Modal Shift Policy in Switzerland

Fact sheet

for:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)

On behalf of:

Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

of the Federal Republic of Germany

European
Climate Initiative
EUKI

by:
Ecofys: Korinna Jörling

03 September 2018

The project Bridging European and Local Climate Action is financed by the European Climate Initiative (EUKI). EUKI is a project financing instrument by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). It is the overarching goal of the EUKI to foster climate cooperation within the European Union in order to mitigate greenhouse gas emissions. It does so through strengthening cross-border dialogue and cooperation as well as exchange of knowledge and experience.

This study is based on a policy paper with an overview of greenhouse gas emission reductions and policy instruments in non-ETS sectors across Europe (hereafter referred to as 'Policy Paper'). The Policy Paper can be downloaded from the EUKI website.

ABBREVIATIONS

ASTRA	Federal Office for streets (‘Bundesamt für Straßen’)
BAV	Federal Office of Transport (‘Bundesamt für Verkehr’)
BIF	Railway infrastructure fund (‘Bahninfrastrukturfonds’)
CHF	Swiss francs
CO_2e	Carbon dioxide equivalent
EU	European Union
EUR	Euro
EV	Electric vehicle
g	Grams
GHG	Greenhouse gas
LULUCF	Land use, land-use change and forestry
LSVA	Duty on heavy-duty transport (‘Leistungsabhängige Schwerverkehrsabgabe’)
NDC	Nationally determined contribution
NIMBY	Not In My Back Yard
NRLA	New Railway Link through the Alps
Rp	Centime
TJ	Terajoule
tkm	Tonne-kilometre
UNFCCC	The United Nations Framework Convention on Climate Change
UVEK	Federal Department of the Environment, Transport, Energy and Communications (‘Eidgenössisches Departement für Umwelt, Verkehr, Energie und Kommunikation’)
USD	United States Dollar
VAT	Value added tax
ZEB	Programme on the future development of the railway infrastructure (‘Zukünftige Entwicklung der Bahninfrastruktur’)

TABLE OF CONTENTS

1 Summary **1**

2 Introduction to the instrument **2**

3 National context **3**

3.1 National climate policy 3
3.2 Sector context 4

4 General description of the policy instrument **7**

4.1 Functioning 7
4.2 History and legal basis 9
4.3 Interlinkages with other policy instruments 10

5 Impacts of the policy instrument **11**

5.1 Effectiveness 11
5.2 Cost efficiency 13
5.3 Co-benefits and side-effects 13
5.4 Success factors and challenges 14

6 Transferability **15**

6.1 General comparability of the context 15
6.2 Properties of the instrument 17
6.3 Potential impacts 20
6.4 Conclusion 21

7 References **23**

1 SUMMARY

The Swiss modal shift policy is an ambitious policy package designed to shift freight transport from roadways to railways[1]. The modal shift policy has been advocated in both Germany and Switzerland by representatives from a wide political spectrum, but the appropriate policies to achieve this target were never enacted in Germany in a manner similar to Switzerland.

While Switzerland has achieved a large share of railway transport in overall freight transport with 39% of tonne-kilometres (tkm) in 2016, the share in Germany is lower at 17% (2017) and decreasing. Given increasing international freight transport volumes and urgent emission reduction requirements, the Swiss modal shift policy may represent an example for Germany.

The Swiss modal shift policy will most likely not achieve its key target of limiting the number of transalpine heavy-duty vehicle crossings to 650,000 in the two years after the opening of the Gotthard tunnel, ergo in 2018. Nevertheless, the policy package has effectively limited road transport and shifted freight volumes to railway. It is estimated that in the absence of the policy 651,000 additional trucks would have passed through the Alps in 2016. In terms of CO_2 reductions, at least 0.7 million tCO_2 were saved in 2017. In the German context, freight trains only require about 20% of the energy and emit around 25% of greenhouse gases per tkm compared to heavy-duty vehicles. Therefore, the emission reduction potential of shifting freight transport from roadways to railways is large. Besides CO_2e emission savings, railway transport has a range of benefits, including lower external costs in terms of noise, landscape and health impacts, as well as reliability and speed. These factors represent strong arguments in the attempt to achieve a commitment to a comprehensive modal shift policy in Germany.

The most striking difference between the German and Swiss railway extension regimes lies in the investment volumes dedicated to road and railway transport, with Switzerland investing 60% of federal infrastructure investments in railway infrastructure in 2016 in contrast to only 47% in Germany. While Switzerland uses revenues from its levy on heavy-duty vehicles to finance railway infrastructure, Germany has explicitly decided against such a cross-financing mechanism. Further, Switzerland has implemented effective planning processes for infrastructure extension and introduced highly efficient railway timetables. Besides limited investment volumes, challenges to transfer the policy package to Germany include that policies must be in line with EU regulation and that political commitment to the shift has not been sufficient in the past. However, these challenges do not represent an impediment to Germany learning from the Swiss example. Public acceptance is rather high, with 90% of citizens in favour of shifting freight transport from the street to the railway network and extending the public transport network.

In conclusion, the shift to railway transport is an important element of meeting the necessary sector emission reductions and has extensive co-benefits. With regard to the Swiss example, especially the planning processes and financing mechanisms can be a source of inspiration to Germany. A shift to railway is conditional on a substantial extension of the railway network on the one hand, as well as sufficient incentives for logistics companies to choose railway over road transport on the other hand.

[1] We thank Mathias Wagner (Swiss Federal Office for Transport, BAV), Erhard Michel and Markus Ksoll (Deutsche Bahn AG) for insights shared during expert interviews on 13 June 2018 and 19 June 2018.

2 INTRODUCTION TO THE INSTRUMENT

The Swiss modal shift policy ('Verlagerungspolitik') emerged in the 1990s. It is designed to limit freight transport through the Alps and shift it from road to railway transport. The policy package is based on two main pillars: to enable the shift to railway transport and to disincentivise road transport.

The first pillar involves the construction of new railway routes, with the New Railway Link through the Alps (NRLA) ('Neue Eisenbahn-Alpentransversale', NEAT) being the most prominent recent project, and the reconstruction of existing routes, including preparing routes for trains of up to four metres in height. It also includes the financial support of transshipment terminals both nationally and in neighbouring countries.

The second pillar comprises a duty for heavy-duty transport calculated with distance travelled, weight, and emissions ('Leistungsabhängige Schwerverkehrsabgabe', LSVA), as well as a travel ban for trucks at night. In addition, the capacity of transit roads is not extended anymore, and controls of freight transport have been tightened.

3 NATIONAL CONTEXT

3.1 National climate policy

Total annual greenhouse gas (GHG) emissions in Switzerland amount to 48.3 million tonnes CO_2 equivalents ($MtCO_2e$) (2016) (BAFU, 2018). Accounting for almost a third of emissions (32%) in 2016, the transport sector is the largest domestic emitter. It is followed by the buildings and industry sectors as well as other sources (BAFU, 2017a) as presented in Figure 1.

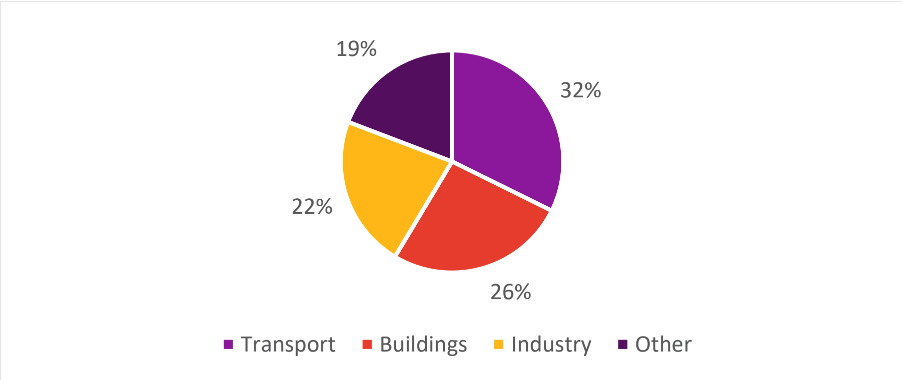


Figure 1: CO_2e emissions per sector in Switzerland in 2016 (BAFU 2017a)

Power generation in Switzerland originates mostly from hydroelectric sources and nuclear power with 57% and 35%, respectively, in 2016 (IEA, 2017). The carbon intensity of the generated electricity is 29.8 gCO_2e/kWh (BAFU, 2016). Although final energy demand, including electricity, heating and transport fuels, is heavily impacted by seasonal and annual variation due to differences in climatic conditions, the overall trend points towards a decline in energy consumption over the past five years. In 2016, gross energy consumption was at 1,087,820 TJ (FOEN, 2018a).

Efforts to contribute to the reduction of GHG emissions can be tracked back to ratifying the United Nations Framework Convention on Climate Change (UNFCCC) in 1993, the Kyoto Protocol in 2003, the Doha Amendment to the Kyoto Protocol in 2015, and the recent Paris Agreement. The Swiss nationally determined contribution (NDC) commits to an overall GHG emission reduction of 50% by 2030 compared to the baseline of 1990 (including LULUCF). 30% of the reductions shall be achieved domestically and the rest through emission reductions abroad. Despite an overall declining trend in Swiss GHG emissions in recent years with -3% between 2005 and 2015 (FOEN, 2018b) (FOEN, 2018a), the Climate Action Tracker rates Switzerland's climate policies and NDC as insufficient to meet its targets. The current Swiss emission level is found to be consistent with global warming between two and three degrees Celsius (Climate Action Tracker, 2018), which is slightly better than the global average of agreed-to-targets (NDCs).

At the national level, the CO_2 Act is the most comprehensive set of policy measures to tackle climate change and emission reductions in Switzerland. The current, second CO_2 Act entered into force in 2013 and is aimed at translating international climate commitments into national policy (FOEN, 2018a). It defines instruments for the buildings, transport and industry sectors. Measures include a CO_2 levy on fuels, an emissions trading system for major emitters, a building efficiency program, efficiency requirements for passenger cars, CO_2 emission compensation, and research and development programmes (Viscom, 2013).

The CO_2 Act was revised in 2017 to cover the timeframe from 2021 to 2030 (BAFU, 2017b). Concrete policy measures in the energy sector are set out in the Energy Strategy 2050. Energy efficiency and the expansion of hydropower and use of renewable energies are at the core of the policy measures (BFE, 2018). Despite these overall targets, the lack of a comprehensive policy plan to tackle emissions per sector, including the transportation sector, is notable (Küng, Georges, Pareschi, & Boulouchos, 2017).

Switzerland is a relatively densely populated country compared to the rest of Europe. The European Union (EU) average of inhabitants per km^2 is at 117.2, whereas Switzerland counts 207.5 inhabitants per km^2 (WKO, 2018). Between 1995 and 2016, the total Swiss population grew by 18%, from 7 million to 8.3 million inhabitants. The current population growth rate is moderate with an annual rate of 1.8% (OECD, 2018). With its high overall economic performance and a GDP per capita at around USD 65,000 (~EUR 55,085), Switzerland is one of the wealthiest countries in the world (OECD, 2018). The overall high level of GDP per capita in international comparison is originating from both high levels of employment and labour productivity. Over the past few years, Switzerland has profiled itself with remarkable resilience towards potential negative influences on the economy, such as the effects of the currency appreciation in 2015 (OECD, 2017).

3.2 Sector context

The share of overall GHG emissions from the transport sector (32%) is very high when compared with the share in Germany of 18% (160 $MtCO_2e$). The difference between Germany and Switzerland is largely due to the high energy sector emissions in Germany[2]. The OECD transport emission average fluctuates around 30% in 2016, making Switzerland an above average transport polluter with the sixth highest emission levels from the transport sector (IEA, 2018b). The annual per capita emissions from the transport sector approximately amount to 1.43 t in Switzerland compared with 1.94 t in Germany.

Absolute emission levels from transport significantly increased between 1990 and 2008 but have declined slightly since 2008 (FOEN, 2017). Meanwhile, the relative share of the transport sector increased from 28% to 32% between 1990 and 2016[3].

Figure 2 illustrates the distribution of emissions within transport in Switzerland. It shows that three fourths (75%) of CO_2e emissions from the transport sector originate from passenger cars. Freight transport makes up 18% of sector emissions, of which two thirds are allocated to heavy-duty vehicles (=/>3.5 t) (FSO, 2018) (BAFU, 2017a). In Germany, passenger cars make up for roughly 61% of sector emissions and a relatively high share of 35% is emitted by commercial vehicles including buses and heavy-duty vehicles (BMU, 2018).

[2] Germany's electricity mix is more carbon-intense, i.e. decreasing the relative share of the other sectors in total GHG emissions.

[3] GHG emissions according to the revised CO_2 Act and Kyoto Protocol (period 2013-2020).

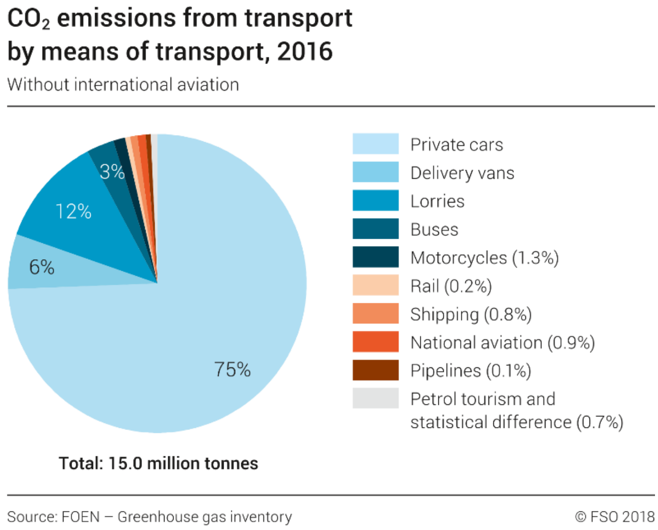


Figure 2: CO_2 emissions from the transport sector by means of transport (FSO, 2018) (FOEN, 2018c)

With one of the most important European freight routes (from Northern to Southern Europe) crossing the country, Switzerland is a key transit country[4]. The most important route passes from Basel to Luzern and Altdorf through the Gotthard tunnel to Lugano and Chiasso. Other routes passing over the Alps include the alpine passes San Bernardino, the Simplon and the great Saint Bernhard, but these are far less important in terms of transported goods.

The transport of goods relies heavily on rail transport, with a share of 39% in total tonne-kilometres (tkm) transported in 2016 (BFS, Güterverkehr in der Schweiz 2015, 2016). The historical trend is shown in Figure 3, illustrating that road transport has grown significantly in share since 1980 and emphasising the need for a modal shift policy.

[4] Transit is defined as traffic not related to import, export or domestic traffic, but only to traffic passing through the country.

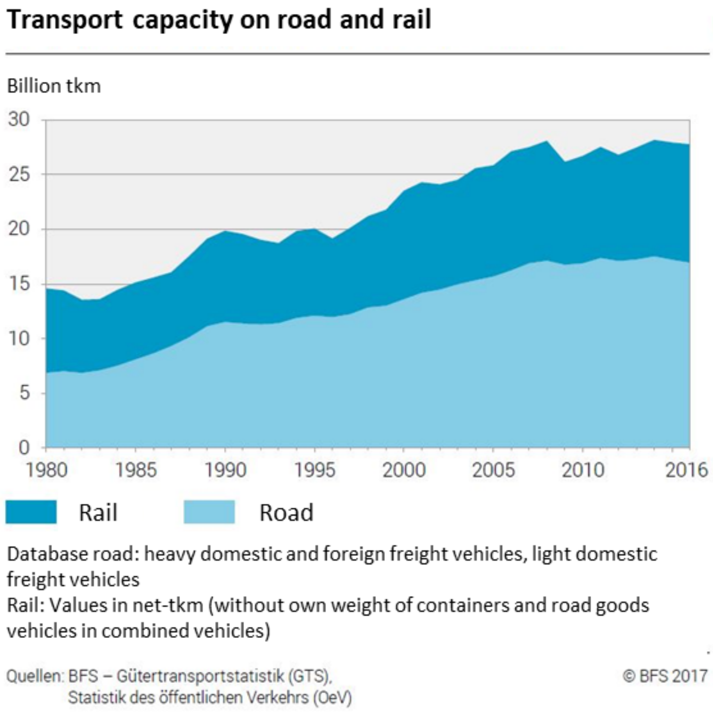


Figure 3: Modal split of street and railway transport of goods (BFS, Güterverkehr in der Schweiz 2015, 2016)

It should be noted that Switzerland closely monitors the number of alpine crossings, the indicator that is at the core of the modal shift key target. The share of railway transport in alpine crossings is much higher than in overall freight transport with 71% in 2016. Looking at the distribution of passenger-kilometre (km) travelled by land in 2015 reveals that the primary mode of transportation is passenger cars with 77%, followed by railway with 17% (Statista, 2018).

Overall transport services of both freight and passenger transport have increased in recent years. Between 1980 and 2015, total passenger km in motorised private transport increased by 44% while public transport on road and rail increased by 83% (FSO, 2018). For railway transport the number of tonnes transported increased by 10% to 29 Mt between 2014 and 2016. Stagnation is expected for 2017 (UVEK, 2017a).

The Ministry mainly responsible for the sector is the Federal Office of Transport ('Bundesamt für Vekehr', BAV). Concrete policy measures tackling the reduction of CO_2 emission in the transport sector include the policy package from the modal shift policy, energy efficiency regulations for newly registered passenger cars, an energy label for new motor vehicles and the mineral oil tax reduction on biofuels and natural gas (FOEN, 2018a) (Thalmann & Vielle, 2018). With regards to CO_2e emission requirements for new passenger vehicles, Switzerland missed its target of 130 g CO_2 per km by about 5 g in 2015 (FOEN, 2018a). The new target for 2020 of 95 grams per km links the EU target with the Swiss target, as both are at the same emission level (FOEN, 2018b) (Climate Action Tracker, 2018).

4 GENERAL DESCRIPTION OF THE POLICY INSTRUMENT

4.1 Functioning

The Swiss modal shift aims only at freight transport. It follows an integrated approach and can be understood as a modal shift policy package. As described in chapter 2, it is based on two main pillars—enabling and incentivising railway transport while disincentivising road transport. A financing mechanism ensures the transfer of revenues from the second pillar to the first. Table 1 provides a brief overview of the individual policy instruments that make up the policy mix.

Table 1: Overview of modal shift policy instruments

Type of instrument	Instrument name
Instruments to disincentivise road transport	Heavy-duty vehicle levy (LSVA)
	Temporary travel ban on freight transport
Instruments to incentivise railway transport	Construction and renovation of railway routes
	Financial support for transshipment terminals
	Noise reduction
	Liberalisation of railway transport
Financing mechanism	Railway infrastructure fund (BIF)

Some of the individual policy instruments have an equivalent in Germany. The most relevant instruments regarding transferability to the German context are the measures to extend the railway network ('Construction and renovation of railway routes') and the financing mechanism ('FinöV Fund'), which is why they will be the focus of this analysis.

- **Construction and renovation of railway routes:** The extension and optimisation of the railway network is implemented in large-scale programmes that can include concrete construction projects as well as measures for the optimisation of the railway system. Each of these programmes must pass national referendums and has an allocated budget. The first of these programmes was 'Bahn 2000'. It began in 1987 and focussed on the introduction of clock-face scheduling, meaning that trains from all directions meet at railway stations at half and full hours. This minimises waiting time for passenger transport. Bahn 2000 was followed by the prestigious NRLA, a project that consists of three new basis tunnels at Lötschberg, Gotthard and Ceneri. The Lötschberg axis was opened in 2007, the Gotthard tunnel has been open to traffic since December 2016 and the Ceneri tunnel is scheduled to open in 2019. The subsequent project was the high-speed railway traffic connection, a programme which optimised some routes and co-financed railway optimisation measures in France and Germany. The HGV connection was followed by the 'Future development of the railway infrastructure programme' ZEB ('Zukünftige Entwicklung der Bahninfrastruktur'). Under ZEB, the feeder routes to the NRLA will be reconstructed to support waggons up to four metres in height until 2020. Switzerland also financially supports feeder routes in Italy. In addition, noise reduction measures are part of the ZEB. After ZEB, the 'expansion phase 2025' FABI ('Finanzierung und Ausbau der Bahninfrastruktur') was decided on by the Swiss people. In 2018, the Swiss parliament will decide on the extension phase to 2035, which is also part of FABI. Future potential measures to extend the railway network are combined under the STEP development programme ('Strategisches Entwicklungsprogramm Bahninfrastruktur'), which lists possible construction measures to be implemented after 2030. As each of the programmes needs to be agreed upon by the public through binding referendums, a high degree of transparency is ensured and NIMBY[5] effects become less likely.

- **BIF Fund:** In 1998, the federal decree on the construction and financing of public transport infrastructure (FinöV) was adopted to finance major infrastructure projects for the modernisation of the Swiss railways. FinöV was absorbed by the new railway infrastructure fund BIF ('Bahninfrastrukturfonds') in 2016. Different sources contribute to the fund, including two per mille of the VAT, two thirds of the revenues from the LSVA, 9% of the revenues from the mineral oil tax, as well as federal and canton contributions. The fund is used to finance the operation and maintenance of the network, research and development as well as network extension, which consumes about a quarter of the fund. The fund ensures that the financing of the long-term construction projects is transparent and reliable.
- **Heavy-duty vehicle levy (LSVA):** The LSVA follows the polluter pays principle. Heavy-duty freight vehicles of 3.5 t and more (either registered domestically or abroad) must pay a duty. It is based on the European emission standards and tkm. The three categories are divided as follows. Category I: Euro 0, 1, 2, 3; Category II: Euro 4, 5; Category I: Euro 6 (EZV, 2018). There is a fee cap at EUR 325, which corresponds to the weighted average for the voyage from Basel to Chiasso. The average fee was CHF 290 (EUR 252) in 2017. To ensure compliance, the Federal Office for roads ASTRA is increasing the number of heavy-duty freight transport control centres to increase control capacities, in particular on the North-South axis. The seventh centre will be opened in 2019 (ASTRA, 2017).
- **Temporary ban on freight transport:** The travel ban on heavy-duty vehicles is in effect all day on public holidays and every other day between 10 p.m. and 5 a.m. There are several exceptions, including passenger transport, agricultural vehicles, public service, etc. (Verkehrsrecht Schweiz, 2018). The travel ban makes freight transport on the roads less convenient and more expensive for logistics companies, increasing the appeal of railway freight transport.
- **Financial support for transhipment terminals:** The construction of transshipment terminals is supported financially. This includes transshipment terminals abroad if they are used for the transhipment of goods transported through Switzerland.
- **Noise reduction:** Trains that do not make a lot of noise can profit from reduced route charges. From 2022 onwards, new and old freight vehicles must comply with a very low noise threshold to use particular routes.
- **Liberalisation of railway transport:** The Swiss railway has been liberalised to the extent that the national railway company SBB does not hold a monopoly anymore, as other railway companies can use the railway network. However, the sector is under governmental control and detailed regulation.

[5] The "Not In My Back Yard" effect describes the opposition by residents to a proposed development in their local area.

In addition to the instruments currently in place, an alpine transit exchange has been a matter of intense discussion for years. An alpine transit exchange would define a maximum number of annual transits. The right to passage would be allocated or, depending on the chosen model, traded, effectively minimising the number of heavy-duty vehicle transits. Since the instrument would only be effective if it was introduced in an internationally coordinated manner, Switzerland is not currently pursuing it.

4.2 History and legal basis

Swiss modal shift policy has been based on federal referenda and consequently anchored in the constitution for over 20 years. While the optimisation of the railway system began in 1987 with 'Bahn 2000', the focus on shifting freight transport emerged later. The impetus for an overarching Swiss modal shift policy was provided by the Initiative for the Alps ('Alpen-Initiative'[6]). This association of environmentalists has its origins in the late 1980s. In May 1989, the group launched an initiative to protect the Alpine region from the negative effects of transit traffic. One year later, the required 100,000 signatures were collected to trigger a federal referendum.

It took another four years for the initiative to be successful. In 1994, Switzerland voted to adopt Art. 84 on alpine transit traffic in the Swiss federal constitution, which would determine Switzerland's transport policy for the coming decades. In the same year, another referendum resulted in the introduction of Art. 85 of the Swiss federal constitution on the heavy goods vehicle levy ('Leistungsabhängige Schwerverkehrsabgabe', LSVA). After another four years, Art. 86 was adopted, which regulates the construction and financing of infrastructure projects in public transport. In the subsequent years, these guiding principles were translated into federal law. Table 1 provides an overview of the individual constitutional principles and laws. The fact that the modal shift policy is anchored on the constitutional level reflects Switzerland's high degree of commitment to modal shift.

Table 2: Legal basis of Swiss modal shift policy

Year introduced	Legal instrument	Type of legal instrument
1991	Federal decision on the construction of the alpine railway transversal ('Bundesbeschluss über den Bau der schweizerischen Eisenbahn-Alpentransversale')	Federal decision
1994	Federal Constitution: Art. 84 Alpine transit traffic (‚Bundesverfassung: Art. 84 Alpenquerender Transitverkehr') Federal Constitution: Art. 85 Heavy-duty traffic levy (‚Bundesverfassung: Art. 85 Schwerverkehrsabgabe')	Constitutional articles
1997	Schwerverkehrsabgabegesetz, SVAG Bundesgesetz vom 19. Dezember über eine leistungsabhängige Schwerverkehrsabgabe (‚Schwerverkehrsabgabegesetz, SVAG')	Implementation law
1998	Federal Constitution: Art. 86 Excise tax on fuel and other traffic taxes (‚Bundesverfassung: Art. 86 Verbrauchssteuer auf Treibstoffen und übrige Verkehrsabgaben')	Constitutional article

[6] The official German title is „Eidgenössische Volksinitiative zum Schutze des Alpengebietes vor dem Transitverkehr".

Year introduced	Legal instrument	Type of legal instrument
1999	Bundesgesetz vom 8. Oktober zur Verlagerung von alpenquerendem Güterschwerverkehr auf die Schiene (‚Verkehrsverlagerungsgesetz')	Implementation law
2008	Law on the shift of goods transport ('Güterverkehrsverlagerungsgesetz, GVVG')	Implementation law

4.3 Interlinkages with other policy instruments

The individual policy instruments that make up the modal shift policy are interlinked with each other and work as a package to drive the shift from street to railway transport.

In addition to national priorities, the legislation of the EU influences the development of freight transport in Switzerland. Not being part of the EU, Switzerland has greater leeway in the design of its modal shift policies than, for instance, Austria. To find a compromise between Swiss priorities and EU legislation, the 'Landverkehrsabkommen' (LVA) was adopted in 1999. It opened the road and rail transport market to the transport of persons and goods. At the same time, it formed the legal basis for the introduction of the LSVA in 2001, as the EU officially recognised this modal shift instrument. Overall, the Swiss modal shift policies are deemed more effective than the instruments Austria is permitted to employ according to EU regulation (SRF, 2018), which means that part of the shift from road to railway transport is in fact a shift of heavy-duty vehicles from Switzerland to Austria (EDA, Landverkehr, 2017).

With a significant impact on electricity demand, the policy also indirectly interacts with electricity sector planning and electricity policy. Given that the railway network is covered by its own grid, this relationship would have to be examined more closely to determine the concrete interactions.

5 IMPACTS OF THE POLICY INSTRUMENT

5.1 Effectiveness

The Swiss modal shift policy was not originally designed with the aim to reduce GHG emissions and still does not have a dedicated GHG emission reduction target. In addition to the impact on CO_2e emissions, it is therefore worth taking into consideration the reduction in total transalpine heavy-duty vehicle rides and the change in modal split between road and railway transport when assessing the effectiveness of the instrument.

The reductions in the number of heavy-duty vehicles crossing the Alps are the primary indicator observed by the Federal Office for Transport (BAV). In 2016, ca. 975,000 heavy-duty vehicles crossed the Alps, marking the first time that the number was under one million since 1994. This means that the intermediate target for 2011 was reached, but five years later. However, the targets to reach 650,000 heavy-duty vehicles two years after the opening of the Gotthard tunnel (which would have been in 2018) will not be reached (Bundesrat, 2008). It is generally expected that it will not be reached in the near future either given the large remaining discrepancy (UVEK, 2017a). Nonetheless, the modal shift policy has been effective. It is estimated that in the absence of the policy, 651,000 additional trucks would have passed the Alps in 2016. The development in the number of annual transalpine rides in relation to the estimated business-as-usual (BAU) scenario is presented in Figure 4.

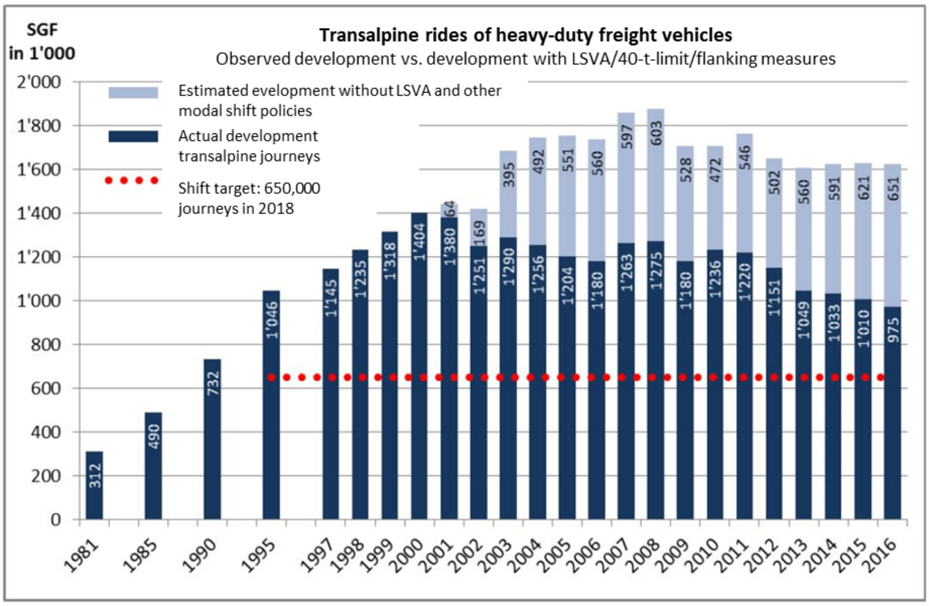


Figure 4: Transalpine traffic development in the old and new regime according to calculations and extrapolations of the BAV (UVEK, 2017b) (Ecoplan & Infras, 2012)

The significant decrease in road traffic was achieved despite the price development being relatively in favour of road transport, e.g. due to the strength of the Swiss franc and low fuel prices.

With regard to transalpine transport, road transport has slowly, but continually lost significant shares in the alpine transit traffic to rail transport, as can be seen in Figure 5. The share of railway in freight transport (in tkm) crossing the Alps was 71% in 2016. This share is particularly impressive when compared with the neighbouring alpine countries: 15% in France and 28% in Austria (UVEK, 2017a).

As discussed in section 3.2, the share of railway in overall freight transport in Switzerland is much lower at 39% in tkm than the one crossing the Alps.

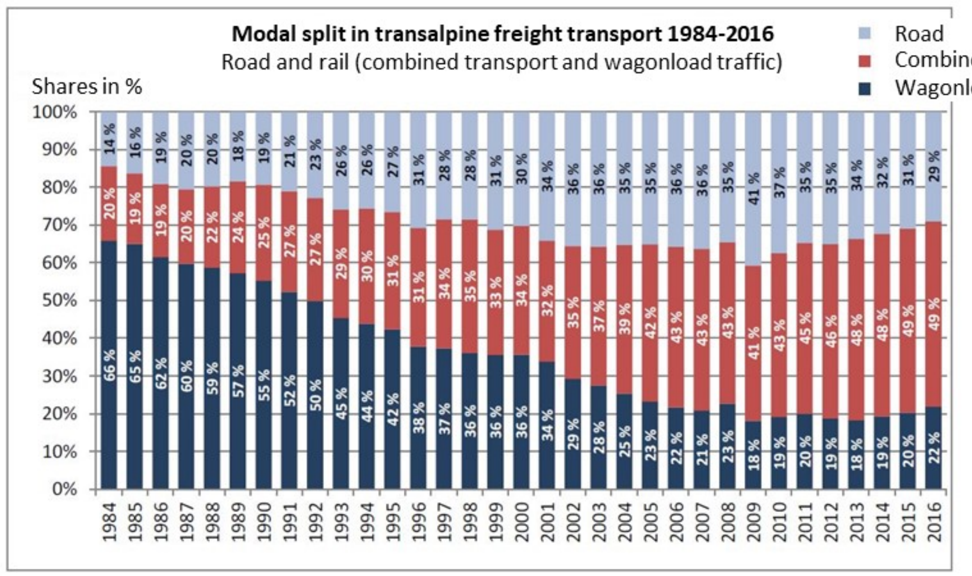


Figure 5: Modal split in transalpine freight traffic 1984-2016 in % (UVEK, 2017b)

The effect on CO_2 emissions is less straightforward. Heavy freight street transport (>/=3,5 t) produced 1.78 $MtCO_2$ in 2015 (BAFU, 2017c).[7] Overall rail transport (freight and passenger transport) produced only 0.3 $MtCO_2$ in 2016 (0.2% of transport sector emissions). This data does not include the emissions from electricity production. Data for emissions from freight railway transport only is not available either; emissions from the railway sector are hence included in the freight transport emissions for this calculation, resulting in 2.08 $MtCO_2$ from freight transport in 2015. The Swiss Federal Department of the Environment, Transport, Energy and Communications (DETEC) (‘Eidgenössisches Departement für Umwelt, Verkehr, Energie und Kommunikation’, UVEK) estimated that the CO_2e emissions of freight transport would be at least 30% higher in 2017, had the instruments of the modal shift policy not been in place. This estimation includes the LSVA, night travel ban, liberalisation of railway transport and extension and support of the railway network (BAV, 2017). From this, it can be derived that annual emissions in 2015 would have been at least 2.7 Mt, meaning that approximately 0.7 $MtCO_2$ were saved in 2017.[8]

The achieved emission reductions are due to railway transport being generally more energy efficient as well as the decrease in slope which is one result of the NRLA and makes train travel less energy intensive. Some companies have quantified their energy consumption to be 15 to 20% lower than before the construction of the NRLA in the Swiss sections of the Gotthard axis (UVEK, 2017a). The savings due to reduced traction imply that all trains under 1,600 t travelling from Basel to Chiasso will be in need of only one locomotive instead of two. The BAV has commissioned a comprehensive study on the reductions of GHG emissions that will be available in summer 2018 (BAV, 2017).

[7] The calculation includes only tank-to-wheel emissions.

[8] The limitation of this calculation is that the data for emissions and assumed emission savings are two years apart. The calculation hence can only provide a general guideline.

An UVEK study from 2017 suggests that tightening the regulations and increasing support for railway transport in an ambitious manner until 2040 (scenario 'Regulativ') would only have a small impact on emissions of the transport sectors emissions, namely a 3% reduction. The reductions resulting from technological efficiency gains until 2040 are estimated to be in the same range, with a potential reduction of 4% of the transport sector emission (scenario 'Technik').

As most efficiency policies, the modal shift policy is subject to rebound effects. The most important rebound effect in this context is one that applies for all traffic and has been described by Daniel Goeudevert: "Who sows roads will reap congestion."[9] The proverb describes the dilemma that arises from new, more convenient traffic infrastructure that may attract more traffic. The general target of the modal shift policy is that the growth in transport will only take place on the railway. In any case, the transport growth cannot continue indefinitely. Eventually, the need for further regulation of goods traffic will have to increase to avoid congestion of the railway network. The increase in traffic can also take place in the passenger transport sector, as the newly constructed network decreases travel times and thereby incentivises longer distances.

5.2 Cost efficiency

Determining the cost efficiency in terms of investments spent per tCO_2e is challenging due to a number of reasons. First, the investment decision is taken based on multiple factors including, for example, health and landscape impacts as discussed in more detail in the following section 5.3. Reducing the efficiency to a single indicator is therefore misleading. Second, the investments are long-term: an investment into a new route helps save CO_2e emissions over multiple decades. While this is similar for other energy efficiency measures such as extensive building retrofits, the difference is that there is no one route that will affect the CO_2e savings, instead it is the efficiency of the overall system that will be decisive for whether or not railway is chosen as the preferred mode. Third, there is insufficient data available for the Swiss example. Notwithstanding these challenges, the study 'Klimapfade in Deutschland' commissioned by the Confederation of German Industry (BDI) assumes the extension of the railway network to be a cost-efficient measure to reduce transport sector emissions in Germany (BCG, 2018).

In 2016, Switzerland spent EUR 2.94 billion on the railway network (Allianz pro Schiene, 2018)[10]. This compares to at least an estimated 0.7 $MtCO_2$ emission savings in the freight sector in 2017 but does not include the savings from passenger transport that also increase with the quality of the railway network. Data for emission savings from the transport sector are not available. Until 2025, CHF 6.4 billion (EUR 5.5 billion) shall be spent on further extensions of the railway network. Until 2035, an investment volume of CHF 11.5 billion (EUR 9.9 billion) has been proposed (UVEK, Finanzierung und Ausbau der Bahninfrastruktur (FABI), 2017a). The expenditures compare to a net revenue of CHF 18.652 billion that were collected from the LSVA between 2003 and 2016 (EDA, 2017a).

5.3 Co-benefits and side-effects

The main target of the modal shift policy is formulated as a quantitative reduction in the number of alpine crossings on the roads. However, there is a range of co-benefits that come with the policy package. The external costs of traffic are defined as costs to the general public, include accidents, noise, health impacts, damages to buildings due to air pollution, climate impacts, environmental and landscape

---

[9] German: "Wer Straßen sät, wird Stau ernten", quote by Daniel Goeudevert, a French poet, and automobile industry consultant.

[10] Calculation: In 2016, Switzerland spent EUR 351 per inhabitant on the railway network and had a population of 8.372 million inhabitants.

impacts, reductions in agricultural yields, damages to forests and soil, habitat loss and traffic jams. These are monitored by the Federal Office for spatial development ('Bundesamt für Raumentwicklung', ARE). Overall, it is estimated that transport of goods on roads causes ten times the external costs of railway transport (Moll, 2016).

In addition to the reduction of external costs, the NRLA has decreased the distance for freight trains between the cantons Uri and Tessin by 30 km, which can, depending on the availability of tracks, shorten travel time by up to 60 minutes. The average reduction is expected to be between 30 and 45 minutes.

Another positive side effect of increasing railway freight transport capacity is that rail passenger transport also benefits since railways are open to both freight and passenger transport. However, freight and passenger transport can also work against each other, as one blocks the routes for the other. The BAV emphasises that an integrated coordination is key to minimising conflict. Clock-face scheduling is one solution in this regard. This potential co-benefit is key given that most emissions in road transport are due to passenger vehicles.

A negative side effect of the expansion of railways is the closure of routes for long periods of time due to construction, which in some cases lasts for up to half a year (UVEK, 2017a).

5.4 Success factors and challenges

The most important success factor is the long-term reliability of the policy. This has been possible in part because of a high degree of public support and repeated agreement with extensions of the policy in referendums. It is also partly due to the nature of the political system in which consensus and the continuation of existing policies play an important role.

The main challenge lies in the lack of international cooperation. The modal shift to the railway can only achieve its full potential if neighbouring countries provide equally efficient infrastructure. Currently, neither Germany nor France or Italy are implementing corresponding measures to meet the requirements of an efficient Europe-wide railway network that allows for a modal shift to railway. Switzerland has been addressing this through different measures. First, it is financially supporting the construction of transshipment terminals on feeder routes in other European countries. Second, it seeks bilateral agreements with neighbouring states. In 1996, such an agreement was adopted between Switzerland and Germany, named the 'Agreement of Lugano'. It formed the basis of the cooperation on an efficient railway network. In particular, the agreement defined the route between Karlsruhe and Basel, also called 'Rheintalbahn', as the main feeder route from the North. Notwithstanding the agreement, the extension of the route has been severely delayed both due to a lack of commitment as well as construction errors in Rastatt (DB Netze, 2016). Construction of the Rastatt tunnel on this route began in 2013 and was expected to finish in 2022. Following a tunnel collapse during construction in August 2017, the Rhine Valley Railway was closed for almost two months and construction is expected to be delayed by two years.

The need for coordination with EU policies is another potential challenge, as Switzerland is in many aspects dependent on the developments in its neighbouring countries but does not have a vote in the EU.

6 TRANSFERABILITY

6.1 General comparability of the context

Switzerland's modal shift policy is an ambitious, long-term commitment. The adaptability to another national context depends on several contextual factors, some of which are quite different in Germany and Switzerland. In principle, the modal shift policy has been advocated in both countries by almost all political parties for decades. As early as 1967, then German transport Minister Georg Leber spoke out in favour of the shift. However, the appropriate policies to achieve this target were not put into place in a manner similar to Switzerland. The key contextual factors are outlined and compared below.

- In both countries, the volume of freight transport is expected to increase. In Germany, the volume increased from 4 billion t in 2004 to 4.5 billion t in 2014. Similarly, CO_2e emissions from freight transport increased from 37 to 59 Mt between 1990 and 2014. The German Ministry for Transport and Digital Infrastructure (BMVI) predicts an increase of 38% in tkm by 2030 compared with 2010, when 607.1 billion tkm were recorded (BMVI, 2014). In Switzerland, the overall trade volume is much smaller, but increases in freight volume can also be noted. Between 2000 and 2016, freight transport increased by 18% to 27.8 billion tkm (BFS, Güterverkehr, 2018).
- The current modal split for freight transport in Germany is dominated by road transport as presented in Figure 6. The share of freight transport is 16.9% in Germany compared to 39% in Switzerland (BFS, 2016). The share of railway transport is currently decreasing slowly in favour of road transport, which stands in contrast to the Swiss development.

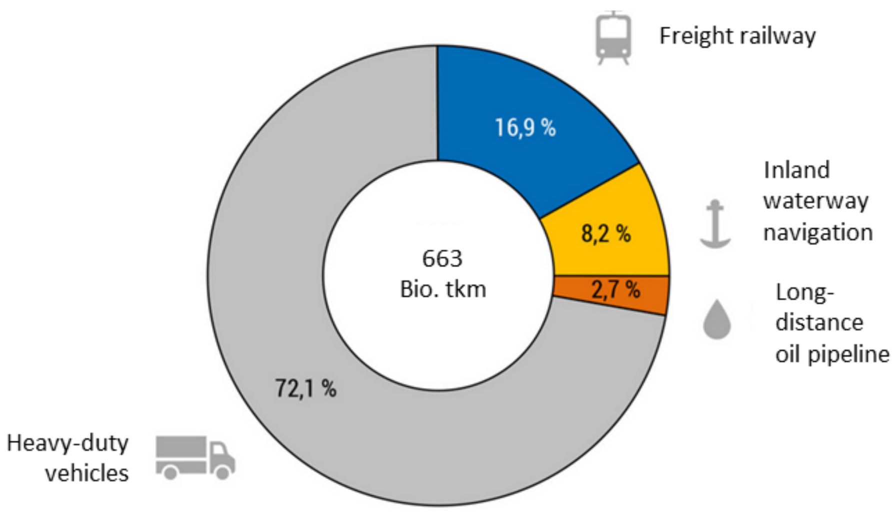


Figure 6: German modal split of freight transport in 2017 (Allianz pro Schiene, 2018)

- The most decisive difference lies in the investment volumes dedicated to road and railway transport respectively, as illustrated in Figure 7.

Figure 7: Federal investments in infrastructure in 2016 (Allianz pro Schiene, 2018)

- Although the German Federal traffic plan 2030 ('Bundesverkehrswegeplan 2030') allocates EUR 112 billion to rail, the planned investments in road renovation and construction totals EUR 132.8 billion (49% of investments). The per capita investments are another indicator that indicates the relatively low investment volumes in Germany compared with other countries from the EU and Switzerland, as presented in Figure 8.

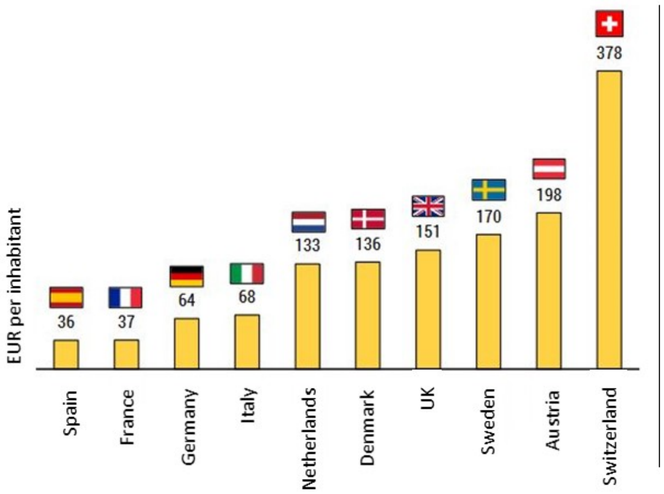


Figure 8: Federal per capita investments into the railway infrastructure in 2016 (Allianz pro Schiene, 2018)

- While Switzerland uses revenues from its levy on heavy-duty vehicles to finance railway infrastructure, Germany has explicitly decided against this manner of cross-financing in favour of a 'closed financing circle', meaning that revenues from the heavy-duty vehicle toll are only invested in road infrastructure. In Switzerland, the annual revenues from the LSVA (~EUR 1.5 billion annually) make up for a significant contribution to the financing of the railway network.
- In Switzerland, continued public support has been a major success factor for the modal shift policy. The regular referendums on the proposed railway infrastructure extension programmes ensure that the citizens are well informed of the developments and are less likely to oppose concrete projects due to the democratic legitimisation. In principle, public acceptance in Germany is also high, with 90% of citizens in favour of shifting freight transport from the street

to the railway network and extending the public transport network (Allianz pro Schiene, 2018). Yet, large infrastructure projects are often faced with large protests such as the construction of Stuttgart's railway station, Stuttgart 21 (Fietz, 2012).

- With 59% electrification of the railway network in 2015, the German railway network lags behind that of the Swiss network with 99% (Allianz pro Schiene, 2012). (In terms of the tkm and passengers transported, about 90% of the railway network are electrified according to Deutsche Bahn AG; corresponding data is not available for Switzerland). Furthermore, the carbon intensity per kWh is significantly higher in Germany, where it exceeds 500 g/kWh, compared with 181.5 gCO_2e/kWh in Switzerland (BAFU, 2016). Both factors mean that the emission savings from shifting away from roads and to rail are lower in Germany than in Switzerland, yet the inclusion of electricity under the EU ETS raises the possibility that electricity sector emissions can be treated as zero (see also sections 6.4 and 2.3 of the Policy Paper).
- Given the much smaller Swiss dimensions both in terms of tkm and passengers transported as well as in terms of the total area, it can be argued that Germany is faced with a greater challenge. The overall larger railway network complicates the introduction of a clock-face scheduling. Further, the important transport routes are more dispersed in comparison with Switzerland having essentially one main route that channels the majority of freight transport.
- While Switzerland was internationally famed for the precise planning of the Gotthard tunnel as it remained within budget and on time, major German projects have recently received negative attention for the opposite reasons, including Berlin's main railway station, Stuttgart 21, the Berlin airport and most recently, the costly delay of the Rastatt construction site in Baden-Württemberg.
- Switzerland's construction projects are particularly challenging because of the country's mountainous landscape. This means that the construction is costlier than in Germany. At the same time, the efficiency gains in Switzerland are larger as the incline can be decreased by base tunnels, reducing the fuel required.
- In contrast to Switzerland, Germany has a national industry for heavy-duty vehicles. The two major companies are Volkswagen with the brands MAN and Scania as well as Daimler, which owns the brands Mercedes Trucks, Freightliner, Western Star, Blamat Benz und Mitsubishi Fuso (Verlag Moderne Industrie, 2016). At the same time, Germany has a significant railway industry with over 1,000 companies and 165,000 employees being directly or indirectly involved in the value chain. Important producers include Siemens, Bombardier Transportation and Alstom (Hans-Böckler-Stiftung, 2016). The analysis of economic impacts of efforts to shift freight volumes to railways should take account of both industries.

6.2 Properties of the instrument

Several of the individual policy instruments that make up the policy mix already exist in Germany. Table 3 provides an overview of the equivalent instruments in the German context.

Table 3: Considerations for transfer of individual policy instruments to Germany

	Instrument name	Considerations for transfer to Germany
Instruments to disincentivise road transport	Heavy transport duty (LSVA)	Germany also has a toll on heavy-duty vehicles ('LKW-Maut') in place. The toll is levied in accordance with the emission class, but the overall cost is lower than in Switzerland. The toll was recently extended from federal highways to all federal roads in the beginning of July 2018 (Toll Collect, 2018). It is estimated that the tax revenue will increase from ca. EUR 4.8 billion to EUR 7.2 billion as a result (Spiegel Online, 2018).
	Temporary travel ban for freight transport	There is a partial driving ban for heavy-duty vehicles in place. On Sundays and public holidays, HGVs are only allowed to drive from 10 p.m. to midnight. In addition, some highways and federal motorways are closed to heavy-duty vehicles over 7.5t in the holiday period from 1 July to 31 August (BAG, 2018). In addition, federal states may close federal roads to HGVs during the night if residents are excessively burdened.
Instruments to incentivise railway transport	Construction and renovation of railway network	The utilisation of the railway network is already high with little leeway for additional shares to be shifted to rail transport. The renovation and construction of railway networks is defined in amending laws to the Federal railway extension law ('Bundesschienenwege-Ausbaugesetzes') from 1993. The latest amendment from December 2016 distinguishes between ongoing and planned projects, some of which have priority over others. As part of the renovation of the railway network, the coalition treaty of 2018 proposes the prioritisation of re-fitting the railway network to allow for trains up to 740m (compared to approximately 500m at present) until 2020, a relatively cost-efficient measure to increase capacities. Such long trains lower costs and increase utilisation of the railway network. The coalition treaty also proposes to introduce the 'Deutschlandtakt', a clock-face schedule similar to the Swiss example (CDU, 2018). Further, the European Train Control System (ETCS) shall be promoted and electrification increased from 60 to 70% of the railway infrastructure.
	Financial support for transhipment terminals	Transshipment terminals for combined transport[11] have been supported since 1998. In 2012, the funding was redesigned and expanded and went into the third extension in 2017. Up to EUR 14 million are available annually for the promotion of private transshipment terminals and freight cars. Over the past 13 years, 135 projects have been funded and implemented, with 30 other projects currently in the waiting loop. The new conditions for support will last until 2020. They include that the limit value for 'technical specification for interoperability (TSI) noise +' is met. For each freight car, the allowance is limited to max. EUR 20,000 (renovation) or EUR 25,000 (replacement). A maximum of EUR 15 million can be applied for per beneficiary within five years (Allianz pro Schiene, 2017a). The grants are given out as non-repayable grants amounting to a maximum of 50% of the eligible costs (Allianz pro Schiene, 2017b).

[11] Combined transport is defined as intermodal transport where the largest part of the journey is by rail and the initial or final parts of the journey, which are as short as possible, by road transport.

	Instrument name	Considerations for transfer to Germany
	Noise reduction	To reduce noise, the BMVI covers 40% of the additional costs incurred in the renovation of existing freight cars or their replacement, provided that they fall below the limit values of the current TSI noise by a certain threshold. According to the Pro-Rail Alliance ('Allianz Pro Schiene'), the amount of funding is expected to total EUR 60 million. Further, from 2022 onwards, new and old freight cars must comply with a very low noise threshold to be allowed on routes. This is analogous to the Swiss regulation. The EU is planning to implement an EU-wide regulation for all freight cars until 2026. In Germany, the introduction of night-time travel bans has been under discussion, but not implemented until today (Eurail Press, 2013).
	Liberalisation of railway transport	Railway transport has been liberalised in Germany. Liberalisation was implemented after the adoption of EU Directive 91/440/EWG on the development of the Community's railways (Council of the European Communities, 1991).
Financing mechanism	Funding	While in Switzerland the revenue from the LSVA is used to finance the railway network, Germany decided in 2010 to introduce a so-called closed financing circle ('geschlossener Finanzierungskreislauf'), meaning that revenues from the heavy-duty vehicle toll are only invested in roads. In 2009, Germany and the railway transport companies of the DB AG agreed to the financing agreement ('Leistungs- und Finanzierungs-vereinbarung', LuFV), which obliges Germany to provide an annual sum for replacement investments into the existing railway network. Between 2009 and 2013, the sum was EUR 2.5 billion per year. In return, the railway transport companies commit to maintaining the network to appropriate standards and making appropriate investments themselves. In 2015, the deal was renewed (LuVF II) with a timeframe of five years. Until 2019, EUR 19.5 billion are provided, an average of EUR 3.9 billion per year.

Besides the instruments that are officially part of the modal shift policy, route charges are an influential factor for the business case of railway transport companies and should be considered in any attempt to shift freight transport from the street to the road: In Germany as well as Switzerland, railway transport companies pay to use the routes. In Switzerland, the charge depends on noise, whether dangerous goods are transported, and the weight. The payment is adjusted according to a set timeframe with the next adjustment planned for 2021. In 2017, the German government committed to reducing the route charge by half with an allocated budget of EUR 350 million (timeframe to be determined). However, it is unclear whether this will be implemented (DVZ, 2018).

Another phenomenon in the context of freight transport in Germany that has received public attention are extensive cases of wage dumping. There is ample evidence that even the large logistics companies are engaged in systematic wage dumping by hiring Eastern European drivers that do not sue for their worker's rights (BR, 2017). There have been similar reports in Switzerland, but the lack of reliable data impedes an exact quantification or comparison (Schweizer Parlament, 2017). In general, the development drives down prices for road freight transport, thereby increasing the current competitive disadvantage of railway transport.

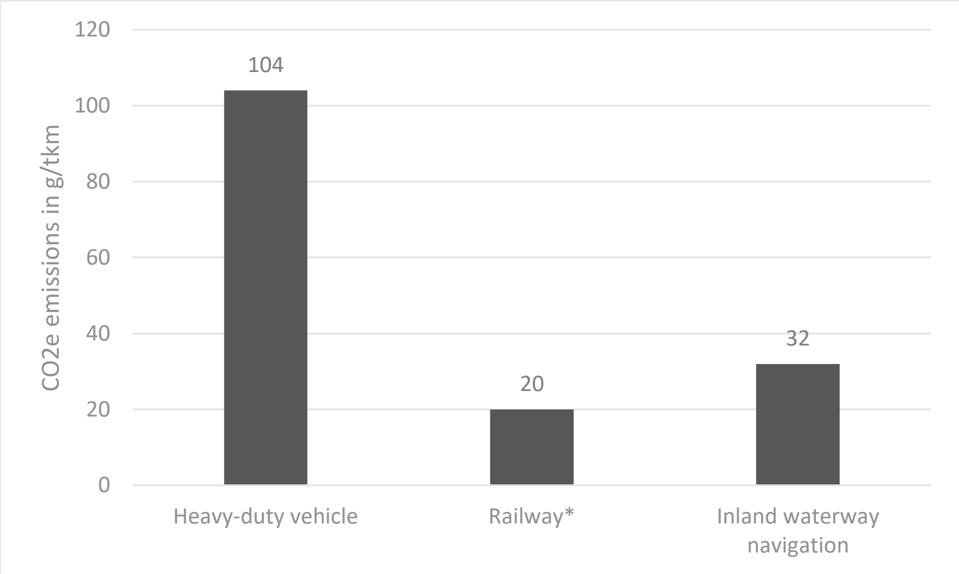
The current coalition treaty of the German government mentions the target to increase the railway freight transport volumes. To this end, the network shall be extended and modernised, a clock-face schedule introduced, the network retrofitted to suit trains of 740 m length and route charges shall be lowered. Finally, the imperative of revenue maximisation shall be abolished. Furthermore, a nation-wide coordination of timetables to improve passenger transport and a halve of noise reduction is foreseen. However, the most urgent measure, namely a large increase in investments into the railway network, is not addressed (Zeit Online, 2018). The recent study ‘Climate pathways for Germany’ (‘Klimapfade für Deutschland’) commissioned by the Federation of German Industry (BDI) argues that to achieve appropriate emissions savings in line with the aim to decrease emissions by 80–95% until 2050, the implicit goal of the Federal railway extension law to achieve 154 billion tkm until 2030 would have to be increased. Further, it is estimated that in order to almost double transport capacity from 117 billion tkm in 2015 to 220 billion tkm in 2050, the infrastructure would have to be extended by 750 km (BCG & Prognos, 2018). The study conducted comprehensive sector analyses to evaluate the role of different measures and technologies for effective emission reductions.

In conclusion, measures that may lend themselves for transfer to the German context include the increase in budget allocation to the renovation and reconstruction of the railway network, an increase in the heavy-duty vehicle toll, an extension of the temporary bans and tightening controls of road freight transport.

6.3 Potential impacts

Measured in CO_2e per tkm, railway freight transport only requires about 20% of the energy and emit around 25% of GHG in the German context compared with road transport, including electricity production (Agora Verkehrswende, 2018). There is some disagreement on this value, but the range is similar in different sources. The Pro-Railway Alliance estimates that in the German context, railway transport emits 20 g CO_2e/tkm compared to 104 gCO2e/tkm from heavy-duty vehicles, as is presented in Figure 9. Importantly, in the German context, the electricity-related emissions for railway fall under the EU ETS whereas fossil combustion in heavy-duty transport does not. The emissions vary depending on the route. In a well-to-wheel analysis, the German Öko-Institut calculated CO_2e emissions in the range of 5–13 tCO_2e per km per year depending on the route (Öko-Institut, 2013).

The methodological challenges of determining the exact emissions savings notwithstanding, the emission savings potential is large. A more extensive railway network enabling a passenger transport shift to rail would also positively affect other factors including air quality, environmental and landscape impacts, and traffic congestion.



*Emission factors are based on the average electricity mix of Germany (rather than the one procured by Deutsche Bahn AG)

Figure 9: CO_2 emissions in g/tkm from freight transport by mode of transport in Germany in 2016 (Well-to-wheel methodology (UBA, 2018))

Besides the impacts on CO_2 emissions, measures such as an increased toll or tighter controls of freight transport would increase the costs of transport. However, in the long-term, a reliable, efficient railway network for freight transport may be more advantageous to the economy than short- and medium-term cost savings.

6.4 Conclusion

Given the large difference in tkm emission intensity between heavy-duty vehicles and railway transport, the shift from road to railway is an important step to reduce sector emissions. To achieve significant shares of railway transport, a substantial modernisation and extension of the railway network in Germany as well as sufficient incentives for logistics companies to choose railway over road transport are necessary, including disincentivising road transport. To achieve the target of shifting significant shares of freight transport to railway transport, Germany can learn from the Swiss experiences with the modal shift policy.

The Swiss example gives an indication of required investment volumes and timeframes needed to achieve a shift in modal shares and associated CO_2e reductions. More specifically, Germany could learn from the planning process as well as the financing mechanisms. Clearly, the instruments would need to be adapted to the German circumstances and be coordinated with EU Member States.

While climate protection is a key argument in the debate on the role of railway transport, there are other strong incentives to shift from road to railway transport including considerations of noise, landscape, health etc. These factors can help to build alliances in favour of railway transport.

More concretely, transferring Swiss policies to the German context would involve the following steps. Financial investments in the railway network would have to be extended significantly. Funding measures for combined transport would have to be continued and potentially extended. The support of noise reduction measures would similarly be continued, also to reduce the risk of NIMBY effects. At the same time, street transport would have to be discouraged. An increase of the heavy-duty toll rates as well as a night-time travel ban should be considered. Finally, freight street transport controls could be tightened to prevent wage dumping. The proposals from the current coalition treaty address a majority of these instruments and therefore present a good starting point. However, they need to be stringently implemented; and further policy instruments are necessary. Given that the extension of railway transport has been the subject of lip service for decades, an extensive, reliable and long-term political and financial commitment will not be easy to reach.

7 REFERENCES

Agora Verkehrswende. (2018). *12 Thesen*. Retrieved from Beim Güterverkehr gilt: Schiene stärken, Straße dekarbonisieren: https://www.agora-verkehrswende.de/12-thesen/beim-gueterverkehr-gilt-schiene-staerken-strasse-dekarbonisieren/

Allianz pro Schiene. (2012, August 9). *Deutschland bei Bahn-Elektrifizierung nur Mittelmaß*. Retrieved from Elektromobilität: "Bund hat Hausaufgaben noch nicht gemacht": https://www.allianz-pro-schiene.de/presse/pressemitteilungen/2012-019-elektromobilitaet-deutschland-bei-bahn-elektrifizierung-mittelmass/

Allianz pro Schiene. (2017a, August 8). *Förderung leiserer Güterwagen mit TSI Lärm+*. Retrieved from https://www.allianz-pro-schiene.de/themen/aktuell/foerderung-leiser-gueterwagen-tsi-laerm/

Allianz pro Schiene. (2017b, January 16). *Bundesverkehrsministerium verlängert Gleisanschlussförderung*. Retrieved from https://www.allianz-pro-schiene.de/themen/aktuell/gleisanschlussfoerderung-fuer-unternehmen/

Allianz pro Schiene. (2018). *Regierungsfraktionen: Trassenpreise noch 2018 runter*. Retrieved from Allianz pro Schiene begrüßt Eile: Marktanteil der Güterbahn sinkt unter 17 Prozent: Allianz pro Schiene begrüßt Eile: Marktanteil der Güterbahn sinkt unter 17 Prozent

ASTRA. (2017). *Bundesamt für Strassen ASTRA*. Retrieved from Kontrollzentren in der ganzen Schweiz: https://www.astra.admin.ch/astra/de/home/themen/schwerverkehr/schwerverkehrskontrollen/kontrollzentren-in-der-ganzen-schweiz.html

BAFU. (2016). *Umweltbilanz Strommix Schweiz 2014.* Uster: Bundesamt für Umwelt BAFU.

BAFU. (2017a). *Emissionen von Treibhausgasen nach revidiertem CO2-Gesetz und Kyoto-Protokoll, 2. Verpflichtungsperiode (2013-2020).* Bern: BUndesamt für Umwelt.

BAFU. (2017b, December 1). *Totalrevision des CO2-Gesetzes*. Retrieved from Totalrevision des CO2-Gesetzes für die Zeit nach 2020 und Verknüpfung des Emissionshandels der Schweiz und der EU: https://www.bafu.admin.ch/bafu/de/home/themen/klima/recht/totalrevision-co2-gesetz.html

BAFU. (2017c). *Pilotstudie zum Treibstoffverbrauch und den Treibhausgasemissionen im Verkehr 1990-2050.* Ph. Wüthrich, B. Notter, J. Heldstab, M. Keller.

BAFU. (2018). *Treibhausgasemissionen leicht höher als im Vorjahr.* Retrieved from https://www.bafu.admin.ch/bafu/de/home/themen/klima/mitteilungen.msg-id-70417.html

BAG. (2018). *Bundesamt für Güterverkehr*. Retrieved from Sonn- und Feiertagsfahrverbot in Deutschland: https://www.bag.bund.de/DE/Navigation/Rechtsvorschriften/Strassenverkehrsrecht/Lkw-Fahrverbote/lkw-fahrverbote_node.html

BAV. (2017). *Beitrag des Güterverkehrs zur Erreichung der Schweizer Klimaziele.* Bern: Bundesamt für Verkehr.

BCG & Prognos. (2018). *Klimapfade für Deutschland.* Boston Consulting Group & Prognos im Auftrag des BDI.

BCG, P. (2018). *Klimapfade in Deutschland.* BDI. Retrieved from http://image-src.bcg.com/Images/Klimapfade-fuer-Deutschland_tcm108-181356.pdf

BFE. (2018, January 1). *Bundesamt für Energie BFE*. Retrieved from Energiestrategie 2050: http://www.bfe.admin.ch/energiestrategie2050/index.html

BFS. (2016). *Güterverkehr in der Schweiz 2015.* Neuchâtel: Bundesamt für Statistik (BFS).

BFS. (2018). *Güterverkehr.* Retrieved from https://www.bfs.admin.ch/bfs/de/home/statistiken/mobilitaet-verkehr/gueterverkehr.html

BMU. (2018). *Klimaschutz in Zahlen.* Retrieved from https://www.bmu.de/fileadmin/Daten_BMU/Pools/Broschueren/klimaschutz_in_zahlen_2018_bf.pdf

BMVI. (2014). *Verkehrsverflechtungsprognose 2030.* Retrieved from https://www.bmvi.de/SharedDocs/DE/Anlage/VerkehrUndMobilitaet/verkehrsverflechtungsprognose-2030-zusammenfassung-los-3.pdf?__blob=publicationFile

BR. (2017, September 12). *Bayerischer Rundfunk*. Retrieved from Verstopfte Straßen, leere Gleise - Ärgernis Güterverkehr - BR Fernsehen: https://www.youtube.com/watch?v=d0-qKPlUi_I

BUND. (2006). *Bund für Umwelt und Naturschutz Deutschland e.V.* Retrieved from Wahnsinn Güterverkehr: https://www.vcd.org/fileadmin/user_upload/Redaktion/Themen/Gueterverkehr/Lkw-Maut/BUND_VCD-Flyer_Gueterverkehr_klein_1.pdf

Bundesrat. (2008). *Der Bundesrat - Das Portal der Schweizer Regierung*. Retrieved from Bundesgesetz über die Verlagerung des alpenquerenden Güterschwerverkehrs von der Strasse auf die Schiene: https://www.admin.ch/opc/de/classified-compilation/20070628/index.html

CDU, S. C. (2018). *Coalition treaty.* Retrieved from https://www.cdu.de/system/tdf/media/dokumente/koalitionsvertrag_2018.pdf?file=1

Climate Action Tracker. (2018). *Switzerland.* Retrieved from https://climateactiontracker.org/countries/switzerland/

Council of the European Communities. (1991). *COUNCIL DIRECTIVE of 29 July 1991 on the development of the Community's railways (91/440/EEC).* The Council of the European Communities.

DB Netze. (2016). *Ausbau- und Neubaustrecke Karlsruhe–Basel.* Karlsruhe: DB Netz AG.

DVZ. (2018). *Deutsche Verkehrs-Zeitung*. Retrieved from Die Halbierung der Trassenpreise kommt nicht vor 2019: https://www.dvz.de/rubriken/politik/detail/news/die-halbierung-der-trassenpreise-kommt-nicht-vor-2019.html

Ecoplan & Infras. (2012). *Strassengüterverkehr in der Schweiz: Entwicklung im alten und neuen Verkehrsregime.* Altdorf / Zürich: Bundesamt für Raumentwicklung (ARE).

EDA. (2017). *Landverkehr.* Eidgenössisches Departement für auswärtige Angelegenheiten EDA.

EDA. (2017a). *Landverkehr.* Retrieved from https://www.eda.admin.ch/dea/de/home/bilaterale-abkommen/ueberblick/bilaterale-abkommen-1/landverkehr.html

Eurail Press. (2013, January 28). *EU hat keine Einwände gegen Nachtfahrverbot für Güterzüge*. Retrieved from https://www.eurailpress.de/news/politik/single-view/news/eu-hat-keine-einwaende-gegen-nachtfahrverbot-fuer-gueterzuege.html

EZV. (2018). *Eidgenössische Zollverwaltung EZV*. Retrieved from LSVA - Allgemeines / Tarife: https://www.ezv.admin.ch/ezv/de/home/information-firmen/transport--reisedokument--strassenabgaben/schwerverkehrsabgaben--lsva-und-psva-/lsva---allgemeines---tarife.html

Fietz, M. (2012, April 6). *Focus Online*. Retrieved from Ob Nachtflugverbot oder Bahnhofausbau - Wir sind auf dem Weg zur „Nimby“-Republik: https://www.focus.de/politik/deutschland/fietz-am-freitag/nachtflugverbot-in-frankfurt-wir-sind-auf-dem-weg-zur-nimby-republik_aid_733594.html

FOEN. (2017). *Data: Greenhouse gas emissions in Switzerland*. Retrieved from https://www.bafu.admin.ch/bafu/en/home/topics/climate/state/data.html

FOEN. (2018a). *Switzerland’s Seventh National Communication and Third Biennial Report under the UNFCCC.* Retrieved from https://unfccc.int/files/national_reports/annex_i_natcom/submitted_natcom/application/pdf/624078315_switzerland-nc7-br3-1-che_nc7_br3_2018.pdf

FOEN. (2018b). *Climate: in brief.* Retrieved from https://www.bafu.admin.ch/bafu/en/home/topics/climate/in-brief.html

FOEN. (2018c). *Switzerland's Greenhouse Gas Inventory 1990–2016.* Bern: Federal Office for the Environment FOEN.

FSO. (2018). *C02 emissions from transport by means of transport.* Retrieved from https://www.bfs.admin.ch/bfs/en/home/statistics/mobility-transport/accidents-environmental-impact.assetdetail.5246062.html

Hans-Böckler-Stiftung. (2016). *Branchenanalyse Bahnindustrie.* Retrieved from https://www.boeckler.de/pdf/p_study_hbs_331.pdf

IEA. (2017). *Switzerland - Energy System Overview.* Retrieved from https://www.iea.org/media/countries/Switzerland.pdf

IEA. (2018a). *Switzerland - Energy System Overview.* Retrieved from https://www.iea.org/media/countries/Switzerland.pdf

IEA. (2018b). *Energy and C02 emissions in the OECD.* Retrieved from https://www.iea.org/media/statistics/Energy_and_CO2_Emissions_in_the_OECD.pdf

Küng, L., Georges, G., Pareschi, G. C., & Boulouchos, K. (2017). *Challenges of decarbonizing the Swiss transport system.* Swiss Transport Research Conference.

Moll, K. (2016). *Das Gebot der Wirksamkeit im Alpenschutz.* Bern: Rechtswissenschaftlichen Fakultät der Universität Bern.

OECD. (2017). *OECD Economic Surveys: Switzerland 2017.* Retrieved from https://read.oecd-ilibrary.org/economics/oecd-economic-surveys-switzerland-2017_eco_surveys-che-2017-en#page14

OECD. (2018). *Switzerland.* Retrieved from https://data.oecd.org/switzerland.htm

Öko-Institut. (2013). *Treibhausgasemissionen durch die Schieneninfrastruktur und Schienenfahrzeuge in Deutschland.* Berlin: Öko-Institut e.V. .

Schweizer Parlament. (2017, May 4). *Die Bundesversammlung — Das Schweizer Parlament* . Retrieved from Lohndumping im Strassentransportgewerbe: https://www.parlament.ch/de/ratsbetrieb/suche-curia-vista/geschaeft?AffairId=20173319

Spiegel Online. (2018, May 15). *Bund beschließt neue Lkw-Maut-Sätze*. Retrieved from http://www.spiegel.de/auto/aktuell/lkw-hoehere-maut-und-co2-grenzwerte-kommen-a-1207819.html

SRF. (2018, June 2). *Heisse Luft am Brenner-Gipfel*. Retrieved from Drei Länder, ein Ziel, kein Plan : https://www.srf.ch/news/international/heisse-luft-am-brenner-gipfel-drei-laender-ein-ziel-kein-plan

Statista. (2018). *Switzerland modal split of passenger transport on land.* Retrieved from https://www.statista.com/statistics/449481/switzerland-modal-split-of-passenger-transport-on-land/

Thalmann, P., & Vielle, M. (2018). *Lowering CO2 emissions in the Swiss transport sector*. Retrieved from https://www.gtap.agecon.purdue.edu/resources/download/8854.pdf

Toll Collect. (2018). *Maut-Tarife*. Retrieved from https://www.toll-collect.de/de/toll_collect/bezahlen/maut_tarife/maut_tarife.html

UBA. (2018). *Vergleich der durchschnittlichen Emissionen einzelner Verkehrsmittel im Güterverkehr - Bezugsjahr 2016.* Retrieved from https://www.umweltbundesamt.de/sites/default/files/medien/366/bilder/dateien/vergleich_der_durchschnittlichen_emissionen_einzelner_verkehrsmittel_im_gueterverkehr_-_bezugsjahr_2016.pdf

UVEK. (2017a). *Bericht über die Verkehrsverlagerung vom November 2017.* Eidgenössisches Departement für Umwelt, Verkehr, Energie und Kommunikation UVEK. Retrieved from https://www.uvek.admin.ch/uvek/de/home/verkehr/verkehrsverlagerung.html

UVEK. (2017a). *Finanzierung und Ausbau der Bahninfrastruktur (FABI).* Retrieved from https://www.uvek.admin.ch/uvek/de/home/verkehr/investitionen/fabi.html

UVEK. (2017b). *Bericht über die Verkehrsverlagerung vom November 2017.* Eidgenössisches Departement für Umwelt, Verkehr, Energie und Kommunikation (UVEK).

Verkehrsrecht Schweiz. (2018). *Informationen zum Strassenverkehrsrecht in der Schweiz*. Retrieved from https://www.verkehrs-recht.ch/arbeits-und-ruhezeiten-fuer-berufsfahrer/sonntags-und-nachtfahrverbot

Verlag Moderne Industrie. (2016, July 28). *Produktion - Technik und Wirtschaft für die deutsche Industrie*. Retrieved from Die 10 größten Lkw-Hersteller der Welt: https://www.produktion.de/bildergalerien/die-10-groessten-lkw-hersteller-der-welt-114.html

Viscom. (2013). *Merkblatt CO2-Gesetzgebung 2013-2020.* Bern: Schweizerischer Verband für visuelle Kommunikation (Viscom).

WKO. (2018). *Europa Bevölkerung.* Retrieved from http://wko.at/statistik/eu/europa-bevoelkerung.pdf

Zeit Online. (2018, February 7). *Die Bahn gibt's ja auch noch*. Retrieved from https://www.zeit.de/mobilitaet/2018-02/verkehrspolitik-grosse-koalition-schienenverkehr-bahn-automobilindustrie