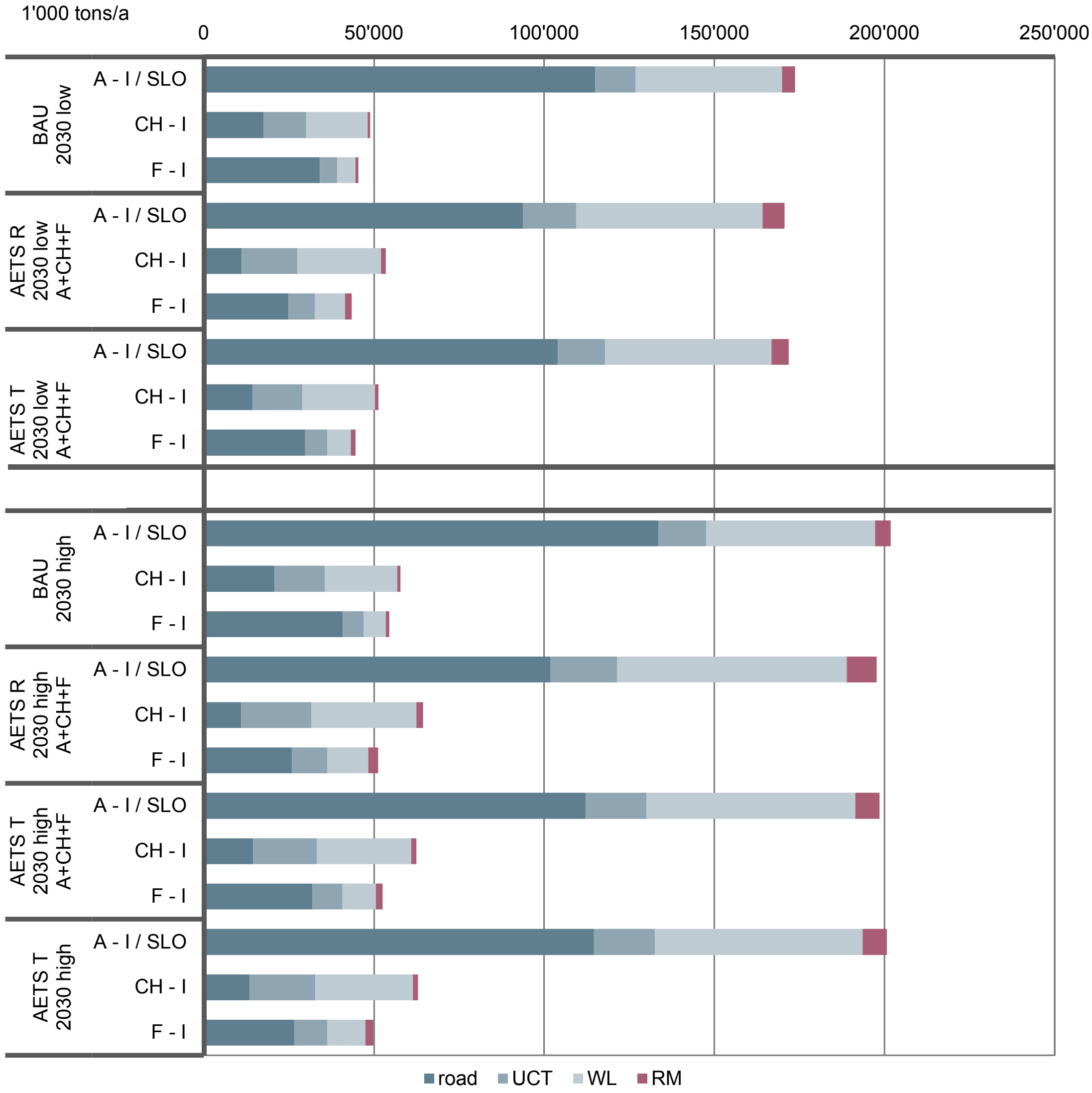
Figure 8-14: AETS T 2020: Transalpine freight transport 2020 in Alpine arch C, in 1'000 tons/a, Δ in 1'000 tons/a and Δ in %



b) 2030

In 2030 the introduction of an AETS system also leads to a general shift of transalpine freight transport from road to rail. But the shifting is stronger due to the higher reduction targets for CO_2-emissions (40% instead of 20% in case of the restrictive instrument). However, the shifts are still lower than in the respective 2030 high scenarios with an ACE (see chapter 8.1.1). In all AETS scenarios for 2030, total transalpine transport volume decreases by only 0.1% - 0.2% (not transported through the Alps anymore, e.g. shifted to East-West relations or freight transports on water). The results of the AETS scenarios for 2030 (see Figure 8-15 for a general overview) are described more precisely on the following pages. However, the pattern of the shifting of transalpine freight transport between modes and corridors is very similar for 2030 high and 2030 low. Overall, the shifting effects are just smaller for 2030 with low growth in transalpine freight transport. Therefore, the results for the scenarios “AETS R 2030 low A+CH+F” and “AETS T 2030 low A+CH+F” are not described in more detail. Instead we refer to the description of the results of the 2030 high scenarios as well as Figure 8-19 and Figure 8-20 on page 181 and 180.

Figure 8-15: **Transalpine freight traffic volumes for BAU and the AETS scenarios 2030 low and high, in 1'000 tons/a**



AETS R 2030 high A+CH+F

In scenario “AETS restrictive 2030 high A+CH+F” the **40% reduction of CO_2-emissions** for transalpine HGV trips in Alpine arch B+ (corresponding to the respective area according to the Alpine Convention) leads to a price of AETS certificates of **0.70 EUR/km** (km within the Alpine Convention area in Alpine arch B+; for the resulting prices per corridor see Figure 8-31).[87] This AETS price is clearly higher than the price for the respective 2020 AETS scenario.

[87] For the relevant distances per transalpine corridor see chapter 5.2.2.

The introduction of an AETS system with 40% reduction of CO_2-emissions leads to a decrease in total transalpine road freight transport volume of around 29% compared to BAU 2030 high (see Figure 8-16 and the respective Figure in the Annex): From 195 to 139 Mill. tons/a. The reduction of road transport volume is varying between corridors: 24% on A – I/SLO, 47% on CH – I and 37% on F – I corridors. On A – I/SLO the reduction again is lower than on the other crossings because the AETS does not include the three easternmost transalpine A – I/SLO corridors (which leads to detouring on Schoberpass, Semmering and Wechsel). Compared to BAU 2030 high the number of transalpine lorries on those three corridors increases by 30%, whereas on the Western A – I/SLO corridors their number decreases by 57%. Consequently, the relocation effects from road to rail are not as high as they would be with an application of the AETS on the whole Alpine arch C. Furthermore, the reduction on F – I corridors is lower than on CH – I corridors because they clearly have the highest modal split for road in BAU 2030 high.

55.7 Mill. tons/a of the total reduction in transalpine road freight transport (56.3 Mill. tons/a) are shifted towards rail corridors. The residual 0.2% of total transport is shifted towards other transport modes not considered here (e.g. transports on water between the Iberian Peninsula and Italy) or not transported anymore. For the different transalpine crossings, the introduction of the AETS leads to the following changes:

- **A – I/SLO**: Transalpine road freight transport volume is reduced by 32 Mill. tons/a (24% of total road freight volume on A – I/SLO corridors). 28 Mill. tons/a are shifted towards A – I/SLO rail corridors.
- **CH – I**: Transalpine road freight transport volume is reduced by 10 Mill. tons/a (47%). 17 Mill. tons/a are shifted towards CH – I rail corridors.
- **F – I**: Transalpine road freight transport volume is reduced by 15 Mill. tons/a (37%). 12 Mill. tons/a are shifted towards F – I rail corridors.

Overall, **total transalpine freight transport volume** (road and rail) is shifted from A – I/SLO (-2% of total transalpine transport in BAU 2030) and F – I corridors (-6%) towards CH – I corridors (+12%). Thus, it can be assumed that for some F – I and A – I/SLO road transport it is more attractive to shift towards CH – I than on their rail corridors. Despite the assumed opening of the new Mont Cenis and Brenner base tunnels, especially the Gotthard rail corridor can attract additional traffic.

Modal split of road of total transalpine freight transport can be reduced by the introduction of the AETS from 62% to 44%.

The **number of total transalpine HGV trips** on road decreases from 15.1 Mill./a to 10.7 Mill./a: -24% on A – I/SLO, -47% on CH – I and -36% on F – I crossings (see Figure 12-21).

Figure 8-16: AETS R 2030 high A+CH+F: Transalpine freight transport 2030 in Alpine arch C, in 1'000 tons/a, Δ in 1'000 tons/a and Δ in %

AETS T 2030 high A+CH+F

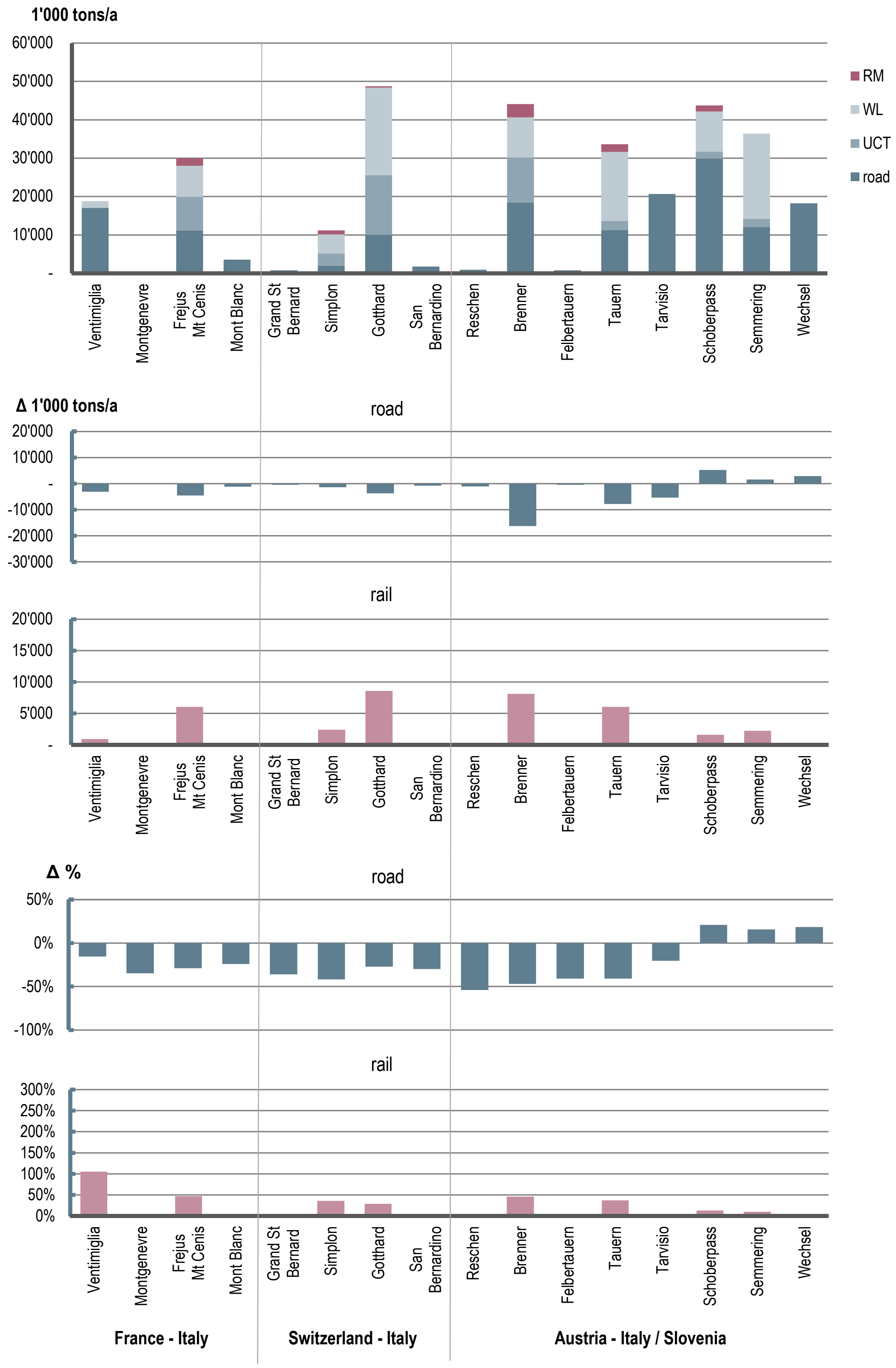
In scenario "AETS tolerant 2030 high A+CH+F" the **20% reduction of CO_2-emissions** for transalpine HGV trips in Alpine arch B+ (corresponding to the respective area according to the Alpine Convention) leads to a price of AETS certificates of **0.40 EUR/km** (km within the Alpine Convention area in Alpine arch B+; for the resulting prices per corridor see Figure 8-31).[88]

The introduction of the AETS with a lower target for the overall reduction of CO_2-emissions leads to a reduction in total transalpine road freight transport volume of around 19% compared to BAU 2030 high (see Figure 8-17 and the respective Figure in the Annex): From 195 to 159 Mill. tons/a.

The pattern of the shifting of transalpine transport between modes and corridors is very similar to the introduction of a more restrictive AETS system with a 40% reduction of CO_2-emissions (scenario "AETS R 2030 high A+CH+F"). Overall, the shifting effects are just smaller. Therefore, the results for scenario AETS T 2030 high A+CH+F are not described in more detail. Instead we refer to the description of the results of the restrictive scenario above and Figure 8-17.

[88] For the relevant distances per transalpine corridor see chapter 5.2.2.

Figure 8-17: AETS T 2030 high A+CH+F: Transalpine freight transport 2030 in Alpine arch C, in 1'000 tons/a, Δ in 1'000 tons/a and Δ in %



AETS T 2030 high

In scenario "AETS tolerant 2030 high" the AETS system is implemented with **country specific targets for the reduction of CO_2-emissions** (i.e. on each of the three groups of transalpine corridors (A – I/SLO, CH – I and F – I) CO_2-emissions have to be reduced by **20%**). This leads to the following prices for the country specific AETS certificates (km within the Alpine Convention area in Alpine arch B+; for the resulting prices per corridor see Figure 8-31):[89]

	AETS prices
A – I/SLO	0.38 EUR/km
CH – I	0.48 EUR/km
F – I	0.60 EUR/km

Compared to scenario "AETS T 2030 high A+CH+F" with one single reduction target for Alpine arch B+, the AETS prices are lower for A – I/SLO and higher for CH – I and F – I corridors.

The introduction of an AETS with country specific reduction targets in 2030 leads to a decrease in total transalpine road freight transport volume of around 20% compared to BAU 2030 high (see Figure 8-18 and the respective Figure in the Annex): From 195 to 155 Mill. tons/a.

In comparison with a tolerant AETS with one single reduction target, the reduction of road transport volume is slightly higher (4 Mill. ton/a) but remains varying: 14.% on A – I/SLO, 35% on CH – I and 35% on F – I corridors (the reduction decreases slightly on A – I/SLO crossings and increases on CH – I and more significantly on F – I crossings, because A – I/SLO crossings face a lower AETS price with a single reduction target). Additionally, the reduction on A – I/SLO is again also lower than on the other crossings because the AETS does not include the three easternmost transalpine A – I/SLO corridors (which leads to detouring of A – I/SLO road transport over Schoberpass, Semmering and Wechsel). The number of transalpine lorries on those three corridors now increases by 19%, whereas on the Western corridors their number decreases by 34% (compared to 37% with one single reduction target).

19.9 Mill. tons/a of the total reduction in transalpine road freight transport (40.4 Mill. tons/a), are shifted towards rail corridors. The residual 0.2% of total transport is shifted towards other transport modes not considered here (e.g. transports on water between the Iberian Peninsula and Italy) or not transported anymore. For the different transalpine crossings, the introduction of the AETS leads to the following changes:

[89] For the relevant distances per transalpine corridor see chapter 5.2.2.

- **A – I/SLO**: Transalpine road freight transport volume is reduced by 19 Mill. tons/a (14% of total road freight volume on A – I/SLO corridors). 18 Mill. tons/a are shifted towards A – I/SLO rail corridors.
- **CH – I**: Transalpine road freight transport volume is reduced by 7 Mill. tons/a (35%). 13 Mill. tons/a are shifted towards CH – I rail corridors.
- **F – I**: Transalpine road freight transport volume is reduced by 14 Mill. tons/a (35%). 10 Mill. tons/a are shifted towards F – I rail corridors.

Overall, **total transalpine freight transport volume** (road and rail) is shifted from F – I (-8.5% of total transalpine transport in BAU 2030) and A – I/SLO (-0.6%) corridors towards CH – I corridors (+9%). Again, with CO_2-reduction targets to be fulfilled by every country by itself, the relatively inelastic road freight demand on F – I corridors causes a higher price per km (from 0.40 EUR/km to 0.60 EUR/km) on these corridors and thus a higher shift from road to rail.

Modal split of road of total transalpine freight transport can be reduced by the introduction of the AETS with a country specific cap from 62% to 49%.

The **number of total transalpine HGV trips** on road decreases from 15.1 Mill./a to 12 Mill./a: -14% on A – I/SLO, -35% on CH – I and -35% on F – I crossings (see Figure 12-21).

Thus, in comparison with an AETS with one common reduction target for CO_2-emissions, A – I/SLO corridors benefit of the introduction of an AETS with country specific reduction targets from lower AETS prices and therefore from a lower necessity to reduce transalpine HGV trips. On the other hand, AETS prices and the reduction of transalpine road transport are higher on CH – I and F – I corridors.

Figure 8-18: AETS T 2030 high: Transalpine freight transport 2030 in Alpine arch C, in 1'000 tons/a, Δ in 1'000 tons/a and Δ in %

AETS R 2030 low A+CH+F and AETS T 2030 low A+CH+F

Figure 8-19: AETS R 2030 low A+CH+F: Transalpine freight transport 2030 in Alpine arch C, in 1'000 tons/a, Δ in 1'000 tons/a and Δ in %

Figure 8-20: AETS T 2030 low A+CH+F: Transalpine freight transport 2030 in Alpine arch C, in 1'000 tons/a, Δ in 1'000 tons/a and Δ in %

8.1.3 TOLL+

In contrast to AETS, the prices per km for TOLL+ are set in TAMM in advance as a fixed toll which has to be paid for all transalpine HGV within Alpine arch B+ (i.e. the prices per km are not calculated by the model as for AETS). The **TOLL+ price per km** (one common price for all crossings within Alpine arch B+) thereby corresponds to the **average price per km of the respective ACE R and AETS R A+CH+F scenarios** (depending on the year examined). To produce one single price for the three groups of transalpine crossings (A – /SLO, CH – I and F – I)

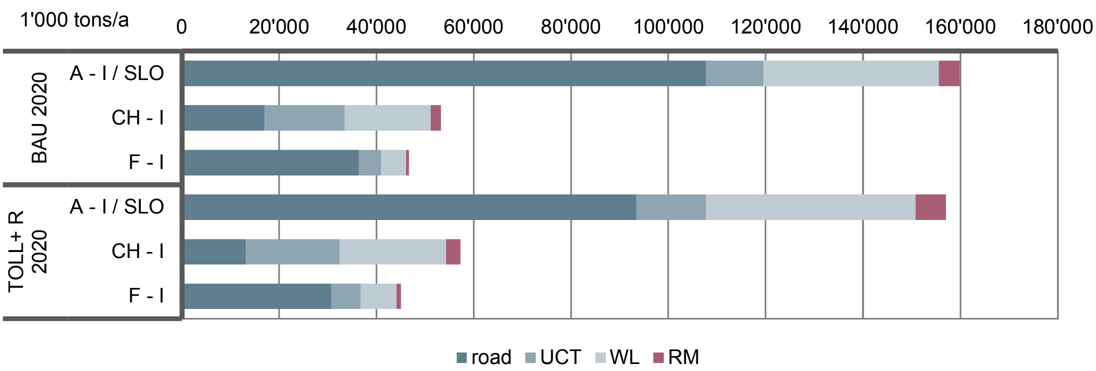
- the average ACP price per km is weighted by the transported volumes per corridor and divided by the average distance of each of the three groups of corridors,
- the average AETS price per km is weighted by the transported volumes and the average AETS price per trip for each of the three groups of corridors.

The following chapters present the results for the analyzed TOLL+ scenarios for 2020 and 2030.

a) 2020

The introduction of a TOLL+ system with a common fixed price per km for all crossings in 2020 also leads to an overall shift of transalpine freight transport from road to rail. The resulting shifts are higher than in the respective AETS scenario but slightly lower than in the scenario with an ACE (modal splits for road: TOLL+: 53%, AETS: 55%, ACE: 52%; see chapter 8.1.2 and 8.1.1). In scenario TOLL+ R 2020, total transalpine transport volume decreases by only 0.1% (not transported through the Alps anymore, e.g. shifted to East-West relations or freight transports on water). The results of the scenario for 2020 (see Figure 8-22 for a general overview) are described more precisely on the following pages.

Figure 8-21: Transalpine freight traffic volumes for BAU and the TOLL+ scenarios 2020, in 1'000 tons/a



TOLL+ R 2020

The fixed TOLL+ price for transalpine HGV trips within Alpine arch B + in scenario “TOLL+ restrictive 2020” amounts to **0.29 EUR/km** (km within the Alpine Convention area in Alpine arch B+; for the resulting prices per corridor see Figure 8-32).[90]

The introduction of TOLL+ leads to a decrease in total transalpine road freight transport volume of around 15% compared to BAU 2020 (see Figure 8-22 and the respective Figure in the Annex): From 161 to 137 Mill. tons/a. In spite of the same price for all crossing within Alpine arch B+ the reduction of road transport volume is varying: 13% on A – I/SLO, 23% on CH – I and 16% on F – I corridors. On A – I/SLO the reduction is lower than on the other crossings because also the TOLL+ does not include the three easternmost transalpine A – I/SLO corridors (which leads to detouring on Schoberpass, Semmering and Wechsel). The number of transalpine lorries on those three corridors increases by 14%, whereas on the Western corridors their number decreases by 29%. Consequently, the relocation effects from road to rail are not as high as they would be with an application of the TOLL+ on the whole Alpine arch C. Furthermore, the reduction on F – I corridors is lower than on CH – I corridors because they clearly have the highest modal split for road in BAU 2020.

23.6 Mill. tons/a of the total reduction in transalpine road freight transport (24 Mill. tons/a) are shifted towards rail corridors. The residual 0.1% of total transport is shifted towards other transport modes not considered here or not transported anymore. For the different transalpine crossings, the introduction of the TOLL+ leads to the following changes:

- **A – I/SLO**: Transalpine road freight transport volume is reduced by 14 Mill. tons/a (13% of total road freight volume on A – I/SLO corridors). 11 Mill. tons/a are shifted towards A – I/SLO rail corridors.
- **CH – I**: Transalpine road freight transport volume is reduced by 4 Mill. tons/a (23%). 8 Mill. tons/a are shifted towards CH – I rail corridors.
- **F – I**: Transalpine road freight transport volume is reduced by 5 Mill. tons/a (16%). 6 Mill. tons/a are shifted towards F – I rail corridors.

Overall, **total transalpine freight transport volume** (road and rail) is shifted from A – I/SLO (-1.8% of total transalpine transport in BAU 2020) and F – I corridors (-3.4%) towards CH – I corridors (+7.7%). Thus, for some F – I and A – I/SLO road transport it is more attractive to shift towards CH – I than on their rail corridors (taking also into account the possibility of detouring via the Eastern A – I/SLO corridors). One of the reasons for this effect is the opening of the Gotthard rail base tunnel.

Modal split of road of total transalpine freight transport can be reduced by the introduction of the TOLL+ from 62% to 53%.

The **number of total transalpine HGV trips** on road decreases from 12.4 Mill./a to 10.6 Mill./a: -13% on A – I/SLO, -23% on CH – I and -16% on F – I crossings (see Figure 12-32).

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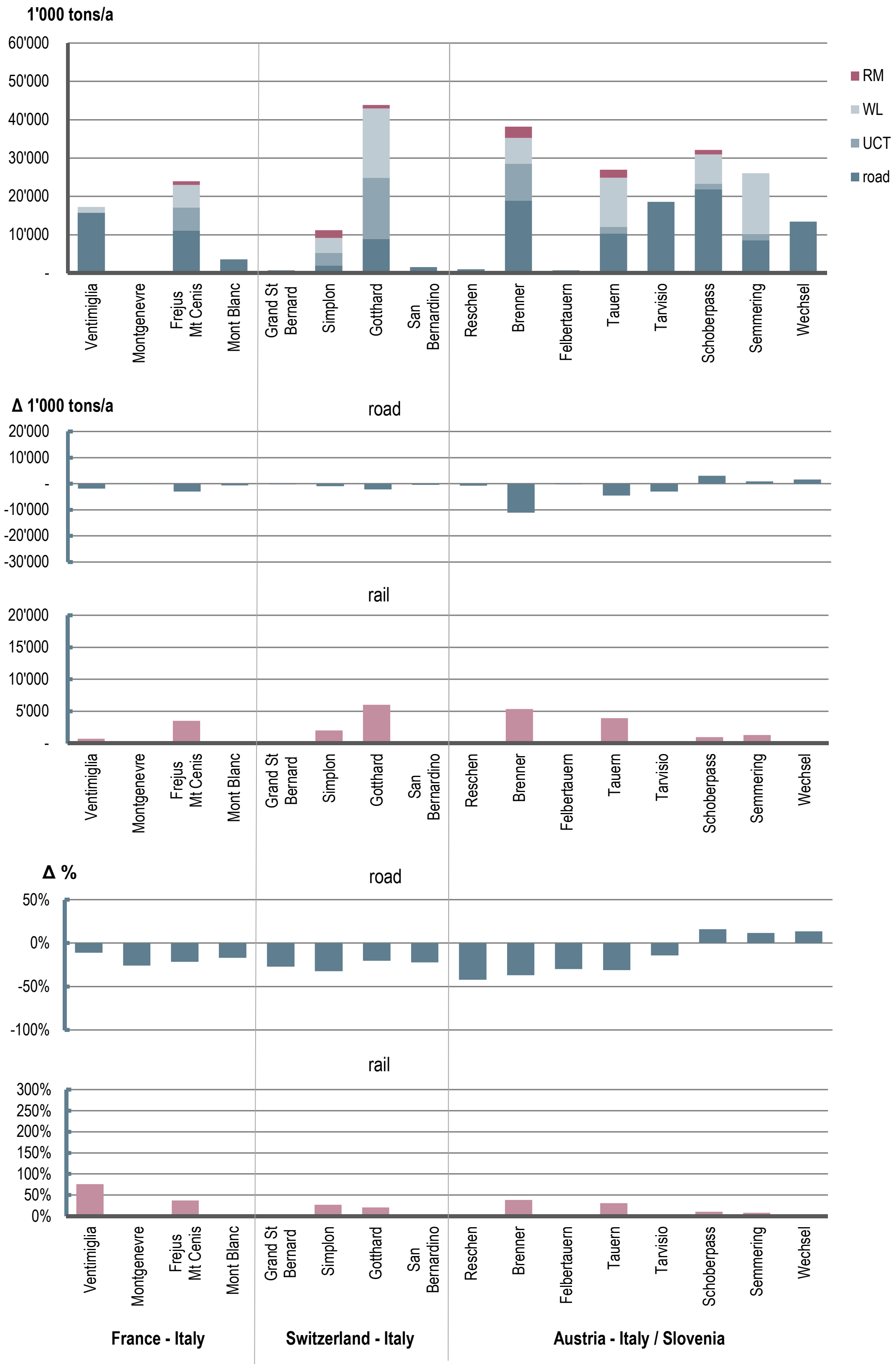
90 For the relevant distances per transalpine corridor see chapter 5.2.2.

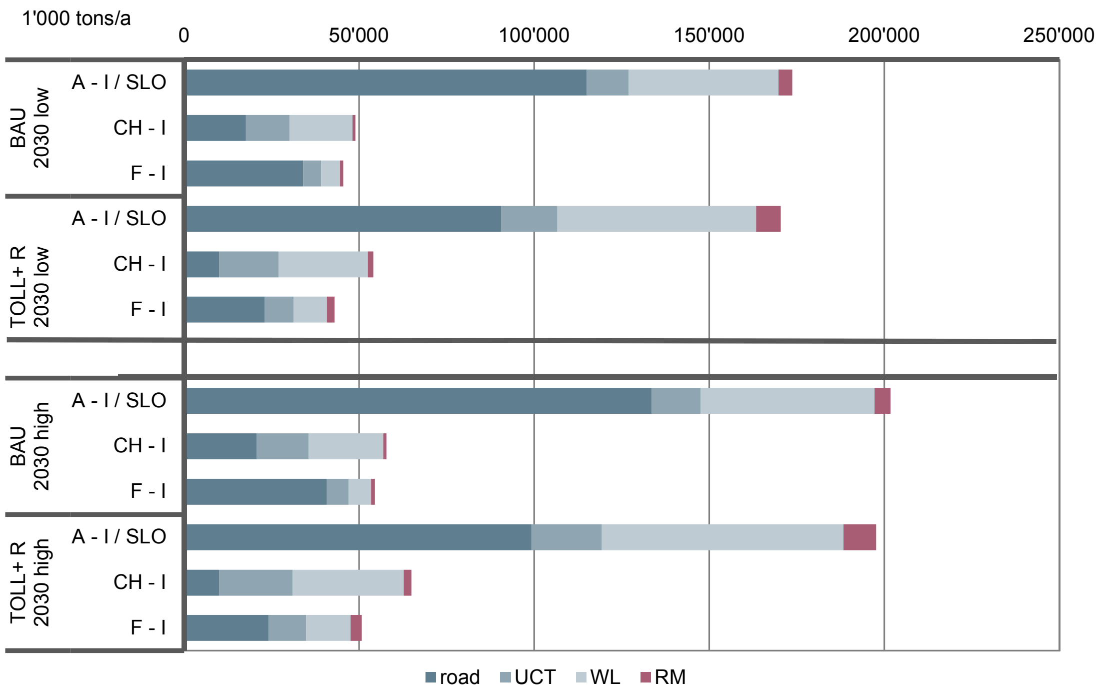
Figure 8-22: TOLL+ R 2020: Transalpine freight transport 2020 in Alpine arch C, in 1'000 tons/a, Δ in 1'000 tons/a and Δ in %



b) 2030

The introduction of a TOLL+ system with a common fixed price per km for all crossings in 2030 also leads to an overall shift of transalpine freight transport from road to rail. The resulting shifts are clearly higher than in the respective AETS scenario but slightly lower than in the scenario with an ACE (modal splits for road for the 2030 high scenarios: TOLL+: 43%, AETS: 51%, ACE: 41%; see chapter 8.1.2 and 8.1.1). In the TOLL+ scenarios in 2030, total transalpine transport volume decreases by only 0.2% (not transported through the Alps anymore, e.g. shifted to East-West relations or freight transports on water). The results of the scenarios for 2030 (see Figure 8-23 for a general overview) are described more precisely on the following pages. However, the pattern of the shifting of transalpine freight transport between modes and corridors is very similar for 2030 high and 2030 low. Overall, the shifting effects are just smaller for 2030 with low growth in transalpine freight transport. Therefore, the results for scenario “TOLL+ R 2030 low” are not described in more detail. Instead we refer to the description of the results of the 2030 high scenario as well as Figure 8-25 on page 188 and the respective figure in the Annex.

Figure 8-23: Transalpine freight traffic volumes for BAU and the TOLL+ scenarios 2030 low and high, in 1'000 tons/a



TOLL+ R 2030 high

The fixed TOLL+ price for transalpine HGV trips within Alpine arch B + in scenario "TOLL+ restrictive 2030 high" amounts to **0.80 EUR/km** (km within the Alpine Convention area in Alpine arch B+; for the resulting prices per corridor see Figure 8-32).[91]

The introduction of TOLL+ leads to a decrease in total transalpine road freight transport volume of around 32% compared to BAU 2030 high (see Figure 8-24 and the respective Figure in the Annex): From 195 to 133 Mill. tons/a. In spite of the same price for all crossing within Alpine arch B+ the reduction of road transport volume is varying: 26% on A – I/SLO, 52% on CH – I and 41% on F – I corridors. On A – I/SLO the reduction is lower than on the other crossings because also the TOLL+ does not include the three easternmost transalpine A – I/SLO corridors (which leads to detouring on Schoberpass, Semmering and Wechsel). The number of transalpine lorries on those three corridors increases by 34%, whereas on the Western corridors their number decreases by 62%. Consequently, the relocation effects from road to rail are not as high as they would be with an application of the TOLL+ on the whole Alpine arch C. Furthermore, the reduction on F – I corridors is lower than on CH – I corridors because they clearly have the highest modal split for road in BAU 2030 high.

61 Mill. tons/a of the total reduction in transalpine road freight transport (61.7 Mill. tons/a) are shifted towards rail corridors. The residual 0.2% of total transport is shifted towards other transport modes not considered here or not transported anymore. For the different transalpine crossings, the introduction of TOLL+ leads to the following changes:

- **A – I/SLO**: Transalpine road freight transport volume is reduced by 34 Mill. tons/a (26% of total road freight volume on A – I/SLO corridors). 30 Mill. tons/a are shifted towards A – I/SLO rail corridors.
- **CH – I**: Transalpine road freight transport volume is reduced by 11 Mill. tons/a (52%). 18 Mill. tons/a are shifted towards CH – I rail corridors.
- **F – I**: Transalpine road freight transport volume is reduced by 17 Mill. tons/a (41%). 13 Mill. tons/a are shifted towards F – I rail corridors.

Overall, **total transalpine freight transport volume** (road and rail) is shifted from A – I/SLO (-2.0% of total transalpine transport in BAU 2030) and F – I corridors (-6.8%) towards CH – I corridors (+12.4%). Thus, for some F – I and A – I/SLO road transport it is still more attractive to shift towards CH – I rail corridors than on their own ones.

Modal split of road of total transalpine freight transport can be reduced by the introduction of the TOLL+ from 62% to 43%.

The **number of total transalpine HGV trips** on road decreases from 15.1 Mill./a to 10.3 Mill./a: -26% on A – I/SLO, -52% on CH – I and -41% on F – I crossings (see Figure 12-32).

[91] For the relevant distances per transalpine corridor see chapter 5.2.2.

Figure 8-24: TOLL+ R 2030 high: Transalpine freight transport 2030 in Alpine arch C, in 1'000 tons/a, Δ in 1’000 tons/a and Δ in %

TOLL+ R 2030 low

Figure 8-25: TOLL+ R 2030 low: Transalpine freight transport 2030 in Alpine arch C, in 1'000 tons/a, Δ in 1'000 tons/a and Δ in %

8.1.4 MIX

The MIX scenarios represent a combination of the three policy instruments analyzed before. For the three groups of transalpine corridors, the following instruments / scenarios are applied:

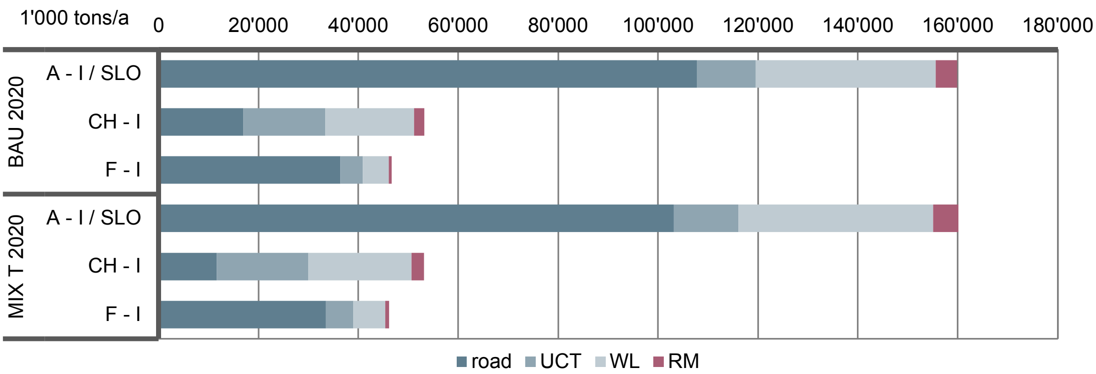
- A – I/SLO: AETS tolerant (10% reduction of CO_2-emissions in 2020, 20% in 2030)
- CH – I: ACE tolerant (cap of 900'000 HGV trips per year)
- F – I: TOLL+ tolerant (TOLL+ price per km corresponding to the lower price of ACE tolerant and AETS tolerant

This chapter presents the results for the two analyzed MIX scenarios for 2020 and 2030 high (no scenario for 2030 low).

a) 2020

The introduction of different instrument in the MIX scenario in 2020 also leads to an overall shift of transalpine freight transport from road to rail. In scenario MIX T 2020, total transalpine transport volume decreases by only 0.1% (not transported through the Alps anymore, e.g. shifted to East-West relations or freight transports on water). The results of the scenario for 2020 (see Figure 8-26 for a general overview) are described more precisely below.

Figure 8-26: Transalpine freight traffic volumes for BAU and the MIX scenarios 2020, in 1'000 tons/a



MIX T 2020

In scenario "MIX tolerant 2020" the caps / reduction targets for transalpine HGV trips of the introduced instruments and the resulting prices per trip or km are as follows (for the resulting prices per corridor see Figure 8-33):[92]

	Caps / reduction target)	ACP / AETS / TOLL+ prices
A – I/SLO	10% reduction of CO_2-emissions	0.11 EUR/km
CH – I	0.9 Mill./a (34% reduction)	81 EUR/trip
F – I	Fixed toll	0.16 EUR/km

The introduction of different instruments leads to a decrease in total transalpine road freight transport volume of around 8% compared to BAU 2020 (see Figure 8-27 and the respective Figure in the Annex): From 161 to 148 Mill. tons/a (only the tolerant AETS scenarios show a lower reduction in 2020). The reduction of road transport volume between corridors is very varying: 4% on A – I/SLO, 31% on CH – I and 8% on F – I corridors. On A – I/SLO the reduction is lower than on the other crossings because the implemented AETS does not include the three easternmost transalpine A – I/SLO corridors (which leads to detouring on Schoberpass, Semmering and Wechsel). The number of transalpine lorries on those three corridors increases by 14%, whereas on the Western corridors their number decreases by 29%. Consequently, the relocation effects from road to rail are not as high as they would be with an application of the AETS on the whole Alpine arch C. Additionally, AETS is clearly the least strong instrument (on the other hand, ACE being the strongest). Furthermore, the reduction on F – I corridors is lower than on CH – I corridors because they clearly have the highest modal split for road in BAU 2020 and the ACE on CH – I corridors is stronger than the TOLL+ on F – I crossings.

12.6 Mill. tons/a of the total reduction in transalpine road freight transport (12.8 Mill. tons/a) are shifted towards rail corridors. The residual 0.1% of total transport is shifted towards other transport modes not considered here or not transported anymore. For the different transalpine crossings, the introduction of the different instruments leads to the following changes:

- **A – I/SLO**: Transalpine road freight transport volume is reduced by 4.5 Mill. tons/a (4% of total road freight volume on A – I/SLO corridors). 5 Mill. tons/a are shifted towards A – I/SLO rail corridors.
- **CH – I**: Transalpine road freight transport volume is reduced by 5.5 Mill. tons/a (31%). 5.5 Mill. tons/a are shifted towards CH – I rail corridors.
- **F – I**: Transalpine road freight transport volume is reduced by 3 Mill. tons/a (8%). 2.5 Mill. tons/a are shifted towards F – I rail corridors.

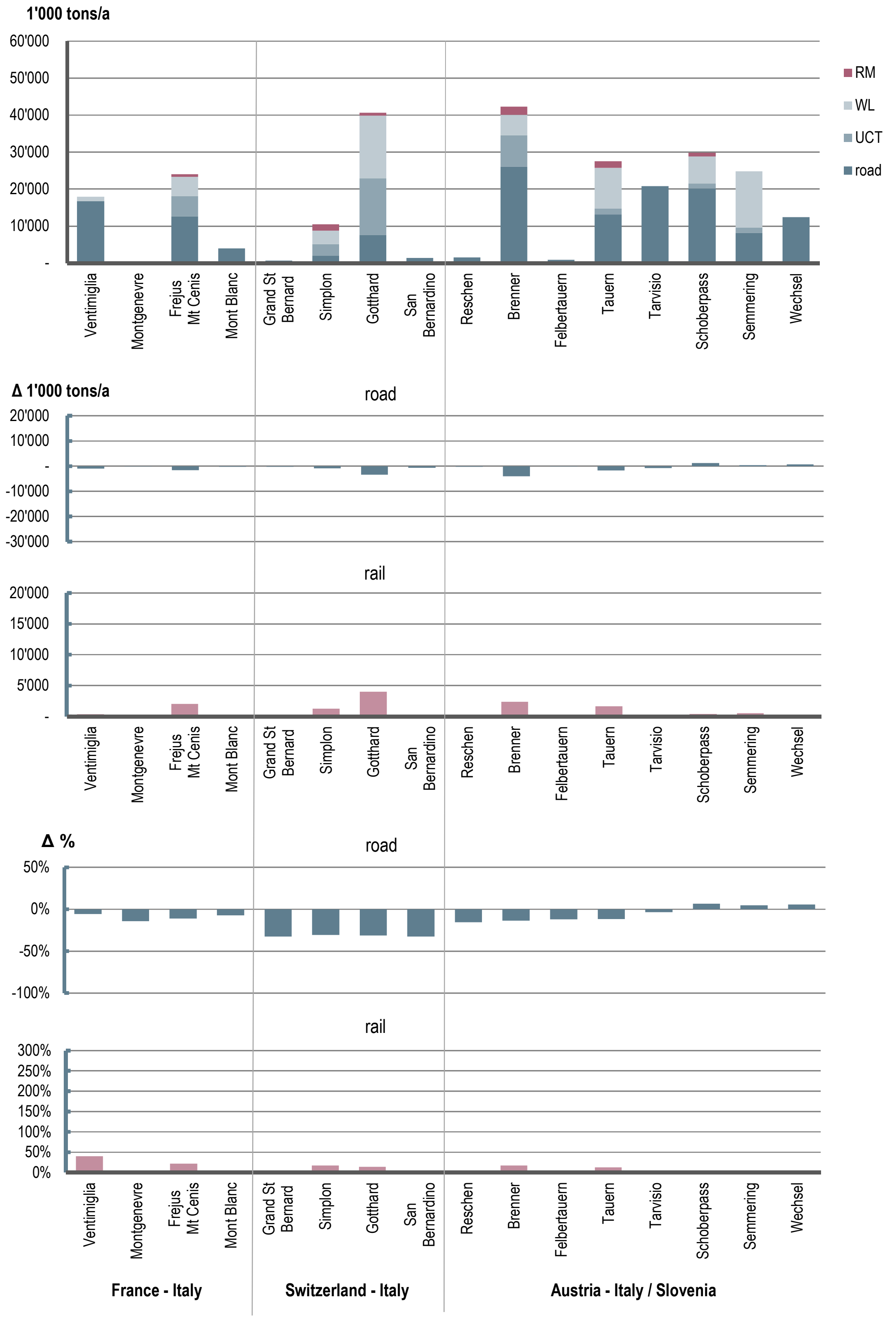
[92] The ACP price on CH – I corridors is lower in the MIX T 2020 scenario than in the ACE T 2020 scenario (81 EUR/trip vs. 93 EUR/trip) due to the weaker mesures on A – I/SLO and F – I corridors (ACE tolerant is stronger than the AETS and TOLL+ in the MIX scenarios). Those weaker measures on the neighbouring corridors decrease the pressure to shift transport from road to rail on CH – I corridors wich leads to a lower ACP price.

Overall, **total transalpine freight transport volume** (road and rail) is only marginally shifted from F – I (-1.0% of total transalpine transport in BAU 2020) towards A – I/SLO corridors (+0.2% of total transalpine transport in BAU 2030). Total volume on CH – I remains virtually unchanged.

Modal split of road can only be reduced from 62% to 57% of total transalpine freight transport.

The **number of total transalpine HGV trips** on road decreases from 12.4 Mill./a to 11.4 Mill./a: -4% on A – I/SLO, -34% on CH – I and -8% on F – I crossings (see Figure 12-38).

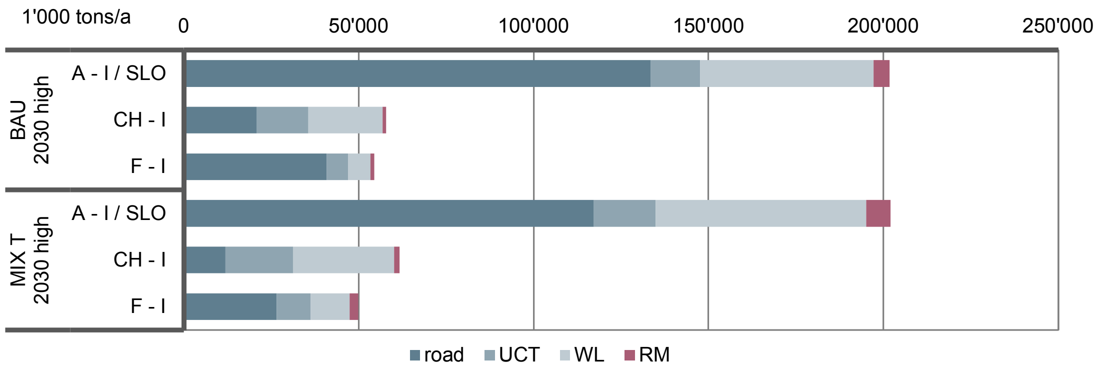
Figure 8-27: MIX T 2020: Transalpine freight transport 2020 in Alpine arch C, in 1'000 tons/a, Δ in 1'000 tons/a and Δ in %



b) 2030

For 2030, only one scenario for 2030 high has been calculated (MIX T 2030 high). The introduction of different instrument in the scenario also leads to an overall shift of transalpine freight transport from road to rail. Total transalpine transport volume decreases by only 0.2% (not transported through the Alps anymore, e.g. shifted to East-West relations or freight transports on water). The results of the scenario for 2030 high (see Figure 8-28 for a general overview) are described more precisely below.

Figure 8-28: Transalpine freight traffic volumes for BAU and the MIX scenarios 2030 high, in 1'000 tons/a



MIX T 2030 high

In scenario "MIX tolerant 2030 high" the caps / reduction targets for transalpine HGV trips of the introduced instruments and the resulting prices per trip or km are as follows (for the resulting prices per corridor see Figure 8-33):[93]

	Caps / reduction target)	ACP / AETS / TOLL+ prices
A – I/SLO	20% reduction of CO_2-emissions	0.34 EUR/km
CH – I	0.9 Mill./a (34% reduction)	160 EUR/trip
F – I	Fixed toll	0.60 EUR/km

The introduction of the different instruments leads to a decrease in total transalpine road freight transport volume of around 20% compared to BAU 2030 high (see Figure 8-29 and the respective Figure in the Annex): From 195 to 156 Mill. tons/a (only the AETS scenario "AETS

[93] The ACP price on CH – I corridors is lower in the MIX T 2030 scenario than in the ACE T 2030 scenario (160 EUR/trip vs. 178 EUR/trip) due to the weaker mesures on A – I/SLO and F – I corridors (ACE tolerant is stronger than the AETS and TOLL+ in the MIX scenarios). Those weaker measures on the neighbouring corridors decrease the pressure to shift transport from road to rail on CH – I corridors wich leads to a lower ACP price.

T 2030 high" shows a lower reduction in 2030 high). The reduction of road transport volume between corridors is again very varying: 12% on A – I/SLO, 43% on CH – I and 35% on F – I corridors. On A – I/SLO corridors the reduction is lower than on the other crossings because the implemented AETS does not include the three easternmost transalpine A – I/SLO corridors (which leads to detouring on Schoberpass, Semmering and Wechsel). Compared to BAU 2030 high the number of transalpine lorries on those three corridors increases by 17%, whereas on the Western A – I/SLO corridors their number decreases by 30%. Consequently, the relocation effects from road to rail are not as high as they would be with an application of the AETS on the whole Alpine arch C. Additionally, AETS is clearly the least strong instrument (on the other hand, ACE being the strongest). Furthermore, the reduction on F – I corridors is lower than on CH – I corridors because they clearly have the highest modal split for road in BAU 2030 high and the ACE on CH – I corridors is stronger than the TOLL+ on F – I crossings.

38.9 Mill. tons/a of the total reduction in transalpine road freight transport (39.4 Mill. tons/a) are shifted towards rail corridors. The residual 0.2% of total transport is shifted towards other transport modes not considered here or not transported anymore. For the different transalpine crossings, the introduction of the different instruments leads to the following changes:

- **A – I/SLO**: Transalpine road freight transport volume is reduced by 16 Mill. tons/a (12% of total road freight volume on A – I/SLO corridors). 16 Mill. tons/a are shifted towards A – I/SLO rail corridors.
- **CH – I**: Transalpine road freight transport volume is reduced by 9 Mill. tons/a (43%). 13 Mill. tons/a are shifted towards CH – I rail corridors.
- **F – I**: Transalpine road freight transport volume is reduced by 14 Mill. tons/a (35%). 10 Mill. tons/a are shifted towards F – I rail corridors.

Overall, **total transalpine freight transport volume** (road and rail) is shifted from F – I (-8.5% of total transalpine transport in BAU 2030) towards CH – I (+6.8%) and A – I/SLO corridors (+0.1%).

Modal split of road can be reduced from 62% to 50% of total transalpine freight transport.

The **number of total transalpine HGV trips** on road decreases from 15.1 Mill./a to 12.0 Mill./a: -12% on A – I/SLO, -46% on CH – I and -35% on F – I crossings (see Figure 12-38).

Figure 8-29: MIX T 2030 high: Transalpine freight transport 2030 in Alpine arch C, in 1'000 tons/a, Δ in 1’000 tons/a and Δ in %

8.2 Effects on road transport prices

The effects on road transport prices of the four groups of scenarios (ACE, AETS, TOLL+ and MIX) for 2020 and 2030 low / high growth are presented

- per trip and country for the ACE scenarios
- and per trip, km and country / corridor for the AETS, TOLL+ and MIX scenarios.

8.2.1 ACE

Figure 8-30 shows the prices for the Alpine crossing permits (ACP) per trip for the three groups of corridors for all ACE scenarios:

- In general the prices cannot be compared between 2020 and 2030 because the implemented measures for A – I/SLO and F – I corridors are different to CH – I corridors (only half of the percentage reduction of CH – I corridors in 2020).
- In the 2020 scenarios with country specific caps, due to the higher caps on A – I/SLO and F – I corridors, ACP prices per trip are always highest on CH – I crossings to reach the stronger cap. In case of a common cap on Alpine arch B+ (scenario “ACE R 2020 A+CH+F”) ACP prices are the same for all corridors.
- In the 2030 scenarios (high and low growth), all three groups of corridors have to reach the same relative cap with the introduction of an ACE. This leads to similar prices on A – I/SLO and CH – I corridors. ACP prices for F – I corridors are always higher. Obviously, road freight transport on F – I corridors reacts more inelastic on price increases than on CH – I and A – I/SLO corridors. There may be several reasons for this repeatedly found pattern: F – I corridors have a comparably high modal split for road. Railway services as a substitute may be less competitive than on CH – I and A – I/SLO corridors. Additionally, the Gotthard base tunnel rail corridor seems to attract rail freight traffic that was originally using more western corridors. Furthermore it has to be stated that ACP prices in general and especially for A – I/SLO crossings would be higher, if the ACE would be applied on all transalpine crossings of the Alpine arch C and not only on Alpine arch B+ (possibility of detouring via the three easternmost A – I/SLO crossings).
  In case of a common cap (scenario “ACE R 2030 high A+CH+F”) ACP prices again are the same for all corridors.

Figure 8-30: ACP prices, in EUR/trip

ACE scenarios	R 2020	R 2020 A+CH+F	T 2020	R 2030 low	T 2030 low	R 2030 high	R 2030 high A+CH+F	T 2030 high
ACP-price per trip in EUR								
A - I / SLO	94	110	59	215	128	263	280	172
CH - I	160	110	93	217	126	269	280	178
F - I	126	110	79	281	166	345	280	229

8.2.2 AETS

Figure 8-31 shows the prices for the AETS certificates per km and per trip for all transalpine corridors and AETS scenarios:

- In the scenarios with one common reduction target for CO_2-emissions AETS prices per corridor are always highest for the relative long Brenner and Reschen crossings (430 and 443 km within the area of the Alpine Convention, compared to the lowest crossing at Mont-Blanc with 251 km).[94]
- In case of country specific reduction targets for CO_2-emissions (scenarios “AETS T 2020” and “AETS T 2030 high”) AETS prices per km of course differ between the three groups of transalpine corridors, with F – I being the highest followed by CH – I and A – I/SLO corridors (A – I/SLO corridor even face a lower price than in the case of a common reduction target).
- Furthermore, as for the ACE scenarios, AETS prices in general and especially for A – I/SLO crossings would be higher, if the AETS would be applied on all transalpine crossings of Alpine arch C and not only on Alpine arch B+ (possibility of detouring via the three easternmost A – I/SLO crossings). This can be clearly shown in a comparison of the scenarios with a common and the scenarios with country specific reduction targets. Due to the possibility of detouring via the three easternmost corridors, the reduction of CO_2-emissions can be reached easier by A – I/SLO road freight transport than by transport on the other crossings (see also above).

94 For the relevant distances per transalpine corridor see chapter 5.2.2.

Figure 8-31: Prices of AETS certificate per trip/corridor and km within the area of the Alpine convention, in EUR/km and EUR/trip

AETS scenarios	R 2020 A+CH+F	T 2020 A+CH+F	T 2020	R 2030 low A+CH+F	T 2030 low A+CH+F	R 2030 high A+CH+F	T 2030 high A+CH+F	T 2030 high
AETS certificate per km in EUR								
A - I / SLO	0.23	0.11	0.09	0.50	0.22	0.70	0.40	0.38
CH - I	0.23	0.11	0.12	0.50	0.22	0.70	0.40	0.48
F - I	0.23	0.11	0.16	0.50	0.22	0.70	0.40	0.60
AETS certificate per trip / corridor in EUR								
A - I / SLO								
Reschen	102	49	40	222	100	310	177	168
Brenner	99	47	39	215	97	301	172	163
Felbertauern	89	43	35	194	87	271	155	147
Tauern	69	33	27	151	68	211	120	114
Tarvisio	69	33	27	151	68	211	120	114
CH - I								
Gr. St. Bernard	74	35	39	161	72	225	128	154
Simplon	86	41	45	188	84	263	150	180
Gotthard	62	30	32	135	61	188	108	129
San Bernardino	67	32	35	146	65	204	116	140
F - I								
Mont-Blanc	58	28	40	126	56	176	100	151
MtCenis/Fréjus	71	34	49	154	69	215	123	184
Montgenerve	70	34	49	153	69	214	122	183
Ventimigla	73	35	51	159	71	222	127	190

8.2.3 TOLL+

The TOLL+ prices per km and corridor for the three groups of corridors for all TOLL+ scenarios are presented in Figure 8-32:

- Because TOLL+ prices are set as fixed prices per km for all crossings, they do not show any differences between the three groups of corridors, as it is the case for the scenarios with ACE caps or CO_2-emission reduction targets.
- Like in the AETS scenarios prices per corridor are always highest for the relative long Brenner and Reschen crossings (430 and 443 km within the area of the Alpine Convention, compared to the lowest crossing at Mont-Blanc with 251 km).[95]
- Furthermore, as for the ACE and AETS scenarios, TOLL+ prices in general and especially for A – I/SLO crossings would be higher, if the AETS would be applied on all transalpine crossings of Alpine arch C and not only on Alpine arch B+ (possibility of detouring via the three easternmost A – I/SLO crossings).

[95] For the relevant distances per transalpine corridor see chapter 5.2.2.

Figure 8-32: TOLL+ prices per trip/corridor and km within the area of the Alpine convention, in EUR/km and EUR/trip

TOLL+ scenarios	R 2020	R 2030 low	R 2030 high
TOLL+ charge per km in EUR			
A - I / SLO	0.29	0.61	0.80
CH - I	0.29	0.61	0.80
F - I	0.29	0.61	0.80
TOLL+ charge per trip / corridor in EUR			
A - I / SLO			
Reschen	128	270	354
Brenner	125	262	344
Felbertauern	112	236	310
Tauern	87	184	241
Tarvisio	87	184	241
CH - I			
Gr. St. Bernard	93	196	257
Simplon	109	229	300
Gotthard	78	164	215
San Bernardino	84	178	233
F - I			
Mont-Blanc	73	153	201
MtCenis/Fréjus	89	187	246
Montgenerve	88	186	244
Ventimigla	92	193	254

8.2.4 MIX

The prices per trip or km and corridor for the three groups of corridors for all MIX scenarios are presented in Figure 8-33:

- The specification of the three instruments implemented in the MIX scenarios is strongest for the CH – I crossings (ACE with a cap of 900'000 HGV trips per year), followed by F – I (TOLL+ in between the other two measures) and A – I/SLO (AETS with a 10% reduction of CO_2-emissions in 2020 and 20% in 2030).
- In the 2020 scenario (MIX T 2020), prices per corridor are highest on CH – I crossings (81 EUR per transalpine HGV trip). The other crossings face prices per corridor from 33 EUR on Tauern and Travisio to 51 EUR on Ventimiglia (which is the F – I corridor with the longest distance within the area of the Alpine Convention).
- In the 2030 high scenario (MIX T 2030 high), prices per corridor are more balanced. They are generally highest on F – I crossings (190 EUR on Ventimiglia), followed by the CH – I (160 EUR per transalpine HGV trip) and the A – I/SLO crossings (highest price per km on Reschen with 151 EUR).

Figure 8-33: Prices of ACP (CH – I), AETS certificate (A – I/SLO) and TOLL+ (F – I) per trip/corridor and km within the area of the Alpine convention, in EUR/km and EUR/trip

MIX scenarios	T 2020	T 2030 high
ACP-price per trip, AETS certificate / TOLL+ charge per km in EUR		
A - I / SLO	0.11	0.34
CH - I	81	160
F - I	0.16	0.60
ACP, AETS certificate or TOLL+ charge per trip / corridor in EUR		
A - I / SLO		
Reschen	49	151
Brenner	47	146
Felbertauern	43	132
Tauern	33	102
Tarvisio	33	102
CH - I	81	160
F - I		
Mont-Blanc	40	151
MtCenis/Fréjus	49	184
Montgenerve	49	183
Ventimigla	51	190

8.3 Costs and revenues for the public sector

The costs and revenues for the public sector of the four groups of scenarios (ACE, AETS, TOLL+ and MIX) for 2020 and 2030 low / high growth are presented for the respective policy instruments and the three Alpine crossing boarder points between the examined countries (A + I / SLO, CH – I and F – I). The present calculation in the upcoming figures includes the following costs and revenues:

- Revenues of the ACE, AETS or TOLL+.
- Operating costs of the policy instruments including depreciation (annual average).

The revenues depend on the number of transalpine HGV trips or vkm within Alpine arch B+ (corresponding area according to the Alpine Convention) and not within Alpine arch C (for which the results for the transport volumes are presented).

Moreover, with regards to a wider analysis of the effects on the public sector, the following costs and revenues would have to be taken into account when introducing any of the instruments analysed:

- Reduced revenues from road tolls (due to the reduction of transalpine HGV trips; e.g. heavy vehicle fee in Switzerland, road tolls in France, Italy and other countries).
- Reduced revenues from petroleum taxes (due to less HGV in the Alpine countries).

- Changes in VAT revenues of road and rail freight traffic (rise for rail, decrease for road).
- Possible changes in the subsidies for rail and additional revenues from track access charges in the railway sector.

Such an overall economic analysis of the effects on the public sector goes beyond the scope of this study and should be done in the framework of future studies.

8.3.1 ACE

The revenues and operating cost (incl. an average yearly depreciation) for the ACE scenarios in 2020 and 2030 low / high are presented in Figure 8-34:

- In general, the effects on public sector cannot be compared between 2020 and 2030 because the implemented measures for A – I/SLO and F – I are different (only half of the percentage reduction of CH – I corridors in 2020).
- In the case of 2030 high the introduction of an ACE with a common cap on Alpine arch B+ (scenario R 2030 high A+CH+F) leads to higher revenues on F – I corridors and to lower revenues on the other corridors. The reason is the following: The introduction of a common cap lessens the necessity on F – I corridors to reduce transalpine HGV trips which reduces the ACP prices on those corridors. Indeed, on F – I corridors the lower price per ACP is outbalanced by the higher number of trips. On the other hand, on CH – I and A – I/SLO corridors ACP prices rise and the number of trips declines compared to a scenario with country specific caps.
  Interestingly, in the 2030 tolerant scenario the revenues are not much lower than in the restrictive ones. The lower prices of ACP is almost outweighed by the higher number of transalpine HGV trips.

Figure 8-34: ACE scenarios: Impacts on costs and revenues for the public sector, in Mill. EUR/a

ACE scenarios in Mill. EUR/a	R 2020	R 2020 A+CH+F	T 2020	R 2030 low	T 2030 low	R 2030 high	R 2030 high A+CH+F	T 2030 high
Austria - Italy / Slovenia (for Alpine arch B+ only)								
revenue form ACE	379	409	267	549	453	666	651	615
Switzerland - Italy								
revenue form ACE	105	98	83	141	114	174	162	158
France - Italy								
revenue form ACE	240	217	169	312	255	383	394	353
total revenue	**724**	**724**	**519**	**1'003**	**822**	**1'224**	**1'207**	**1'126**
operating costs	37	37	37	37	37	37	37	37
total balance	**687**	**688**	**483**	**967**	**785**	**1'187**	**1'171**	**1'089**

Remarks: For the costs of implementation see Figure 3-8 (Operating expenditure in M € (during example year 2017)) in chapter 3.7.13. To the operating expenditures we added an average depreciation of 9.1 Mio. EUR/a for the ACE system.

8.3.1 AETS

Figure 8-35 shows the revenues and operating cost (incl. an average yearly depreciation) for the AETS scenarios in 2020 and 2030 low / high:

The introduction of country specific reduction targets for CO_2-emissions leads to lower revenues on A – I/SLO corridors and to higher revenues on the other corridors (AETS price per km is also lower on A – I/SLO). This reflects the higher prices of an AETS-certificate per HGV-km on F – I and CH – I corridors.

Figure 8-35: AETS scenarios: Impacts on costs and revenues for the public sector, in Mill. EUR/a

AETS scenarios in Mill. EUR/a	R 2020 A+CH+F	T 2020 A+CH+F	T 2020	R 2030 low A+CH+F	T 2030 low A+CH+F	R 2030 high A+CH+F	T 2030 high A+CH+F	T 2030 high
Austria - Italy / Slovenia (for Alpine arch B+ only)								
revenue from AETS	344	191	161	533	341	685	575	574
Switzerland - Italy								
revenue from AETS	74	40	43	128	75	176	134	149
France - Italy								
revenue from AETS	159	82	113	270	145	394	277	346
total revenue	**576**	**312**	**317**	**931**	**561**	**1'255**	**986**	**1'070**
operating costs	37	37	37	37	37	37	37	37
total balance	**540**	**275**	**281**	**895**	**525**	**1'219**	**949**	**1'033**

Remarks: For the costs of implementation see Figure 3-8 (Operating expenditure in M € (during example year 2017)) in chapter 3.7.13. To the operating expenditures we added an average depreciation of 9.1 Mio. EUR/a for the ACE system.

8.3.2 TOLL+

Figure 8-36 shows the revenues and operating cost (incl. an average yearly depreciation) for the TOLL+ scenarios in 2020 and 2030 low / high. In accordance with the different TOLL+ prices and transport volumes per corridor, the highest revenues are generated on A – I/SLO crossings, followed by F – I and CH – I corridors. The yearly operating costs are around 16 Mill. EUR lower than for the ACE and AETS.

Figure 8-36: TOLL+ scenarios: Impacts on costs and revenues for the public sector, in Mill. EUR/a

TOLL+ scenarios in Mill. EUR/a	R 2020	R 2030 low	R 2030 high
Austria - Italy / Slovenia (for Alpine arch B+ only)			
revenue from TOLL+	401	565	689
Switzerland - Italy			
revenue from TOLL+	88	140	183
France - Italy			
revenue from TOLL+	193	305	420
total revenue	**682**	**1'010**	**1'292**
operating costs	21	21	21
total balance	**661**	**989**	**1'271**

Remarks: For the costs of implementation see Figure 3-8 (Operating expenditure in M € (during example year 2017)) in chapter 3.7.13. To the operating expenditures we added an average depreciation of 9.1 Mio. EUR/a for the ACE system.

8.3.3 MIX

The revenues and operating cost (incl. an average yearly depreciation) for the MIX scenarios in 2020 and 2030 low / high are summarised in Figure 8-37. Again, the revenues differ with the different prices and transport volumes per corridor.

Figure 8-37: MIX scenarios: Impacts on costs and revenues for the public sector, in Mill. EUR/a

MIX scenarios in Mill. EUR/a	T 2020	T 2030 high
Austria - Italy / Slovenia (for Alpine arch B+ only)		
revenue from ACE / AETS / TOLL+	197	547
Switzerland - Italy		
revenue from ACE / AETS / TOLL+	73	143
France - Italy		
revenue from ACE / AETS / TOLL+	114	328
total revenue	**385**	**1'018**
operating costs	32	32
total balance	**353**	**986**

Remarks: For the costs of implementation see Figure 3-8 (Operating expenditure in M € (during example year 2017)) in chapter 3.7.13. To the operating expenditures we added an average depreciation of 9.1 Mio. EUR/a for the ACE system.

8.4 Analysis of rail capacities

First of all, let us mention that an in-depth analysis of the economic impacts of an introduction of ACE, AETS or TOLL+ is explicitly not the duty of this study. For this question a separate study will be carried out. But of course, it is obvious that a higher price for transalpine road freight transport due to the introduction of a charge or a cap causes economic costs on the one hand and economic benefits due to lower external costs on the other hand. Let us mention here two arguments that are central with respect to the economic effects:

- First, are overall capacities (road and rail) for transalpine freight transport changed in a way that overall infrastructure supply is below the demand for transalpine freight transport?
- Second, if there is enough capacity for transalpine freight transport, to which extent increases the price for transalpine freight transport due to the introduction of ACE, AETS or TOLL+, who pays the higher prices and what kind of secondary effects do they cause?

In this chapter we have a look on the first question. As mentioned, the second one will be analysed in another study looking in more depth at the overall economic effects of the introduction of ACE, AETS or TOLL+ (including the economic benefit of lower external costs).

As a start we notice that the introduction of ACE, AETS or TOLL+ does practically not reduce the overall volume of transalpine freight transport, but a strong modal shift from road to rail freight transport will occur. Therefore we conclude that if the railway corridors have sufficient capacities to meet this increasing demand for transalpine rail freight transport there will be no overall capacity constraint.

Figure 8-38 summarises the capacity analysis for the four railway corridors with a new base tunnel in the year 2030. It shows that the degree of capacity utilisation of the new transalpine rail base tunnels (Mont Cenis/Fréjus, Lötschberg, Gotthard, Brenner) will be rather low in the business as usual scenarios.

The introduction of one of the instruments in order to increase the price for transalpine road freight transport – in Figure 8-38 shown at the example of the restrictive ACE-scenarios for 2030 – causes a marked change of the degree of capacity utilisation.[96]

[96] The scenarios “ACE R 2030 low” and “ACE R 2030 high” lead to the strongest shift from road to rail of all of the scenarios analysed.

Figure 8-38: Use of railway capacities in 2030 at the Brenner-, Gotthard-, Simplon and Mont Cenis/Fréjus-corridors with new base tunnels

Alpine corridor	Overall capacity with new base tunnel (freight trains/day)	Demand in Mill. tons			Demand in trains / day			Total demand (trains/day)	Remaining capacity (trains/day)
		BAU 2030 low							
		UCT	WL	RM	UCT	WL	RM	Total	
Brenner	220	7.38	5.73	1.54	56	31	13	100	**120**
Gotthard	252	10.42	14.89	0.19	79	80	2	161	**91**
Simplon	108	2.04	3.16	0.55	16	17	5	37	**71**
Mont Cenis	220	5.15	4.64	0.87	39	25	7	72	**148**
		BAU 2030 high							
		UCT	WL	RM	UCT	WL	RM	Total	
Brenner	220	8.85	6.86	1.85	67	37	16	120	**100**
Gotthard	252	12.36	17.58	0.22	94	94	2	190	**62**
Simplon	108	2.43	3.72	0.67	18	20	6	44	**64**
Mont Cenis	220	6.18	5.56	1.04	47	30	9	86	**134**
		ACE 2030 R low							
		UCT	WL	RM	UCT	WL	RM	Total	
Brenner	220	10.46	9.68	3.60	80	52	31	162	**58**
Gotthard	252	14.44	21.61	0.45	110	116	4	229	**23**
Simplon	108	3.02	4.88	1.18	23	26	10	59	**49**
Mont Cenis	220	8.99	8.71	2.85	68	47	24	140	**80**
		ACE 2030 R high							
		UCT	WL	RM	UCT	WL	RM	Total	
Brenner	220	13.02	12.25	4.88	99	66	42	206	**14**
Gotthard	252	17.66	26.47	0.62	135	142	5	281	**-29**
Simplon	108	3.74	5.98	1.60	28	32	14	74	**34**
Mont Cenis	220	11.39	11.23	4.10	87	61	35	183	**37**

Assumptions:

- Average net-tonnage per train: UCT: 525t, WL: 748t, RM: 468t. This net-tonnage is based on today's length of trains. If in future longer trains were allowed the average net-tonnage would be higher.
- As demand is not distributed evenly over time, the daily capacity to the yearly overall capacity is not calculated with a factor of 365 but with a rather conservative factor of 250.
- For the Mont Cenis / Fréjus rail corridor (with new base tunnel) it is assumed that the overall capacity is the same as for the Brenner corridor (220 freight trains/day).

Figure 8-38 shows that in both BAU scenarios (BAU 2030 low and 2030 high), an important part of the available capacity for freight transport at the three railway corridors Brenner, Gotthard and Simplon will not be used. As expected, the degree of capacity utilisation raises markedly with the introduction of a restrictive ACE regime.[97] But only in the case of high growth assumptions we have with the Gotthard corridor one case where the available capacity is not sufficient (scenario “ACE R 2030 high”). For this case we would expect a shift of rail freight traffic from the Gotthard to the Simplon corridor and to a smaller extent to the Brenner or Mont Cenis/Fréjus corridor. We have to emphasise that the results in Figure 8-38 are based on today’s length of freight trains. If in the future longer freight trains were allowed the capacity of the transalpine railway corridors would substantially increase.

8.5 Conclusion

8.5.1 Comparison of instruments with respect to transport volumes

a) 2020

In 2020, the strongest effects regarding transalpine freight transport volumes on the whole Alpine arch C occur in the restrictive ACE scenario with country specific caps: Around 27 Mill. tons/a are shifted from road to rail (“ACE R 2020”). The effects are just slightly stronger than with a restrictive ACE with a common cap for Alpine arch B+ (scenario “ACE R 2020 A+CH+F). In contrast, the lowest shifting effects occur in the scenario with a tolerant AETS system with a common reduction target for CO_2-emissions (around 10 Mill. tons/a in scenario “AETS T 2020 A+CH+F”). The TOLL+ scenarios lie in between the ACE and AETS scenarios whereas the MIX scenarios are closer to the AETS scenarios (regarding shifting effects from road to rail).

Figure 8-39 and Figure 8-40 show the changes in transalpine road and rail freight transport in the 2020 scenarios in absolute values and in % with respect to BAU 2020 for the three considered groups of corridors within the Alpine arch C:

- The **A – I/SLO** corridors generally observe the lowest percentage reduction in transalpine road freight transport (partly due to the weaker measures than on the CH – I corridors in the case of an ACE and on the other hand due to the possibility of detouring via the three easternmost A – I/SLO corridors (see also Figure 8-43 further below). With common measures (one ACE cap or a common AETS reduction target for Alpine arch B+) the reductions are higher than with a country specific implementation of the instruments.
- On **CH – I** corridors the percentage reduction in transalpine road freight transport is generally highest. With common measures (one ACE cap or a common AETS reduction target for Alpine arch B+) the reductions are lower than with a country specific implementation of the instruments.

[97] For a detailed analysis of the ACE scenarios see chapter 7.3, 8.1.1 and chapter 10 and 12 in the Annex. A similar result would emerge with a restrictive AETS or TOLL+ regime.

- The percentage reduction in transalpine road freight transport on **F – I** corridors generally lies between the reductions on the other crossings. The reduction tends to be higher with country specific reduction targets as the introduction of a common cap lessens the necessity on F – I corridors to reduce transalpine HGV trips.
- Regarding the changes in absolute values the reduction are highest on A – I/SLO corridores followed by CH – I and F – I crossings.

Figure 8-39: Scenarios 2020: Δ in Mill. tons/a to BAU 2020 for transalpine road and rail freight transport

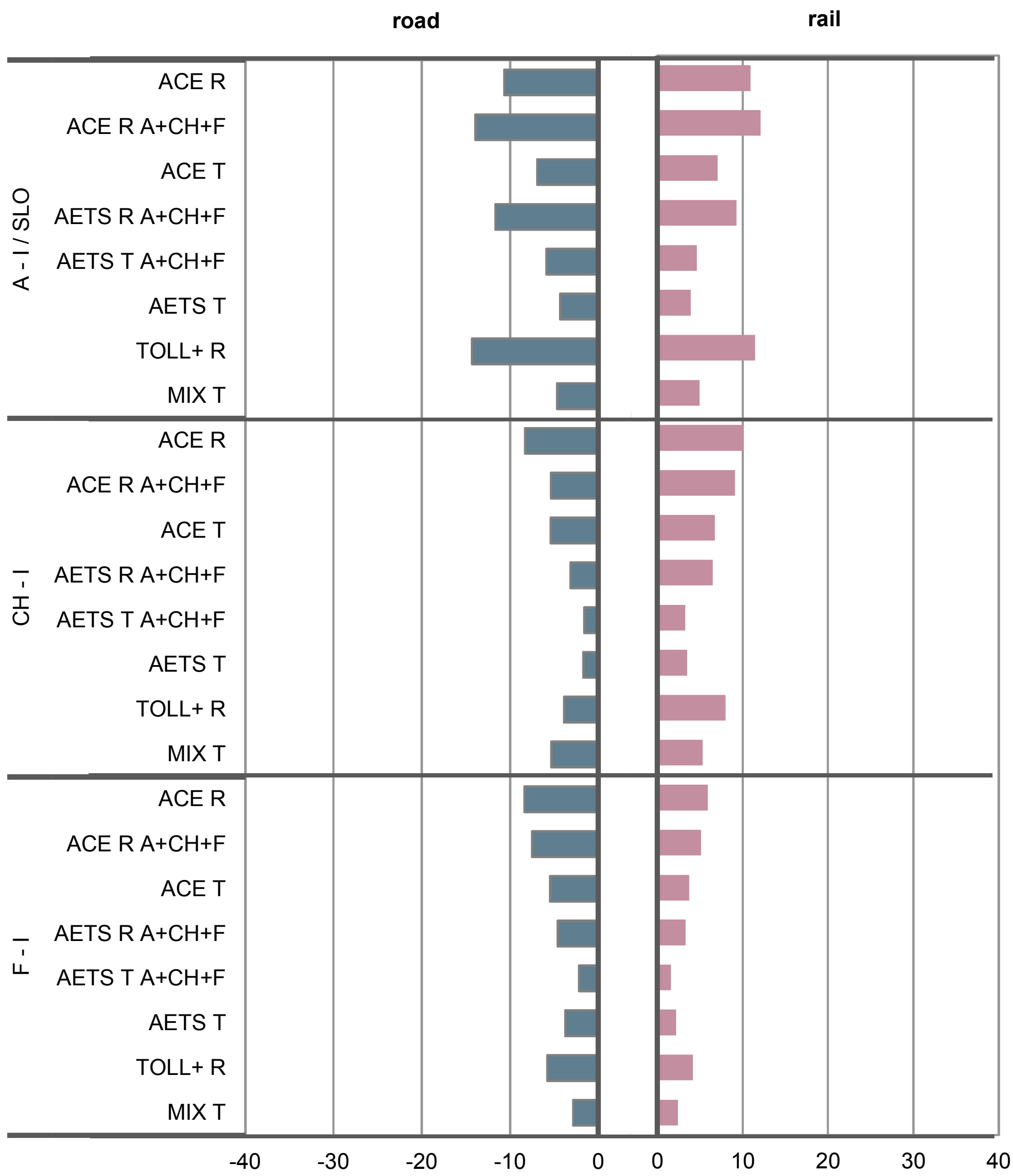
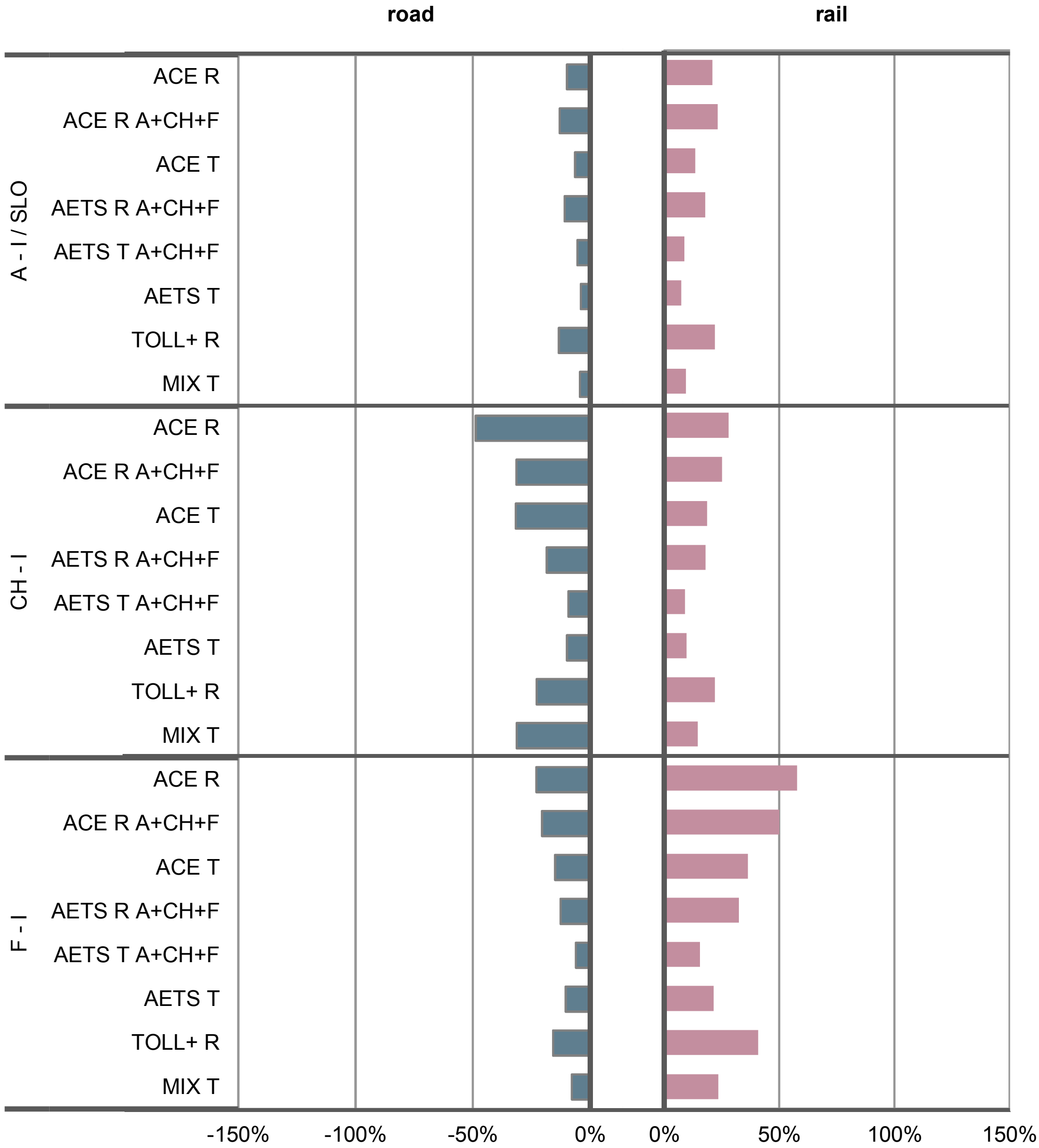


Figure 8-40: Scenarios 2020: Δ in % to BAU 2020 for transalpine road and rail freight transport



b) 2030 high growth

In 2030 (looking at the scenarios with high growth only), the strongest effects occur in the restrictive ACE scenario with country specific caps: Regarding the whole Alpine arch C around 65 Mill. tons/a are shifted from road to rail ("ACE R 2030 high"). In contrast, the lowest shifting effects occur in the scenario with a tolerant AETS system with a common reduction target for CO_2-emissions (around 36 Mill. tons/a). The TOLL+ scenarios lie in between the ACE and AETS scenarios whereas the MIX scenarios are closer to the AETS scenarios (but still higher than AETS regarding shifting effects from road to rail).

When comparing the restrictive ACE and AETS scenarios the total shifting effects from road to rail are about 9 Mill. tons/a higher in case of an ACE.

All policy instruments tend to result in a general shift of transalpine freight transport (mainly road transport) from F – I corridors and to a clearly lower extent also from A – I/SLO corridors towards CH – I rail corridors. Thus, especially for some F – I road transport it is more attractive to shift towards CH – I rail corridors than on their own ones. This effect is even more pronounced in case of a common measure. There may be several reasons for this repeatedly found pattern:

- F – I corridors have a comparably high modal split for road. Therefore it is not surprising that F – I rail corridors have the clearly highest growth rates for transalpine rail transport (see Figure 8-42). But for some of the road freight traffic originally using F – I corridors it seems to be more attractive to shift on a Swiss rail corridor (e.g. traffic from the North-Eastern part of France or from the UK).
- Additionally, the Gotthard base tunnel rail corridor seems to attract rail freight traffic that was originally using more western corridors. It seems that despite the assumed opening of the new Mont Cenis base tunnel, especially the Gotthard rail corridor can attract additional transport.

Figure 8-41 and Figure 8-42 show the changes in transalpine road and rail freight transport in the 2030 scenarios in absolute values and in % with respect to BAU 2020 for the three considered groups of corridors within the Alpine arch C:

- Due to the possibility of detouring via the three easternmost A – I/SLO corridors (see also Figure 8-43 further below) the **A – I/SLO** corridors clearly observe the lowest percentage reduction in transalpine road freight transport. With common measures (one ACE cap or a common AETS reduction target for Alpine arch B+) the reductions are slightly higher than with a country specific implementation of the instruments.
- On **CH – I** corridors the percentage reduction in transalpine road freight transport is generally highest. With common measures (one ACE cap or a common AETS reduction target for Alpine arch B+) the reductions are slightly higher than with a country specific implementation of the instruments.
- The percentage reduction in transalpine road freight transport on **F – I** corridors lies below the reductions on CH – I but above A – I/SLO crossings. The reduction tends to be higher with country specific reduction targets compared to the introduction of a common cap.
- Regarding the changes in absolute values the reduction are highest on A – I/SLO corridores followed by CH – I and F – I crossings.
- In general, AETS leads to a higher relative reduction of vkm than of transalpine HGV trips within the area of the Alpine convention. This can be exemplified with the transport volumes on the Brenner-corridor (430 km distance within the Alpine Convention area) and the Tauern-corridor (301 km distance). Whereas in the scenario “ACE R 2030 high” 14.7 Mio. tonnes are transported on the Brenner road corridor it is noticeably less in the scenario “AETS R 2030 high” with 11.3 Mio. tonnes. At the Tauern corridor on the other hand 5.2 Mio. tonnes are transported in the scenario “ACE R 2030 high” but this figure rises to

7.1 Mio. tonnes in the scenario “AETS R 2030 high”. So, for almost 2 Mio. tonnes a detour effect away from the Brenner- to the Tauern-axis can be observed. Overall, this detouring causes longer trips outside the Alpine area which increases again total CO_2-emissions. This effect is the consequence of restricting the CO_2-certificates to the distance driven within the Alpine Convention area, and not to the entire door-to-door trip.

Figure 8-41: Scenarios 2030 high: Δ in Mill. tons/a to BAU 2030 high for transalpine road and rail freight transport

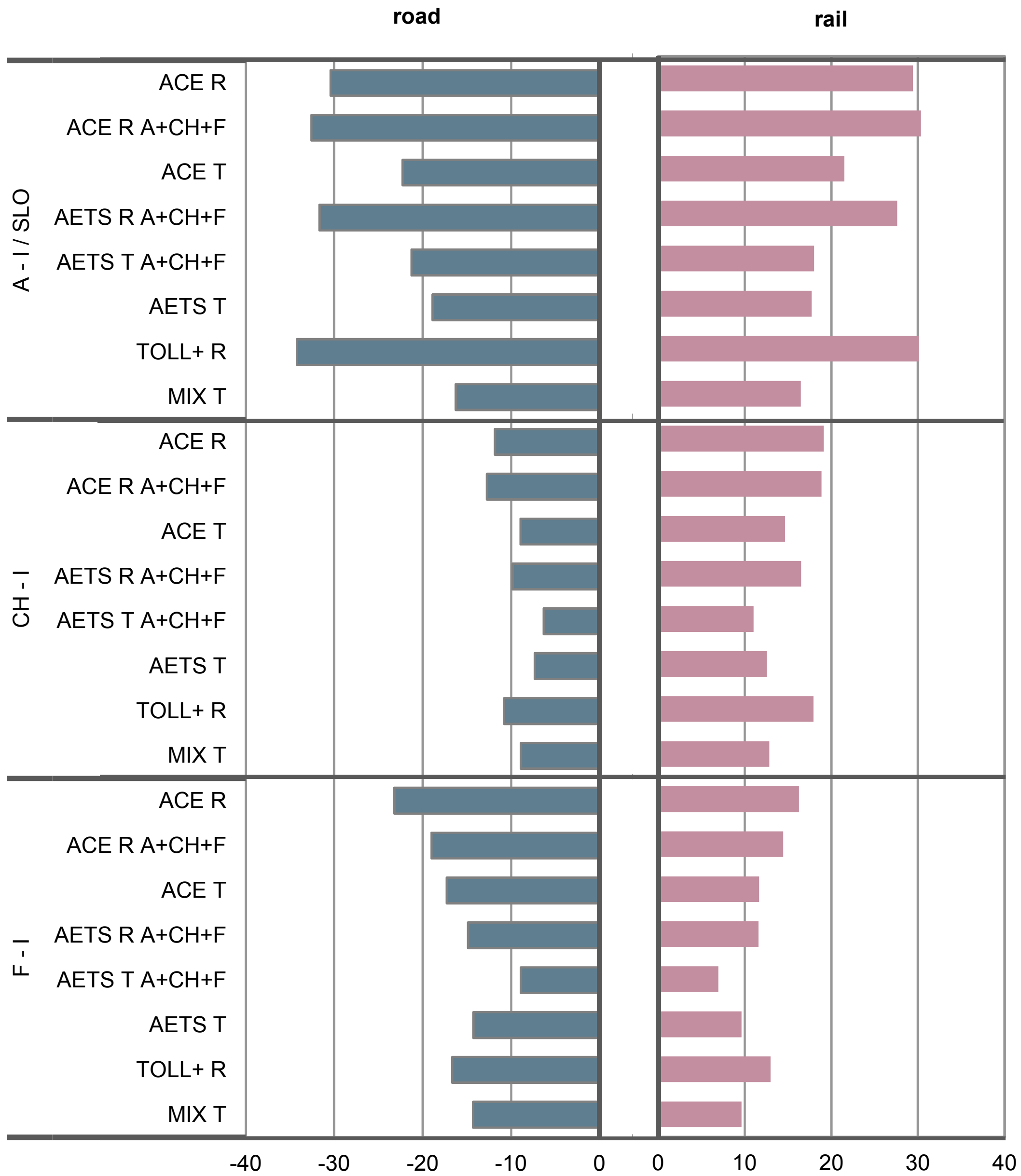
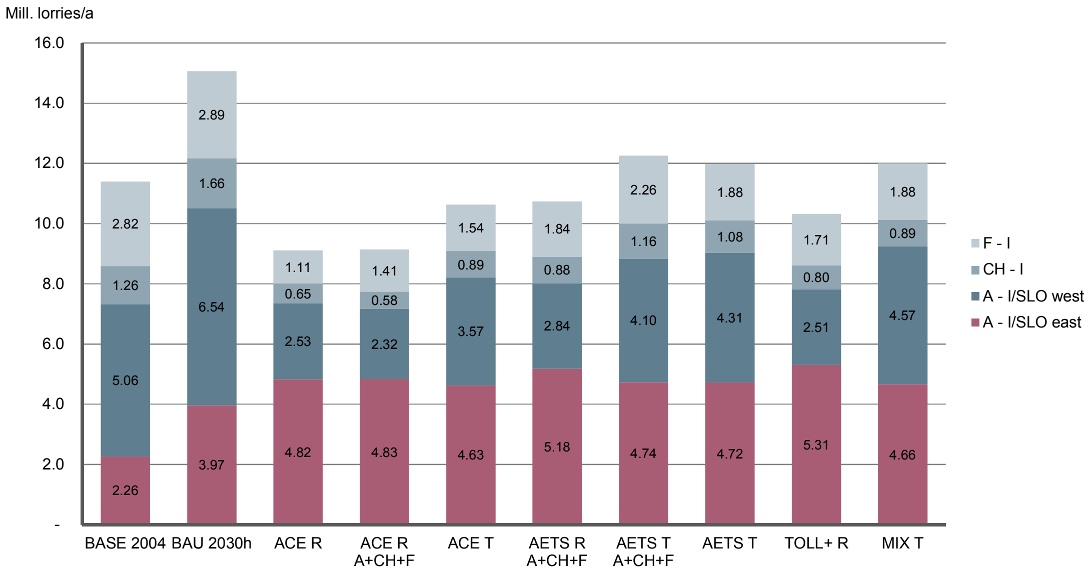


Figure 8-42: Scenarios 2030 high: Δ in % to BAU 2030 high for transalpine road and rail freight transport

It is important to mention that for all analyzed policy instruments the shifts of transalpine freight transport from road to rail in Alpine arch C would be higher if the measures would include all corridors within Alpine arch C. Because of the **limitation on Alpine arch B+** the exclusion of the three easternmost A – I/SLO corridors leads to a marked detouring effect and consequently more road freight transport on those corridors. This is clearly shown by Figure 8-43 which presents a summary of the results for the number of transalpine HGV trips for each of the scenarios for 2030 high growth. In order to distinguish between the crossing points for which the pricing instruments are applied (B+) and those which are excluded, volumes through Austria are split into two blocks – the Eastern (unaffected) routes, which see a rise in number of HGV trips and the Western (affected) routes, which see a decrease in number of HGV trips.

Figure 8-43: Transalpine lorry trips for the 2030 high scenarios, in Mill. lorries/a



Remark: The scales are measured in millions of lorries crossing the Alps per annum. The BASE 2004 column on the left hand side of the chart shows the observed volumes in 2004.

8.5.2 Comparison of instruments with respect to transport prices

Depending on the strength of the applied policy instrument and the observed year (2020 or 2030 low / high) the prices for transalpine HGV-trips per corridor increase by the following amounts (for all prices see chapter 8.2):

- **2020**: From 27 EUR/trip/corridor at the Tauern and Tarvisio corridors (scenario AETS T 2020) to 160 EUR/trip/corridor at CH – I corridors (scenario ACE R 2020).
- **2030 low**: From 56 EUR/trip/corridor at the Mont Blanc corridor (scenario AETS T 2030 low A+CH+F) to 281 EUR/trip/corridor at F – I corridors (scenario ACE R 2030 low).
- **2030 high**: From 102 EUR/trip/corridor at the Tauern and Tarvisio corridors (scenario MIX T 2030 high A+CH+F) to 345 EUR/trip/corridor at F – I corridors (scenario ACE R 2030 high).

For AETS and TOLL+, prices per corridor depend on the length of the corridor. Thus, for some transalpine HGV trips it may be cheaper to accept a detour via a corridor with a shorter distance within the area of the Alpine Convention.

8.5.3 Comparison of instruments with respect to costs and revenues for the public sector

In this study the analysis of the impacts on costs and revenues is restricted to

- the calculation of the direct revenues generated by ACE, AETS or TOLL+
- the calculation of the operating costs of the policy instruments

A wider analysis would have to take into account a number of further impacts as e.g. reduced revenues from road tolls and petroleum taxes as well as less costs for rail subsidies or additional revenues from railway track access charges.

Generally, it can be observed that the revenues are higher the more restrictive an instruments is. But on the other hand, the most restrictive scenarios do not generate the highest revenues as in these scenarios the shifting effect from road to rail outweighs the higher price per road freight trip.

Overall, the expected direct revenues are in the following range for the different instruments:

- ACE: 519 Mill. EUR/a (T 2020) to 1’224 Mill. EUR/a (R 2030 high)
- AETS: 275 Mill. EUR/a (T 2020 A+CH+F) to 1’255 Mill. EUR/a (R 2030 high A+CH+F)
- TOLL+: 682 Mill. EUR/a (R 2020) to 1’292 Mill. EUR/a (R 2030)
- MIX: 385 Mill. EUR/a (T 2020) to 1’018 Mill. EUR/a (T 2030)

The estimated operating costs are about 37 Mill. EUR/a for ACE- and AETS-scenarios, around 21 Mill. EUR/a for TOLL+ -scenarios and about 32 Mill. EUR/a for MIX-scenarios.

8.5.4 Analysis of capacities

Finally, the analysis of the capacity use shows that railway capacities in 2030 are large enough to absorb the large shifting effect of transalpine freight transport from road to rail. It can be clearly shown that in the BAU-scenarios the degree of capacity utilisation of the new transalpine rail base tunnels will be comparatively low. In other words: The construction of new rail base tunnels at the Mont Cenis/Fréjus-, Lötschberg-, Gotthard- and Brenner-corridor asks directly for the the implementation of an ACE- / AETS or TOLL+ -scenario in order to use these new capacities to a good degree.

8.5.5 Overall conclusion

This study delivers an analysis of three different transport policy instruments, the Alpine Crossing Exchange (ACE), the Alpine Emission Trading System (AETS) and TOLL+. All instruments aim at limiting transalpine road freight transport and shifting transport activities to rail. In the first part of the report, the instruments are described in detail. It is also shown how these instruments can be implemented and operated as well as what their costs would be.

The analysis of the impacts is based on a transport model – the TAMM – that was developed as a dedicated transalpine freight transport model and that is diffentiated according to all transalpine corridors, to road and rail freight transport including three different rail modes and to NSTR types of goods. The base year results of the model are calibrated according to 2004 data. It would be preferable to update the base year as soon as the new 2009 data set is available (which is not already the case).

The forecast in the business as usual scenarios for 2020 and 2030 corresponds to recent trends and is based on EU iTREN-2030 forecasts of trade volumes between European countries. It shows that growth of transalpine freight transport is shifting gradually towards the more easterly corridors. Of course, the assumptions used for the business as usual scenarios may be subject for discussion. In our view, given short and medium term uncertainties, the assumptions are well founded and are based on the most actual trends. In the business as usual (BAU) scenarios, forecast growth of transalpine rail freight transport is stronger than road freight transport. This is due to the introduction of new rail base tunnels (Mont Cenis and Brenner until 2030, Gotthard and Lötschberg before 2020) and other factors that cause noticeable productivity effects in the rail sector. On the other hand it is assumed that existing subsidies in rail transport (mainly for unaccompanied combined transport) are phased out.

As basis for the impact analysis a total of 21 scenarios for the ACE, the AETS and TOLL+ instruments were defined, run, and analysed. The thresholds used are derived in a pragmatic way in order to cover the implementation of the instruments from tolerant to more restrictive versions. The study shows the impacts of these scenarios on volumes and prices of transalpine freight transport. Additionally the direct effects on costs and revenues for the public sector and on capacities for transalpine rail freight transport are analysed. The results for the different scenarios are plausible. The more restrictive a scenario, the more transport volumes are shifted away from road to rail transport. Different per-trip prices via different crossings (as in the case of the AETS-scenarios) cause detouring effects towards corridors with lower price increases. The extent to which the instruments can be balanced by corridor across the whole region determines the extent to which they lead to desirable rather than perverse incentives.

The study delivers a basis for the governments of the Alpine countries to decide if one or a combination of these instruments should be established. The study produces no explicit recommendation with respect to the three instruments. All of these instruments could be introduced. In any case a co-ordinated introduction over the whole Alpine arch and not only a part of it is preferable in order to avoid unwanted detouring effects. Nevertheless, for a concrete implementation certain aspects such as the distribution of revenues between countries, the explicit organisation of auction procedures and questions of enforcement have to be determined in more detail.

PART IV: Annex

9 Basic attributes of the three instruments ACE, AETS and TOLL+

The overview below summarises the main attributes and principles of the three instruments ACE, AETS and TOLL+ in terms of the following basic attributes:

- Definition of passage right
- Validity
- Spatial Scope
- Quantitative targets
- Local and Short Distance Transport
- Supervision
- Allocation
- Trading
- Layout and Operations

	Alpine Crossing Exchange (ACE)	Alpine Emission Trading System (AETS)	Differentiated toll systems (TOLL+)
Definition of passage right	HGV with a maximum gross vehicle weight of more than 3.5 t have to produce an Alpine Crossing Permit (ACP) for a journey through an Alpine crossing which is subject to the ACE. A defined amount of Alpine Crossing Units (ACU) qualifies for an ACP. The ACP is assigned to a specific vehicle and entitles that vehicle to a one-way journey through an Alpine crossing within a specific period of time. The required amount of ACU per ACP may be dependent on the vehicle type (e.g. emission category). Local and short distance transport may require less ACU.	HGV with a max. gross vehicle weight of more than 3.5 t have to purchase CO_2 emission certificates depending on distance travelled within the region of the Alpine convention and the vehicle class. The certificates are auctioned once a year and they are tradable within the period of validity at an exchange market.	HGV with a maximum gross vehicle weight above 3.5 or 12 tonnes pay a time differentiated toll and an additional environmental charge directly when using the alpine crossing. The toll to be paid is based on the regular toll, in addition, the environmental surcharge and the toll modulation tariff are added. The surcharge consists of the vehicle characteristics (total weight or number of axles) and the emissions; the surcharge can be different between the Alpine crossings. In case of TOLL+ there is no limitation of total numbers of passage rights. The demand for Alpine passages for a particular Alpine crossing at a particular time is regulated via the differentiated toll to be paid. In the TOLL+ regime no initial provision or trading of “passage rights” is foreseen.
Validity	ACU are valid for a specific period of time (e.g. 15 months). The period of validity of consecutive ACU overlaps (e.g. 3 months). The ACP has the same period of validity as the ACU. In the event of long lasting break-downs of the system, the period of validity of an ACU may be extended.	CO_2-certificates are valid for a specific period of time. This period should be longer than one year to have a overlapping of validity of two periods. This increases the flexibility of the user. The over lapping should be as short as possible to keep overview on certificates. The suggested period of validity is about 15 month.	The differentiated tolls are paid directly when passing a particular Alpine crossing. But in any case these modulated toll rates can change during the year and per Alpine cross-ing.

	Alpine Crossing Exchange (ACE)	Alpine Emission Trading System (AETS)	Differentiated toll systems (TOLL+)
Spatial Scope	ACP may be used for all Alpine crossings subject to the ACE within a country. The ACE does not intend to manage the day-to-day traffic though the Alpine crossings. For long lasting breakdowns of the traffic system, it may be agreed that ACP may be temporarily used at foreign Alpine crossings.	The certificates can be used for all Alpine crossings that are part of the system. No distinction between countries is made. This leads to one price at one point of trading time for a certificate during auctioning and trading phase for the whole system. This is important because the system does not intend to manage the day-to-day traffic over the Alps.	TOLL+ aims on a more efficient and environmental friendly use of the transport infrastructure at the Alpine crossings by cutting peaks in traffic demand at a particular crossing by applying different tolls for the day and/or time of use as well as the internalisation of external costs.
Quantitative targets	The quantitative targets are expressed as the maximal allowed number of transalpine HGV-trips per country and year. Alpine coun-tries coordinate these targets in order to avoid undesired traffic detours. The yearly quantitative targets are defined at least 4 years in advance.	The quantitative targets are expressed as the maximum CO_2 emission of Alpine crossing trips within the region of the Alpine convention within a country (depending on a countries CO_2 emission reduction target). This maximum CO_2 emission of the participating countries are summed up and auctioned and traded on one market platform. These targets have to be fixed for some years (e.g. 4 years) in advance to enable the transport companies a planning.	In TOLL+ no total quantitative targets are set with respect to the total amount of HGV Alpine crossings. It is in every toll operator's choice to decide on the toll amount to be paid at different days and/or times and so to meet the objective of cutting traffic peaks at Alpine crossings. The environmental surcharge depends on the possibilities given by the (still to be adopted) revision of Directive 1999/62/EC.

	Alpine Crossing Exchange (ACE)	Alpine Emission Trading System (AETS)	Differentiated toll systems (TOLL+)
Local and Short Distance Transport	Local and short distance transport may be given priority in order to avoid an obstruction of the traffic between neighbouring economic areas on both sides of the Alpine crossings and thus the splitting of interdependent areas. Local and short distance transport is defined according to the length of the Alpine crossing transport. It is the transported freight (and not the journey of the vehicle) which is used for the required acceptance of a vehicle for local traffic or short distance traffic. In order to assure the enforcement of this special rule, ZIP-code areas on both sides of the Alpine crossing are used as spatial reference of origin and destination for the admission of local and short distance transports. The driver has to prove that the transport has been correctly declared as a local or short distance transport.	All liable vehicles and all liable trips are included in the AETS system. In comparison to the ACE system no exemption for short distance transport is necessary. All trips are treated according to the trip distance within the Alpine region. Short distance transport need less certificates then long distance transports. Moreover, short distance trips are usually done with smaller HGVs than long distance trips. Small HGVs normally also have lower CO_2-emissions. AETS is linked to CO_2 emissions. Therefore the use of higher percentage of bio-diesel leads to a reduction of CO_2 emission and therefore a reduction of needed certificates. The treatment of this issue is not possible with the existing information. Other exemptions are not in line with the non-discriminatory principle so no further exemptions are foreseen.	Whether exemptions or special regulations for the local traffic or short distance travel are necessary, must be analysed more deeply (see question in chapter 2.3.3).

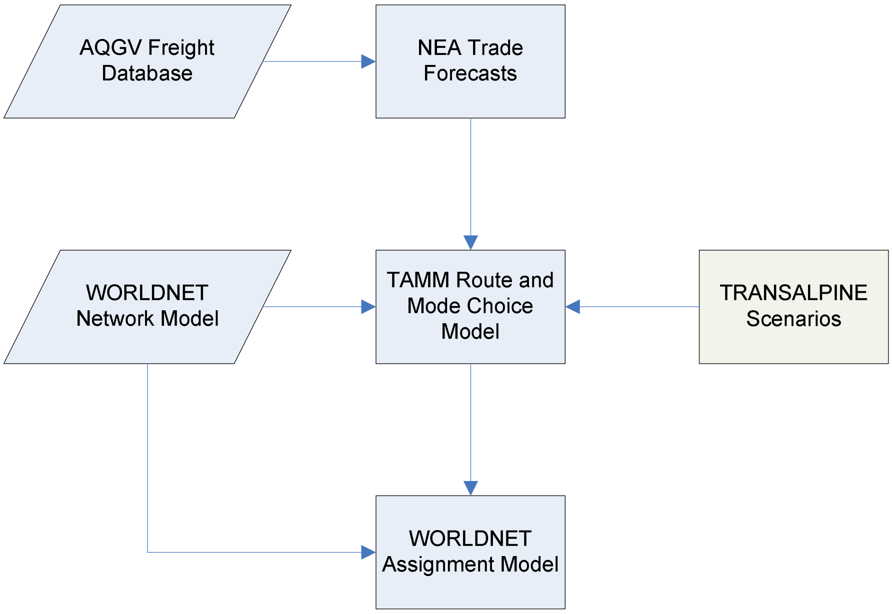
	Alpine Crossing Exchange (ACE)	Alpine Emission Trading System (AETS)	Differentiated toll systems (TOLL+)
Supervision	The federal government ensures that all necessary functions for the operation of the ACE are provided. Its task is the supervision of the complete system. The government may introduce suitable measures during a severe breakdown of the ACE system in order to restore the functional capability.	The overall responsibility for the AETS system has the individual government. But it is possible the government authorises an existing organisation (e.g. the ASFINGA in Austria) to take over the supervision and ensure the functioning of the system	In the TOLL+ regime the particular toll operator supervises the system and assures the correct functioning.
Allocation	ACU are auctioned at regular intervals. One single market participant may not purchase more than 25% of ACU per auctioning. The auctioning includes ACU for the running and for future years in a time graded mode.	CO_2 certificates are auctioned at regular intervals. One auction handles all certificates for all participating countries. One single market participant may not purchase more than 25 % of the certificates per auctioning. The auctioning includes also certificates of future years.	There is no initial allocation of “passage rights”, e.g. via an auction, in a TOLL+ regime.
Trade	ACU may be freely purchased and traded. They only exist in an electronic form within an ACU register. An assigned ACP for a vehicle is not tradable. ACP may be exchanged in ACU at any time. Trade with ACU is not restricted to a central platform. Market makers ensure the liquidity of the market. They will have to purchase a minimum amount of ACU at the initial assignment and are obliged to place bid and asked prices.	CO_2 certificates have to be traded over one central (virtual) platform to guarantee one price at one point of trading time for the whole system. All countries participating at the system are linked to this platform. Sub-platforms and market makers are allowed but have to be linked to this central platform to guarantee this single price. CO_2 certificates exist only in an electronic form. The platform has to guarantee a trading time around the clock to give the transport companies as much flexibility as possible and the possibility to purchase certificates ad hoc for short time transport orders.	There is no trading of “passage rights” in a TOLL+ regime.

	Alpine Crossing Exchange (ACE)	Alpine Emission Trading System (AETS)	Differentiated toll systems (TOLL+)
Layout and Operations	System management includes the availability and operations of three registers and three inter-faces: owner register, ACU register and vehicle register. The validation of ACP is done electronically and with free flow traffic (without stopping the vehicles). The installation of an On-Board Unit (OBU) with dedicated short range communication is mandatory. The drivers and vehicle owners must cooperate with the ACE by taking care that every vehicle is equipped with a working OBU and possessing the necessary ACP before starting a journey over the Alpine crossing. OBU can be purchased at points of sales and are assigned to vehicles. The points of sales are located at the access roads to the Alpine crossings and near the driveways to the charged ACE-roads. The drivers and vehicle owners are com-pletely liable for the discharge of the ACP.	System management includes the availability and operations of three registers and three interfaces: owner register, Emission certificate register and vehicle register. The validation of the certificates is done electronically and within free flow traffic (without stopping the vehicles). The standard CO_2 emission has to be declared at the time of entrance of a vehicle in the system via vehicle registration document. This information will be implemented in the OBU. This is the same procedure as chosen for the EURO classes within the Austrian toll system. An additional manual controlling is possible and recommendable to check misuse of OBU and to be present on the road. This can be done by the control organs for the toll systems in the different countries. The installation of an OBU with DSRC is The drivers and vehicle owners must coop-erate with the AETS by taking care that every vehicle is equipped with a working OBU and possessing the necessary certificates before starting a journey with the Alpine crossing. OBU can be purchased at points of sales and are assigned to vehicles. The points of sales are located at the access roads to the Alpine crossings and near the driveways to the charged AETS roads. The drivers and vehicle owners are completely liable for the discharge of the certificates.	The TOLL+ system comprises the Toll operator's back-office, the roadside infrastructure at the Alpine crossings and OBU for electronic debiting of the toll to be paid when crossing the Alps. The installation of an OBU with dedicated short range communication is mandatory. The OBU can be purchased at point of sales and are assigned to vehicles. The points of sales are located at the access roads to the Alpine crossings and near the drive-ways to the charged ACE-roads.

10 The TAMM (TransAlpine Multimodal Model)

In the following flow chart, the main components of the model system are shown.

Figure 10-1: Transalpine Model System Overview



There are two main data components, three model components, and a set of scenarios defining the forecast assumptions which are discussed in the following chapters in-depth.

10.1 AQGV Freight Database

Quantification of base year freight flows is based entirely on the 2004 AQGV survey. Surveys are carried out in parallel by the Austrian, Swiss and French Governments, and compiled into a common database. The most recent complete survey was carried out in 2004.

The model is based upon the CAFT04_MOD dataset, containing information about the tonnages per mode and Alpine corridor. The only important data transformation is the conversion of the recorded zoning to the scheme designed for the WORLDNET project, now also being implemented within TRANSTOOLS. For example, the Italian NUTS2 zone ITD3 (Veneto) is converted to the WORLDNET NUTS3 zone 118130301 (Verona). Suitable conversions from NUTS2 or equivalent to NUTS3 have been chosen.

Table 10-1: Data Extraction from the AQGV Database

ID	*ALP CRO*	*TRA DIR*	*MOD ALP*	*ORI MAX*	*ORIMAXWN*	*DES MAX*	*DESMAXWN*	*COM MOD*	*GOO WET*
1	AT2	2	2	ITD3	118130301	NO	125000101	5	26.120
2	AT2	2	2	ITD1	118130100	AT12	101010207	9	287.196
3	AT2	2	2	ITD2	118130200	AT12	101010207	9	123.084
4	AT2	2	2	ITC1	118120101	AT31	101030102	5	3305.650
5	AT2	2	2	ITC1	118120101	AT31	101030102	9	154.000
6	AT2	2	4	ITD3	118130301	AT31	101030102	9	15.826

A summary of the data is shown below:

Table 10-2: 2004 AQGV Freight Traffic, Millions of Tonnes

	ROAD	UCT	WL	RM	TOTAL RAIL	TOTAL
	m.T	m.T	m.T	m.T	m.T	m.T
Reschen	2.0					2.0
Brenner	31.0	4.7	3.9	1.6	10.2	41.2
Felbertauern	0.9					0.9
Tauern	12.2	0.8	6.3	1.0	8.0	20.2
Schoberpass	14.5	0.6	4.2	0.5	5.4	19.9
Semmering	5.6	0.7	8.9	0.0	9.6	15.2
Wechsel	8.8				0.0	8.8
Tarvisio	18.8				0.0	18.8
Grand St Bernard	0.6					0.6
Simplon	0.7	2.6	3.0	1.2	6.8	7.5
Gotthard	9.9	9.7	6.0	0.5	16.1	26.0
San Bernadino	1.3					1.3
Mont Blanc	5.2					5.2
Frejus Mt Cenis	16.8	2.6	3.7	0.0	6.3	23.0
Montgenevre	0.3					0.3
Ventimiglia	18.0				0.0	18.0
Grand Total	146.5	21.5	36.0	4.9	62.3	208.8
Alpine arch C	127.7	21.5	36.0	4.9	62.3	190.0

It shows a total of 208.8 million tonnes crossing the Alpine region in 2004, of which, 146.5 million tonnes go by road and 62.3 million by rail.

This can be compared with the volumes published in ALPINFO 2007 for 2004:

Table 10-3: 2004 ALPINFO Freight Volumes (Million Tonnes, HGV 000s)

	ROAD		UCT	WL	RM	TOTAL RAIL	TOTAL
	m.T	000 HGV	m.T	m.T	m.T	m.T	m.T
Reschen	2.0	135					2.0
Brenner	31.5	1,983	4.7	3.9	1.6	10.2	41.7
Felbertauern	0.9	82					0.9
Tauern	12.2	941	0.8	6.3	1.0	8.1	20.3
Schoberpass	14.6	1,281	0.6	4.2	0.5	5.3	19.9
Semmering	5.6	528	0.7	8.9		9.6	15.2
Wechsel	8.8	988	0.1	0.1		0.2	9.0
Tarvisio	19.1	1,404	0.5	5.3		5.8	24.9
Grand St Bernard	0.6	65					0.6
Simplon	0.7	67	2.6	3.0	1.2	6.8	7.5
Gotthard	9.9	969	9.7	6.0	0.5	16.2	26.1
San Bernadino	1.3	154					1.3
Mont Blanc	5.2	353					5.2
Frejus Mt Cenis	16.8	1,131	3.2	3.7		6.9	23.7
Montgenevre	0.3	31					0.3
Ventimiglia	18.0	1,345		0.5		0.5	18.5
Grand Total	147.5	11,457	22.9	41.9	4.8	69.6	217.1
Alpine arch C	128.4	10,053	22.4	36.6	4.8	63.8	192.1

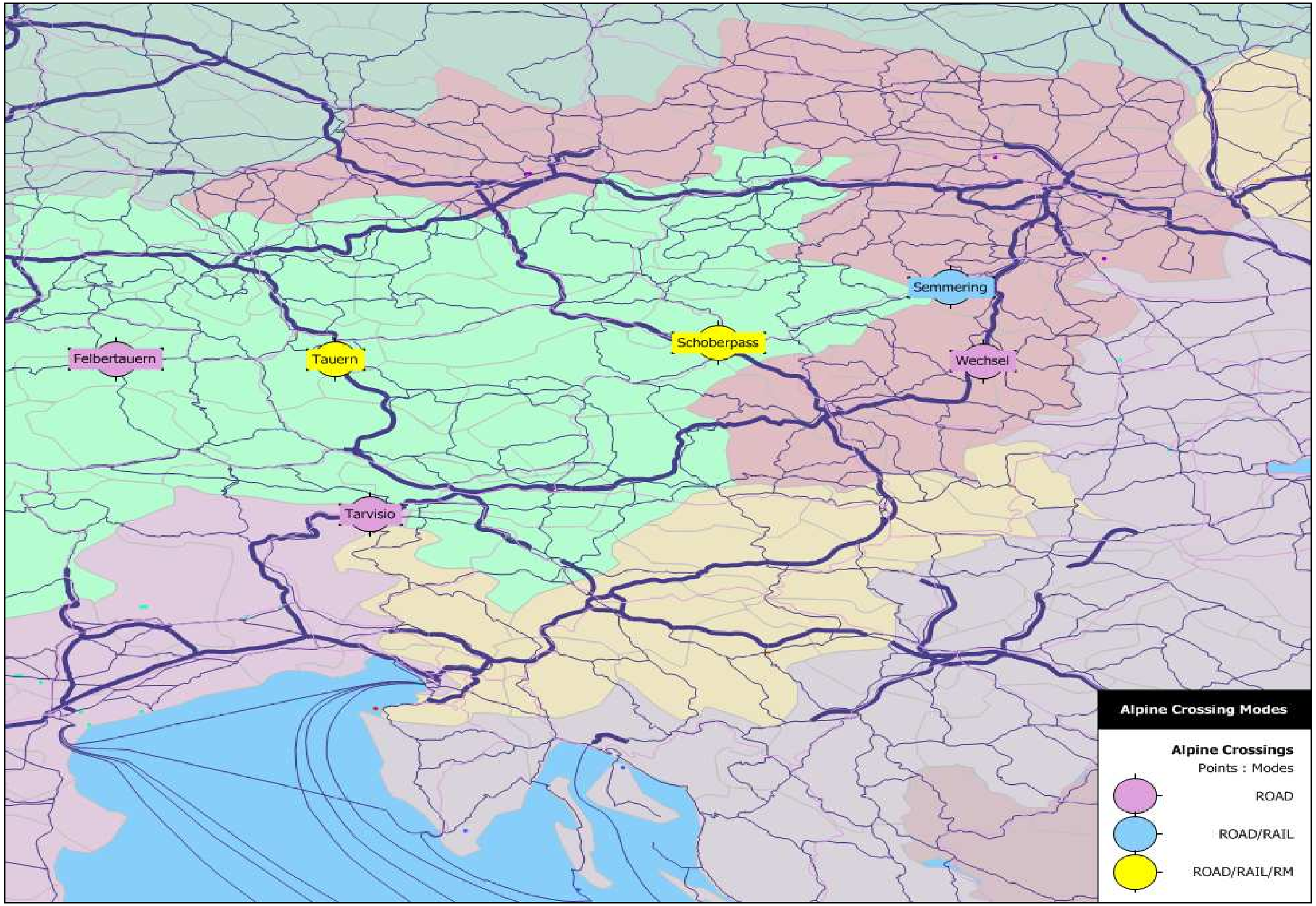
Note that the total tonnages derived directly from the AQGV survey database by summing the GOOWET field may differ from the reported ALPINFO figures.

ALPINFO uses a more sophisticated interpretation of consignment weights, whereas the model is using the simplest interpretation. For comparison purposes, we have estimated from AQGV, a total tonnage of 208.8 million tonnes across all routes, and 190.0 for Alpine arch C. ALPINFO reports a figure of 192.1 million tonnes for Alpine arch C, and a figure of 217.1 million tonnes for all crossing points can be inferred.

The definition of Alpine arch C refers to a set of crossing points from which the Tarvisio route is excluded. Tarvisio is linked via motorway to other passes e.g. Tauern and Wechsel, (see Figure 10-2) so transalpine flows crossing Tarvisio also use another crossing point. When summing tonnes by crossing point, Tarvisio may be excluded in order to avoid a double count.

Within the model runs, some O/D combinations cannot be modelled e.g. where the trading regions are outside the model’s zoning system e.g. Canary Islands, or if they are unknown.

Figure 10-2: Tarvisio Crossing Point



For reference, the ALPINFO 2007 are shown below.

Table 10-4: 2007 ALPINFO Freight Volumes (Million Tonnes, HGV 000s)

	ROAD		UCT	WL	RM	TOTAL RAIL	TOTAL
	m.T	000 HGV	m.T	m.T	m.T	m.T	m.T
Reschen	1.4	100					1.4
Brenner	35.0	2,177	6.4	3.8	3.1	13.3	48.3
Felbertauern	0.9	80					0.9
Tauern	13.2	1,001	1.1	7.3	0.6	9.0	22.2
Schoberpass	16.5	1,428	1.1	4.0	0.8	5.9	22.4
Semmering	5.5	511	0.6	8.0		8.6	14.1
Wechsel	12.0	1,196	0.1	0.1		0.2	12.2
Tarvisio	19.9	1,426	0.7	5.8	0.5	7.0	26.9
Grand St Bernard	0.6	55					0.6
Simplon	0.9	82	4.9	3.3	1.6	9.8	10.7
Gotthard	10.9	963	10.1	5.0	0.4	15.5	26.4
San Bernadino	1.8	162					1.8
Mont Blanc	8.6	590					8.6
Frejus Mt Cenis	13.1	876	2.4	3.8	0.4	6.6	19.7
Montgenevre	0.7	65					0.7
Ventimiglia	19.4	1,455	0.0	0.7		0.7	20.1
Grand Total	160.4	12,167	27.4	41.8	7.4	76.6	237.0
Alpine arch C	140.5	10,741	26.7	36.0	6.9	69.6	210.1

Data[98] for 2008, published in 2009 shows a 1% increase for Swiss road freight, measured in number of vehicles. This is so far the high point in terms of traffic.

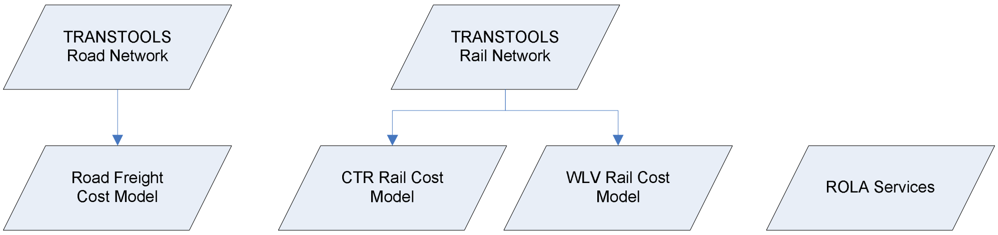
10.2 WORLDNET Network Model

Detailed road and rail networks have been used for computing distances, journey times, and transport costs. These are updated with the networks produced by the EC's WORLDNET study, following the design specification of the EC's TRANS-TOOLS model. The networks cover the whole of Europe, and provide sufficient detail for Transalpine freight flows.

Unlike TRANS-TOOLS, the Transalpine model handles three distinct categories of rail, allowing diversions between them to occur. This is handled via a two stage process for unaccompanied combined transport (CTR) and conventional wagon load freight (WLV). ROLA is handled separately:

[98] Güterverkehr durch die Schweizer Alpen 2008, Bundesamt für Verkehr.

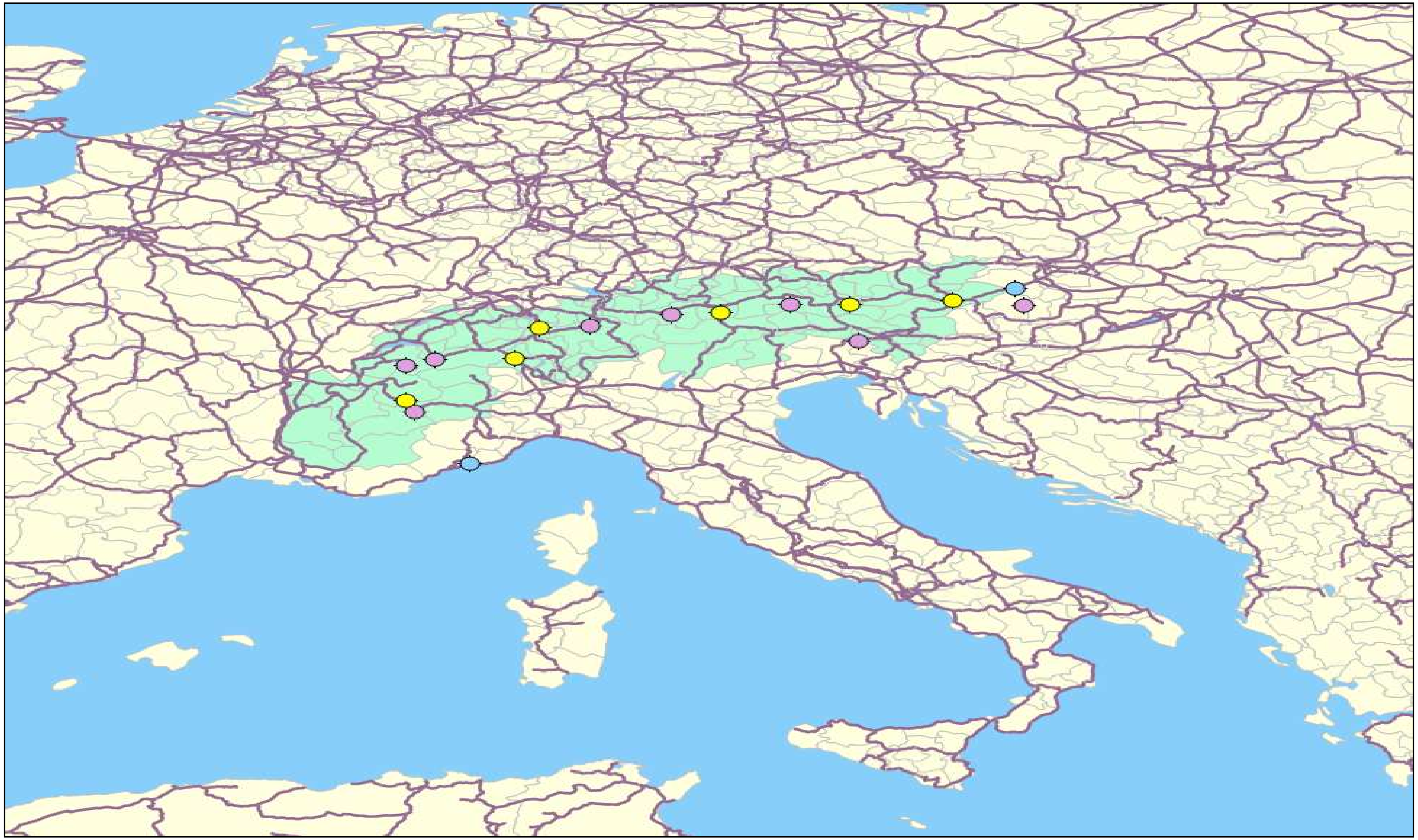
Figure 10-3: Structure of Network Model



The supply side therefore consists of a network database describing the road and track lay-outs, and a cost model for converting distances and times into costs. ROLA is simply a set of connections with fixed costs and journey times. The crossing points shown with yellow mark-ers have ROLA services.

Figure 10-4: WORLDNET Road Network

Figure 10-5: WORLDNET Rail Network



10.3 NEA Trade Forecasts

Once the base matrix has been estimated in a form compatible with the model's expected inputs, it is necessary to be able to project the flows to levels that might be applicable in the years when the ACE scheme is expected to be in operation.

The forecasting method, and in fact the forecasts have not been changed since the 2008 study, on the basis that these were long run forecasts, where a short-term downturn was already taken into account. For reference, the methodology is reprinted here.

10.3.1 Forecasting Methodology

For the current set of requirements, a separate trade model has been employed, using inputs from the WORLDNET and ITREN studies. It uses an agent-based simulation to project financial trade flows, and then it combines these results with more detailed projections of trade tonnages. Therefore it combines a high-level global macroeconomic forecast with the more detailed analysis of trade volumes by product and between specific pairs of countries. These two main components, the global trade model and the trend model are described below.

10.3.2 Global trade model

The pattern of global trade involves a complex set of interactions between national economies. Typical macroeconomic approaches tend to focus on a single economy at a time, and to relate trade growth to other equally unpredictable economic indicators e.g. GDP. They may be data intensive and focus more on the equilibrium state rather than the economy's path towards this equilibrium. The trade model developed by NEA attempts to be practical, requiring only historical trade data and standard indicators such as GDP and population to obtain reasonable forecasts for countries' total imports and exports. It is also dynamic, capturing the interactions between countries, and not requiring exogenous forecasts of explanatory variables.

Input data (historical value of trade between country pairs) is gathered from the Eurostat Comext[99] and the United Nation's Comtrade[100] trade databases. Together, it is possible to build up a picture of total world trade as a *closed system*. There may also be overlaps between the data sources, allowing a certain degree of validation to take place. If several versions of the same trade flow are available these time series can be consolidated into one, using a smoothing algorithm.

The algorithm removes outliers, fills in gaps, and validates annual growth, so that one harmonised time series is obtained. When that is done for all different country pairs, global origin-destination matrices can be constructed. Presently, the last "known" year is 2009 for the

[99] Link to Europa - Eurostat - External Trade.

[100] http://comtrade.un.org/

majority of countries, with historical records going back to 1995. Prior to 1995, it becomes difficult to harmonise the data due to changes in national boundaries, particularly in Eastern Europe and Central Asia.

The global trade model is an agent-based simulation model. This means that countries are modelled as autonomous individuals, existing as separate entities within the system. They each have their own variables and behaviour. The model iterates one year at a time, starting at the base year (2009) with the capability of continuing indefinitely.

The import and export forecasts are initially produced on a national level (without interaction between countries), taking into account the size of the economy and historical trends in the country's trade. Additionally, trade growth is subject to various constraints such as a limited trade deficit. After the new import and export levels are determined for each country in the system, the agents interact with each other to restore balance ; one country's exports have to be absorbed as another country's imports, and the other way around.

The model places more emphasis on historical quantitative data analysis as opposed to current expectations concerning the relevant indicators in specific countries. Although external expectations can be taken into account, for example, by using predetermined national import and export growth rates, this is generally not done. The effect this has on the model as a whole is typically quite insignificant, especially into the medium and longer term range.

10.3.3 Trend model

The output of the global trade model is a set of financial trade flows at a national level. However, transport oriented applications require detailed trade flows from country to country with product information, measured in tonnes.

Therefore a separate trend-based approach has been developed. It generates unconstrained projections of these detailed cargo flows. These can be converted into dollar equivalents using trade-data derived value densities ($ per tonne), and then summed, so that the aggregate values can be compared with the outputs of the global trade model and constrained by it.

The commodity grouping used is the three-digit NSTR coding[101]. Trade flows are already grouped accordingly in the EU Comext and UN Comtrade trade databases. Similar to the total trade flows that are used as input for the global trade model, the disaggregated trade flows (in both tonnes and values) are taken from the databases, and a smoothing algorithm is applied to the resulting time series where needed.

Initial tonne forecasts are made by simply extending the series into the future, letting the short-term trend converge to the long-term trend. A monetary value is attached to these figures by using historical value-per-tonne rates. Then, the values for each commodity group

[101] NSTR: Nomenclature Uniforme des Marchandises pour les Statistiques des Transports.

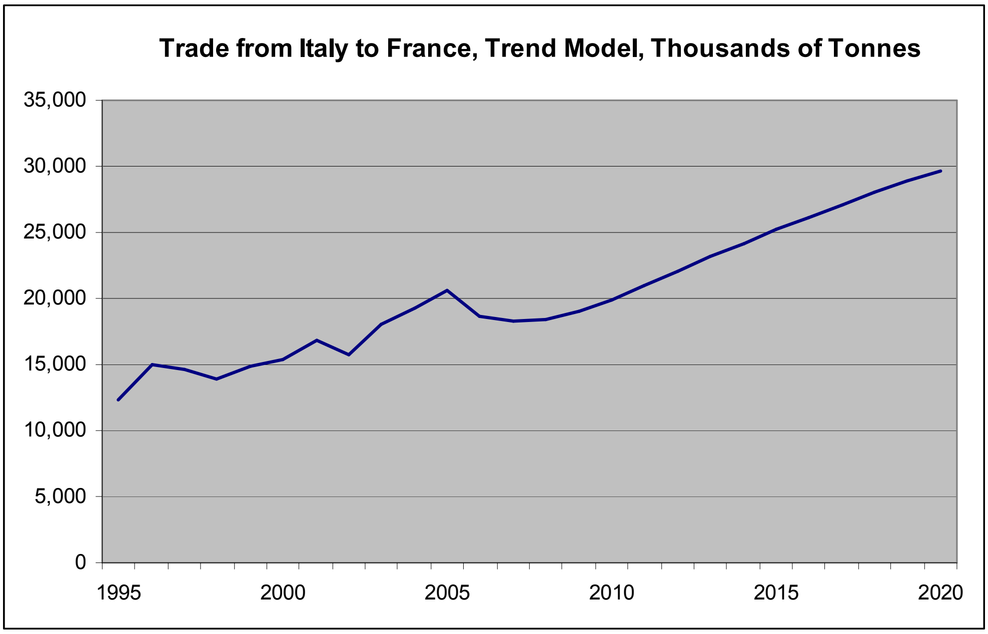
are added up and compared to the output of the global trade model. Finally, the tonne forecasts are adjusted up or down based on the discrepancy between the two values.

10.3.4 Step-by-Step Example of Forecasting Methodology

The process is explained step-by-step with the following diagrams. The example is based on an actual trade flow between Italy and France with no commodity detail, but in practice the same method is used for every country pair and for every commodity. Commodity details have been taken out of the example, because it is then easier to compare the output of the Trend Model with the output of the Global Trade Model (which also has no commodity information), and to show how the latter constrains the former.

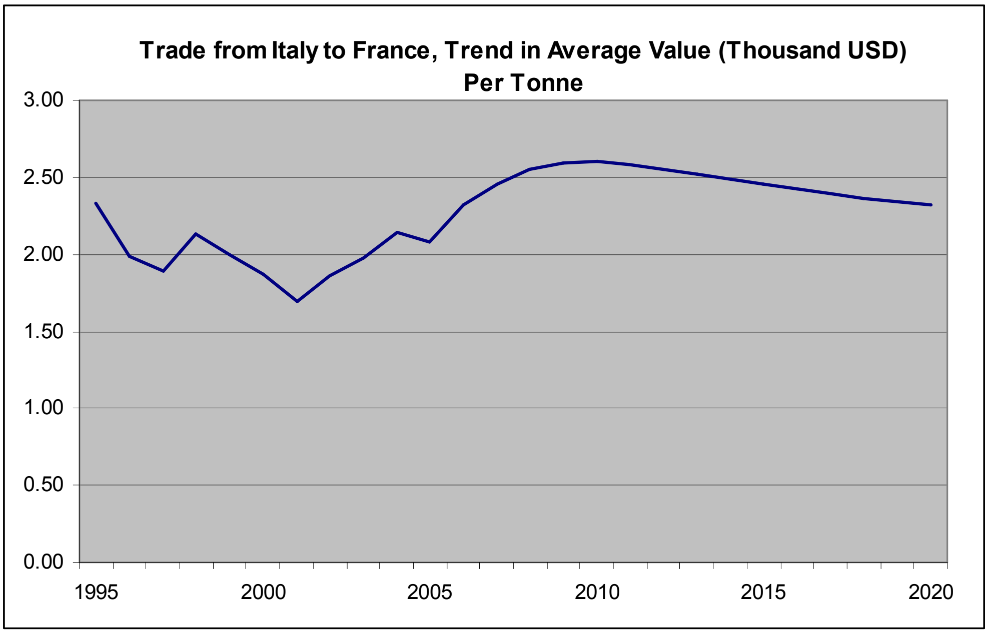
Step 1: Trade tonnes are projected for each commodity group using the Trend Model, for every pair of countries. Data exists between 1995 and 2009, after which a projection is made without any constraints. The objective is to create a basic set of forecasts in which current levels of growth are reflected.

Figure 10-6: Step 1 - Projection of Trade Volumes with Trend Model



Step 2: A forecast of the value to weight ratio is made, again for each pair of countries and each NST3 product, again by projecting recent historical time series. In the Italy/France example, there has been a steady increase in the dollars per tonne ratio between 2000 and 2009, partly explained by the dollar's decline relative to the Euro, and partly explained by the product mix.

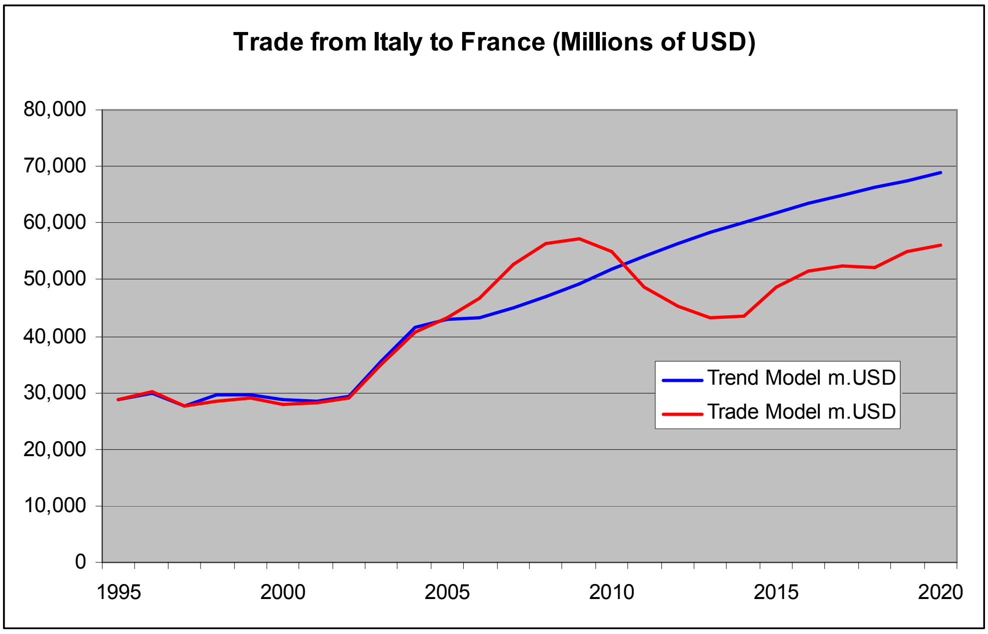
Figure 10-7: Step 2 - Projection of the Value to Weight Ratio



Since there is relatively little information that the model can use (e.g. with respect to currencies) for the forecast values, it tends towards a safe estimate close to the last recorded value, with a trend that tends towards the long term linear pattern.

Step 3: By combining the projected tonnage with the projected value per tonne it is possible to estimate future trade in value terms for each country pair and for each product group. These raw forecasts are then aggregated over all product groups so that total trade values per country pair can be compared with the outcome from the Global Trade Model output (see below).

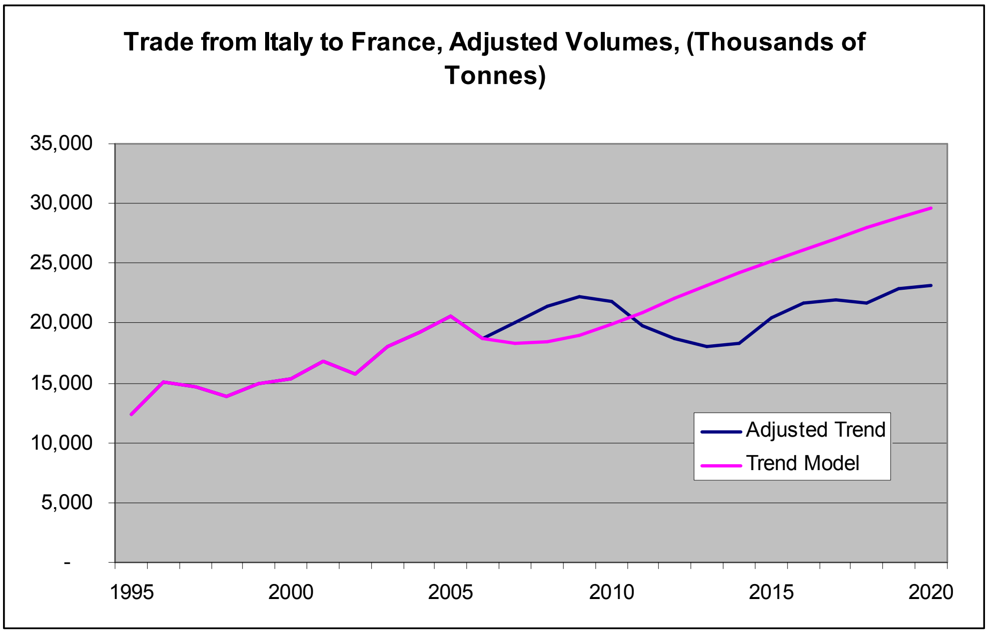
Figure 10-8: Step 3 - Comparison of Trend Model and Trade Model Results



Note that the fundamental pattern of growth produced by each model is similar, i.e. tending towards US$60bn, but that the trend model is a smooth projection, whereas the trade model oscillates. The trend model outputs have been generated simply by looking at individual trade flows without considering their impact at a macroeconomic level. By contrast, the trade model outputs have only considered interactions between countries at an aggregate level, without considering trends in specific industries. Ideally the model needs to reflect both, so the trade model values are used as high-level constraints upon the trend model. In this way, the dynamic interactions caused by the cumulative effects of unsustainable trade imbalances are passed down to the more detailed model.

Step 4: "Correction Factors" are calculated from the Step 3 outcomes for each country pair in each forecast year and used to adjust the tonnage forecasts for each commodity group. In this way, the high level forecasts will agree with the aggregation of the lower level trade flows, and there will be internal consistency between the more integrated global trade model and the more atomistic trend model.

Figure 10-9: Step 4 - Adjusted Tonnages

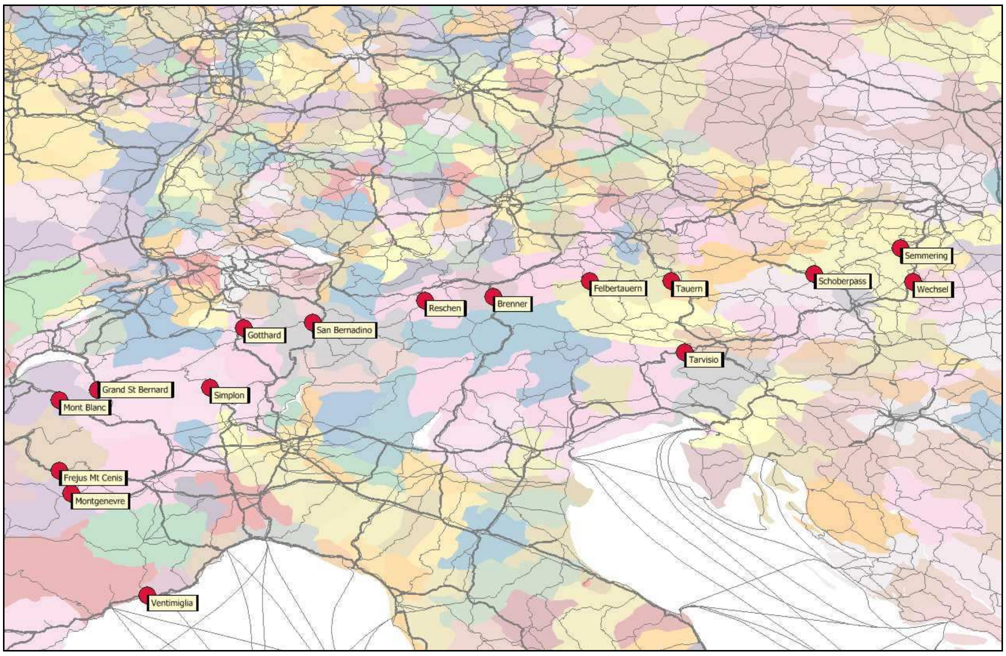


The adjusted tonnage series is shown in Figure 10-9, with the forecast being adjusted downwards towards 25.0 million by 2020. Once this final step is implemented, the tonnage forecasts, the value per tonne forecasts, the value forecasts, and the macroeconomic forecasts are all in agreement.

10.4 TAMM Route and Mode Choice Model

Transalpine models focus upon the traffic crossing a screen line stretching from the Mediterranean coast at the French/Italian border to the Eastern part of Austria. Internally, the model analyses diversions between the full set of routes, even if pricing is only applied to certain routes (see Figure 4-3).

Figure 10-10: Transalpine Screen Line

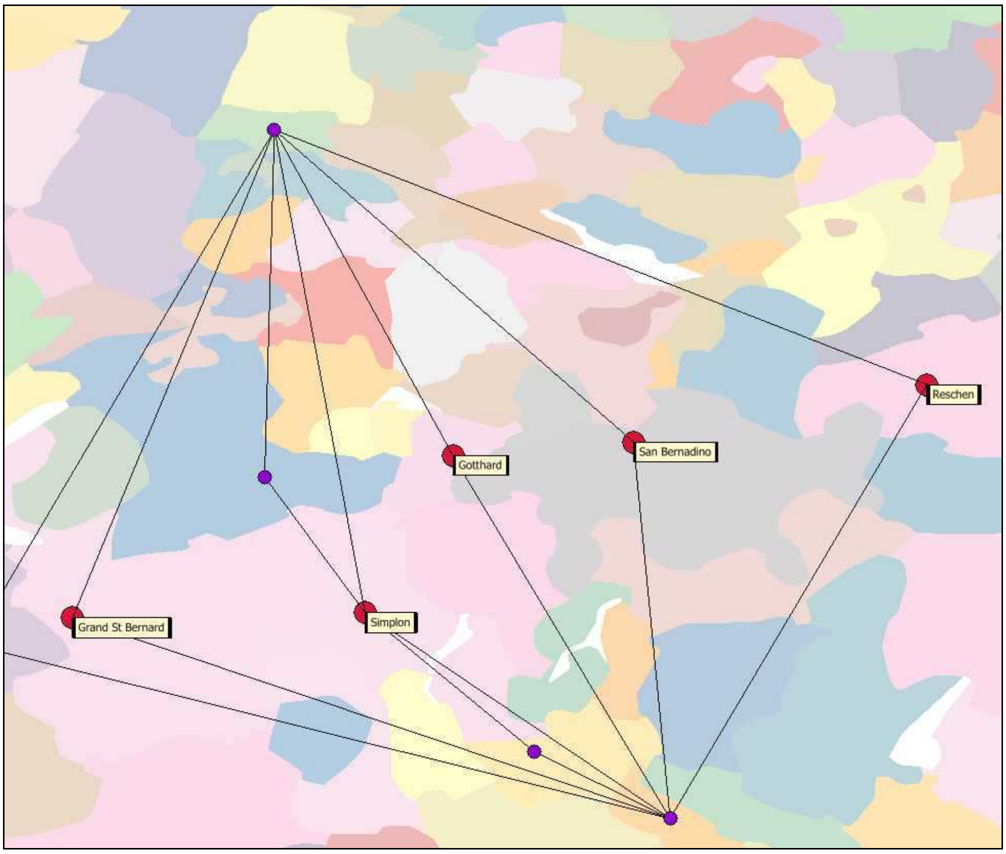


All the O/D flows within the model cross the screen line, and the main task for the assignment process is to estimate the costs for the alternative transport chains, and to estimate the proportions of each freight flow using each transport chain.

Transport chains will either be pure road, pure rail, or a combination of road and rail. In turn, the rail links are classified as wagonload (WL), unaccompanied combined transport (UCT) and accompanied combined transport (RM). The availability of a particular link on any given crossing point follows reality, using the AQGV survey data to reveal which modes are used across which of the passes in the screen line.

The model therefore constructs a virtual network, based upon simplified links. Each link is a single mode, connecting an origin or destination point to either an Alpine pass or a point at which it can change mode e.g. a RM terminal. An example of one of these simplified multimodal networks is shown in Figure 10-11 .

Figure 10-11: Multimodal Network – Schematic View



The next step involves assigning tonnages to the generated transport chains in proportion to their attractiveness. This is achieved with a multinomial logit function[102] that converts attractiveness (the negative of impedance or simply transport cost) into choice probabilities:

$$P_n(i) = \frac{e^{V_{in}}}{\sum_{j \in C_n} e^{V_{jn}}} \quad (1)$$

Where:

$P_n(i)$ represents the probability of user *n* selecting alternative *i*.

V_{in} represents the attractiveness of alternative *i* to user *n*.

C_n represents the choice set – the range of available alternatives.

and

$$V_{in} = -\beta X_{in} \quad (2)$$

[102] Ben-Akiva, Lerman, 1985, "Discrete Choice Analysis, Theory and Application to Travel demand", The MIT Press.

Where:

X_{in} represents the cost of alternative *i* to user *n*.

β represents a model parameter.

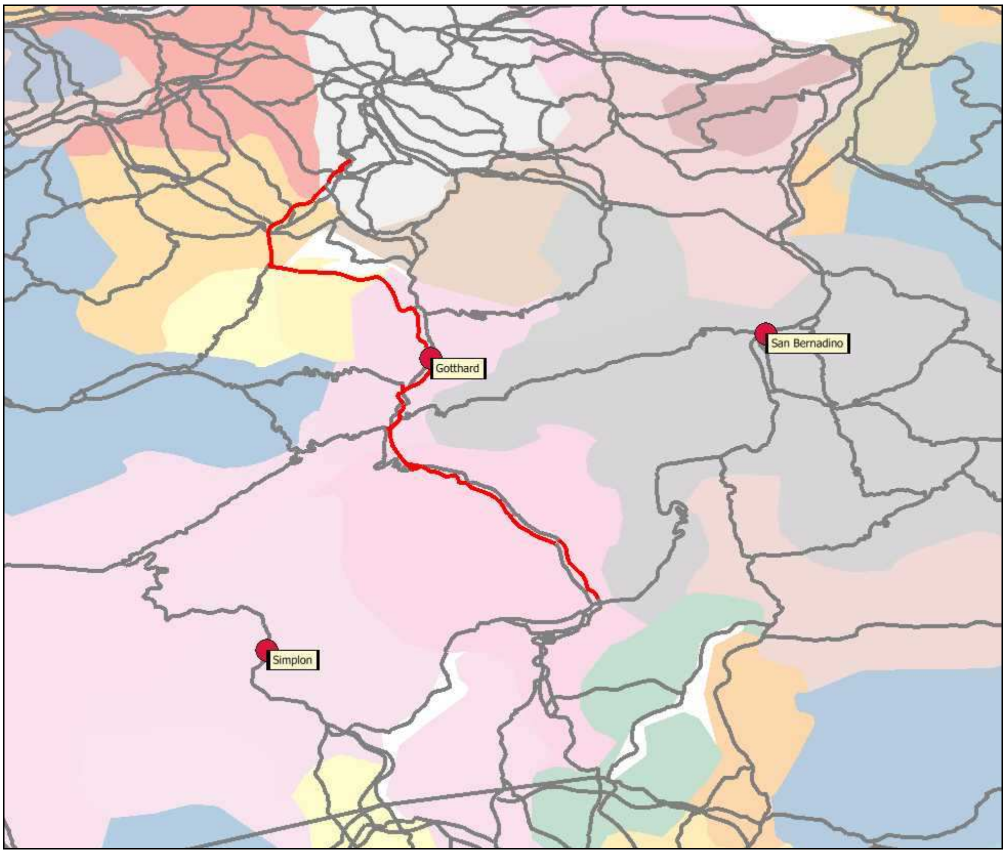
The logit model provides a simple mechanism for converting a set of transport alternatives with estimated costs into a set of probabilities that sum to unity. The beta parameter controls the shape of the probability distribution, i.e. the extent to which the model is assigning some traffic to sub-optimal choices.

In order to calculate the impedances, detailed representations of the road and rail networks are used, and combined with detailed cost models, both derived from the ETIS-BASE study, with the objective of calculating realistic transport costs along optimal routes within any given modal network.

Thus, there is a two-tier network model in operation:

- The first tier constructs a virtual multimodal network, containing simplified links, focusing upon origins, destinations, mode interchanges and Alpine passes. Each link has a single impedance value. By comparing all route and mode options within this network it is possible to compare impedances for all available transport chains and to assign choice probabilities, thus determining the share of traffic via each Alpine pass and by each of the crossing modes. In the model, all possible paths between any pair of origins and destinations are enumerated, so that traffic can be assigned to the "best 'k' paths" rather than to the "optimal path". Inefficient paths are therefore excluded within the choice calculation rather than in the path enumeration.
- The second tier attempts to be a realistic representation of the detailed road and rail networks. See Figure 10-12 for an example showing the road layer. The purpose of this tier is to hold the data required in order to calculate the higher level link impedances. In the next stage of the model the same detailed networks are used for traffic assignment.

Figure 10-12: Underlying Representation of Road Links



For a trip between Zürich and Milan, impedances via the Gotthard pass would be calculated by running a straightforward “optimal path” algorithm, based on generalised cost impedances, therefore taking into account time and cost considerations. The cost models are different for each country, to take into account different regulations, and additional costs such as road tolls can be made link specific. In this way, a large number of local factors can be taken into account.

The main advantage of this two-tier approach is that it is never necessary to calculate a “k path” choice set from a realistic, and by implication large and complex network. This keeps model computation run-times low, and that in turn allows more time for model calibration, and demands less time for model construction.

10.5 WORLDNET Traffic Assignment System (WNAS)

An assignment stage has been added in 2009 so that the analysis can be extended beyond a comparison of flows at the crossing points or O/Ds to an analysis of flows according to territory. It permits greater accuracy in calculating, for example, tonne kilometres per mode and per model region, or per country.

The methodology has been adopted from the system developed for the WORLDNET[103] project, which uses the same network models and similar costs models. It has been developed further for the modelling carried out within the Serbian Transport Master Plan[104].

The principal modification for the Transalpine study has been the need to assign intermodal and bulk rail flows separately, according to different cost functions.

As mentioned, the TAMM model is responsible for determining mode shares and allocations of traffic by route, integrating all the policy assumptions including ACE. Therefore it is important that the WNAS assignment model does not re-route the traffic. These are frozen in the assignment by converting the Transalpine trips into legs, split at the Alpine crossing points. In the final assignment stage, only the routes chosen between origin and crossing point, and between crossing point and destination are variable.

Using WNAS it is possible to simulate link loading and multi-path assignment by specifying how much of the link capacity should be allocated to each traffic type, and parameters for the speed-flow curve. The model iterates, assigning a fixed proportion of the total traffic matrix at each turn. At the end of each iteration, the link impedances are recalculated based on the flow to capacity ratio. By varying the specified capacity and the number of iterations, the extent to which the result resembles an all-or-nothing short path assignment can be varied.

In this study, only long distance freight flows are being considered, so a large proportion of the total traffic flow within the study area is not assigned. This would include all passenger traffic and local or national freight traffic. Without detailed traffic counts, only limited calibration at the link level is possible, so a moderate level of multi-path simulation with four iterations has been used.

The base year road assignments are shown overleaf.

[103] WORLDNET, 2009, NEA et al, on behalf of the European Commission, DG-TREN.

[104] Serbian Transport Masterplan, 2009, Italferr, NEA, on behalf of the European Commission.

Figure 10-13: Base Year Estimated Transalpine Road Assignments

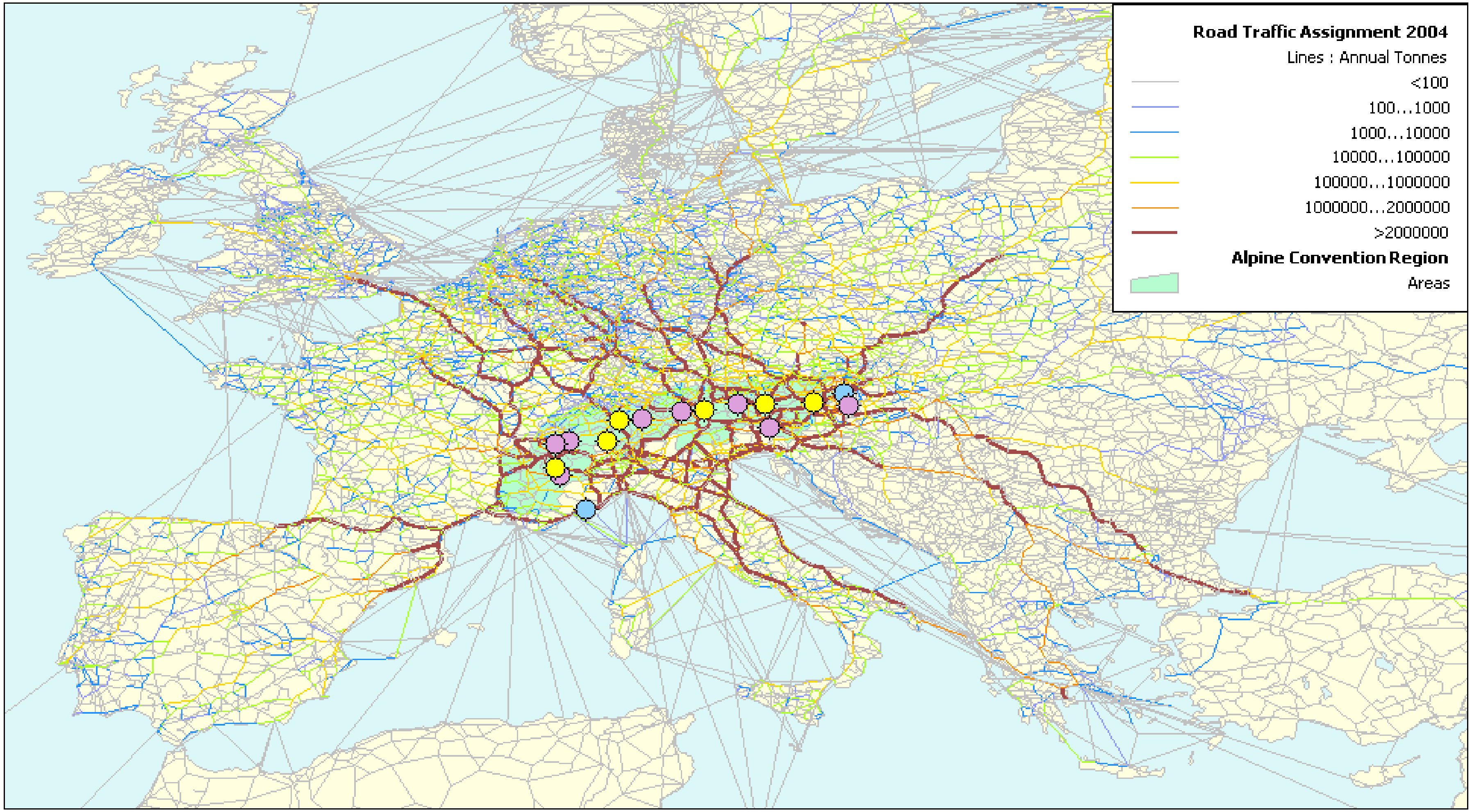
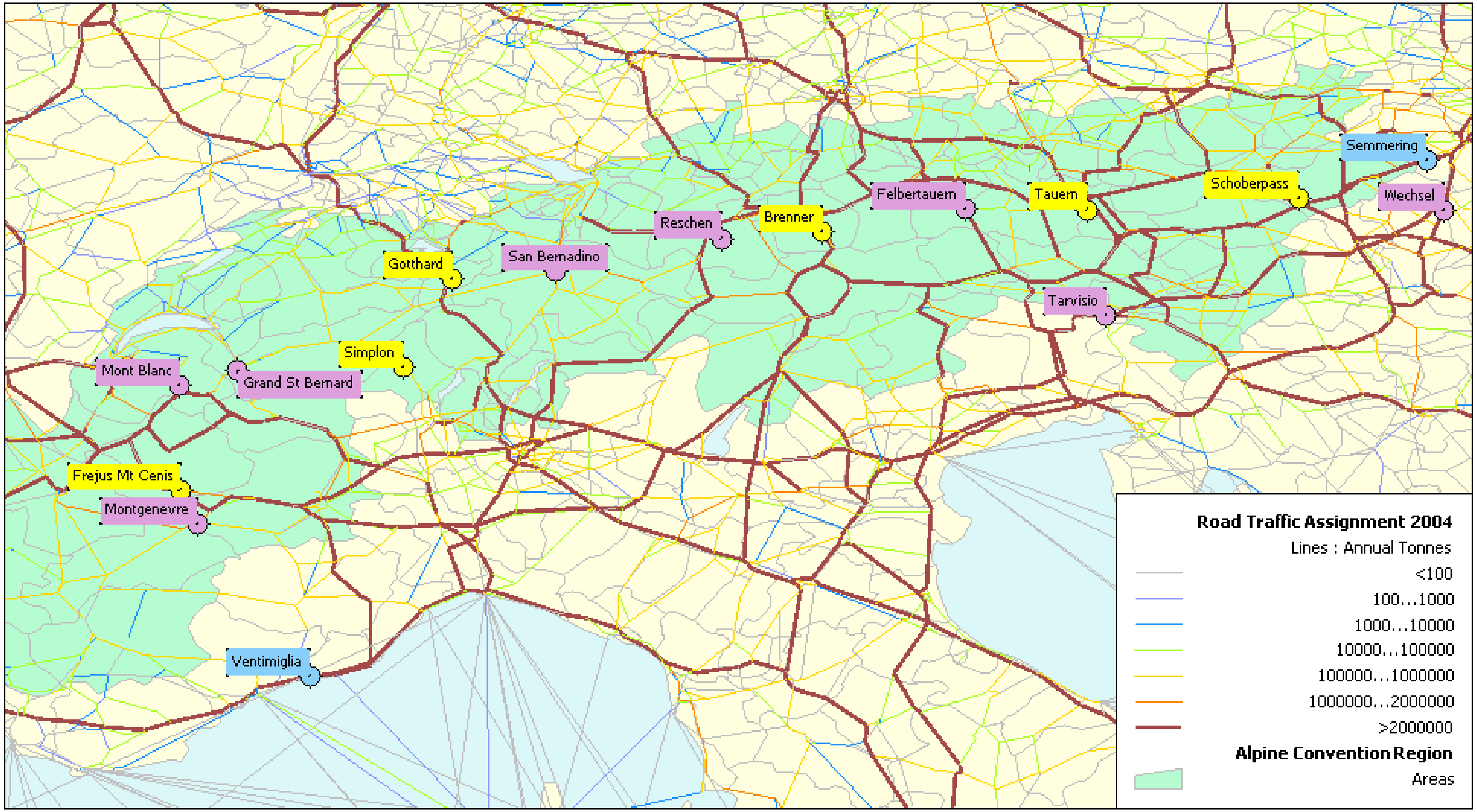


Figure 10-14: Base Year Estimated Transalpine Road Assignments, Alpine Region



11 Assumptions for modelling freight transport demand

This section describes and constitutes the crucial assumptions for the modeling of transalpine freight transport, including productivity effects and subsidies for combined transport. It is structured according to the following three areas (for base case 2004 and business as usual 2020 / 2030):

- Modeling of **growth in freight transport**
- **Assumptions for the transport services and the cost factors** for road and rail freight transport in Switzerland, Austria and France (incl. productivity effects and subsidies, see below; for the cost factors for the other countries see chapter 10 about the TAMM).
- **Productivity effects** for road and rail freight transport from 2004 to 2020/30 and their implementation in TAMM
- The implementation of the reducing **subsidies** in Switzerland, Austria and France for UCT and RM (track cost subsidies, subsidies per shipment and train)

All the cost factors are mainly presented for Switzerland. For a more detailed overview of the TAMM and the underlying assumption for the European transport network we refer to chapter 10 and the previous study of Ecoplan and NEA about the impacts of different variations of an Alpine crossing exchange.[105]

Furthermore, within the mentioned study, the principal assumptions have been discussed in a Workshop in January 2010. The results of this workshop have been integrated in the calculations with TAMM and if necessary the assumptions were adjusted.

11.1.1 Growth in freight transport

For forecasting the future growth in transalpine freight transport through TAMM, two additional models are combined:

- A global **trade model**, based on inputs from the WORLDNET and ITREN studies of the EU, for projecting future financial trade flows. The economic growth in the European countries is based ITREN forecast for 2030.[106]
- To forecast detailed flows of goods (for NSTR freight groups (Nomenclature uniforme des marchandises pour les Statistiques des TRansports) and on NUTS3-level) the results of the trade model are combined with detailed projections of the traded tonnages of a **trend model** (see chapter 10).

[105] Ecoplan, NEA (2010), Auswirkungen verschiedener Varianten der Alpentransitbörse, S. 92ff.

[106] Schade Wolfgang et al. (2010), The iTREN-2030 Integrated Scenario until 2030.

11.1.2 Assumptions for the services and cost factors

a) Exchange rate and value date

For all calculations within the present study (assumptions and runs with the TAMM) the following exchange rate for conversion of CHF to EUR and vice versa is used: 1.5625 CHF/EUR. If not indicated elsewise, all values and costs are given EUR with 2004 as the base year.

b) Road freight transport

The costs for Alpine crossing road freight transport include three main elements:

- Terminal costs (loading and unloading), fixed costs per shipment
- Time dependent costs, e.g. depreciation or the driver's work hours
- Costs per km, e.g. fuel

The average net tonnage per HGV increases in Switzerland from 9.9 tons in 2004 to 12.5 tons in 2020 (increase of the weight limit to 40 tons).

The following table shows the cost factors for the Alpine crossing road freight transport in Switzerland for the reference cases (although the transport relations are affected by transport costs in all countries of the relation).

Figure 11-1: Cost factors road freight transport 2004 / 2020 / 2030 in EUR per HGV

Type of costs	fixed / variable	Unit	2004	2020	2030
Infrastructure	Track Variable	EUR / km	0.3193	0.6480	0.6480
	Track Fixed	EUR / min	-	-	-
Haulage	Traction Variable	EUR / km	0.3357	0.3357	0.3357
	Traction Fixed	EUR / min	0.5413	0.5413	0.5413
Equipment	Equip Variable	EUR / km	0.0252	0.0252	0.0252
	Equip Fixed	EUR / min	0.0397	0.0397	0.0397
Loading / Unloading	Terminals Variable	EUR / km	-	-	-
	Terminals Fixed	EUR / Load	183.9267	183.9267	183.9267
Overhead / Profit	Service Variable	EUR / km	-	-	-
	Service Fixed	EUR / min	0.2484	0.2484	0.2484
Surcharge 2004 due to 34t		EUR / vkm	0.2000	-	-
Road costs summary					
Fixed Cost per Minute		EUR / Ton / Min	0.0838	0.0664	0.0664
Running Cost per Km		EUR / Ton / km	0.0889	0.0807	0.0807
Fixed costs per load		EUR / Ton / load	18.5785	14.7141	14.7141
Costs per vkm		EUR / vkm	0.8802	1.0089	1.0089

Remark: The rise in the variable track costs from 2004 to 2020 and the surchage 2004 are due to the increase of the average net tonnage per HGV from 9.9 tons in 2004 to 12.5 tons in 2020 (higher weight limit of 40 tons) and an increase in the heavy vehicle fee.

c) Rail freight transport

The costs of Alpine crossing rail freight transport through Switzerland are affected by the circumstances of all countries of a relation. But as mentioned above, in the following tables we only present the assumptions for the Swiss rail network (for UCT, WL and RM).

Figure 11-2: UCT, assumptions and cost factors 2004 / 2020 / 2030

UCT in CH: operational assumptions	Unit	2004	2020	2030
Maximum Trailing Length	Metres	750	750	750
Load Factor	%	80%	80%	80%
Net Weight Per Unit	Tonnes	17.5	17.5	17.5
Weight of Empty Unit	Tonnes	2.10	2.10	2.10
Maximum Wagons Per Train	Number	38	38	38
Weight per Wagon	Tonnes	20	20	20
Weight Per Loco	Tonnes	84	84	84
Average Load	FEU	30	30	30
Gross Train Weight	Tonnes	1'516	1'432	1'432
Cargo Weight	Tonnes	525	525	525
Number of locos in CH: Gotthard	Number	2	1	1
Number of locos in CH: Lötschberg/Simplon	Number	2	2	2
Number of locos in AU	Number	2	2	1
Number of locos in FR/IT	Number	2	2	1.2
Number of locos in DE, FR, IT, BE, NL	Number	1	1	1
UCT in CH: cost factors				
Track Cost per FEU Km	EUR	0.154	0.154	0.154
Traction Cost per FEU per Hour: Gotthard	EUR	9.880	9.880	9.880
Traction Cost per FEU per Hour: Lötschberg/Simplon	EUR	9.880	9.880	9.880
Traction Cost per FEU per Km	EUR	0.030	0.030	0.030
Wagon Cost per FEU per Hour	EUR	1.244	0.995	0.995
Terminal Cost per FEU	EUR	59.100	47.280	47.280
Headquarter Cost per FEU	EUR	11.850	9.480	9.480
Cargo Speed: Gotthard	kph	40.00	60	60
Cargo Speed: Lötschberg/Simplon	kph	40.00	50	50
Preparation Hours	Hours	6	4	4
Payload	FEU	30	30	30
Fixed reduction due to base tunnel: Gotthard	EUR per shipment	-	-38.14	-38.14
Fixed reduction due to base tunnel: Lötschberg/Simplon	EUR per shipment	-	-	-
Reduction of subsidies (cost increase per FEU), NL	EUR	-	39.44	78.89
Reduction of subsidies (cost increase per FEU), rest	EUR	-	48.11	96.22
Additional base tunnel track charge per FEU: Gotthard	EUR	-	2.43	2.43
Add. base tunnel track charge per FEU: Lötschberg/Simplon	EUR	-	1.49	1.49

Remarks: In TAMM, the productivity effects due to the new base tunnel on the Gotthard corridor are modelled with a fixed reduction per shipment.
For the underlying productivity effects and the handling of subsidies (reduction of individual cost factors, “Reduction of subsidies” und “Additional base tunnel track charge”) see chapter 11.1.3 and 11.1.4.

Figure 11-3: WL, assumptions and cost factors 2004 / 2020 / 2030

WL in CH: operational assumptions	Unit	2004	2020	2030
Cargo Speed: Gotthard	km / h	40	60	60
Cargo Speed: Lötschberg/Simplon	km / h	40	50	50
Maximum Trailing Length	Metres	600	600	600
Load Factor	Percentage	85%	85%	85%
Preparation Time	Hrs	8	8	8
Weight Per Wagon	Tonnes	23	23	23
Maximum Wagons	Wagons	20	20	20
Weight Per Loco	Tonnes	84	84	84
Interest Rate	% Per Annum	5%	5%	5%
Tonnes of Cargo/Wagon	Tonnes	37.4	37.4	37.4
Average Cargo Load	Tonnes	748	748	748
Gross Train Weight	Tonnes	1292	1292	1292
Number of locos CH: Gotthard	Number	2	1	1
Number of locos in CH: Lötschberg/Simplon	Number	2	2	2
Number of locos in AU	Number	2	2	1
WL in CH: cost factors				
Traction - Variable: Gotthard	EUR Per Cargo T.Km	0.0088	0.0049	0.0049
Traction - Variable: Lötschberg/Simplon	EUR Per Cargo T.Km	0.0088	0.0088	0.0088
Traction - Fixed (2 hours per train)	2 Hrs Per Train (Per Tonne	0.7552	0.4398	0.4398
Wagons	EUR/Cargo Tonne Per Hr	0.0441	0.0397	0.0397
Track	EUR/Cargo Tonne Km	0.0053	0.0053	0.0053
Terminals	EUR/Cargo Tonne	1.1107	1.1107	1.1107
Additional base tunnel track charge per Tonne: Gotthard	EUR/Cargo Tonne	-	0.0975	0.0975
Add. base tunnel track charge per Tonne: Lötschberg/Simplon	EUR/Cargo Tonne	-	0.0599	0.0599

Remarks: In TAMM, the productivity effects due to the new base tunnel on the Gotthard corridor are modelled with a fixed reduction per train.
For the underlying productivity effects and the handling of subsidies (reduction of individual cost factors) see chapter 11.1.3 and 11.1.4.

Figure 11-4: RM, assumption and prices 2004 / 2020 / 2030

RM in CH: operational assumptions	Unit	2004	2020	2030
Number of Locomotives	Number	2	2	2
Passenger Coach Weight	Tonnes	40	40	40
Locomotive Weight	Tonnes	84	84	84
Wagon Weight (Per Platform)	Tonnes	18.5	18.5	18.5
Maximum Trailing Length	Metres	500	720	720
Truck Capacity	Number	22	32	32
Load Factor	Per Cent	85%	80%	80%
Average Load	Number	19	26	26
Truck Tare Weight	Tonnes	13	14	14
Truck Cargo Weight	Tonnes	16.8	18.0	18.0
Gross Train Weight	Tonnes	1'211	1'632	1'632
Train Cargo Weight	Tonnes	313	468	468
Trains per Year (CH)	Number	6'300	unlimited	unlimited
Trains per Day Per Direction	Number	13	unlimited	unlimited
RM in CH: prices				
Lugano-Basel	EUR/shipment	225	227	340
Lugano-Freiburg	EUR/shipment	300	292	405
Milano-Singen	EUR/shipment	400	289	402
Novara-Freiburg	EUR/shipment	410	372	485
New Rola Basel-Domodossola	EUR/shipment	n/a	n/a	n/a
New Rola Basel-Chiasso	EUR/shipment	n/a	n/a	n/a

Remarks: In TAMM, the productivity effects for RM are modeled as a similar reduction as for UCT.
For the underlying productivity effects and the handling of subsidies (reduction of costs / prices) see chapter 11.1.3 and 11.1.4.

11.1.3 Productivity effects

a) Road freight transport

For the Alpine crossing road freight transport, for the business as usual scenarios 2020 / 2030 the following productivity effects have been taken into account (see also chapter 11.1.2b):

- Increase of the average net tonnage per HGV in Switzerland from 9.9 tons in 2004 to 12.5 tons in 2020 (higher weight limit of 40 tons)
- Therefore, abolition of the surcharge due to the 34 tons weight limit (2004) in 2020

b) Rail freight transport

To account for the productivity effects within the Alpine crossing rail freight transport, the following assumptions have been made (all productivity effects already occur in 2020; from 2020 to 2030 no more productivity effects are assumed):

- From 2004 to 2020 productivity effects occur on the **whole European rail network** irrespective of the new base tunnels (due to 24h service, lower fix costs because of higher volumes, less delays on cross boarder relations, establishment of international rail freight corridors (tracks with priority etc.), progress with IT technologies etc.). For UCT those productivity gains affect the “Wagon, Terminal and Headquarter Cost” and the “Preparation Hours”. Because the potential for productivity gains for WL in generally lower, for WL they only apply on “Wagon Cost” and “Preparation Hours”. In the cost sets for the different modes of transport, those effects (UCT 20%, WL 10% reduction of costs[107]) are implemented through the factor “Productivity effects 2004-2020” (see Figure 11-5). The “Preparation Hours” can be reduced by around 35% (UCT from 6 to 4, WL from 8 to 5 hours), which is implemented through the factor “Productivity effect on Prep. Hours 2004-2020”. Additionally, cargo speed rises between 2004 and 2020 from 40 to 50 km/h (factor “productivity effect on cargo speed).[108]
- Due to the new base tunnels, productivity effects also occur on the **Gotthard** (Gotthard base tunnel, GBT)**, Lötschberg / Simplon** (LBT)**, Brenner** (BBT) **und Mont Cenis** (MCBT) **corridors.**[109] Thereby, the new base tunnels on the Swiss corridors are already operating in 2020, whereas the Brenner and Mont Cenis base tunnels only open up for service in 2030. However, the effects on the Lötschberg / Simplon corridor cannot fully be realized because of limitations due to the Simplon tunnel (steeper slope etc.). Therefore, for the Lötschberg / Simplon corridor we only apply a reduced distance and time, even though the reduction in time is relatively small (for the further productivity effects on the other corridors see below and the reduction of cost factors for the Gotthard corridor in Figure 11-2, Figure 11-3 and Figure 11-4). In general, the new base tunnels lead to shorter distances and higher cargo speeds, which reduce the overall duration of the transport relations. In TAMM this is implemented through the factor „Effects of new base tunnel on Cargo speed“. The increase in cargo speed is assumed to be 20% (from 50 to 60 km/h). Furthermore, due to the lower slopes of the new base tunnel, the number of locomotives for UCT and WL can be reduced from two (without base tunnel) to one (with base tunnel). This leads to a reduction of transaction costs of 42% (UCT) and 30% (WL) on the Gotthard and Brenner corridor. Because in France and Italy the reduction from two to one locomotive only affects a relatively small share of the total distance, on the Mont Cenis corridor the reduction is only 8% (To account for that, in the calculations of rail freight transport in France and Italy we only assume 1.2 locomotives for the whole distance in the cases without the new base tunnels). For RM, longer trains are possible.

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[107] IWW / Nestar (2009, Internalisation of External Costs of Transport: Impact on Rail, S. 24ff) assume a significantly higher growth in productivity: 1.8% per year or 33% from 2004 to 2020. Therefore, our assumptions are relatively low. Furthermore, they are only applied on parts of the total costs.

[108] According to the FOT, higher speeds than 40 km/h can already be observed today.

[109] The assumptions about the productivity effects for rail freight transport due to the new base tunnels were again validated and updated through discussions with the Swiss cargo rail way services (SBB, interview with Daniel Schnetzer / Joachim Joos and BLS, interview with Joachim Schöpfer).

Figure 11-5: Factors for the implementation of productivity effects (2004-2020 und due to new base tunnels) und the reduction of subsidies

Factors	GBT, BBT, MCBT		LBT	
	UCT	WL	UCT	WL
Productivity effects 2004-2020	0.80	0.90	0.80	0.90
Productivity effect on Prep. Hours 2004-2020	0.67	0.625	0.67	0.625
Traction Cost per FEU per Loco Hour (due to new base tunnel)	0.67	-	-	-
Productivity effect on Cargo speed	1.25	1.25	1.25	1.25
Effects of new base tunnel on Cargo speed	1.20	1.20	-	-
Reduction of subsidies 2004 - 2020	0.67	-	0.67	-

11.1.4 Subsidies for combined transport

To account for the subsidies for UCT and RM (WL does not receive any more subsidies in 2004) and their reduction and abolishment we made the following assumptions (for an overview of the subsidies per train and shipment see Figure 11-6):

- In **Switzerland**, according to the information of the FOT, **track cost subsidies** for UCT and RM will be abolished till 2010. But simultaneously, the subsidies per shipment and train will be increased by the same amount. Thus, those subsidies are only going to be distributed by another instrument. Therefore, for 2004 we already implement the 2010 system and increased the track costs simultaneously. For the calculations within TAMM, no more adjustments are necessary.[110] In **Austria and France**, the subsidies for UCT and RM are already paid per shipment today (for France, no rail subsidies are taken into account (even though for RM small subsidies are paid)).[111]
- As assumed, the **subsidies per train and shipment** will be reduced step by step and fall away until 2030. This leads to the highest increase in prices for Swiss UCT and RM by 2020 and even further by 2030 and a relatively lower increase in Austria and France (due to the lower level of subsidies). The reduction of the subsidies per train and shipment is in line with the intention of the governments to reduce the subsidies for combined transport step by step. In Switzerland this tendency can already be observed in the call for bids from 2005 – 2009[112] Therefore, and arranged with the responsible government bodies, we assume that the subsidies for UCT will be reduced by 50% and for and RM by 10% till 2020 (see Figure 11-6). Because it can be supposed that the cargo rail companies take along some amount of the subsidies for their own (deadweight effect) and the competition between the different Alpine corridors we assume that only 2/3 of the abolishing subsidies

110 For UCT different subsidies per train are paid according to the country of origin of a transport (Southwest Germany, Great Britain etc.) However, in TAMM we only differentiate between NL and the rest of Europe, for which we use an average rate which is weighted by transport volumes.

111 The reason for not considering the French subsidies is that the necessary information was delivered after the calculations with the TAMM.

112 BAV (2005-2009), Offertverfahren kombinierter Verkehr 2005 – 2009.

will be shifted towards the prices (see factor “Reduction of subsidies 2004-2020” in Figure 11-5). In 2030 all subsidies for combined transport will be abolished in all three countries.

Figure 11-6: Subsidies for UCT and RM in Switzerland, Austria and France, 2004 / 2020 / 2030

Subsidies (in EUR)	per shipment			per train		
	2004	2020	2030	2004	2020	2030
Switzerland*						
UCT (UKV), trains from/to NL	90	45	-	850	425	-
UCT (UKV), trains from/to rest	90	45	-	1'630	815	
RM (Rola)	109	98	-	2'048	1'843	-
Austria						
UCT (UKV)**	35	18	-	-	-	-
RM (Rola), Brenner	75	68	-	-	-	-
RM (Rola), Tauern	80	72	-	-	-	-
RM (Rola), Schoberpass	85	77	-	-	-	-
France***						
UCT (UKV)	24	-	-	-	-	-
RM (Rola)	24	-	-	-	-	-

* The subsidies in Switzerland for 2004 refer to 2010, because we already apply the 2010 system without track cost subsidies.
** In Austria, the subsidies are shown for transport relations with more than 250km, for relations below 250km the subsidies are lower.
*** For France, the subsidies are assumed to be abolished already in 2020, following the information of Sylvain Glantenay, Chargé de mission études et prospectives, Mission des Alpes et des Pyrénées (2010): “Ce dispositif, approuvé par la Commission Européenne, est en vigueur jusqu'en 2012. Il n'y a pas de visibilité sur la poursuite d'un tel dispositif au delà de 2012.“
Sources: BAV (2005-2009), Offertverfahren kombinierter Verkehr 2005 – 2009. Christian Schimanofsky, Deputy, Austrian Federal Ministry of Transport, Innovation and Technology (2010). Sylvain Glantenay, Chargé de mission études et prospectives, Mission des Alpes et des Pyrénées (2010).

11.1.5 Implementation in TAMM

For the implementation of the cost sets for Alpine crossing rail freight transport (UCT, WL, RM) per corridor / country in TAMM we proceeded as follows:

- **UCT**: The productivity effects between 2004 and 2020 (e.g. lower terminal costs) are modeled directly within the cost sets. The productivity gains due to the new base tunnels (e.g. shorter distance) are modeled as a fixed reduction per shipment on the relevant corridors (which is easier to model than within the cost sets, because the base tunnel effects do not apply on the whole rail network). The abolishing subsidies are modeled as additional fix costs per forty foot container unit equivalent (FEU) (see factor “Reduction of subsidies (cost increase per FEU)” in the figures in chapter 11.1.2).
- **WL**: Productivity effects identical as for UCT. Subsidies do not exist for WL.

- **RM**: The prices for Alpine crossing RM relations are not implemented bottom-up as for UCT and WL, but as total price per HGV consignment (based on information of the RM supplier). Therefore, we model the productivity effects between 2004 and 2020 as 50% of the productivity effects for UCT, because we estimate the future potential for increases in efficiency for RM to be half the size of the potential for UCT. The reduction in costs due to productivity effects of the new base tunnels are modeled as the average effects of UCT. Additionally, due to the new base tunnels, the maximal length of trains increases for RM from 500m to 720m from 2004 to 2020. For this reason, the same amount of shipment can be transported with fewer locomotives, which leads to a further reduction of track costs. The abolishing subsidies are simply added by 2/3 to the total prices per shipment.

12 Detailed results

12.1 Base case 2004

Figure 12-1: Base case 2004: Transalpine freight transport 2004 in Alpine arch C, in 1'000 tons/a

country / corridor	rail				road	share of road	total	share of total
	UCT	WL	RM	total				
A - I / SLO	6'808	23'242	3'111	33'162	93'029	73.7%	**126'191**	60.7%
Reschen	-	-	-	-	1'987	100.0%	**1'987**	1.0%
Brenner	4'750	3'848	1'622	10'220	30'539	74.9%	**40'759**	19.6%
Felbertauern	-	-	-	-	907	100.0%	**907**	0.4%
Tauern	794	6'222	959	7'974	12'109	60.3%	**20'083**	9.7%
Schoberpass	599	4'260	530	5'389	14'408	72.8%	**19'797**	9.5%
Semmering	665	8'913	-	9'578	5'581	36.8%	**15'160**	7.3%
Wechsel	-	-	-	-	8'740	100.0%	**8'740**	4.2%
Tarvisio	-	-	-	-	18'758	100.0%	**18'758**	9.0%
CH - I	11'819	9'018	1'669	22'507	12'453	35.6%	**34'959**	16.8%
Gr. St. Bernard	-	-	-	-	595	100.0%	**595**	0.3%
Simplon	2'525	3'045	1'204	6'773	668	9.0%	**7'441**	3.6%
Gotthard	9'294	5'973	466	15'734	9'868	38.5%	**25'602**	12.3%
San Bernardino	-	-	-	-	1'321	100.0%	**1'321**	0.6%
F - I	2'653	4'274	-	6'927	39'740	85.2%	**46'667**	22.5%
Mont-Blanc	-	-	-	-	5'112	100.0%	**5'112**	2.5%
MtCenis/Fréjus	2'645	3'737	-	6'381	16'417	72.0%	**22'798**	11.0%
Montgenerve	-	-	-	-	331	100.0%	**331**	0.2%
Ventimigla	8	537	-	545	17'880	97.0%	**18'425**	8.9%
total	**21'280**	**36'534**	**4'780**	**62'595**	**145'222**	**69.9%**	**207'817**	100.0%
share	10.2%	17.6%	2.3%	30.1%	69.9%		100.0%	

12.2 BAU-scenarios

Figure 12-2: Overview total transalpine freight transport volumes per country, in 1'000 tons

		road	Δ %	UCT	WL	RM	rail	Δ %	total	g total	Δ %
base case 2004	A - I / SLO	93'029		6'808	23'242	3'111	33'162		126'191		
	CH - I	12'453		11'819	9'018	1'669	22'507		34'959		
	F - I	39'740		2'653	4'274	-	6'927		46'667	207'817	
BAU 2020	A - I / SLO	107'763	15.8%	11'789	36'052	4'290	52'132	57.2%	159'895		26.7%
	CH - I	17'007	36.6%	16'407	17'749	2'042	36'198	60.8%	53'206		52.2%
	F - I	36'418	-8.4%	4'504	5'154	568	10'226	47.6%	46'643	259'744	-0.1%
BAU 2030 low	A - I / SLO	115'001	23.6%	11'933	42'888	3'849	58'670	76.9%	173'671		37.6%
	CH - I	17'623	41.5%	12'460	18'054	738	31'252	38.9%	48'875		39.8%
	F - I	34'026	-14.4%	5'182	5'341	871	11'394	64.5%	45'419	267'966	-2.7%
BAU 2030 high	A - I / SLO	133'498	43.5%	14'110	49'584	4'591	68'285	105.9%	201'783		59.9%
	CH - I	20'781	66.9%	14'784	21'298	889	36'971	64.3%	57'753		65.2%
	F - I	40'795	2.7%	6'218	6'407	1'044	13'670	97.4%	54'464	314'000	16.7%

Figure 12-3: Number of Lorries per country in transalpine freight transport for road and RM in Alpine arch C 2004, 2020 and 2030 (low and high), in 1'000 HGV

road				
base case / BAU **country**	**base case 2004**	**BAU 2020**	**BAU 2030 low**	**BAU 2030 high**
number of lorries				
A - I / SLO	7'325	8'485	9'055	10'512
CH - I	1'258	1'361	1'410	1'662
F - I	2'818	2'583	2'413	2'893
total	**11'401**	**12'429**	**12'878**	**15'067**
in % of base case 2004				
A - I / SLO	100%	116%	124%	144%
CH - I	100%	108%	112%	132%
F - I	100%	92%	86%	103%
total	**100%**	**109%**	**113%**	**132%**

rolling motorway				
base case / BAU **country**	**base case 2004**	**BAU 2020**	**BAU 2030 low**	**BAU 2030 high**
number of lorries				
A - I / SLO	185	238	214	255
CH - I	99	113	41	49
F - I	-	32	48	58
total	**285**	**383**	**303**	**362**
in % of base case 2004				
A - I / SLO	100%	129%	115%	138%
CH - I	100%	114%	41%	50%
F - I				
total	**100%**	**135%**	**107%**	**127%**

12.2.1 2020

Figure 12-4: BAU 2020: Transalpine freight transport 2020, Alpine arch C, 1'000 tons/a

country / corridor	rail				road	share of road	total	share of total
	UCT	WL	RM	total				
A - I / SLO	11'789	36'052	4'290	52'132	107'763	67.4%	**159'895**	61.6%
Reschen	-	-	-	-	1'808	100.0%	**1'808**	0.7%
Brenner	7'559	4'523	1'788	13'869	30'131	68.5%	**44'000**	16.9%
Felbertauern	-	-	-	-	1'035	100.0%	**1'035**	0.4%
Tauern	1'455	9'797	1'503	12'755	14'848	53.8%	**27'603**	10.6%
Schoberpass	1'308	6'982	999	9'290	18'894	67.0%	**28'183**	10.9%
Semmering	1'468	14'750	-	16'218	7'712	32.2%	**23'929**	9.2%
Wechsel	-	-	-	-	11'769	100.0%	**11'769**	4.5%
Tarvisio	-	-	-	-	21'567	100.0%	**21'567**	8.3%
CH - I	16'407	17'749	2'042	36'198	17'007	32.0%	**53'205**	20.5%
Gr. St. Bernard	-	-	-	-	982	100.0%	**982**	0.4%
Simplon	2'721	3'076	1'414	7'212	2'938	28.9%	**10'150**	3.9%
Gotthard	13'685	14'673	628	28'986	11'089	27.7%	**40'075**	15.4%
San Bernardino	-	-	-	-	1'998	100.0%	**1'998**	0.8%
F - I	4'504	5'154	568	10'226	36'418	78.1%	**46'643**	18.0%
Mont-Blanc	-	-	-	-	4'284	100.0%	**4'284**	1.6%
MtCenis/Fréjus	4'474	4'297	568	9'339	14'182	60.3%	**23'521**	9.1%
Montgenerve	-	-	-	-	295	100.0%	**295**	0.1%
Ventimigla	30	857	-	887	17'657	95.2%	**18'543**	7.1%
total	**32'700**	**58'955**	**6'900**	**98'555**	**161'188**	**62.1%**	**259'743**	100.0%
share	12.6%	22.7%	2.7%	37.9%	62.1%		100.0%	

Figure 12-5: BAU 2020: Growth in transalpine freight transport 2004-2020, Alpine arch C

country / corridor	rail				road	share of road	total	share
	UCT	WL	RM	total				
A - I / SLO	73.2%	55.1%	37.9%	57.2%	15.8%		**26.7%**	
Reschen					-9.0%		**-9.0%**	
Brenner	59.1%	17.5%	10.2%	35.7%	-1.3%		**8.0%**	
Felbertauern					14.2%		**14.2%**	
Tauern	83.3%	57.5%	56.7%	60.0%	22.6%		**37.4%**	
Schoberpass	118.4%	63.9%	88.6%	72.4%	31.1%		**42.4%**	
Semmering	120.6%	65.5%		69.3%	38.2%		**57.8%**	
Wechsel					34.7%		**34.7%**	
Tarvisio					15.0%		**15.0%**	
CH - I	38.8%	96.8%	22.3%	60.8%	36.6%		**52.2%**	
Gr. St. Bernard					65.0%		**65.0%**	
Simplon	7.8%	1.0%	17.5%	6.5%	339.8%		**36.4%**	
Gotthard	47.2%	145.6%	34.8%	84.2%	12.4%		**56.5%**	
San Bernardino					51.2%		**51.2%**	
F - I	69.8%	20.6%		47.6%	-8.4%		**-0.1%**	
Mont-Blanc					-16.2%		**-16.2%**	
MtCenis/Fréjus	69.2%	15.0%		46.3%	-13.6%		**3.2%**	
Montgenerve					-10.9%		**-10.9%**	
Ventimigla	285.3%	59.4%		62.6%	-1.2%		**0.6%**	
total	**53.7%**	**61.4%**	**44.3%**	**57.4%**	**11.0%**		**25.0%**	
share	22.9%	29.1%	15.5%	26.0%	-11.2%			

12.2.2 2030 low

Figure 12-6: BAU 2030 low: Transalpine freight transport 2030, Alpine arch C, 1'000 tons/a

country / corridor	rail				road	share of road	total	share of total
	UCT	WL	RM	total				
A - I / SLO	11'933	42'888	3'849	58'670	115'001	66.2%	**173'671**	64.8%
Reschen	-	-	-	-	1'711	100.0%	**1'711**	0.6%
Brenner	7'381	5'728	1'537	14'646	29'140	66.6%	**43'786**	16.3%
Felbertauern	-	-	-	-	1'095	100.0%	**1'095**	0.4%
Tauern	1'512	11'139	1'164	13'814	16'647	54.6%	**30'461**	11.4%
Schoberpass	1'382	8'255	1'149	10'786	21'853	67.0%	**32'639**	12.2%
Semmering	1'658	17'766	-	19'424	9'181	32.1%	**28'604**	10.7%
Wechsel	-	-	-	-	13'665	100.0%	**13'665**	5.1%
Tarvisio	-	-	-	-	21'709	100.0%	**21'709**	8.1%
CH - I	12'460	18'054	738	31'252	17'623	36.1%	**48'875**	18.2%
Gr. St. Bernard	-	-	-	-	1'019	100.0%	**1'019**	0.4%
Simplon	2'036	3'164	554	5'754	2'846	33.1%	**8'599**	3.2%
Gotthard	10'423	14'890	185	25'498	11'695	31.4%	**37'193**	13.9%
San Bernardino	-	-	-	-	2'063	100.0%	**2'063**	0.8%
F - I	5'182	5'341	871	11'394	34'026	74.9%	**45'420**	16.9%
Mont-Blanc	-	-	-	-	3'876	100.0%	**3'876**	1.4%
MtCenis/Fréjus	5'153	4'635	871	10'658	13'096	55.1%	**23'754**	8.9%
Montgenerve	-	-	-	-	251	100.0%	**251**	0.1%
Ventimigla	30	706	-	735	16'803	95.8%	**17'538**	6.5%
total	**29'575**	**66'283**	**5'458**	**101'316**	**166'650**	**62.2%**	**267'965**	100.0%
share	11.0%	24.7%	2.0%	37.8%	62.2%		100.0%	

Figure 12-7: BAU 2030 low: Growth in transalpine freight transport 2004-2030, Alpine arch

country / corridor	rail				road	share of road	total	share
	UCT	WL	RM	total				
A - I / SLO	75.3%	84.5%	23.7%	76.9%	23.6%		**37.6%**	
Reschen					-13.9%		**-13.9%**	
Brenner	55.4%	48.9%	-5.2%	43.3%	-4.6%		**7.4%**	
Felbertauern					20.8%		**20.8%**	
Tauern	90.4%	79.0%	21.4%	73.2%	37.5%		**51.7%**	
Schoberpass	130.7%	93.8%	116.7%	100.1%	51.7%		**64.9%**	
Semmering	149.2%	99.3%		102.8%	64.5%		**88.7%**	
Wechsel					56.4%		**56.4%**	
Tarvisio					15.7%		**15.7%**	
CH - I	5.4%	100.2%	-55.8%	38.9%	41.5%		**39.8%**	
Gr. St. Bernard					71.3%		**71.3%**	
Simplon	-19.3%	3.9%	-54.0%	-15.1%	326.0%		**15.6%**	
Gotthard	12.1%	149.3%	-60.3%	62.1%	18.5%		**45.3%**	
San Bernardino					56.1%		**56.1%**	
F - I	95.4%	25.0%		64.5%	-14.4%		**-2.7%**	
Mont-Blanc					-24.2%		**-24.2%**	
MtCenis/Fréjus	94.8%	24.0%		67.0%	-20.2%		**4.2%**	
Montgenerve					-24.3%		**-24.3%**	
Ventimigla	281.4%	31.3%		34.9%	-6.0%		**-4.8%**	
total	**39.0%**	**81.4%**	**14.2%**	**61.9%**	**14.8%**		**28.9%**	
share	7.8%	40.7%	-11.5%	25.5%	-11.0%			

12.2.3 2030 high

Figure 12-8: BAU 2030 high: Transalpine freight transport 2030, Alpine arch C, 1'000 tons/a

country / corridor	rail				road	share of road	total	share of total
	UCT	WL	RM	total				
A - I / SLO	14'110	49'584	4'591	68'285	133'498	66.2%	**201'783**	64.3%
Reschen	-	-	-	-	2'035	100.0%	**2'035**	0.6%
Brenner	8'852	6'860	1'845	17'556	34'717	66.4%	**52'273**	16.6%
Felbertauern	-	-	-	-	1'223	100.0%	**1'223**	0.4%
Tauern	1'785	13'126	1'377	16'287	19'087	54.0%	**35'375**	11.3%
Schoberpass	1'578	9'352	1'370	12'300	24'668	66.7%	**36'968**	11.8%
Semmering	1'895	20'246	-	22'141	10'411	32.0%	**32'552**	10.4%
Wechsel	-	-	-	-	15'370	100.0%	**15'370**	4.9%
Tarvisio	-	-	-	-	25'987	100.0%	**25'987**	8.3%
CH - I	14'784	21'298	889	36'971	20'781	36.0%	**57'752**	18.4%
Gr. St. Bernard	-	-	-	-	1'212	100.0%	**1'212**	0.4%
Simplon	2'426	3'718	665	6'809	3'411	33.4%	**10'221**	3.3%
Gotthard	12'358	17'580	224	30'161	13'710	31.2%	**43'871**	14.0%
San Bernardino	-	-	-	-	2'448	100.0%	**2'448**	0.8%
F - I	6'218	6'407	1'044	13'670	40'795	74.9%	**54'464**	17.3%
Mont-Blanc	-	-	-	-	4'649	100.0%	**4'649**	1.5%
MtCenis/Fréjus	6'183	5'561	1'044	12'788	15'701	55.1%	**28'490**	9.1%
Montgenerve	-	-	-	-	301	100.0%	**301**	0.1%
Ventimigla	35	846	-	881	20'143	95.8%	**21'024**	6.7%
total	**35'113**	**77'289**	**6'524**	**118'925**	**195'074**	**62.1%**	**313'999**	100.0%
share	11.2%	24.6%	2.1%	37.9%	62.1%		100.0%	

Figure 12-9: BAU 2030 high: Growth in transalpine freight transport 2004-2030, Alpine arch

country / corridor	rail				road	share of road	total	share
	UCT	WL	RM	total				
A - I / SLO	107.2%	113.3%	47.6%	105.9%	43.5%		**59.9%**	
Reschen					2.4%		**2.4%**	
Brenner	86.3%	78.3%	13.7%	71.8%	13.7%		**28.2%**	
Felbertauern					34.9%		**34.9%**	
Tauern	124.8%	111.0%	43.6%	104.2%	57.6%		**76.1%**	
Schoberpass	163.5%	119.5%	158.4%	128.2%	71.2%		**86.7%**	
Semmering	184.9%	127.2%		131.2%	86.5%		**114.7%**	
Wechsel					75.9%		**75.9%**	
Tarvisio					38.5%		**38.5%**	
CH - I	25.1%	136.2%	-46.8%	64.3%	66.9%		**65.2%**	
Gr. St. Bernard					103.7%		**103.7%**	
Simplon	-3.9%	22.1%	-44.7%	0.5%	410.6%		**37.4%**	
Gotthard	33.0%	194.3%	-52.0%	91.7%	38.9%		**71.4%**	
San Bernardino					85.3%		**85.3%**	
F - I	134.4%	49.9%		97.4%	2.7%		**16.7%**	
Mont-Blanc					-9.1%		**-9.1%**	
MtCenis/Fréjus	133.8%	48.8%		100.4%	-4.4%		**25.0%**	
Montgenerve					-9.2%		**-9.2%**	
Ventimigla	356.4%	57.4%		61.7%	12.7%		**14.1%**	
total	**65.0%**	**111.6%**	**36.5%**	**90.0%**	**34.3%**		**51.1%**	
share	9.2%	40.0%	-9.7%	25.7%	-11.1%			

12.3 ACE

Figure 12-10: ACE scenarios: Number of Lorries per country in transalpine freight transport for road and RM in Alpine arch C

road											
ACE scenarios country	BAU 2020	R 2020	R 2020 A+CH+F	T 2020	BAU 2030 low	R 2030 low	T 2030 low	BAU 2030 high	R 2030 high	R 2030 high A+CH+F	T 2030 high
number of lorries											
A - I / SLO	8'485	7'372	7'082	7'761	9'055	6'717	7'502	10'512	7'355	7'158	8'203
CH - I	1'361	655	894	895	1'410	651	902	1'662	647	580	885
F - I	2'583	1'904	1'975	2'137	2'413	1'112	1'537	2'893	1'111	1'407	1'543
total	**12'429**	**9'931**	**9'952**	**10'793**	**12'878**	**8'480**	**9'942**	**15'067**	**9'113**	**9'145**	**10'631**
in % of the respective BAU scenario											
A - I / SLO	100%	87%	83%	91%	100%	74%	83%	100%	70%	68%	78%
CH - I	100%	48%	66%	66%	100%	46%	64%	100%	39%	35%	53%
F - I	100%	74%	76%	83%	100%	46%	64%	100%	38%	49%	53%
total	**100%**	**80%**	**80%**	**87%**	**100%**	**66%**	**77%**	**100%**	**60%**	**61%**	**71%**

rolling motorway											
ACE scenarios country	BAU 2020	R 2020	R 2020 A+CH+F	T 2020	BAU 2030 low	R 2030 low	T 2030 low	BAU 2030 high	R 2030 high	R 2030 high A+CH+F	T 2030 high
number of lorries											
A - I / SLO	238	342	353	353	214	390	320	255	507	517	425
CH - I	113	173	169	169	41	90	69	49	123	124	97
F - I	32	64	59	59	48	158	106	58	228	200	160
total	**383**	**580**	**581**	**581**	**303**	**639**	**495**	**362**	**858**	**841**	**682**
in % of the respective BAU scenario											
A - I / SLO	100%	144%	148%	148%	100%	182%	150%	100%	199%	203%	167%
CH - I	100%	153%	149%	149%	100%	221%	168%	100%	250%	250%	196%
F - I	100%	204%	187%	187%	100%	327%	219%	100%	393%	345%	276%
total	**100%**	**151%**	**152%**	**152%**	**100%**	**211%**	**163%**	**100%**	**237%**	**232%**	**188%**

12.3.1 2020

Figure 12-11: Overview total transalpine freight transport volumes per country, in 1'000 tons/a

		road	Δ %	UCT	WL	RM	rail	Δ %
BAU 2020	A - I / SLO	107'763		11'789	36'052	4'290	52'132	
	CH - I	17'007		16'407	17'749	2'042	36'198	
	F - I	36'418		4'504	5'154	568	10'226	
ACE $^{R}_{2020}$	A - I / SLO	97'092	-9.9%	14'164	42'725	6'161	63'050	20.9%
	CH - I	8'711	-48.8%	20'002	23'206	3'121	46'330	28.0%
	F - I	28'049	-23.0%	6'669	8'295	1'160	16'124	57.7%
ACE $^{R}_{2020A+CH+F}$	A - I / SLO	93'837	-12.9%	14'366	43'524	6'360	64'251	23.2%
	CH - I	11'670	-31.4%	19'711	22'556	3'038	45'306	25.2%
	F - I	28'939	-20.5%	6'410	7'881	1'060	15'351	50.1%
ACE $^{T}_{2020}$	A - I / SLO	100'849	-6.4%	13'352	40'345	5'459	59'156	13.5%
	CH - I	11'609	-31.7%	18'857	21'377	2'693	42'928	18.6%
	F - I	30'973	-14.9%	5'917	7'131	904	13'953	36.4%

Figure 12-12: ACE R 2020: Alpine crossing freight transport 2020 in Alpine arch C, in 1'000 tons/a and Δ to BAU 2020 in %

country / corridor	rail				road	share of road	total	share of total	ACP-price EUR/trip
	UCT	WL	RM	total					
A - I / SLO	14'164	42'725	6'161	63'050	97'092	60.6%	**160'142**	61.7%	94
Reschen	-	-	-	-	1'344	100.0%	**1'344**	0.5%	
Brenner	9'348	6'436	2'883	18'666	23'110	55.3%	**41'776**	16.1%	
Felbertauern	-	-	-	-	804	100.0%	**804**	0.3%	
Tauern	1'807	12'733	2'119	16'660	9'683	36.8%	**26'343**	10.2%	
Schoberpass	1'429	7'640	1'159	10'228	21'931	68.2%	**32'159**	12.4%	
Semmering	1'580	15'915	-	17'495	8'615	33.0%	**26'110**	10.1%	
Wechsel	-	-	-	-	13'408	100.0%	**13'408**	5.2%	
Tarvisio	-	-	-	-	18'197	100.0%	**18'197**	7.0%	
CH - I	20'002	23'206	3'121	46'330	8'711	15.8%	**55'040**	21.2%	160
Gr. St. Bernard	-	-	-	-	497	100.0%	**497**	0.2%	
Simplon	3'436	4'215	2'134	9'785	1'604	14.1%	**11'389**	4.4%	
Gotthard	16'566	18'991	987	36'545	5'638	13.4%	**42'183**	16.3%	
San Bernardino	-	-	-	-	971	100.0%	**971**	0.4%	
F - I	6'669	8'295	1'160	16'124	28'049	63.5%	**44'173**	17.0%	126
Mont-Blanc	-	-	-	-	2'770	100.0%	**2'770**	1.1%	
MtCenis/Fréjus	6'586	6'548	1'160	14'294	10'064	41.3%	**24'359**	9.4%	
Montgenerve	-	-	-	-	189	100.0%	**189**	0.1%	
Ventimigla	83	1'747	-	1'830	15'025	89.1%	**16'854**	6.5%	
total	**40'835**	**74'226**	**10'443**	**125'504**	**133'852**	**51.6%**	**259'356**	100.0%	
share	15.7%	28.6%	4.0%	48.4%	51.6%		100.0%		

country / corridor	rail				road	share of road	total	share
	UCT	WL	RM	total				
A - I / SLO	20.1%	18.5%	43.6%	20.9%	-9.9%		**0.2%**	
Reschen					-25.7%		**-25.7%**	
Brenner	23.7%	42.3%	61.2%	34.6%	-23.3%		**-5.1%**	
Felbertauern					-22.3%		**-22.3%**	
Tauern	24.2%	30.0%	41.0%	30.6%	-34.8%		**-4.6%**	
Schoberpass	9.2%	9.4%	16.0%	10.1%	16.1%		**14.1%**	
Semmering	7.6%	7.9%		7.9%	11.7%		**9.1%**	
Wechsel					13.9%		**13.9%**	
Tarvisio					-15.6%		**-15.6%**	
CH - I	21.9%	30.7%	52.8%	28.0%	-48.8%		**3.4%**	
Gr. St. Bernard					-49.4%		**-49.4%**	
Simplon	26.3%	37.0%	50.9%	35.7%	-45.4%		**12.2%**	
Gotthard	21.1%	29.4%	57.2%	26.1%	-49.2%		**5.3%**	
San Bernardino					-51.4%		**-51.4%**	
F - I	48.1%	60.9%		57.7%	-23.0%		**-5.3%**	
Mont-Blanc					-35.3%		**-35.3%**	
MtCenis/Fréjus	47.2%	52.4%	104.4%	53.1%	-29.0%		**3.6%**	
Montgenerve					-35.8%		**-35.8%**	
Ventimigla	176.4%	103.9%		106.4%	-14.9%		**-9.1%**	
total	**24.9%**	**25.9%**	**51.3%**	**27.3%**	**-17.0%**		**-0.1%**	
share	25.1%	26.1%	51.6%	27.5%	-16.8%			

Figure 12-13: ACE R 2020 A+CH+F: Alpine crossing freight transport 2020 in Alpine arch C, in 1'000 tons/a and Δ to BAU 2020 in %

country / corridor	rail				road	share of road	total	share of total	ACP-price EUR/trip
	UCT	WL	RM	total					
A - I / SLO	14'366	43'524	6'360	64'251	93'837	59.4%	**158'087**	61.0%	110
Reschen	-	-	-	-	1'215	100.0%	**1'215**	0.5%	
Brenner	9'484	6'664	2'992	19'140	21'217	52.6%	**40'358**	15.6%	
Felbertauern	-	-	-	-	761	100.0%	**761**	0.3%	
Tauern	1'851	13'105	2'194	17'150	8'848	34.0%	**25'998**	10.0%	
Schoberpass	1'441	7'714	1'175	10'330	22'297	68.3%	**32'626**	12.6%	
Semmering	1'590	16'041	-	17'631	8'713	33.1%	**26'344**	10.2%	
Wechsel	-	-	-	-	13'614	100.0%	**13'614**	5.2%	
Tarvisio	-	-	-	-	17'171	100.0%	**17'171**	6.6%	
CH - I	19'711	22'556	3'038	45'306	11'670	20.5%	**56'976**	22.0%	110
Gr. St. Bernard	-	-	-	-	678	100.0%	**678**	0.3%	
Simplon	3'364	4'058	2'078	9'500	2'168	18.6%	**11'668**	4.5%	
Gotthard	16'348	18'498	960	35'806	7'476	17.3%	**43'282**	16.7%	
San Bernardino	-	-	-	-	1'347	100.0%	**1'347**	0.5%	
F - I	6'410	7'881	1'060	15'351	28'939	65.3%	**44'290**	17.1%	110
Mont-Blanc	-	-	-	-	2'897	100.0%	**2'897**	1.1%	
MtCenis/Fréjus	6'334	6'254	1'060	13'649	10'442	43.3%	**24'091**	9.3%	
Montgenerve	-	-	-	-	200	100.0%	**200**	0.1%	
Ventimigla	76	1'627	-	1'703	15'400	90.0%	**17'103**	6.6%	
total	**40'487**	**73'962**	**10'459**	**124'908**	**134'446**	**51.8%**	**259'353**	100.0%	
share	15.6%	28.5%	4.0%	48.2%	51.8%		100.0%		

country / corridor	rail				road	share of road	total	share
	UCT	WL	RM	total				
A - I / SLO	21.9%	20.7%	48.2%	23.2%	-12.9%		**-1.1%**	
Reschen					-32.8%		**-32.8%**	
Brenner	25.5%	47.4%	67.3%	38.0%	-29.6%		**-8.3%**	
Felbertauern					-26.5%		**-26.5%**	
Tauern	27.2%	33.8%	46.0%	34.5%	-40.4%		**-5.8%**	
Schoberpass	10.2%	10.5%	17.5%	11.2%	18.0%		**15.8%**	
Semmering	8.3%	8.8%		8.7%	13.0%		**10.1%**	
Wechsel					15.7%		**15.7%**	
Tarvisio					-20.4%		**-20.4%**	
CH - I	20.1%	27.1%	48.8%	25.2%	-31.4%		**7.1%**	
Gr. St. Bernard					-30.9%		**-30.9%**	
Simplon	23.6%	31.9%	47.0%	31.7%	-26.2%		**15.0%**	
Gotthard	19.5%	26.1%	52.8%	23.5%	-32.6%		**8.0%**	
San Bernardino					-32.6%		**-32.6%**	
F - I	42.3%	52.9%		50.1%	-20.5%		**-5.0%**	
Mont-Blanc					-32.4%		**-32.4%**	
MtCenis/Fréjus	41.6%	45.5%	86.8%	46.1%	-26.4%		**2.4%**	
Montgenerve					-32.4%		**-32.4%**	
Ventimigla	153.6%	89.9%		92.1%	-12.8%		**-7.8%**	
total	**23.8%**	**25.5%**	**51.6%**	**26.7%**	**-16.6%**		**-0.2%**	
share	24.0%	25.6%	51.8%	26.9%	-16.5%			

Figure 12-14: ACE T 2020: Alpine crossing freight transport 2020 in Alpine arch C, in 1'000 tons/a and Δ to BAU 2020 in %

country / corridor	rail				road	share of road	total	share of total	ACP-price EUR/trip
	UCT	WL	RM	total					
A - I / SLO	13'352	40'345	5'459	59'156	100'849	63.0%	**160'006**	61.7%	59
Reschen	-	-	-	-	1'508	100.0%	**1'508**	0.6%	
Brenner	8'742	5'755	2'452	16'948	25'610	60.2%	**42'558**	16.4%	
Felbertauern	-	-	-	-	888	100.0%	**888**	0.3%	
Tauern	1'680	11'656	1'906	15'242	11'421	42.8%	**26'663**	10.3%	
Schoberpass	1'389	7'422	1'101	9'912	20'852	67.8%	**30'764**	11.9%	
Semmering	1'541	15'512	-	17'054	8'295	32.7%	**25'348**	9.8%	
Wechsel	-	-	-	-	12'823	100.0%	**12'823**	4.9%	
Tarvisio	-	-	-	-	19'452	100.0%	**19'452**	7.5%	
CH - I	18'857	21'377	2'693	42'928	11'609	21.3%	**54'536**	21.0%	93
Gr. St. Bernard	-	-	-	-	668	100.0%	**668**	0.3%	
Simplon	3'202	3'829	1'848	8'879	2'114	19.2%	**10'993**	4.2%	
Gotthard	15'655	17'549	845	34'049	7'501	18.1%	**41'550**	16.0%	
San Bernardino	-	-	-	-	1'326	100.0%	**1'326**	0.5%	
F - I	5'917	7'131	904	13'953	30'973	68.9%	**44'926**	17.3%	79
Mont-Blanc	-	-	-	-	3'256	100.0%	**3'256**	1.3%	
MtCenis/Fréjus	5'855	5'733	904	12'492	11'451	47.8%	**23'943**	9.2%	
Montgenerve	-	-	-	-	224	100.0%	**224**	0.1%	
Ventimigla	62	1'398	-	1'460	16'043	91.7%	**17'503**	6.7%	
total	**38'126**	**68'854**	**9'057**	**116'037**	**143'431**	**55.3%**	**259'468**	100.0%	
share	14.7%	26.5%	3.5%	44.7%	55.3%		100.0%		

country / corridor	rail				road	share of road	total	share
	UCT	WL	RM	total				
A - I / SLO	13.3%	11.9%	27.2%	13.5%	-6.4%		**0.1%**	
Reschen					-16.6%		**-16.6%**	
Brenner	15.7%	27.2%	37.1%	22.2%	-15.0%		**-3.3%**	
Felbertauern					-14.2%		**-14.2%**	
Tauern	15.5%	19.0%	26.8%	19.5%	-23.1%		**-3.4%**	
Schoberpass	6.2%	6.3%	10.2%	6.7%	10.4%		**9.2%**	
Semmering	5.0%	5.2%		5.2%	7.6%		**5.9%**	
Wechsel					9.0%		**9.0%**	
Tarvisio					-9.8%		**-9.8%**	
CH - I	14.9%	20.4%	31.9%	18.6%	-31.7%		**2.5%**	
Gr. St. Bernard					-32.0%		**-32.0%**	
Simplon	17.6%	24.5%	30.7%	23.1%	-28.1%		**8.3%**	
Gotthard	14.4%	19.6%	34.5%	17.5%	-32.4%		**3.7%**	
San Bernardino					-33.6%		**-33.6%**	
F - I	31.4%	38.4%		36.4%	-14.9%		**-3.7%**	
Mont-Blanc					-24.0%		**-24.0%**	
MtCenis/Fréjus	30.9%	33.4%	59.3%	33.8%	-19.3%		**1.8%**	
Montgenerve					-24.2%		**-24.2%**	
Ventimigla	108.1%	63.2%		64.7%	-9.1%		**-5.6%**	
total	**16.6%**	**16.8%**	**31.3%**	**17.7%**	**-11.0%**		**-0.1%**	
share	16.7%	16.9%	31.4%	17.9%	-10.9%			

12.3.2 2030

Figure 12-15: Overview total transalpine freight transport volumes per country, in 1'000 tons/a

		road	Δ %	UCT	WL	RM	rail	Δ %
BAU2030 low	A - I / SLO	115'001		11'933	42'888	3'849	58'670	
	CH - I	17'623		12'460	18'054	738	31'252	
	F - I	34'026		5'182	5'341	871	11'394	
ACE $^{R}_{2030\ low}$	A - I / SLO	92'525	-19.5%	16'222	57'059	7'023	80'304	36.9%
	CH - I	8'846	-49.8%	17'457	26'487	1'628	45'572	45.8%
	F - I	17'237	-49.3%	9'122	10'966	2'846	22'934	101.3%
ACE $^{T}_{2030\ low}$	A - I / SLO	100'083	-13.0%	14'838	52'237	5'768	72'844	24.2%
	CH - I	11'848	-32.8%	15'987	23'867	1'238	41'092	31.5%
	F - I	22'955	-32.5%	7'874	8'924	1'905	18'703	64.2%
		road	**Δ %**	**UCT**	**WL**	**RM**	**rail**	**Δ %**
BAU2030 high	A - I / SLO	133'498		14'110	49'584	4'591	68'285	
	CH - I	20'781		14'784	21'298	889	36'971	
	F - I	40'795		6'218	6'407	1'044	13'670	
ACE $^{R}_{2030\ high}$	A - I / SLO	103'086	-22.8%	19'885	68'698	9'124	97'707	43.1%
	CH - I	8'953	-56.9%	21'400	32'448	2'220	56'068	51.7%
	F - I	17'585	-56.9%	11'561	14'265	4'102	29'928	118.9%
ACE $^{R}_{2030\ high\ A+CH+F}$	A - I / SLO	100'924	-24.4%	20'012	69'296	9'309	98'618	44.4%
	CH - I	8'062	-61.2%	21'289	32'317	2'226	55'832	51.0%
	F - I	21'809	-46.5%	11'119	13'368	3'604	28'091	105.5%
ACE $^{T}_{2030\ high}$	A - I / SLO	111'226	-16.7%	18'476	63'664	7'654	89'795	31.5%
	CH - I	11'851	-43.0%	19'997	29'915	1'738	51'650	39.7%
	F - I	23'530	-42.3%	10'338	12'118	2'883	25'339	85.4%

Figure 12-16: ACE R 2030 low: Alpine crossing freight transport 2030 in Alpine arch C, in 1'000 tons/a and Δ to BAU 2030 low in %

country / corridor	rail				road	share of road	total	share of total	ACP-price EUR/trip
	UCT	WL	RM	total					
A - I / SLO	16'222	57'059	7'023	80'304	92'525	53.5%	**172'828**	64.6%	215
Reschen	-	-	-	-	764	100.0%	**764**	0.3%	
Brenner	10'462	9'677	3'604	23'743	14'609	38.1%	**38'352**	14.3%	
Felbertauern	-	-	-	-	567	100.0%	**567**	0.2%	
Tauern	2'230	17'489	1'929	21'648	5'704	20.9%	**27'352**	10.2%	
Schoberpass	1'620	9'606	1'490	12'716	28'694	69.3%	**41'410**	15.5%	
Semmering	1'910	20'287	-	22'197	11'251	33.6%	**33'448**	12.5%	
Wechsel	-	-	-	-	17'375	100.0%	**17'375**	6.5%	
Tarvisio	-	-	-	-	13'561	100.0%	**13'561**	5.1%	
CH - I	17'457	26'487	1'628	45'572	8'846	16.3%	**54'418**	20.3%	217
Gr. St. Bernard	-	-	-	-	535	100.0%	**535**	0.2%	
Simplon	3'015	4'878	1'180	9'073	1'712	15.9%	**10'786**	4.0%	
Gotthard	14'442	21'609	448	36'499	5'624	13.4%	**42'123**	15.8%	
San Bernardino	-	-	-	-	974	100.0%	**974**	0.4%	
F - I	9'122	10'966	2'846	22'934	17'237	42.9%	**40'170**	15.0%	281
Mont-Blanc	-	-	-	-	1'285	100.0%	**1'285**	0.5%	
MtCenis/Fréjus	8'990	8'705	2'846	20'541	5'416	20.9%	**25'957**	9.7%	
Montgenerve	-	-	-	-	82	100.0%	**82**	0.0%	
Ventimigla	132	2'261	-	2'393	10'454	81.4%	**12'846**	4.8%	
total	**42'801**	**94'511**	**11'497**	**148'809**	**118'607**	**44.4%**	**267'417**	100.0%	
share	16.0%	35.3%	4.3%	55.6%	44.4%		100.0%		

country / corridor	rail				road	share of road	total	share
	UCT	WL	RM	total				
A - I / SLO	35.9%	33.0%	82.4%	36.9%	-19.5%		**-0.5%**	
Reschen					-55.4%		**-55.4%**	
Brenner	41.7%	68.9%	134.4%	62.1%	-49.9%		**-12.4%**	
Felbertauern					-48.3%		**-48.3%**	
Tauern	47.5%	57.0%	65.8%	56.7%	-65.7%		**-10.2%**	
Schoberpass	17.2%	16.4%	29.7%	17.9%	31.3%		**26.9%**	
Semmering	15.2%	14.2%		14.3%	22.6%		**16.9%**	
Wechsel					27.1%		**27.1%**	
Tarvisio					-37.5%		**-37.5%**	
CH - I	40.1%	46.7%	120.5%	45.8%	-49.8%		**11.3%**	
Gr. St. Bernard					-47.5%		**-47.5%**	
Simplon	48.1%	54.2%	113.3%	57.7%	-39.8%		**25.4%**	
Gotthard	38.6%	45.1%	142.3%	43.1%	-51.9%		**13.3%**	
San Bernardino					-52.8%		**-52.8%**	
F - I	76.0%	105.3%		101.3%	-49.3%		**-11.6%**	
Mont-Blanc					-66.8%		**-66.8%**	
MtCenis/Fréjus	74.5%	87.8%	226.9%	92.7%	-58.6%		**9.3%**	
Montgenerve					-67.4%		**-67.4%**	
Ventimigla	346.2%	220.3%		225.4%	-37.8%		**-26.8%**	
total	**44.7%**	**42.6%**	**110.6%**	**46.9%**	**-28.8%**		**-0.2%**	
share	45.0%	42.9%	111.1%	47.2%	-28.7%			

Figure 12-17: ACE T 2030 low: Alpine crossing freight transport 2030 in Alpine arch C, in 1'000 tons/a and Δ to BAU 2030 low in %

country / corridor	rail				road	share of road	total	share of total	ACP-price EUR/trip
	UCT	WL	RM	total					
A - I / SLO	14'838	52'237	5'768	72'844	100'083	57.9%	**172'927**	64.6%	128
Reschen	-	-	-	-	1'077	100.0%	**1'077**	0.4%	
Brenner	9'487	8'353	2'736	20'575	19'628	48.8%	**40'204**	15.0%	
Felbertauern	-	-	-	-	747	100.0%	**747**	0.3%	
Tauern	1'978	15'239	1'668	18'885	9'040	32.4%	**27'925**	10.4%	
Schoberpass	1'548	9'195	1'365	12'109	26'303	68.5%	**38'411**	14.4%	
Semmering	1'825	19'450	-	21'275	10'530	33.1%	**31'805**	11.9%	
Wechsel	-	-	-	-	16'061	100.0%	**16'061**	6.0%	
Tarvisio	-	-	-	-	16'697	100.0%	**16'697**	6.2%	
CH - I	15'987	23'867	1'238	41'092	11'848	22.4%	**52'939**	19.8%	126
Gr. St. Bernard	-	-	-	-	702	100.0%	**702**	0.3%	
Simplon	2'717	4'345	907	7'969	2'196	21.6%	**10'165**	3.8%	
Gotthard	13'270	19'522	331	33'122	7'603	18.7%	**40'726**	15.2%	
San Bernardino	-	-	-	-	1'347	100.0%	**1'347**	0.5%	
F - I	7'874	8'924	1'905	18'703	22'955	55.1%	**41'657**	15.6%	166
Mont-Blanc	-	-	-	-	2'009	100.0%	**2'009**	0.8%	
MtCenis/Fréjus	7'778	7'268	1'905	16'951	7'796	31.5%	**24'747**	9.3%	
Montgenerve	-	-	-	-	132	100.0%	**132**	0.0%	
Ventimigla	96	1'656	-	1'752	13'018	88.1%	**14'770**	5.5%	
total	**38'699**	**85'028**	**8'911**	**132'638**	**134'885**	**50.4%**	**267'523**	100.0%	
share	14.5%	31.8%	3.3%	49.6%	50.4%		100.0%		

country / corridor	rail				road	share of road	total	share
	UCT	WL	RM	total				
A - I / SLO	24.3%	21.8%	49.9%	24.2%	-13.0%		**-0.4%**	
Reschen					-37.1%		**-37.1%**	
Brenner	28.5%	45.8%	78.0%	40.5%	-32.6%		**-8.2%**	
Felbertauern					-31.8%		**-31.8%**	
Tauern	30.9%	36.8%	43.3%	36.7%	-45.7%		**-8.3%**	
Schoberpass	12.1%	11.4%	18.8%	12.3%	20.4%		**17.7%**	
Semmering	10.0%	9.5%		9.5%	14.7%		**11.2%**	
Wechsel					17.5%		**17.5%**	
Tarvisio					-23.1%		**-23.1%**	
CH - I	28.3%	32.2%	67.7%	31.5%	-32.8%		**8.3%**	
Gr. St. Bernard					-31.1%		**-31.1%**	
Simplon	33.4%	37.3%	63.9%	38.5%	-22.8%		**18.2%**	
Gotthard	27.3%	31.1%	78.9%	29.9%	-35.0%		**9.5%**	
San Bernardino					-34.7%		**-34.7%**	
F - I	51.9%	67.1%		64.2%	-32.5%		**-8.3%**	
Mont-Blanc					-48.2%		**-48.2%**	
MtCenis/Fréjus	50.9%	56.8%	118.9%	59.0%	-40.5%		**4.2%**	
Montgenerve					-47.5%		**-47.5%**	
Ventimigla	224.2%	134.7%		138.3%	-22.5%		**-15.8%**	
total	**30.8%**	**28.3%**	**63.3%**	**30.9%**	**-19.1%**		**-0.2%**	
share	31.1%	28.5%	63.5%	31.1%	-18.9%			

Figure 12-18: ACE R 2030 high: Alpine crossing freight transport 2030 in Alpine arch C, in 1'000 tons/a and Δ to BAU 2030 high in %

country / corridor	rail				road	share of road	total	share of total	ACP-price EUR/trip
	UCT	WL	RM	total					
A - I / SLO	19'885	68'698	9'124	97'707	103'086	51.3%	**200'793**	64.1%	263
Reschen	-	-	-	-	746	100.0%	**746**	0.2%	
Brenner	13'017	12'250	4'876	30'143	14'685	32.8%	**44'828**	14.3%	
Felbertauern	-	-	-	-	536	100.0%	**536**	0.2%	
Tauern	2'734	21'623	2'398	26'756	5'204	16.3%	**31'959**	10.2%	
Schoberpass	1'893	11'142	1'850	14'884	33'871	69.5%	**48'756**	15.6%	
Semmering	2'241	23'682	-	25'924	13'260	33.8%	**39'183**	12.5%	
Wechsel	-	-	-	-	20'440	100.0%	**20'440**	6.5%	
Tarvisio	-	-	-	-	14'345	100.0%	**14'345**	4.6%	
CH - I	21'400	32'448	2'220	56'068	8'953	13.8%	**65'021**	20.8%	269
Gr. St. Bernard	-	-	-	-	549	100.0%	**549**	0.2%	
Simplon	3'736	5'979	1'601	11'316	1'758	13.4%	**13'074**	4.2%	
Gotthard	17'664	26'469	619	44'752	5'680	11.3%	**50'432**	16.1%	
San Bernardino	-	-	-	-	966	100.0%	**966**	0.3%	
F - I	11'561	14'265	4'102	29'928	17'585	37.0%	**47'513**	15.2%	345
Mont-Blanc	-	-	-	-	1'207	100.0%	**1'207**	0.4%	
MtCenis/Fréjus	11'386	11'231	4'102	26'719	5'316	16.6%	**32'036**	10.2%	
Montgenerve	-	-	-	-	75	100.0%	**75**	0.0%	
Ventimigla	175	3'034	-	3'209	10'986	77.4%	**14'195**	4.5%	
total	**52'846**	**115'410**	**15'447**	**183'704**	**129'623**	**41.4%**	**313'327**	100.0%	
share	16.9%	36.8%	4.9%	58.6%	41.4%		100.0%		

country / corridor	rail				road	share of road	total	share
	UCT	WL	RM	total				
A - I / SLO	40.9%	38.5%	98.7%	43.1%	-22.8%		**-0.5%**	
Reschen					-63.4%		**-63.4%**	
Brenner	47.1%	78.6%	164.4%	71.7%	-57.7%		**-14.2%**	
Felbertauern					-56.1%		**-56.1%**	
Tauern	53.2%	64.7%	74.2%	64.3%	-72.7%		**-9.7%**	
Schoberpass	19.9%	19.1%	35.0%	21.0%	37.3%		**31.9%**	
Semmering	18.3%	17.0%		17.1%	27.4%		**20.4%**	
Wechsel					33.0%		**33.0%**	
Tarvisio					-44.8%		**-44.8%**	
CH - I	44.7%	52.4%	149.8%	51.7%	-56.9%		**12.6%**	
Gr. St. Bernard					-54.7%		**-54.7%**	
Simplon	54.0%	60.8%	140.7%	66.2%	-48.5%		**27.9%**	
Gotthard	42.9%	50.6%	177.0%	48.4%	-58.6%		**15.0%**	
San Bernardino					-60.5%		**-60.5%**	
F - I	85.9%	122.6%		118.9%	-56.9%		**-12.8%**	
Mont-Blanc					-74.0%		**-74.0%**	
MtCenis/Fréjus	84.2%	102.0%	292.9%	108.9%	-66.1%		**12.4%**	
Montgenerve					-75.1%		**-75.1%**	
Ventimigla	394.9%	258.7%		264.1%	-45.5%		**-32.5%**	
total	**50.5%**	**49.3%**	**136.8%**	**54.5%**	**-33.6%**		**-0.2%**	
share	50.8%	49.6%	137.3%	54.8%	-33.4%			

Figure 12-19: ACE R 2030 high A+CH+F: Alpine crossing freight transport 2030 in Alpine arch C, in 1'000 tons/a and Δ to BAU 2030 high in %

country / corridor	rail				road	share of road	total	share of total	ACP-price EUR/trip
	UCT	WL	RM	total					
A - I / SLO	20'012	69'296	9'309	98'618	100'924	50.6%	**199'543**	63.7%	280
Reschen	-	-	-	-	681	100.0%	**681**	0.2%	
Brenner	13'113	12'433	5'014	30'560	13'569	30.7%	**44'129**	14.1%	
Felbertauern	-	-	-	-	507	100.0%	**507**	0.2%	
Tauern	2'759	21'900	2'431	27'090	4'732	14.9%	**31'822**	10.2%	
Schoberpass	1'897	11'190	1'865	14'952	34'181	69.6%	**49'133**	15.7%	
Semmering	2'243	23'774	-	26'017	13'342	33.9%	**39'359**	12.6%	
Wechsel	-	-	-	-	20'623	100.0%	**20'623**	6.6%	
Tarvisio	-	-	-	-	13'290	100.0%	**13'290**	4.2%	
CH - I	21'289	32'317	2'226	55'832	8'062	12.6%	**63'894**	20.4%	280
Gr. St. Bernard	-	-	-	-	476	100.0%	**476**	0.2%	
Simplon	3'687	5'914	1'603	11'203	1'480	11.7%	**12'683**	4.0%	
Gotthard	17'602	26'403	623	44'629	5'214	10.5%	**49'843**	15.9%	
San Bernardino	-	-	-	-	893	100.0%	**893**	0.3%	
F - I	11'119	13'368	3'604	28'091	21'809	43.7%	**49'901**	15.9%	280
Mont-Blanc	-	-	-	-	1'656	100.0%	**1'656**	0.5%	
MtCenis/Fréjus	10'961	10'642	3'604	25'208	6'947	21.6%	**32'154**	10.3%	
Montgenerve	-	-	-	-	104	100.0%	**104**	0.0%	
Ventimigla	158	2'725	-	2'884	13'103	82.0%	**15'987**	5.1%	
total	**52'421**	**114'981**	**15'140**	**182'542**	**130'796**	**41.7%**	**313'338**	100.0%	
share	16.7%	36.7%	4.8%	58.3%	41.7%		100.0%		

country / corridor	rail				road	share of road	total	share
	UCT	WL	RM	total				
A - I / SLO	41.8%	39.8%	102.8%	44.4%	-24.4%		**-1.1%**	
Reschen					-66.6%		**-66.6%**	
Brenner	48.1%	81.2%	171.8%	74.1%	-60.9%		**-15.6%**	
Felbertauern					-58.5%		**-58.5%**	
Tauern	54.6%	66.8%	76.6%	66.3%	-75.2%		**-10.0%**	
Schoberpass	20.2%	19.7%	36.1%	21.6%	38.6%		**32.9%**	
Semmering	18.4%	17.4%		17.5%	28.2%		**20.9%**	
Wechsel					34.2%		**34.2%**	
Tarvisio					-48.9%		**-48.9%**	
CH - I	44.0%	51.7%	150.5%	51.0%	-61.2%		**10.6%**	
Gr. St. Bernard					-60.8%		**-60.8%**	
Simplon	51.9%	59.1%	141.0%	64.5%	-56.6%		**24.1%**	
Gotthard	42.4%	50.2%	178.8%	48.0%	-62.0%		**13.6%**	
San Bernardino					-63.5%		**-63.5%**	
F - I	78.8%	108.6%		105.5%	-46.5%		**-8.4%**	
Mont-Blanc					-64.4%		**-64.4%**	
MtCenis/Fréjus	77.3%	91.4%	245.2%	97.1%	-55.8%		**12.9%**	
Montgenerve					-65.6%		**-65.6%**	
Ventimigla	347.7%	222.2%		227.2%	-35.0%		**-24.0%**	
total	**49.3%**	**48.8%**	**132.1%**	**53.5%**	**-33.0%**		**-0.2%**	
share	49.6%	49.1%	132.6%	53.8%	-32.8%			

Figure 12-20: ACE T 2030 high: Alpine crossing freight transport 2030 in Alpine arch C, in 1'000 tons/a and Δ to BAU 2030 high in %

country / corridor	rail				road	share of road	total	share of total	ACP-price EUR/trip
	UCT	WL	RM	total					
A - I / SLO	18'476	63'664	7'654	89'795	111'226	55.3%	**201'021**	64.1%	172
Reschen	-	-	-	-	1'081	100.0%	**1'081**	0.3%	
Brenner	12'026	10'861	3'823	26'709	20'228	43.1%	**46'938**	15.0%	
Felbertauern	-	-	-	-	717	100.0%	**717**	0.2%	
Tauern	2'482	19'300	2'123	23'906	8'340	25.9%	**32'245**	10.3%	
Schoberpass	1'820	10'719	1'708	14'247	31'303	68.7%	**45'550**	14.5%	
Semmering	2'148	22'785	-	24'933	12'466	33.3%	**37'399**	11.9%	
Wechsel	-	-	-	-	18'992	100.0%	**18'992**	6.1%	
Tarvisio	-	-	-	-	18'099	100.0%	**18'099**	5.8%	
CH - I	19'997	29'915	1'738	51'650	11'851	18.7%	**63'501**	20.3%	178
Gr. St. Bernard	-	-	-	-	712	100.0%	**712**	0.2%	
Simplon	3'448	5'470	1'264	10'182	2'267	18.2%	**12'449**	4.0%	
Gotthard	16'549	24'445	473	41'468	7'550	15.4%	**49'018**	15.6%	
San Bernardino	-	-	-	-	1'323	100.0%	**1'323**	0.4%	
F - I	10'338	12'118	2'883	25'339	23'530	48.1%	**48'869**	15.6%	229
Mont-Blanc	-	-	-	-	1'884	100.0%	**1'884**	0.6%	
MtCenis/Fréjus	10'198	9'715	2'883	22'796	7'649	25.1%	**30'445**	9.7%	
Montgenerve	-	-	-	-	122	100.0%	**122**	0.0%	
Ventimigla	140	2'403	-	2'543	13'874	84.5%	**16'418**	5.2%	
total	**48'812**	**105'697**	**12'275**	**166'784**	**146'607**	**46.8%**	**313'391**	100.0%	
share	15.6%	33.7%	3.9%	53.2%	46.8%		100.0%		

country / corridor	rail				road	share of road	total	share
	UCT	WL	RM	total				
A - I / SLO	30.9%	28.4%	66.7%	31.5%	-16.7%		**-0.4%**	
Reschen					-46.9%		**-46.9%**	
Brenner	35.9%	58.3%	107.3%	52.1%	-41.7%		**-10.2%**	
Felbertauern					-41.4%		**-41.4%**	
Tauern	39.1%	47.0%	54.3%	46.8%	-56.3%		**-8.8%**	
Schoberpass	15.3%	14.6%	24.7%	15.8%	26.9%		**23.2%**	
Semmering	13.3%	12.5%		12.6%	19.7%		**14.9%**	
Wechsel					23.6%		**23.6%**	
Tarvisio					-30.4%		**-30.4%**	
CH - I	35.3%	40.5%	95.5%	39.7%	-43.0%		**10.0%**	
Gr. St. Bernard					-41.3%		**-41.3%**	
Simplon	42.1%	47.1%	90.1%	49.5%	-33.6%		**21.8%**	
Gotthard	33.9%	39.1%	111.8%	37.5%	-44.9%		**11.7%**	
San Bernardino					-46.0%		**-46.0%**	
F - I	66.3%	89.1%		85.4%	-42.3%		**-10.3%**	
Mont-Blanc					-59.5%		**-59.5%**	
MtCenis/Fréjus	64.9%	74.7%	176.1%	78.3%	-51.3%		**6.9%**	
Montgenerve					-59.4%		**-59.4%**	
Ventimigla	296.0%	184.1%		188.6%	-31.1%		**-21.9%**	
total	**39.0%**	**36.8%**	**88.2%**	**40.2%**	**-24.8%**		**-0.2%**	
share	39.3%	37.0%	88.5%	40.5%	-24.7%			

12.4 AETS

Figure 12-21: AETS scenarios: Number of Lorries per country in transalpine freight transport for road and RM in Alpine arch C

AETS scenarios / country	BAU 2020	R 2020 A+CH+F	T 2020 A+CH+F	T 2020	BAU 2030 low	R 2030 low A+CH+F	T 2030 high A+CH+F	BAU 2030 high	R 2030 high A+CH+F	T 2030 high A+CH+F	T 2030 high
road											
number of lorries											
A - I / SLO	8'485	7'566	8'022	8'145	9'055	7'377	8'189	10'512	8'020	8'837	9'027
CH - I	1'361	1'109	1'235	1'226	1'410	886	1'145	1'662	878	1'156	1'076
F - I	2'583	2'257	2'427	2'316	2'413	1'764	2'113	2'893	1'838	2'262	1'883
total	**12'429**	**10'932**	**11'684**	**11'687**	**12'878**	**10'026**	**11'447**	**15'067**	**10'735**	**12'256**	**11'985**
in % of the respective BAU scenario											
A - I / SLO	100%	89%	95%	96%	100%	81%	90%	100%	76%	84%	86%
CH - I	100%	81%	91%	90%	100%	63%	81%	100%	53%	70%	65%
F - I	100%	87%	94%	90%	100%	73%	88%	100%	64%	78%	65%
total	**100%**	**88%**	**94%**	**94%**	**100%**	**78%**	**89%**	**100%**	**71%**	**81%**	**80%**

AETS scenarios / country	BAU 2020	R 2020 A+CH+F	T 2020 A+CH+F	T 2020	BAU 2030 low	R 2030 low A+CH+F	T 2030 high A+CH+F	BAU 2030 high	R 2030 high A+CH+F	T 2030 high A+CH+F	T 2030 high
rolling motorway											
number of lorries											
A - I / SLO	238	325	280	273	214	360	280	255	491	396	395
CH - I	113	153	132	132	41	77	56	49	111	83	87
F - I	32	48	39	42	48	106	71	58	161	111	136
total	**383**	**526**	**451**	**447**	**303**	**543**	**408**	**362**	**763**	**590**	**618**
in % of the respective BAU scenario											
A - I / SLO	100%	137%	117%	115%	100%	169%	131%	100%	193%	155%	155%
CH - I	100%	135%	116%	116%	100%	188%	137%	100%	225%	169%	177%
F - I	100%	152%	123%	132%	100%	218%	147%	100%	278%	191%	235%
total	**100%**	**137%**	**118%**	**116%**	**100%**	**179%**	**134%**	**100%**	**211%**	**163%**	**171%**

12.4.1 2020

Figure 12-22: Overview total transalpine freight transport volumes per country, in 1'000 tons/a

		road	Δ %	UCT	WL	RM	rail	Δ %
BAU 2020	A - I / SLO	107'763		11'789	36'052	4'290	52'132	
	CH - I	17'007		16'407	17'749	2'042	36'198	
	F - I	36'418		4'504	5'154	568	10'226	
AETS R 2020A+CH+F	A - I / SLO	96'090	-10.8%	13'855	41'710	5'859	61'424	17.8%
	CH - I	13'857	-18.5%	18'824	21'130	2'747	42'701	18.0%
	F - I	31'827	-12.6%	5'762	6'919	864	13'545	32.5%
AETS T 2020 A+CH+F	A - I / SLO	101'885	-5.5%	12'849	38'856	5'039	56'744	8.8%
	CH - I	15'433	-9.3%	17'654	19'453	2'373	39'480	9.1%
	F - I	34'223	-6.0%	5'122	5'994	699	11'815	15.5%
AETS T 2020	A - I / SLO	103'440	-4.0%	12'705	38'411	4'922	56'038	7.5%
	CH - I	15'331	-9.9%	17'738	19'590	2'368	39'697	9.7%
	F - I	32'656	-10.3%	5'341	6'329	747	12'418	21.4%

Figure 12-23: AETS R 2020 A+CH+F: Alpine crossing freight transport 2020 in Alpine arch C, in 1'000 tons/a and Δ to BAU 2020 in %

country / corridor	rail				road	share of road	total	share of total	AETS-price EUR/km
	UCT	WL	RM	total					
A - I / SLO	13'855	41'710	5'859	61'424	96'090	61.0%	**157'513**	60.7%	0.23
Reschen	-	-	-	-	1'174	100.0%	**1'174**	0.5%	
Brenner	9'147	6'333	2'728	18'208	20'963	53.5%	**39'171**	15.1%	
Felbertauern	-	-	-	-	781	100.0%	**781**	0.3%	
Tauern	1'742	12'172	2'002	15'916	11'139	41.2%	**27'055**	10.4%	
Schoberpass	1'408	7'520	1'128	10'056	21'321	68.0%	**31'377**	12.1%	
Semmering	1'557	15'686	-	17'243	8'434	32.8%	**25'677**	9.9%	
Wechsel	-	-	-	-	13'071	100.0%	**13'071**	5.0%	
Tarvisio	-	-	-	-	19'208	100.0%	**19'208**	7.4%	
CH - I	18'824	21'130	2'747	42'701	13'857	24.5%	**56'558**	21.8%	0.23
Gr. St. Bernard	-	-	-	-	764	100.0%	**764**	0.3%	
Simplon	3'175	3'748	1'883	8'806	2'157	19.7%	**10'963**	4.2%	
Gotthard	15'649	17'382	864	33'895	9'290	21.5%	**43'185**	16.6%	
San Bernardino	-	-	-	-	1'647	100.0%	**1'647**	0.6%	
F - I	5'762	6'919	864	13'545	31'827	70.1%	**45'372**	17.5%	0.23
Mont-Blanc	-	-	-	-	3'715	100.0%	**3'715**	1.4%	
MtCenis/Fréjus	5'703	5'567	864	12'133	11'718	49.1%	**23'851**	9.2%	
Montgenerve	-	-	-	-	233	100.0%	**233**	0.1%	
Ventimigla	59	1'352	-	1'411	16'162	92.0%	**17'573**	6.8%	
total	**38'441**	**69'758**	**9'470**	**117'669**	**141'774**	**54.6%**	**259'443**	100.0%	
share	14.8%	26.9%	3.7%	45.4%	54.6%		100.0%		

country / corridor	rail				road	share of road	total	share
	UCT	WL	RM	total				
A - I / SLO	17.5%	15.7%	36.6%	17.8%	-10.8%		**-1.5%**	
Reschen					-35.1%		**-35.1%**	
Brenner	21.0%	40.0%	52.6%	31.3%	-30.4%		**-11.0%**	
Felbertauern					-24.6%		**-24.6%**	
Tauern	19.8%	24.2%	33.2%	24.8%	-25.0%		**-2.0%**	
Schoberpass	7.7%	7.7%	12.9%	8.2%	12.8%		**11.3%**	
Semmering	6.1%	6.3%		6.3%	9.4%		**7.3%**	
Wechsel					11.1%		**11.1%**	
Tarvisio					-10.9%		**-10.9%**	
CH - I	14.7%	19.0%	34.5%	18.0%	-18.5%		**6.3%**	
Gr. St. Bernard					-22.2%		**-22.2%**	
Simplon	16.7%	21.8%	33.2%	22.1%	-26.6%		**8.0%**	
Gotthard	14.3%	18.5%	37.5%	16.9%	-16.2%		**7.8%**	
San Bernardino					-17.6%		**-17.6%**	
F - I	27.9%	34.2%		32.5%	-12.6%		**-2.7%**	
Mont-Blanc					-13.3%		**-13.3%**	
MtCenis/Fréjus	27.5%	29.5%	52.2%	29.9%	-17.4%		**1.4%**	
Montgenerve					-21.0%		**-21.0%**	
Ventimigla	99.2%	57.8%		59.2%	-8.5%		**-5.2%**	
total	**17.6%**	**18.3%**	**37.2%**	**19.4%**	**-12.0%**		**-0.1%**	
share	17.7%	18.5%	37.4%	19.5%	-11.9%			

Figure 12-24: AETS T 2020 A+CH+F: Alpine crossing freight transport 2020 in Alpine arch C, in 1'000 tons/a and Δ to BAU 2020 in %

country / corridor	rail				road	share of road	total	share of total	AETS-price EUR/km
	UCT	WL	RM	total					
A - I / SLO	12'849	38'856	5'039	56'744	101'885	64.2%	**158'629**	61.1%	0.11
Reschen	-	-	-	-	1'477	100.0%	**1'477**	0.6%	
Brenner	8'380	5'426	2'227	16'032	25'427	61.3%	**41'459**	16.0%	
Felbertauern	-	-	-	-	906	100.0%	**906**	0.3%	
Tauern	1'596	10'950	1'750	14'296	13'016	47.7%	**27'312**	10.5%	
Schoberpass	1'360	7'259	1'062	9'681	20'091	67.5%	**29'772**	11.5%	
Semmering	1'513	15'221	-	16'734	8'070	32.5%	**24'804**	9.6%	
Wechsel	-	-	-	-	12'410	100.0%	**12'410**	4.8%	
Tarvisio	-	-	-	-	20'489	100.0%	**20'489**	7.9%	
CH - I	17'654	19'453	2'373	39'480	15'433	28.1%	**54'913**	21.2%	0.11
Gr. St. Bernard	-	-	-	-	869	100.0%	**869**	0.3%	
Simplon	2'952	3'412	1'634	7'998	2'535	24.1%	**10'533**	4.1%	
Gotthard	14'702	16'041	739	31'482	10'202	24.5%	**41'684**	16.1%	
San Bernardino	-	-	-	-	1'826	100.0%	**1'826**	0.7%	
F - I	5'122	5'994	699	11'815	34'223	74.3%	**46'038**	17.7%	0.11
Mont-Blanc	-	-	-	-	4'015	100.0%	**4'015**	1.5%	
MtCenis/Fréjus	5'078	4'910	699	10'688	12'972	54.8%	**23'659**	9.1%	
Montgenerve	-	-	-	-	264	100.0%	**264**	0.1%	
Ventimigla	43	1'084	-	1'127	16'972	93.8%	**18'099**	7.0%	
total	**35'625**	**64'303**	**8'111**	**108'039**	**151'541**	**58.4%**	**259'580**	100.0%	
share	13.7%	24.8%	3.1%	41.6%	58.4%		100.0%		

country / corridor	rail				road	share of road	total	share
	UCT	WL	RM	total				
A - I / SLO	9.0%	7.8%	17.4%	8.8%	-5.5%		**-0.8%**	
Reschen					-18.3%		**-18.3%**	
Brenner	10.9%	20.0%	24.5%	15.6%	-15.6%		**-5.8%**	
Felbertauern					-12.5%		**-12.5%**	
Tauern	9.7%	11.8%	16.4%	12.1%	-12.3%		**-1.1%**	
Schoberpass	4.0%	4.0%	6.3%	4.2%	6.3%		**5.6%**	
Semmering	3.1%	3.2%		3.2%	4.6%		**3.7%**	
Wechsel					5.5%		**5.5%**	
Tarvisio					-5.0%		**-5.0%**	
CH - I	7.6%	9.6%	16.2%	9.1%	-9.3%		**3.2%**	
Gr. St. Bernard					-11.4%		**-11.4%**	
Simplon	8.5%	10.9%	15.6%	10.9%	-13.7%		**3.8%**	
Gotthard	7.4%	9.3%	17.6%	8.6%	-8.0%		**4.0%**	
San Bernardino					-8.6%		**-8.6%**	
F - I	13.7%	16.3%		15.5%	-6.0%		**-1.3%**	
Mont-Blanc					-6.3%		**-6.3%**	
MtCenis/Fréjus	13.5%	14.3%	23.1%	14.4%	-8.5%		**0.6%**	
Montgenerve					-10.6%		**-10.6%**	
Ventimigla	44.9%	26.5%		27.1%	-3.9%		**-2.4%**	
total	**8.9%**	**9.1%**	**17.5%**	**9.6%**	**-6.0%**		**-0.1%**	
share	9.0%	9.1%	17.6%	9.7%	-5.9%			

Figure 12-25: AETS T 2020: Alpine crossing freight transport 2020 in Alpine arch C, in 1'000 tons/a and Δ to BAU 2020 in %

country / corridor	rail				road	share of road	total	share of total	AETS-price EUR/km
	UCT	WL	RM	total					
A - I / SLO	12'705	38'411	4'922	56'038	103'440	64.9%	**159'478**	61.4%	0.09
Reschen	-	-	-	-	1'549	100.0%	**1'549**	0.6%	
Brenner	8'270	5'279	2'160	15'708	26'464	62.8%	**42'172**	16.2%	
Felbertauern	-	-	-	-	930	100.0%	**930**	0.4%	
Tauern	1'575	10'766	1'709	14'050	13'378	48.8%	**27'427**	10.6%	
Schoberpass	1'352	7'215	1'054	9'622	19'901	67.4%	**29'523**	11.4%	
Semmering	1'508	15'151	-	16'659	8'016	32.5%	**24'675**	9.5%	
Wechsel	-	-	-	-	12'308	100.0%	**12'308**	4.7%	
Tarvisio	-	-	-	-	20'893	100.0%	**20'893**	8.0%	
CH - I	17'738	19'590	2'368	39'697	15'331	27.9%	**55'028**	21.2%	0.12
Gr. St. Bernard	-	-	-	-	869	100.0%	**869**	0.3%	
Simplon	2'985	3'464	1'633	8'082	2'580	24.2%	**10'661**	4.1%	
Gotthard	14'753	16'126	736	31'615	10'097	24.2%	**41'712**	16.1%	
San Bernardino	-	-	-	-	1'786	100.0%	**1'786**	0.7%	
F - I	5'341	6'329	747	12'418	32'656	72.5%	**45'073**	17.4%	0.16
Mont-Blanc	-	-	-	-	3'810	100.0%	**3'810**	1.5%	
MtCenis/Fréjus	5'291	5'139	747	11'177	12'182	52.2%	**23'359**	9.0%	
Montgenerve	-	-	-	-	248	100.0%	**248**	0.1%	
Ventimigla	50	1'191	-	1'240	16'416	93.0%	**17'656**	6.8%	
total	**35'784**	**64'331**	**8'038**	**108'153**	**151'426**	**58.3%**	**259'579**	100.0%	
share	13.8%	24.8%	3.1%	41.7%	58.3%		100.0%		

country / corridor	rail				road	share of road	total	share
	UCT	WL	RM	total				
A - I / SLO	7.8%	6.5%	14.7%	7.5%	-4.0%		**-0.3%**	
Reschen					-14.3%		**-14.3%**	
Brenner	9.4%	16.7%	20.8%	13.3%	-12.2%		**-4.2%**	
Felbertauern					-10.2%		**-10.2%**	
Tauern	8.2%	9.9%	13.7%	10.1%	-9.9%		**-0.6%**	
Schoberpass	3.4%	3.3%	5.4%	3.6%	5.3%		**4.8%**	
Semmering	2.7%	2.7%		2.7%	4.0%		**3.1%**	
Wechsel					4.6%		**4.6%**	
Tarvisio					-3.1%		**-3.1%**	
CH - I	8.1%	10.4%	16.0%	9.7%	-9.9%		**3.4%**	
Gr. St. Bernard					-11.5%		**-11.5%**	
Simplon	9.7%	12.6%	15.5%	12.1%	-12.2%		**5.0%**	
Gotthard	7.8%	9.9%	17.1%	9.1%	-8.9%		**4.1%**	
San Bernardino					-10.6%		**-10.6%**	
F - I	18.6%	22.8%		21.4%	-10.3%		**-3.4%**	
Mont-Blanc					-11.1%		**-11.1%**	
MtCenis/Fréjus	18.3%	19.6%	31.7%	19.7%	-14.1%		**-0.7%**	
Montgenerve					-16.0%		**-16.0%**	
Ventimigla	66.7%	39.0%		39.9%	-7.0%		**-4.8%**	
total	**9.4%**	**9.1%**	**16.5%**	**9.7%**	**-6.1%**		**-0.1%**	
share	9.5%	9.2%	16.6%	9.8%	-6.0%			

12.4.2 2030

Figure 12-26: Overview total transalpine freight transport volumes per country, in 1'000 tons/a

		road	Δ %	UCT	WL	RM	rail	Δ %
BAU2030 low	A - I / SLO	115'001		11'933	42'888	3'849	58'670	
	CH - I	17'623		12'460	18'054	738	31'252	
	F - I	34'026		5'182	5'341	871	11'394	
AETS ^{R} $_{2030\ lowA+CH+F}$	A - I / SLO	93'685	-18.5%	15'655	54'810	6'488	76'954	31.2%
	CH - I	11'070	-37.2%	16'421	24'568	1'385	42'374	35.6%
	F - I	24'870	-26.9%	7'820	8'818	1'899	18'538	62.7%
AETS ^{T} $_{2030\ lowA+CH+F}$	A - I / SLO	103'995	-9.6%	13'898	48'885	5'046	67'830	15.6%
	CH - I	14'317	-18.8%	14'581	21'436	1'013	37'031	18.5%
	F - I	29'792	-12.4%	6'480	6'949	1'280	14'709	29.1%
		road	**Δ %**	**UCT**	**WL**	**RM**	**rail**	**Δ %**
BAU2030 high	A - I / SLO	133'498		14'110	49'584	4'591	68'285	
	CH - I	20'781		14'784	21'298	889	36'971	
	F - I	40'795		6'218	6'407	1'044	13'670	
AETS ^{R} $_{2030\ highA+CH+F}$	A - I / SLO	101'850	-23.7%	19'602	67'449	8'838	95'889	40.4%
	CH - I	10'970	-47.2%	20'582	30'897	1'997	53'477	44.6%
	F - I	25'917	-36.5%	10'320	12'042	2'905	25'267	84.8%
AETS ^{T} $_{2030\ highA+CH+F}$	A - I / SLO	112'234	-15.9%	17'866	61'300	7'125	86'291	26.4%
	CH - I	14'457	-30.4%	18'780	27'717	1'500	47'996	29.8%
	F - I	31'896	-21.8%	8'841	9'789	1'991	20'621	50.8%
AETS ^{T} $_{2030\ high}$	A - I / SLO	114'639	-14.1%	17'863	61'060	7'101	86'024	26.0%
	CH - I	13'448	-35.3%	19'296	28'638	1'573	49'507	33.9%
	F - I	26'549	-34.9%	9'695	11'143	2'453	23'290	70.4%

Figure 12-27: AETS R 2030 low A+CH+F: Alpine crossing freight transport 2030 in Alpine arch C, in 1'000 tons/a and Δ to BAU 2030 low in %

country / corridor	rail UCT	rail WL	rail RM	rail total	road	share of road	total	share of total	AETS-price EUR/km
A - I / SLO	15'655	54'810	6'488	76'954	93'685	54.9%	**170'639**	63.8%	0.50
Reschen	-	-	-	-	648	100.0%	**648**	0.2%	
Brenner	10'122	9'344	3'272	22'738	13'184	36.7%	**35'921**	13.4%	
Felbertauern	-	-	-	-	578	100.0%	**578**	0.2%	
Tauern	2'093	16'276	1'792	20'160	8'366	29.3%	**28'526**	10.7%	
Schoberpass	1'581	9'378	1'425	12'384	27'337	68.8%	**39'722**	14.8%	
Semmering	1'859	19'813	-	21'672	10'849	33.4%	**32'520**	12.2%	
Wechsel	-	-	-	-	16'605	100.0%	**16'605**	6.2%	
Tarvisio	-	-	-	-	16'119	100.0%	**16'119**	6.0%	
CH - I	16'421	24'568	1'385	42'374	11'070	20.7%	**53'444**	20.0%	0.50
Gr. St. Bernard	-	-	-	-	581	100.0%	**581**	0.2%	
Simplon	2'772	4'441	1'009	8'222	1'448	15.0%	**9'670**	3.6%	
Gotthard	13'649	20'127	376	34'152	7'731	18.5%	**41'883**	15.7%	
San Bernardino	-	-	-	-	1'309	100.0%	**1'309**	0.5%	
F - I	7'820	8'818	1'899	18'538	24'870	57.3%	**43'407**	16.2%	0.50
Mont-Blanc	-	-	-	-	2'729	100.0%	**2'729**	1.0%	
MtCenis/Fréjus	7'726	7'201	1'899	16'826	8'518	33.6%	**25'344**	9.5%	
Montgenerve	-	-	-	-	146	100.0%	**146**	0.1%	
Ventimigla	93	1'618	-	1'711	13'478	88.7%	**15'189**	5.7%	
total	**39'896**	**88'196**	**9'773**	**137'865**	**129'625**	**48.5%**	**267'490**	100.0%	
share	14.9%	33.0%	3.7%	51.5%	48.5%		100.0%		

country / corridor	rail UCT	rail WL	rail RM	rail total	road	share of road	total	share
A - I / SLO	31.2%	27.8%	68.6%	31.2%	-18.5%		**-1.7%**	
Reschen					-62.1%		**-62.1%**	
Brenner	37.1%	63.1%	112.8%	55.2%	-54.8%		**-18.0%**	
Felbertauern					-47.2%		**-47.2%**	
Tauern	38.5%	46.1%	54.0%	45.9%	-49.7%		**-6.4%**	
Schoberpass	14.4%	13.6%	24.1%	14.8%	25.1%		**21.7%**	
Semmering	12.1%	11.5%		11.6%	18.2%		**13.7%**	
Wechsel					21.5%		**21.5%**	
Tarvisio					-25.7%		**-25.7%**	
CH - I	31.8%	36.1%	87.6%	35.6%	-37.2%		**9.3%**	
Gr. St. Bernard					-43.0%		**-43.0%**	
Simplon	36.1%	40.4%	82.3%	42.9%	-49.1%		**12.5%**	
Gotthard	30.9%	35.2%	103.3%	33.9%	-33.9%		**12.6%**	
San Bernardino					-36.5%		**-36.5%**	
F - I	50.9%	65.1%		62.7%	-26.9%		**-4.4%**	
Mont-Blanc					-29.6%		**-29.6%**	
MtCenis/Fréjus	50.0%	55.4%	118.2%	57.9%	-35.0%		**6.7%**	
Montgenerve					-41.8%		**-41.8%**	
Ventimigla	215.9%	129.2%		132.7%	-19.8%		**-13.4%**	
total	**34.9%**	**33.1%**	**79.1%**	**36.1%**	**-22.2%**		**-0.2%**	
share	35.1%	33.3%	79.4%	36.3%	-22.1%			

Figure 12-28: AETS T 2030 low A+CH+F: Alpine crossing freight transport 2030 in Alpine arch C, in 1'000 tons/a and Δ to BAU 2030 low in %

country / corridor	rail UCT	rail WL	rail RM	rail total	road	share of road	total	share of total	AETS-price EUR/km
A - I / SLO	13'898	48'885	5'046	67'830	103'995	60.5%	**171'825**	64.2%	0.22
Reschen	-	-	-	-	1'115	100.0%	**1'115**	0.4%	
Brenner	8'852	7'605	2'301	18'759	20'580	52.3%	**39'338**	14.7%	
Felbertauern	-	-	-	-	819	100.0%	**819**	0.3%	
Tauern	1'796	13'616	1'464	16'876	12'538	42.6%	**29'414**	11.0%	
Schoberpass	1'489	8'854	1'282	11'625	24'543	67.9%	**36'169**	13.5%	
Semmering	1'760	18'810	-	20'570	10'002	32.7%	**30'572**	11.4%	
Wechsel	-	-	-	-	15'098	100.0%	**15'098**	5.6%	
Tarvisio	-	-	-	-	19'300	100.0%	**19'300**	7.2%	
CH - I	14'581	21'436	1'013	37'031	14'317	27.9%	**51'348**	19.2%	0.22
Gr. St. Bernard	-	-	-	-	787	100.0%	**787**	0.3%	
Simplon	2'421	3'823	749	6'992	2'097	23.1%	**9'089**	3.4%	
Gotthard	12'161	17'613	264	30'038	9'737	24.5%	**39'776**	14.9%	
San Bernardino	-	-	-	-	1'696	100.0%	**1'696**	0.6%	
F - I	6'480	6'949	1'280	14'709	29'792	66.9%	**44'501**	16.6%	0.22
Mont-Blanc	-	-	-	-	3'350	100.0%	**3'350**	1.3%	
MtCenis/Fréjus	6'423	5'848	1'280	13'551	10'855	44.5%	**24'405**	9.1%	
Montgenerve	-	-	-	-	198	100.0%	**198**	0.1%	
Ventimigla	58	1'101	-	1'159	15'389	93.0%	**16'547**	6.2%	
total	**34'960**	**77'271**	**7'339**	**119'570**	**148'104**	**55.3%**	**267'673**	100.0%	
share	13.1%	28.9%	2.7%	44.7%	55.3%		100.0%		

country / corridor	rail UCT	rail WL	rail RM	rail total	road	share of road	total	share
A - I / SLO	16.5%	14.0%	31.1%	15.6%	-9.6%		**-1.1%**	
Reschen					-34.8%		**-34.8%**	
Brenner	19.9%	32.8%	49.7%	28.1%	-29.4%		**-10.2%**	
Felbertauern					-25.2%		**-25.2%**	
Tauern	18.8%	22.2%	25.8%	22.2%	-24.7%		**-3.4%**	
Schoberpass	7.8%	7.2%	11.6%	7.8%	12.3%		**10.8%**	
Semmering	6.2%	5.9%		5.9%	8.9%		**6.9%**	
Wechsel					10.5%		**10.5%**	
Tarvisio					-11.1%		**-11.1%**	
CH - I	17.0%	18.7%	37.2%	18.5%	-18.8%		**5.1%**	
Gr. St. Bernard					-22.8%		**-22.8%**	
Simplon	18.9%	20.8%	35.2%	21.5%	-26.3%		**5.7%**	
Gotthard	16.7%	18.3%	43.1%	17.8%	-16.7%		**6.9%**	
San Bernardino					-17.8%		**-17.8%**	
F - I	25.1%	30.1%		29.1%	-12.4%		**-2.0%**	
Mont-Blanc					-13.6%		**-13.6%**	
MtCenis/Fréjus	24.6%	26.2%	47.0%	27.1%	-17.1%		**2.7%**	
Montgenerve					-21.0%		**-21.0%**	
Ventimigla	95.7%	56.0%		57.6%	-8.4%		**-5.6%**	
total	**18.2%**	**16.6%**	**34.5%**	**18.0%**	**-11.1%**		**-0.1%**	
share	18.3%	16.7%	34.6%	18.1%	-11.0%			

Figure 12-29: AETS R 2030 high A+CH+F: Alpine crossing freight transport 2030 in Alpine arch C, in 1'000 tons/a and Δ to BAU 2030 high in %

country / corridor	rail				road	share of road	total	share of total	AETS-price EUR/km
	UCT	WL	RM	total					
A - I / SLO	19'602	67'449	8'838	95'889	101'850	51.5%	**197'739**	63.1%	0.70
Reschen	-	-	-	-	517	100.0%	**517**	0.2%	
Brenner	12'884	12'242	4'715	29'840	11'300	27.5%	**41'141**	13.1%	
Felbertauern	-	-	-	-	499	100.0%	**499**	0.2%	
Tauern	2'651	20'869	2'317	25'837	7'105	21.6%	**32'942**	10.5%	
Schoberpass	1'866	10'989	1'807	14'662	32'954	69.2%	**47'616**	15.2%	
Semmering	2'201	23'349	-	25'549	12'980	33.7%	**38'529**	12.3%	
Wechsel	-	-	-	-	19'883	100.0%	**19'883**	6.3%	
Tarvisio	-	-	-	-	16'611	100.0%	**16'611**	5.3%	
CH - I	20'582	30'897	1'997	53'477	10'970	17.0%	**64'446**	20.6%	0.70
Gr. St. Bernard	-	-	-	-	563	100.0%	**563**	0.2%	
Simplon	3'524	5'604	1'443	10'571	1'333	11.2%	**11'904**	3.8%	
Gotthard	17'058	25'294	554	42'906	7'791	15.4%	**50'697**	16.2%	
San Bernardino	-	-	-	-	1'283	100.0%	**1'283**	0.4%	
F - I	10'320	12'042	2'905	25'267	25'917	50.6%	**51'185**	16.3%	0.70
Mont-Blanc	-	-	-	-	2'789	100.0%	**2'789**	0.9%	
MtCenis/Fréjus	10'182	9'675	2'905	22'762	8'519	27.2%	**31'281**	10.0%	
Montgenerve	-	-	-	-	139	100.0%	**139**	0.0%	
Ventimigla	138	2'367	-	2'505	14'471	85.2%	**16'977**	5.4%	
total	**50'504**	**110'389**	**13'740**	**174'633**	**138'737**	**44.3%**	**313'370**	100.0%	
share	16.1%	35.2%	4.4%	55.7%	44.3%		100.0%		

country / corridor	rail				road	share of road	total	share
	UCT	WL	RM	total				
A - I / SLO	38.9%	36.0%	92.5%	40.4%	-23.7%		**-2.0%**	
Reschen					-74.6%		**-74.6%**	
Brenner	45.6%	78.4%	155.6%	70.0%	-67.4%		**-21.3%**	
Felbertauern					-59.2%		**-59.2%**	
Tauern	48.6%	59.0%	68.3%	58.6%	-62.8%		**-6.9%**	
Schoberpass	18.3%	17.5%	31.9%	19.2%	33.6%		**28.8%**	
Semmering	16.1%	15.3%		15.4%	24.7%		**18.4%**	
Wechsel					29.4%		**29.4%**	
Tarvisio					-36.1%		**-36.1%**	
CH - I	39.2%	45.1%	124.8%	44.6%	-47.2%		**11.6%**	
Gr. St. Bernard					-53.5%		**-53.5%**	
Simplon	45.2%	50.7%	117.0%	55.2%	-60.9%		**16.5%**	
Gotthard	38.0%	43.9%	147.9%	42.3%	-43.2%		**15.6%**	
San Bernardino					-47.6%		**-47.6%**	
F - I	66.0%	88.0%		84.8%	-36.5%		**-6.0%**	
Mont-Blanc					-40.0%		**-40.0%**	
MtCenis/Fréjus	64.7%	74.0%	178.2%	78.0%	-45.7%		**9.8%**	
Montgenerve					-54.0%		**-54.0%**	
Ventimigla	290.2%	179.9%		184.3%	-28.2%		**-19.3%**	
total	**43.8%**	**42.8%**	**110.6%**	**46.8%**	**-28.9%**		**-0.2%**	
share	44.1%	43.1%	111.0%	47.1%	-28.7%			

Figure 12-30: AETS T 2030 high A+CH+F: Alpine crossing freight transport 2030 in Alpine arch C, in 1'000 tons/a and Δ to BAU 2030 high in %

country / corridor	rail				road	share of road	total	share of total	AETS-price EUR/km
	UCT	WL	RM	total					
A - I / SLO	17'866	61'300	7'125	86'291	112'234	56.5%	**198'525**	63.3%	0.40
Reschen	-	-	-	-	937	100.0%	**937**	0.3%	
Brenner	11'651	10'508	3'506	25'666	18'466	41.8%	**44'131**	14.1%	
Felbertauern	-	-	-	-	722	100.0%	**722**	0.2%	
Tauern	2'343	18'046	1'977	22'365	11'266	33.5%	**33'632**	10.7%	
Schoberpass	1'777	10'469	1'642	13'888	29'908	68.3%	**43'796**	14.0%	
Semmering	2'095	22'278	-	24'373	12'043	33.1%	**36'416**	11.6%	
Wechsel	-	-	-	-	18'205	100.0%	**18'205**	5.8%	
Tarvisio	-	-	-	-	20'687	100.0%	**20'687**	6.6%	
CH - I	18'780	27'717	1'500	47'996	14'457	23.1%	**62'454**	19.9%	0.40
Gr. St. Bernard	-	-	-	-	775	100.0%	**775**	0.2%	
Simplon	3'166	4'971	1'097	9'234	1'985	17.7%	**11'219**	3.6%	
Gotthard	15'613	22'746	403	38'762	9'977	20.5%	**48'739**	15.5%	
San Bernardino	-	-	-	-	1'720	100.0%	**1'720**	0.5%	
F - I	8'841	9'789	1'991	20'621	31'896	60.7%	**52'517**	16.8%	0.40
Mont-Blanc	-	-	-	-	3'534	100.0%	**3'534**	1.1%	
MtCenis/Fréjus	8'744	8'073	1'991	18'808	11'164	37.2%	**29'973**	9.6%	
Montgenerve	-	-	-	-	196	100.0%	**196**	0.1%	
Ventimigla	97	1'715	-	1'812	17'001	90.4%	**18'813**	6.0%	
total	**45'487**	**98'806**	**10'615**	**154'908**	**158'587**	**50.6%**	**313'495**	100.0%	
share	14.5%	31.5%	3.4%	49.4%	50.6%		100.0%		

country / corridor	rail				road	share of road	total	share
	UCT	WL	RM	total				
A - I / SLO	26.6%	23.6%	55.2%	26.4%	-15.9%		**-1.6%**	
Reschen					-54.0%		**-54.0%**	
Brenner	31.6%	53.2%	90.1%	46.2%	-46.8%		**-15.6%**	
Felbertauern					-41.0%		**-41.0%**	
Tauern	31.3%	37.5%	43.6%	37.3%	-41.0%		**-4.9%**	
Schoberpass	12.6%	11.9%	19.8%	12.9%	21.2%		**18.5%**	
Semmering	10.5%	10.0%		10.1%	15.7%		**11.9%**	
Wechsel					18.4%		**18.4%**	
Tarvisio					-20.4%		**-20.4%**	
CH - I	27.0%	30.1%	68.8%	29.8%	-30.4%		**8.1%**	
Gr. St. Bernard					-36.1%		**-36.1%**	
Simplon	30.5%	33.7%	64.9%	35.6%	-41.8%		**9.8%**	
Gotthard	26.3%	29.4%	80.3%	28.5%	-27.2%		**11.1%**	
San Bernardino					-29.7%		**-29.7%**	
F - I	42.2%	52.8%		50.8%	-21.8%		**-3.6%**	
Mont-Blanc					-24.0%		**-24.0%**	
MtCenis/Fréjus	41.4%	45.2%	90.6%	47.1%	-28.9%		**5.2%**	
Montgenerve					-34.7%		**-34.7%**	
Ventimigla	173.6%	102.8%		105.6%	-15.6%		**-10.5%**	
total	**29.5%**	**27.8%**	**62.7%**	**30.3%**	**-18.7%**		**-0.2%**	
share	29.8%	28.0%	63.0%	30.5%	-18.6%			

Figure 12-31: AETS T 2030 high: Alpine crossing freight transport 2030 in Alpine arch C, in 1'000 tons/a and Δ to BAU 2030 high in %

country / corridor	rail				road	share of road	total	share of total	AETS-price EUR/km
	UCT	WL	RM	total					
A - I / SLO	17'863	61'060	7'101	86'024	114'639	57.1%	**200'664**	64.0%	0.38
Reschen	-	-	-	-	1'009	100.0%	**1'009**	0.3%	
Brenner	11'656	10'430	3'497	25'582	19'605	43.4%	**45'188**	14.4%	
Felbertauern	-	-	-	-	745	100.0%	**745**	0.2%	
Tauern	2'333	17'932	1'964	22'229	11'712	34.5%	**33'940**	10.8%	
Schoberpass	1'776	10'446	1'641	13'863	29'796	68.2%	**43'659**	13.9%	
Semmering	2'098	22'252	-	24'350	12'024	33.1%	**36'374**	11.6%	
Wechsel	-	-	-	-	18'139	100.0%	**18'139**	5.8%	
Tarvisio	-	-	-	-	21'609	100.0%	**21'609**	6.9%	
CH - I	19'296	28'638	1'573	49'507	13'448	21.4%	**62'955**	20.1%	0.48
Gr. St. Bernard	-	-	-	-	727	100.0%	**727**	0.2%	
Simplon	3'302	5'204	1'149	9'655	1'894	16.4%	**11'549**	3.7%	
Gotthard	15'994	23'434	424	39'852	9'283	18.9%	**49'135**	15.7%	
San Bernardino	-	-	-	-	1'544	100.0%	**1'544**	0.5%	
F - I	9'695	11'143	2'453	23'290	26'549	53.3%	**49'839**	15.9%	0.60
Mont-Blanc	-	-	-	-	2'861	100.0%	**2'861**	0.9%	
MtCenis/Fréjus	9'570	8'998	2'453	21'021	8'822	29.6%	**29'843**	9.5%	
Montgenerve	-	-	-	-	150	100.0%	**150**	0.0%	
Ventimigla	125	2'145	-	2'270	14'716	86.6%	**16'985**	5.4%	
total	**46'854**	**100'841**	**11'127**	**158'822**	**154'636**	**49.3%**	**313'458**	100.0%	
share	14.9%	32.2%	3.5%	50.7%	49.3%		100.0%		

country / corridor	rail				road	share of road	total	share
	UCT	WL	RM	total				
A - I / SLO	26.6%	23.1%	54.7%	26.0%	-14.1%		**-0.6%**	
Reschen					-50.4%		**-50.4%**	
Brenner	31.7%	52.0%	89.6%	45.7%	-43.5%		**-13.6%**	
Felbertauern					-39.1%		**-39.1%**	
Tauern	30.7%	36.6%	42.7%	36.5%	-38.6%		**-4.1%**	
Schoberpass	12.5%	11.7%	19.8%	12.7%	20.8%		**18.1%**	
Semmering	10.7%	9.9%		10.0%	15.5%		**11.7%**	
Wechsel					18.0%		**18.0%**	
Tarvisio					-16.8%		**-16.8%**	
CH - I	30.5%	34.5%	77.0%	33.9%	-35.3%		**9.0%**	
Gr. St. Bernard					-40.0%		**-40.0%**	
Simplon	36.1%	40.0%	72.7%	41.8%	-44.5%		**13.0%**	
Gotthard	29.4%	33.3%	89.7%	32.1%	-32.3%		**12.0%**	
San Bernardino					-36.9%		**-36.9%**	
F - I	55.9%	73.9%		70.4%	-34.9%		**-8.5%**	
Mont-Blanc					-38.5%		**-38.5%**	
MtCenis/Fréjus	54.8%	61.8%	134.9%	64.4%	-43.8%		**4.7%**	
Montgenerve					-50.1%		**-50.1%**	
Ventimigla	252.3%	153.6%		157.5%	-26.9%		**-19.2%**	
total	**33.4%**	**30.5%**	**70.6%**	**33.5%**	**-20.7%**		**-0.2%**	
share	33.7%	30.7%	70.9%	33.8%	-20.6%			

12.5 TOLL+

Figure 12-32: TOLL+ scenarios: Number of Lorries per country in transalpine freight transport for road and RM in Alpine arch C

road						
TOLL+ scenarios country	**BAU 2020**	**R 2020**	**BAU 2030 low**	**R 2030 low**	**BAU 2030 high**	**R 2030 high**
number of lorries						
A - I / SLO	8'485	7'359	9'055	7'126	10'512	7'817
CH - I	1'361	1'050	1'410	799	1'662	800
F - I	2'583	2'173	2'413	1'634	2'893	1'710
total	**12'429**	**10'582**	**12'878**	**9'559**	**15'067**	**10'328**
in % of the respective BAU scenario						
A - I / SLO	100%	87%	100%	79%	100%	74%
CH - I	100%	77%	100%	57%	100%	48%
F - I	100%	84%	100%	68%	100%	59%
total	**100%**	**85%**	**100%**	**74%**	**100%**	**69%**

rolling motorway						
TOLL+ scenarios country	**BAU 2020**	**R 2020**	**BAU 2030 low**	**R 2030 low**	**BAU 2030 high**	**R 2030 high**
number of lorries						
A - I / SLO	238	348	214	390	255	519
CH - I	113	163	41	85	49	120
F - I	32	53	48	121	58	180
total	**383**	**564**	**303**	**596**	**362**	**819**
in % of the respective BAU scenario						
A - I / SLO	100%	146%	100%	182%	100%	203%
CH - I	100%	144%	100%	208%	100%	243%
F - I	100%	168%	100%	250%	100%	310%
total	**100%**	**147%**	**100%**	**197%**	**100%**	**226%**

12.5.1 2020

Figure 12-33: Overview total transalpine freight transport volumes per country, in 1'000 tons/a

		road	Δ %	UCT	WL	RM	rail	Δ %
BAU 2020	A - I / SLO	107'763		11'789	36'052	4'290	52'132	
	CH - I	17'007		16'407	17'749	2'042	36'198	
	F - I	36'418		4'504	5'154	568	10'226	
TOLL+ $^{R}_{2020}$	A - I / SLO	93'453	-13.3%	14'299	43'040	6'260	63'599	22.0%
	CH - I	13'125	-22.8%	19'338	21'894	2'937	44'170	22.0%
	F - I	30'645	-15.9%	6'066	7'378	955	14'398	40.8%

Figure 12-34: TOLL+ R 2020: Alpine crossing freight transport 2020 in Alpine arch C, in 1'000 tons/a and Δ to BAU 2020 in %

country / corridor	rail				road	share of road	total	share of total	TOLL+ price EUR/km
	UCT	WL	RM	total					
A - I / SLO	14'299	43'040	6'260	63'599	93'453	59.5%	**157'052**	60.5%	0.29
Reschen	-	-	-	-	1'044	100.0%	**1'044**	0.4%	
Brenner	9'481	6'745	2'983	19'209	18'994	49.7%	**38'203**	14.7%	
Felbertauern	-	-	-	-	725	100.0%	**725**	0.3%	
Tauern	1'811	12'759	2'117	16'688	10'260	38.1%	**26'948**	10.4%	
Schoberpass	1'429	7'636	1'160	10'225	21'901	68.2%	**32'126**	12.4%	
Semmering	1'578	15'899	-	17'477	8'605	33.0%	**26'082**	10.1%	
Wechsel	-	-	-	-	13'385	100.0%	**13'385**	5.2%	
Tarvisio	-	-	-	-	18'540	100.0%	**18'540**	7.1%	
CH - I	19'338	21'894	2'937	44'170	13'125	22.9%	**57'295**	22.1%	0.29
Gr. St. Bernard	-	-	-	-	716	100.0%	**716**	0.3%	
Simplon	3'276	3'903	2'009	9'187	1'990	17.8%	**11'177**	4.3%	
Gotthard	16'063	17'992	928	34'982	8'858	20.2%	**43'840**	16.9%	
San Bernardino	-	-	-	-	1'561	100.0%	**1'561**	0.6%	
F - I	6'066	7'378	955	14'398	30'645	68.0%	**45'043**	17.4%	0.29
Mont-Blanc	-	-	-	-	3'565	100.0%	**3'565**	1.4%	
MtCenis/Fréjus	5'998	5'887	955	12'839	11'123	46.4%	**23'962**	9.2%	
Montgenerve	-	-	-	-	219	100.0%	**219**	0.1%	
Ventimigla	68	1'491	-	1'559	15'738	91.0%	**17'297**	6.7%	
total	**39'703**	**72'312**	**10'151**	**122'166**	**137'223**	**52.9%**	**259'390**	100.0%	
share	15.3%	27.9%	3.9%	47.1%	52.9%		100.0%		

country / corridor	rail				road	share of road	total	share
	UCT	WL	RM	total				
A - I / SLO	21.3%	19.4%	45.9%	22.0%	-13.3%		**-1.8%**	
Reschen					-42.3%		**-42.3%**	
Brenner	25.4%	49.1%	66.8%	38.5%	-37.0%		**-13.2%**	
Felbertauern					-30.0%		**-30.0%**	
Tauern	24.5%	30.2%	40.9%	30.8%	-30.9%		**-2.4%**	
Schoberpass	9.3%	9.4%	16.1%	10.1%	15.9%		**14.0%**	
Semmering	7.5%	7.8%		7.8%	11.6%		**9.0%**	
Wechsel					13.7%		**13.7%**	
Tarvisio					-14.0%		**-14.0%**	
CH - I	17.9%	23.4%	43.8%	22.0%	-22.8%		**7.7%**	
Gr. St. Bernard					-27.0%		**-27.0%**	
Simplon	20.4%	26.9%	42.1%	27.4%	-32.3%		**10.1%**	
Gotthard	17.4%	22.6%	47.7%	20.7%	-20.1%		**9.4%**	
San Bernardino					-21.9%		**-21.9%**	
F - I	34.7%	43.1%		40.8%	-15.9%		**-3.4%**	
Mont-Blanc					-16.8%		**-16.8%**	
MtCenis/Fréjus	34.1%	37.0%	68.2%	37.5%	-21.6%		**1.9%**	
Montgenerve					-25.9%		**-25.9%**	
Ventimigla	127.1%	74.0%		75.8%	-10.9%		**-6.7%**	
total	**21.4%**	**22.7%**	**47.1%**	**24.0%**	**-14.9%**		**-0.1%**	
share	21.6%	22.8%	47.3%	24.1%	-14.8%			

12.5.2 2030

Figure 12-35: Overview total transalpine freight transport volumes per country, in 1'000 tons/a

		road	Δ %	UCT	WL	RM	rail	Δ %
BAU 2030 low	A - I / SLO	115'001		11'933	42'888	3'849	58'670	
	CH - I	17'623		12'460	18'054	738	31'252	
	F - I	34'026		5'182	5'341	871	11'394	
TOLL+ [R] 2030 low	A - I / SLO	90'496	-21.3%	16'186	56'717	7'013	79'917	36.2%
	CH - I	9'990	-43.3%	16'967	25'547	1'537	44'051	41.0%
	F - I	23'043	-32.3%	8'269	9'507	2'180	19'956	75.2%
		road	**Δ %**	**UCT**	**WL**	**RM**	**rail**	**Δ %**
BAU 2030 high	A - I / SLO	133'498		14'110	49'584	4'591	68'285	
	CH - I	20'781		14'784	21'298	889	36'971	
	F - I	40'795		6'218	6'407	1'044	13'670	
TOLL+ [R] 2030 high	A - I / SLO	99'275	-25.6%	20'024	69'030	9'341	98'396	44.1%
	CH - I	10'005	-51.9%	21'022	31'711	2'160	54'894	48.5%
	F - I	24'116	-40.9%	10'719	12'710	3'240	26'670	95.1%

Figure 12-36: TOLL+ R 2030 low: Alpine crossing freight transport 2030 in Alpine arch C, in 1'000 tons/a and Δ to BAU 2030 low in %

country / corridor	rail				road	share of road	total	share of total	TOLL+ price EUR/km
	UCT	WL	RM	total					
A - I / SLO	16'186	56'717	7'013	79'917	90'496	53.1%	**170'412**	63.7%	0.61
Reschen	-	-	-	-	521	100.0%	**521**	0.2%	
Brenner	10'496	9'871	3'641	24'007	11'012	31.4%	**35'020**	13.1%	
Felbertauern	-	-	-	-	507	100.0%	**507**	0.2%	
Tauern	2'191	17'168	1'897	21'256	7'032	24.9%	**28'288**	10.6%	
Schoberpass	1'608	9'538	1'475	12'621	28'293	69.2%	**40'915**	15.3%	
Semmering	1'891	20'141	-	22'032	11'136	33.6%	**33'168**	12.4%	
Wechsel	-	-	-	-	17'127	100.0%	**17'127**	6.4%	
Tarvisio	-	-	-	-	14'868	100.0%	**14'868**	5.6%	
CH - I	16'967	25'547	1'537	44'051	9'990	18.5%	**54'041**	20.2%	0.61
Gr. St. Bernard	-	-	-	-	517	100.0%	**517**	0.2%	
Simplon	2'880	4'636	1'115	8'632	1'252	12.7%	**9'883**	3.7%	
Gotthard	14'087	20'910	422	35'420	7'048	16.6%	**42'467**	15.9%	
San Bernardino	-	-	-	-	1'174	100.0%	**1'174**	0.4%	
F - I	8'269	9'507	2'180	19'956	23'043	53.6%	**43'000**	16.1%	0.61
Mont-Blanc	-	-	-	-	2'501	100.0%	**2'501**	0.9%	
MtCenis/Fréjus	8'163	7'689	2'180	18'032	7'713	30.0%	**25'745**	9.6%	
Montgenerve	-	-	-	-	128	100.0%	**128**	0.0%	
Ventimigla	106	1'818	-	1'924	12'701	86.8%	**14'625**	5.5%	
total	**41'422**	**91'771**	**10'731**	**143'924**	**123'529**	**46.2%**	**267'454**	100.0%	
share	15.5%	34.3%	4.0%	53.8%	46.2%		100.0%		

country / corridor	rail				road	share of road	total	share
	UCT	WL	RM	total				
A - I / SLO	35.6%	32.2%	82.2%	36.2%	-21.3%		**-1.9%**	
Reschen					-69.6%		**-69.6%**	
Brenner	42.2%	72.3%	136.9%	63.9%	-62.2%		**-20.0%**	
Felbertauern					-53.7%		**-53.7%**	
Tauern	45.0%	54.1%	63.0%	53.9%	-57.8%		**-7.1%**	
Schoberpass	16.4%	15.5%	28.5%	17.0%	29.5%		**25.4%**	
Semmering	14.0%	13.4%		13.4%	21.3%		**16.0%**	
Wechsel					25.3%		**25.3%**	
Tarvisio					-31.5%		**-31.5%**	
CH - I	36.2%	41.5%	108.2%	41.0%	-43.3%		**10.6%**	
Gr. St. Bernard					-49.3%		**-49.3%**	
Simplon	41.4%	46.5%	101.5%	50.0%	-56.0%		**14.9%**	
Gotthard	35.1%	40.4%	128.3%	38.9%	-39.7%		**14.2%**	
San Bernardino					-43.1%		**-43.1%**	
F - I	59.6%	78.0%		75.2%	-32.3%		**-5.3%**	
Mont-Blanc					-35.5%		**-35.5%**	
MtCenis/Fréjus	58.4%	65.9%	150.5%	69.2%	-41.1%		**8.4%**	
Montgenerve					-48.8%		**-48.8%**	
Ventimigla	258.8%	157.6%		161.7%	-24.4%		**-16.6%**	
total	**40.1%**	**38.5%**	**96.6%**	**42.1%**	**-25.9%**		**-0.2%**	
share	40.3%	38.7%	97.0%	42.3%	-25.7%			

Figure 12-37: TOLL+ R 2030 high: Alpine crossing freight transport 2030 in Alpine arch C, in 1'000 tons/a and Δ to BAU 2030 high in %

country / corridor	rail				road	share of road	total	share of total	TOLL+ price EUR/km
	UCT	WL	RM	total					
A - I / SLO	20'024	69'030	9'341	98'396	99'275	50.2%	**197'671**	63.1%	0.80
Reschen	-	-	-	-	426	100.0%	**426**	0.1%	
Brenner	13'177	12'664	5'079	30'919	9'605	23.7%	**40'524**	12.9%	
Felbertauern	-	-	-	-	445	100.0%	**445**	0.1%	
Tauern	2'729	21'608	2'408	26'745	6'078	18.5%	**32'823**	10.5%	
Schoberpass	1'888	11'123	1'855	14'866	33'793	69.4%	**48'659**	15.5%	
Semmering	2'230	23'636	-	25'866	13'240	33.9%	**39'107**	12.5%	
Wechsel	-	-	-	-	20'358	100.0%	**20'358**	6.5%	
Tarvisio	-	-	-	-	15'330	100.0%	**15'330**	4.9%	
CH - I	21'022	31'711	2'160	54'894	10'005	15.4%	**64'899**	20.7%	0.80
Gr. St. Bernard	-	-	-	-	507	100.0%	**507**	0.2%	
Simplon	3'615	5'768	1'557	10'939	1'169	9.7%	**12'108**	3.9%	
Gotthard	17'407	25'944	604	43'955	7'170	14.0%	**51'125**	16.3%	
San Bernardino	-	-	-	-	1'158	100.0%	**1'158**	0.4%	
F - I	10'719	12'710	3'240	26'670	24'116	47.5%	**50'786**	16.2%	0.80
Mont-Blanc	-	-	-	-	2'569	100.0%	**2'569**	0.8%	
MtCenis/Fréjus	10'570	10'146	3'240	23'956	7'777	24.5%	**31'733**	10.1%	
Montgenerve	-	-	-	-	123	100.0%	**123**	0.0%	
Ventimigla	150	2'564	-	2'714	13'648	83.4%	**16'362**	5.2%	
total	**51'766**	**113'452**	**14'742**	**179'959**	**133'397**	**42.6%**	**313'356**	100.0%	
share	16.5%	36.2%	4.7%	57.4%	42.6%		100.0%		

country / corridor	rail				road	share of road	total	share
	UCT	WL	RM	total				
A - I / SLO	41.9%	39.2%	103.5%	44.1%	-25.6%		**-2.0%**	
Reschen					-79.1%		**-79.1%**	
Brenner	48.9%	84.6%	175.3%	76.1%	-72.3%		**-22.5%**	
Felbertauern					-63.6%		**-63.6%**	
Tauern	52.9%	64.6%	74.9%	64.2%	-68.2%		**-7.2%**	
Schoberpass	19.7%	18.9%	35.4%	20.9%	37.0%		**31.6%**	
Semmering	17.6%	16.7%		16.8%	27.2%		**20.1%**	
Wechsel					32.4%		**32.4%**	
Tarvisio					-41.0%		**-41.0%**	
CH - I	42.2%	48.9%	143.1%	48.5%	-51.9%		**12.4%**	
Gr. St. Bernard					-58.2%		**-58.2%**	
Simplon	49.0%	55.1%	134.0%	60.6%	-65.7%		**18.5%**	
Gotthard	40.9%	47.6%	170.1%	45.7%	-47.7%		**16.5%**	
San Bernardino					-52.7%		**-52.7%**	
F - I	72.4%	98.4%		95.1%	-40.9%		**-6.8%**	
Mont-Blanc					-44.7%		**-44.7%**	
MtCenis/Fréjus	70.9%	82.4%	210.3%	87.3%	-50.5%		**11.4%**	
Montgenerve					-59.2%		**-59.2%**	
Ventimigla	322.6%	203.1%		207.9%	-32.2%		**-22.2%**	
total	**47.4%**	**46.8%**	**126.0%**	**51.3%**	**-31.6%**		**-0.2%**	
share	47.7%	47.1%	126.4%	51.6%	-31.5%			

12.6 MIX

Figure 12-38: MIX scenarios: Number of Lorries per country in transalpine freight transport for road and RM in Alpine arch C

road				
MIX scenarios country	BAU 2020	T 2020	BAU 2030 high	T 2030 high
number of lorries				
A - I / SLO	8'485	8'119	10'512	9'232
CH - I	1'361	905	1'662	893
F - I	2'583	2'380	2'893	1'880
total	**12'429**	**11'404**	**15'067**	**12'006**
in % of the respective BAU scenario				
A - I / SLO	100%	96%	100%	88%
CH - I	100%	66%	100%	54%
F - I	100%	92%	100%	65%
total	**100%**	**92%**	**100%**	**80%**

rolling motorway				
MIX scenarios country	BAU 2020	T 2020	BAU 2030 high	T 2030 high
number of lorries				
A - I / SLO	238	284	255	384
CH - I	113	141	49	87
F - I	32	43	58	137
total	**383**	**468**	**362**	**608**
in % of the respective BAU scenario				
A - I / SLO	100%	119%	100%	151%
CH - I	100%	124%	100%	177%
F - I	100%	137%	100%	236%
total	**100%**	**122%**	**100%**	**168%**

12.6.1 2020

Figure 12-39: Overview total transalpine freight transport volumes per country, in 1'000 tons/a

		road	Δ %	UCT	WL	RM	rail	Δ %
BAU 2020	A - I / SLO	107'763		11'789	36'052	4'290	52'132	
	CH - I	17'007		16'407	17'749	2'042	36'198	
	F - I	36'418		4'504	5'154	568	10'226	
MIX $^{T}_{2020}$	A - I / SLO	103'108	-4.3%	12'955	39'005	5'106	57'065	9.5%
	CH - I	11'675	-31.3%	18'328	20'636	2'540	41'504	14.7%
	F - I	33'564	-7.8%	5'430	6'421	779	12'629	23.5%

Figure 12-40: MIX T 2020: Alpine crossing freight transport 2020 in Alpine arch C, in 1'000 tons/a and Δ to BAU 2020 in %

country / corridor	rail				road	share of road	total	share of total	price EUR/km; EUR/trip
	UCT	WL	RM	total					
A - I / SLO	12'955	39'005	5'106	57'065	103'108	64.4%	**160'173**	61.7%	0.11
Reschen	-	-	-	-	1'528	100.0%	**1'528**	0.6%	
Brenner	8'472	5'474	2'279	16'225	26'086	61.7%	**42'311**	16.3%	
Felbertauern	-	-	-	-	911	100.0%	**911**	0.4%	
Tauern	1'604	11'014	1'758	14'376	13'112	47.7%	**27'488**	10.6%	
Schoberpass	1'362	7'269	1'069	9'699	20'150	67.5%	**29'849**	11.5%	
Semmering	1'517	15'248	-	16'765	8'093	32.6%	**24'858**	9.6%	
Wechsel	-	-	-	-	12'438	100.0%	**12'438**	4.8%	
Tarvisio	-	-	-	-	20'791	100.0%	**20'791**	8.0%	
CH - I	18'328	20'636	2'540	41'504	11'675	22.0%	**53'180**	20.5%	81
Gr. St. Bernard	-	-	-	-	663	100.0%	**663**	0.3%	
Simplon	3'083	3'654	1'744	8'481	2'039	19.4%	**10'520**	4.1%	
Gotthard	15'245	16'981	796	33'023	7'622	18.8%	**40'645**	15.7%	
San Bernardino	-	-	-	-	1'351	100.0%	**1'351**	0.5%	
F - I	5'430	6'421	779	12'629	33'564	72.7%	**46'193**	17.8%	0.16
Mont-Blanc	-	-	-	-	3'968	100.0%	**3'968**	1.5%	
MtCenis/Fréjus	5'380	5'226	779	11'385	12'644	52.6%	**24'028**	9.3%	
Montgenerve	-	-	-	-	253	100.0%	**253**	0.1%	
Ventimigla	50	1'195	-	1'244	16'698	93.1%	**17'943**	6.9%	
total	**36'712**	**66'061**	**8'425**	**111'198**	**148'347**	**57.2%**	**259'545**	100.0%	
share	14.1%	25.5%	3.2%	42.8%	57.2%		100.0%		

country / corridor	rail				road	share of road	total	share
	UCT	WL	RM	total				
A - I / SLO	9.9%	8.2%	19.0%	9.5%	-4.3%		**0.2%**	
Reschen					-15.5%		**-15.5%**	
Brenner	12.1%	21.0%	27.4%	17.0%	-13.4%		**-3.8%**	
Felbertauern					-12.0%		**-12.0%**	
Tauern	10.2%	12.4%	17.0%	12.7%	-11.7%		**-0.4%**	
Schoberpass	4.1%	4.1%	6.9%	4.4%	6.6%		**5.9%**	
Semmering	3.3%	3.4%		3.4%	4.9%		**3.9%**	
Wechsel					5.7%		**5.7%**	
Tarvisio					-3.6%		**-3.6%**	
CH - I	11.7%	16.3%	24.4%	14.7%	-31.3%		**0.0%**	
Gr. St. Bernard					-32.4%		**-32.4%**	
Simplon	13.3%	18.8%	23.3%	17.6%	-30.6%		**3.6%**	
Gotthard	11.4%	15.7%	26.8%	13.9%	-31.3%		**1.4%**	
San Bernardino					-32.4%		**-32.4%**	
F - I	20.5%	24.6%		23.5%	-7.8%		**-1.0%**	
Mont-Blanc					-7.4%		**-7.4%**	
MtCenis/Fréjus	20.2%	21.6%	37.2%	21.9%	-10.8%		**2.2%**	
Montgenerve					-14.2%		**-14.2%**	
Ventimigla	67.1%	39.4%		40.4%	-5.4%		**-3.2%**	
total	**12.3%**	**12.1%**	**22.1%**	**12.8%**	**-8.0%**		**-0.1%**	
share	12.4%	12.1%	22.2%	12.9%	-7.9%			

12.6.2 2030

Figure 12-41: Overview total transalpine freight transport volumes per country, in 1'000 tons/a

		road	Δ %	UCT	WL	RM	rail	Δ %
BAU 2030 high	A - I / SLO	133'498		14'110	49'584	4'591	68'285	
	CH - I	20'781		14'784	21'298	889	36'971	
	F - I	40'795		6'218	6'407	1'044	13'670	
MIX ^{T} 2030 high	A - I / SLO	117'249	-12.2%	17'644	60'185	6'914	84'744	24.1%
	CH - I	11'880	-42.8%	19'345	28'863	1'573	49'782	34.7%
	F - I	26'513	-35.0%	9'700	11'144	2'459	23'304	70.5%

Figure 12-42: MIX T 2030 high: Alpine crossing freight transport 2030 in Alpine arch C, in 1'000 tons/a and Δ to BAU 2030 high in %

country / corridor	rail				road	share of road	total	share of total	price EUR/ km; EUR/trip
	UCT	WL	RM	total					
A - I / SLO	17'644	60'185	6'914	84'744	117'249	58.0%	**201'992**	64.4%	0.34
Reschen	-	-	-	-	1'118	100.0%	**1'118**	0.4%	
Brenner	11'507	10'180	3'377	25'065	21'278	45.9%	**46'343**	14.8%	
Felbertauern	-	-	-	-	788	100.0%	**788**	0.3%	
Tauern	2'290	17'535	1'915	21'740	12'474	36.5%	**34'214**	10.9%	
Schoberpass	1'762	10'365	1'622	13'750	29'383	68.1%	**43'133**	13.8%	
Semmering	2'085	22'105	-	24'189	11'902	33.0%	**36'091**	11.5%	
Wechsel	-	-	-	-	17'910	100.0%	**17'910**	5.7%	
Tarvisio	-	-	-	-	22'396	100.0%	**22'396**	7.1%	
CH - I	19'345	28'863	1'573	49'782	11'880	19.3%	**61'662**	19.7%	160
Gr. St. Bernard	-	-	-	-	702	100.0%	**702**	0.2%	
Simplon	3'311	5'247	1'147	9'705	2'196	18.5%	**11'901**	3.8%	
Gotthard	16'034	23'617	426	40'077	7'642	16.0%	**47'719**	15.2%	
San Bernardino	-	-	-	-	1'340	100.0%	**1'340**	0.4%	
F - I	9'700	11'144	2'459	23'304	26'513	53.2%	**49'817**	15.9%	0.60
Mont-Blanc	-	-	-	-	2'874	100.0%	**2'874**	0.9%	
MtCenis/Fréjus	9'576	9'003	2'459	21'038	8'834	29.6%	**29'872**	9.5%	
Montgenerve	-	-	-	-	150	100.0%	**150**	0.0%	
Ventimigla	124	2'141	-	2'266	14'655	86.6%	**16'921**	5.4%	
total	**46'690**	**100'193**	**10'947**	**157'829**	**155'642**	**49.7%**	**313'472**	100.0%	
share	14.9%	32.0%	3.5%	50.3%	49.7%		100.0%		

country / corridor	rail				road	share of road	total	share
	UCT	WL	RM	total				
A - I / SLO	25.1%	21.4%	50.6%	24.1%	-12.2%		**0.1%**	
Reschen					-45.1%		**-45.1%**	
Brenner	30.0%	48.4%	83.1%	42.8%	-38.7%		**-11.3%**	
Felbertauern					-35.5%		**-35.5%**	
Tauern	28.3%	33.6%	39.1%	33.5%	-34.7%		**-3.3%**	
Schoberpass	11.7%	10.8%	18.4%	11.8%	19.1%		**16.7%**	
Semmering	10.0%	9.2%		9.2%	14.3%		**10.9%**	
Wechsel					16.5%		**16.5%**	
Tarvisio					-13.8%		**-13.8%**	
CH - I	30.8%	35.5%	77.1%	34.7%	-42.8%		**6.8%**	
Gr. St. Bernard					-42.1%		**-42.1%**	
Simplon	36.5%	41.1%	72.5%	42.5%	-35.6%		**16.4%**	
Gotthard	29.7%	34.3%	90.6%	32.9%	-44.3%		**8.8%**	
San Bernardino					-45.3%		**-45.3%**	
F - I	56.0%	73.9%		70.5%	-35.0%		**-8.5%**	
Mont-Blanc					-38.2%		**-38.2%**	
MtCenis/Fréjus	54.9%	61.9%	135.5%	64.5%	-43.7%		**4.9%**	
Montgenerve					-50.1%		**-50.1%**	
Ventimigla	251.8%	153.1%		157.1%	-27.2%		**-19.5%**	
total	**33.0%**	**29.6%**	**67.8%**	**32.7%**	**-20.2%**		**-0.2%**	
share	33.2%	29.9%	68.1%	32.9%	-20.1%			

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14 Abbreviations

ACE	Alpine Crossing Exchange
A – I/SLO	Austria – Italy / Slovenia, transalpine corridors between Austria and Italy / Slovenia
ACU	Alpine Crossing Unit
ACP	Alpine Crossing Permit
AETS	Alpine Emission Trading System
BBT	Brenner base Tunnel
CEN	Comité Européen de Normalisation, European Committee for Standardisation
DSRC	Dedicated Short Range Communication
EETS	European Electronic Toll Service
EFC	Electronic Fee Collection
EMC	Emission Certificate
F – I	France – Italy, transalpine corridors between France and Italy
GBT	Gotthard base tunnel
GPS	Global Positioning System
GVW	Gross Vehicle Weight
HGV	Heavy Goods Vehicle
LBT	Lötschberg base tunnel
LSVA	Leistungsabhängige Schwerverkehrsabgabe (Swiss Heavy Vehicles Fee)
LT	Local Traffic
MCBT	Mont Cenis base tunnel
OBU	On-Board Unit
OTC	Over-the-counter (market)
CH – I	Switzerland – Italy, transalpine corridors between Switzerland and Italy
SDT	Short Distance Traffic
TPLN	Taxe Poids Lourds Nationale (French Heavy Vehicles Fee)