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Fair and efficient prices in the transport sector

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Summary

1. A new pricing system for Switzerland

According to economic theory, appropriate pricing enables the optimal allocation of scarce resources. With their approval of distance and weight dependent HGV-tax at the end of September 1998, the Swiss people adopted an important measure for road transport pricing policy. This kills three birds with one stone. Firstly it embodies the causality principle and internalises the costs of accidents and environmental pollution, thus tending to reduce them. Secondly it helps to finance ongoing infrastructure construction in Switzerland, above all for the new rail transit lines. Thirdly it exploits the productivity effect of replacing the 28 tonne limit, and is thus the most important measure supporting bilateral negotiations between Switzerland and the EU. For the first time, this measure pays for so-called external costs previously covered by public funding.

Likewise at EU level, pricing policy in the transport sector is playing an increasingly important role. The EU "green paper" on fair and efficient prices (EU 1995) propagates the pan-European internalisation of external costs. The current white paper "Fair Payment of Infrastructure Use" (EU 1998) proposes a pricing system aligned toward social marginal cost pricing: transport infrastructure users should cover the infrastructure costs they actually cause. The EU considers above all that this will encourage more efficient use of (scarce) infrastructure resources, thus helping to relieve traffic congestion.

The present study investigates how transport infrastructure pricing policy in Switzerland can be improved for greater transparency and coherence, mainly with a view to road and rail transportation.[1] New proposals are worked out based both on theoretical analysis and on current EU policy. In order to identify an optimal pricing scenario for Switzerland, existing transport infrastructure costs are first evaluated and pricing rules derived as a theoretical and empirical basis for pricing policy improvements in this sector. As a second step, three scenarios are evaluated in detail for putting these pricing structures into practice.

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1 Not including air transportation

2. Evaluation parameters: external costs and pricing rules

About 9 billion CHF of costs are currently not covered by the Swiss transportation system. In future this situation is likely to get worse, particularly with regard to private road traffic, as shown in the diagram below.

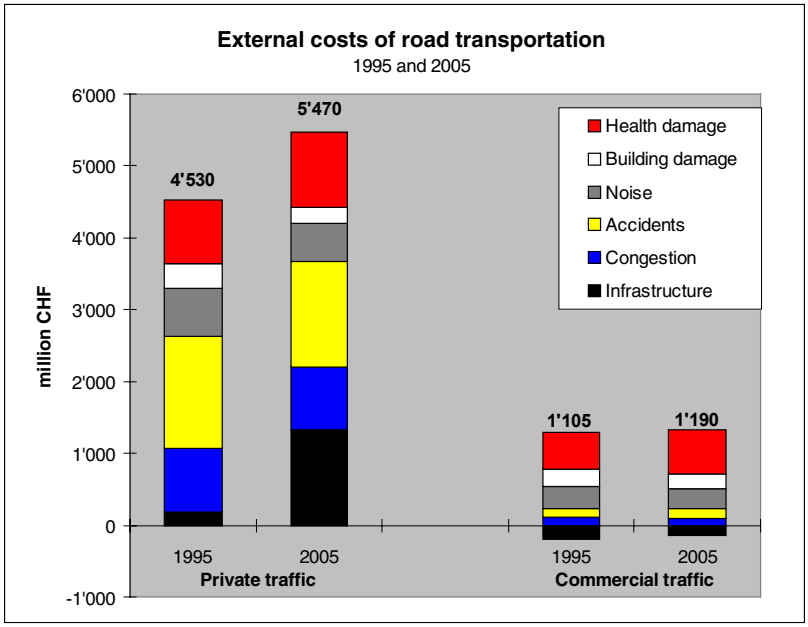

Figure S-1: Main external cost developments in road transportation for 1995 and 2005 (not including costs of climate change risks; New HGV-tax not taken into account). Above all for private road traffic, the rise in external costs is more than 20%.

The increase in external costs of private road traffic is due above all to infrastructure costs. This is because total revenues from mineral oil taxation rises at a lower rate due to decreasing specific fuel consumption, and is not enough to cover growing maintenance costs. Although specific environmental pollution is decreasing particularly in connection with road traffic, the resultant environmental costs are not falling because traffic volume is still growing while a considerable time delay is involved before environmental damage starts to reduce. The situation with commercial road transport is better, because in the end external costs will be covered by the new distance and weight dependent HGV-tax (at CHF 0.027 per km and tonne gross weight as agreed bilaterally with the EU). The main aspect with regard to rail transportation is the infrastructure deficit. Within the framework of rail system reform, the first step toward reducing this deficit has now been taken in the shape of a new governmental financing

agreement with the Swiss Federal Railways, who estimate that infrastructure cost coverage will increase from 58% to 75% as a result.

Based on existing cost data, optimal pricing rules can be derived in the various sectors, whereby prices have to be divided into allocation components and financing components. Table S-1 below summarizes the main cost relations applying to road and rail transportation.

Cost area	**Unit**	**Road passenger**	**Road freight**	**Rail passenger 2)**	**Rail freight 3)**
Infrastructure – Marginal costs – Full costs	Cents/km 1)	 2 13	 70 35	 400 1220	 170 710
Congestion (marginal costs, motorways)	Cents/vehicle	30-70	50-150	-	-
Accidents	Cents/km	1.9	1.5	55	55
Atmospheric pollution	Cents/km	2.3	10.8	-	-
Noise	Cents/km	0.7	3.7	49	45
Climatic effects	Cents/km	2.8	7.4	2	11
Other costs	Cents/km	0.7-1.7	5-8.3	41-70	370-700

1) per vehicle.km (road) or train.km (rail)
2) Infrastructure costs 1996 (assumption: 1996 = 2005)
3) Infrastructure costs (locomotive costs only) 1996 (assumption: 1996 = 2005)

Table S-1: Summary of main transportation cost relations in Switzerland as a pricing basis (as of 2005). Infrastructure costs are divided into fixed and variable components. Variable costs can be taken approximately as marginal costs. All accident and environmental costs are variable.
(Source: Ecoplan 1998, SBB estimates)

Theoretically, pricing should be based on marginal costs. Hence without taking account of network expansion, only short-term external costs per additional traffic unit serve as a price basis, both with regard to infrastructures and the associated congestion, accident and environmental costs. This approach is currently being propagated by the EU as "Social Marginal Cost Pricing", but it only partially covers average costs and financing needs.

There are various other approaches, which also cover long-term marginal costs (taking account of network expansion). Apart from the allocation component, prices should also cover financing requirements. On way of doing this is by so-called "Two Part

Pricing" (covering fixed costs with an fixed entry fee) or "Ramsey-Pricing" (price differentiation according to demand, with full cost coverage).

If each aspect is analyzed per cost area, results vary widely – there is no single transportation price. Depending on cost area, various aspects take precedence. For example the infrastructure or kilometre price (which can be determined by differentiated road pricing), the fuel price (mainly for atmospheric pollution) or the insurance price (for internalising accident costs). On the other hand noise, environmental and landscape damage costs can hardly be tied down to behavioural changes. The financing component of prices is much more important here.

3. Evaluation of three scenarios

In order to show up all the possibilities in Switzerland, three scenarios are investigated in detail here. Results are deliberately referred to the current situation (and tools available), without taking account of the new HGV-tax or specific gains from the rail reform:

1. **Social Marginal Cost Pricing:** In line with EU Commission proposals, this scenario formulates a pricing system systematically covering short-term marginal costs (infrastructures, congestion, accidents, environmental costs). The basis is a differentiated road pricing scheme.

2. **Financing:** This scenario is founded on current efforts toward ecological financing legislation, and deals mainly with private road traffic. The pricing system for road traffic is aligned to full cost coverage[2] and deliberately based on current evaluation parameters (mineral oil taxation, motor vehicle road tax). For rail transportation, subsidized to a certain extent by road traffic revenues, the current situation (taking account of rail reform) is regarded as optimal.

3. **Environment:** This scenario is systematically based on compliance with environmental pollution limits, and also includes for safety improvement measures.

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2 It covers officially proven external costs (accidents, building damage, health care and noise costs), which make up about two thirds of identified overall costs.

Based on software using the linear programming principle, it shows how these limits can be complied with at minimal cost.

The following tables show the main aspects and results:

	Social Marginal Cost Pricing	**Financing**	**Environment**
Principle	Costs to be covered by pricing alone. Main focus on price allocation function.	Simplest possible charging of external road transportation costs, taking special account of public transport financing needs	Optimally efficient combination of measures to minimize environmental pollution costs
Pricing measure orientation	Directly oriented to marginal costs	Average costs (internal and official external costs; road transportation only)	Cost/benefit ratio of measures
Non price oriented measures included	Institutional measures: motorway construction	Institutional measures: partially earmarked funds	All measures (above all political/legal measures)
Links between private and public transport	None Cross-financing Infrastructures Overall optimization	Deliberate cross-subsidizing	Ecological financing as a systematic optimization measure
Use of revenues	For traffic control investments (unimodal)	For subsidizing public transport	For financing environmental protection measures as far as necessary and reasonable
Relation to external costs	Marginal cost coverage decisive for pricing	Average cost relations decisive for pricing	Cost relations to reflect the benefits of internalization measures
Fairness	Coverage of traffic costs (marginal cost coverage)	Cross-subsidizing from road to rail (full cost coverage)	Existing resident compensation (infrastructure cost coverage as today)
Main tools and instruments	Hi-tech: Differentiated road pricing	Optimization of existing charges and fees	Differentiated bundle of measures: Fuel duty, km-related charges, various technical and legislative measures, systematic safety enhancement measures
Optimization steps required for determining which measures to take within each scenario	- Identify marginal costs - Minimize implementation costs	- Identify average costs - Optimize taxation	- Determine priority of main measures - Determine cost effectiveness links - Establish synergies - Optimal coordination of measures
Relation to existing taxation system	Low - new system superimposed	High, same interfaces	Medium (same interfaces in part)

Table S-2: Overview of scenarios investigated

	Social Marginal Cost Pricing	Financing'	Environment
Change in transportation pricing			
Road passsenger traffic	Var. + 5% (max. congestion + 520%) Fixed: – 5%	Var. +10% Fixed: + 7%	Var. + 40% Fixed: no change
Road freight traffic 1)	Var. + 77% (max. +480%) Fixed: – 3%	Var. + 57% Fixed: –1%	Var. +90% Fixed: -3%
Rail traffic	Unchanged, more efficient pricing structure	Unchanged	Unchanged
Traffic effects			
Reduction of road traffic	Private - 1% Freight - 19%	Private - 8% Freight -12%	Greater than with "Financing" scenario
Increase of public transport	Private + 5% Freight + 16%	Private + 8% Freight + 11% Additional funding	Greater than with "Financing" scenario
Reduction of congestion	Cost reduction about CHF 142 million	Cost reduction about CHF 64 million	Minimal
Environmental effects			
Atmospheric pollution	NO_X - 7% VOC - 6% PM -18% Emission reduction in cities	NO_X - 10% VOC - 15% PM - 34%	NO_X - 45% VOC - 48% PM - 48% (targets reached)
Climatic protection	CO_2 - 5%	CO_2 - 9%	CO_2 - 26% (targets reached)
Noise	Reduction mainly in cities (–6% on average)	Overall reduction (additional funding)	Noise legislation targets reached
Safety (accident reduction)	- 12%	- 3%	Fatalities: - 65% Injuries: - 24%
Financial effects			
Net income from pricing measures (compared with now)	+ CHF 2.8 billion (road traffic + 50%)	+ CHF 3.6 billion (road traffic + 62%)	+ CHF 7.9 billion (road traffic + 140%)
Relation to overall traffic financing needs	Deficit CHF 1 billion	Deficit CHF 0.3 billion	Surplus CHF 4.6 billion
Economic effects			
Costs: - Implementation - Utilization losses	 CHF 300-660 million CHF 160 million	 CHF 60 million CHF 130 million	CHF 2'820 million
Efficiency improvement (eliminated external costs)	CHF 560 million	CHF 280 million	Not estimated since not comparable
Welfare benefits (net)	CHF 95 million (with higher implementation costs: loss of CHF 270 million)	CHF 90 million	Slightly negative (implementation costs rather higher than accident and health care cost savings)

1) Change compared with today (Distance and weight dependent HGV-tax not taken into account)

Table S-3: Effects of the three scenarios investigated (relative to conditions as of 1995)

These three scenarios are evaluated below based on various given criteria.

Criterion	Degree of fulfilment 1	2	3	4	5
Short-term efficiency					
Long-term efficiency					
Safety contribution					
Environmental contribution					
Cost coverage					
Fairness between transportation modes					
Administrative feasibility					
Sustainable public transport supply					
Contribution to the national economy					
Contribution to compensation goals					
Coherence of CH-EU transportation policies					

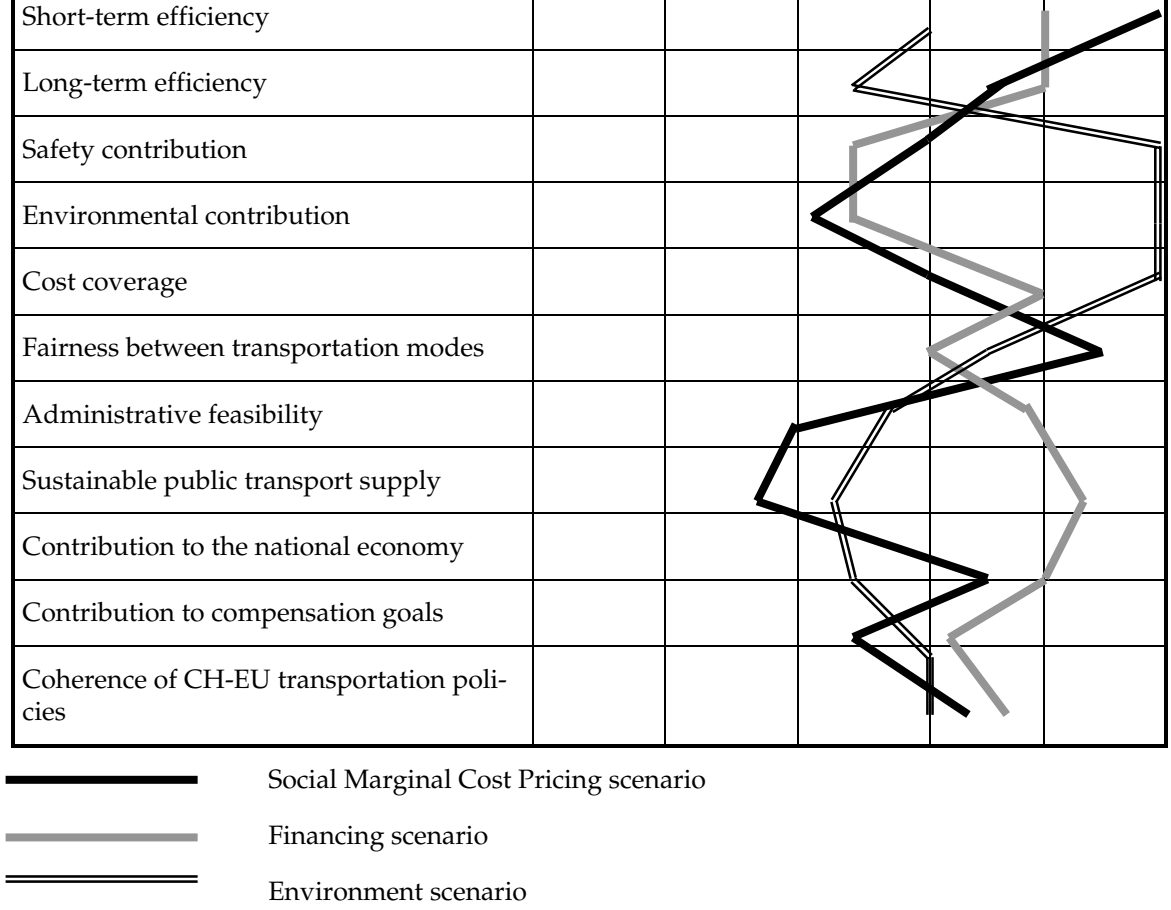

Figure S-2: Comparative overall analysis of the three scenarios

This evaluation clearly shows that only one combination of the individual scenario elements brings an optimal pricing policy taking account of all goals. For example a marginal cost oriented pricing system can only work on a phased technical basis adaptable to Swiss conditions, which must above all be compatible with developments abroad. Neither can it cover road and rail financing needs. To optimally utilize the various advantages and functions of public transport as a fair system, an approach is needed which also takes account of the respective institutional and transport evaluation systems for infrastructure expansions. For one pricing system alone is not enough to reach environmental goals. Other measures are also required, above all in relation to safety, traffic control, voluntary contributions, technical regulations and atmospheric

emission control. To ensure comprehensive attainment of environmental goals in connection with transportation, fuel prices would have to be increased by 50 Swiss cents per litre and a kilometre charge of at least 10 cents levied on private road traffic.

4. A pricing scenario for transportation in Switzerland

Based on the current state of transportation policy and results of the three scenarios examined above, the following strategic principles can be formulated:

- The strategy must be aligned toward long-term efficiency and the objectives of a sustainable transport system. Pricing must therefore meet the following requirements:
  - Structural: alignment to marginal costs in the various areas: greater price differentiation
  - Financial: coverage of future outlay for infrastructures, safety and environment.

  From the economic point of view, coverage of long-term marginal costs takes priority. Financing must cover the upkeep of existing infrastructures, the costs of future expansion, and relevant environmental costs. The strategy can thus be based on the approach of Social Marginal Cost Pricing, but must be reinforced with additional tools and instruments.

- The strategy must cover all kinds of transportation, in order to optimally exploit their various synergies and clearly delineate common transportation performance. This traditionally direct Swiss approach, with the Railway Act, rail reform and capacity-related trucking duty, has to be reinforced above all with comprehensive financing and evaluation systems.

- Appropriate institutional conditions **and mandates should support the system** to enable market-conform pricing. With respect to railways this has already been initiated, since rail reform differentiates between transport operations and infrastructures. With respect to road transportation, partial separation of networks has not yet been studied due to the Swiss network configuration. Nevertheless, the possibility of institutionally separating out the Swiss motorway network is realistic. This enables comparable mandates to be formulated for the national motorway and main rail networks:

- Optimal operation and maintenance of existing networks
- Optimal capacity management (including the financing of possible expansions)

- A differential pricing system should be introduced by stages. Analysis results still show various insecurities with regard to future development. This applies not only to "correct" pricing levels, but also to the technical basis required. For this reason the strategy must be as flexible as possible in order to take account of future changes and improvements. Great importance is attached here to EU compatibility, since a go-it-alone Swiss system without interoperability can hardly be efficient.

- Pricing must take account of fairness components. On the one hand the various transportation modes must be treated equally, i.e. with the same principles. On the other hand pricing must avoid undesirable regional or social side-effects as far as possible and suitably compensate victims accordingly. Fairness also means charging all future transportation system costs at source to those causing them. Long-term cost coverage thus entails a fairness component as well as efficiency.
  In future second-best strategies (environmental protection legislation alone) should be abandoned in favour of a "first-best" or optimal strategy which charges external costs at source. In the long term this means that the national rail network must likewise cover its own infrastructure costs. Introducing this strategic change takes time, however. A dynamic mandate should therefore be formulated for the railways, so that infrastructure cost coverage can be increased in parallel to the internalization of external costs.

The main strategic modules are summarized below:

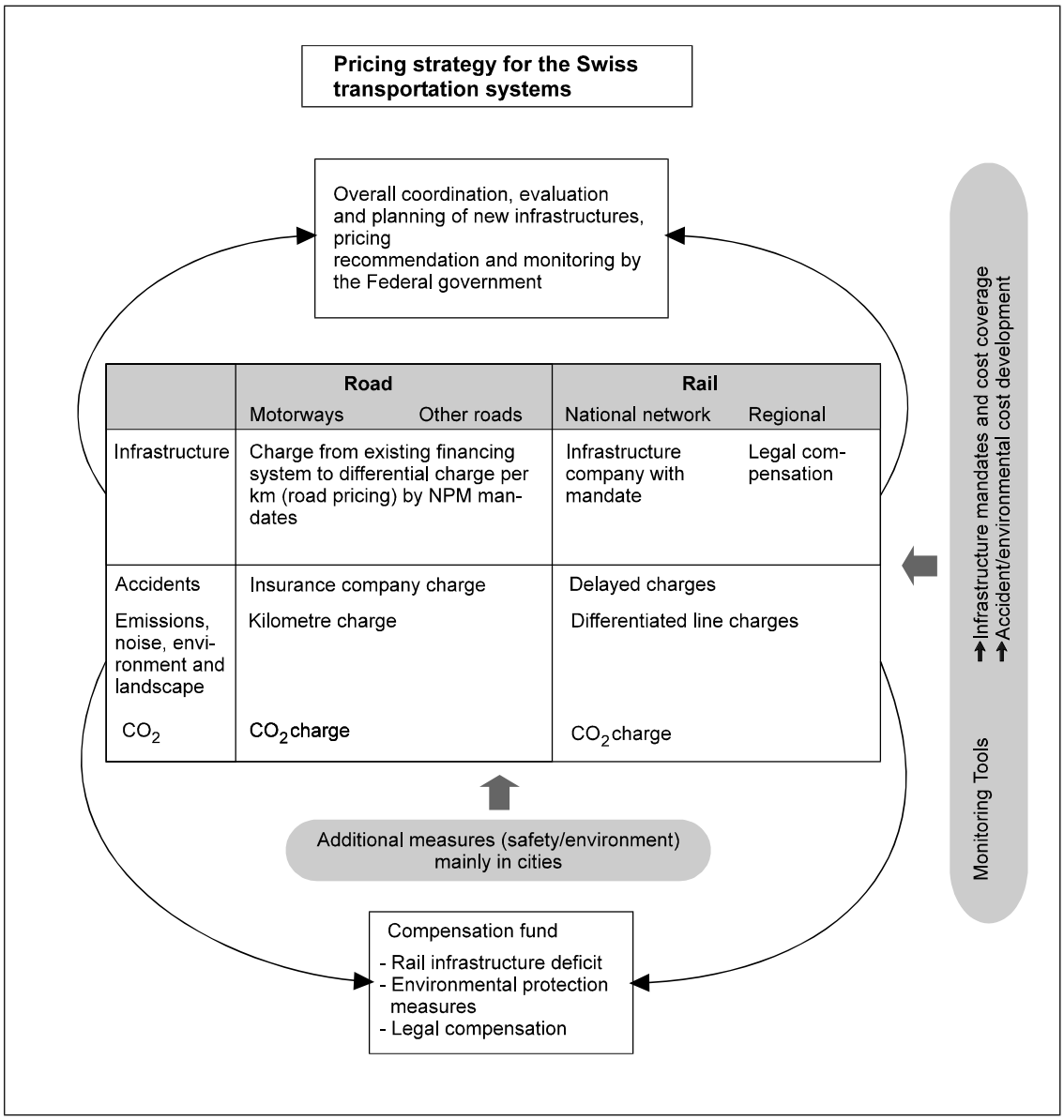

Figure S-3: Proposed pricing strategy for the Swiss transportation systems

Road passenger traffic: Introduction of a charge per kilometre

This is where the most urgent action is required. Although analysis shows that a differentiated road-pricing scenario is rather pointless in the short term, changing to a kilometre charge is the only long-term possibility for differentiating transportation costs on a variable basis. Since mineral oil taxation can only be differentiated to a limited extent and revenues (per vehicle) from this source will decrease as fuel consumption decrease, it will no longer serve in future as the main source of tax revenue.

Furthermore, lower fuel consumption also means lower operating costs, which weakens the effect of a (steep) rise in fuel prices. A differentiated kilometre-related charge should therefore be introduced by stages as soon as technical developments allow. The primary purpose of this charge (in the same way as capacity-related trucking fees) will be to cover external environmental pollution costs. In the long term it will also cover infrastructure costs in the sense of differentiated road pricing. The ultimate goal of this km-related charge and a CO_2 charge (instead of fuel tax) is complete coverage of long-term costs. Mineral oil tax and road tax can thus be reduced, and in the medium term the latter can even be eliminated.

The system should be complemented with a state levy on insurance companies, in order to cover external costs of accidents. This annual charge would be about 200 to 300 CHF per insured party. Liability insurance premiums would thus be increased and better adapted to risk coverage.

Road freight transport: Extension of distance and weight dependent HGV tax

With the introduction of capacity-related trucking fees, the main foundations for kilometre-related charges are already laid. This system has to be further developed so that it also covers infrastructure costs and includes light duty vehicles as well (up to 3.5 tonne gross weight).

Public road transport: Same system as for railways

Basically, the same cost principles should apply here as for private road traffic. Public transport vehicles (buses) should therefore pay a capacity-related fee comparable to the trucking fee and with similar differentiation — with the exception of city transport. Since city congestion is mainly caused by private traffic, there is no point in charging this back to public transport vehicles. Fair cost charging also allows fairer evaluation of public transport (e.g. for bus/train comparison) — at the present time bus operators pay no infrastructure fees and can thus charge lower fares than the railways.

Rail transport: Environmentally oriented track pricing and dynamic mandates

The Federal Act on track pricing lays the main foundations for a more transparent railway pricing system. These charges are based on the marginal cost principle (taking account of cost coverage criteria, energy and environmental criteria). This makes them compatible with the EU approach, which is increasingly adopted internationally. A future-oriented pricing policy must also take account of future financing needs, however. Under current market competition conditions, the railways cannot do this. As a

first step, therefore, track prices must be adapted to include for environmental costs. The second step will be to raise prices successively in order to cover infrastructure costs as well.

Overall integration

Although pricing alone can internalize transportation costs, an optimal and sustainable transportation policy requires additional measures as well.

- **Institutional requirements**: With clear mandates to system operators, infrastructure prices and cost coverage can be better coordinated and monitored. This is particularly urgent with respect to road transportation, where a kilometre fee will make it much simpler to charge costs to individual categories. The new charge on insurance companies must cover accident costs as fairly as possible according to risk, by setting tariffs accordingly.
- **Overall transportation evaluation systems**: Evaluation of network expansion possibilities should also include for multimodality, or at least for the expansion plans of other transport systems. One approach to this is strategic environmental impact analysis at various levels (Policy, Programmes, Plans, Projects).
- **Spatial planning tools**: Based on a transportation infrastructure plan, comprehensive coordination is possible. One example of this is the 'Alpine transit plan'.
- **Additional environmental measures**: The Environment scenario clearly shows that to reach all environmental goals in the transportation sector, additional measures are necessary for greater cost effectiveness. These not only include ”voluntary” institutional measures, but also technical (vehicles/infrastructure) or traffic regulations. These measures can be financed by setting up a special fund.

Financing: compensation fund instead of earmarked fuel tax

A coherent approach including all transportation systems must also link funding allocation with financing requirements, thus including at the same time for distribution aspects (public and private transport, regional task distribution). Such a compensation fund would cover various needs:

- Purpose of compensation fund:
  - Financing (temporary) rail infrastructure deficits
  - Financing various environmental and safety measures

- Funding origin:
  From environmental fees and external accident cost coverage levies on road and rail transport

- Fund usage:
  - Rail infrastructure deficit coverage
  - Infrastructure-related environmental protection measures (noise, nature and landscape, accident prevention, traffic control projects),
  - Compensation payments for noise and accident damage
  - Prefinancing of new investments

The financing of new investments beyond the scope of infrastructure providers must also be covered. To this purpose the fund provides basic financing. The application of such financing and the necessity for cross-financing must be decided from case to case. This depends on evaluation results using the comprehensive tools proposed.

Urban additions: Parking charge policy as an intermediate measure

Most cities are not only seriously affected by external traffic costs, but also have financial problems at the present time which limit efficient traffic control and calming measures. With the long-term kilometre-related charging system and city surcharges, external costs (environmental and congestion) can be integrated more systematically in the pricing system. Furthermore, this generates additional funding (on top of the compensation fund) for city traffic control improvements.

In the short and medium term, however, integral road pricing systems are only possible to a limited extent in urban areas. For this reason it is very important to study various intermediate possibilities. A good basis for this intermediate phase is to charge appropriate parking fees both for public and private transport, or to introduce a simple zonal fee system. These methods take account in particular of the higher cost per unit area in cities, and help to generate the necessary income accordingly. But they are not entirely suitable for systematic traffic control in the sense of "Congestion Pricing". Apart from pricing, various other measures (such as speed limits 30 km/h in residential zones) can also reduce environmental costs and thus the external costs of transportation.

Implementation aspects: Toward a differentiated pricing system

The main aspect here is the implementation of a new pricing strategy for road passenger transport (private and public). Transition from the current rather undifferentiated taxation system to a medium to long-term strategy of differentiated road pricing is much more difficult than for road freight transport or rail transport. Implementation involves various problems such as fixing price levels, technical and legal questions, federal and institutional aspects, and last but not least: public acceptance above all of the data protection aspect.

The following eight steps (see Table S-4) form a basis for implementing these proposals in Switzerland. Most important here are the transitional aspects in road passenger transport, based on existing pricing principles, until an appropriate and cost-effective road pricing technique has been developed.

Monitoring instruments: Comprehensive cost charging

Switzerland has a comparatively good basis for cost estimation in the transportation sector. For effective implementation of the proposed pricing strategy, however, additional elements are required taking account in particular of a comprehensive traffic system approach. Priority here is given to comparable infrastructure accounting between road and rail, and a wider basis for environmental cost charging. In the end, marginal costs have to be determined for all areas. This particularly applies to infrastructure cost charging, which soon will be subject to considerable changes in the road transportation sector if the truck weight limit is increased (higher maintenance costs due to increased road deterioration). Here again, the next step will be to include for air traffic as well.

Action	Timing	Requirements 1)	Price development
1. Rail reform and rail infrastructure mandate	1999, ongoing	Institutional separation between infrastructures and traffic	Falling rail passenger/freight prices (traffic and infrastructure) thanks to greater productivity. Higher cost coverage thanks to dynamic mandates.
2. Introduction of capacity-related trucking fees (HGV Km-tax)	2001	HGV-Km tax technology (distance and weight dependent)	Rising road freight prices (productivity effects of abolishing the 28 tonne limit)
3. Private road traffic measures – CO_2 tax – Parking charges or zonal road pricing in urban areas	2001, ongoing	International development, price differential compared with abroad	Rising fuel prices for road passenger/freight traffic Higher road pricing in cities
4. Charges levied on insurance companies	by 2005 (rail as of 2005)	Implementation problems solved	Liability insurance premiums rise according to risk as a result.
5. Introduction of km-related fee, New financing funds, Earmarked fuel charges abolished	as of 2005	Fee charging techniques, EU-compatibility	Road passenger traffic km charge according to external costs, mineral oil tax retained, but with new fund, Motor vehicle tax retained
6. Introduction of KM-tax for light duty vehicles and busses	as of 2005	Fee charging techniques	Light duty vehicles and bus charges increased to ensure cost fairness in freight and public transport (road versus rail).
7. Km-charges converted to road pricing	as of 2005	Legal basis, Fee charging techniques, EU-compatibility	Road passenger/freight traffic: km-fee and capacity related trucking/bus fees increased to take over financing; Differentiation enables km pricing above all on motorways, Mineral oil tax reduces accordingly, Motor vehicle tax abolished
8. Fee differentiation	as of 2005	Fee charging techniques, EU-compatibility, Rail cost coverage, Environmental cost coverage	Ongoing differentiation of both road and rail prices according to capacity (by infrastructure operators, urban organizations) similar to transport cost developments.

1) without taking account of political acceptance

Table S-4: Phased transition from the current status to a fair and efficient pricing system