Energy Compass PSI

Navigating the energy transition
#1/2025

Turning the corner

Analysing the future of personal mobility in Switzerland to achieve net-zero greenhouse gas emissions.

PSI

Editorial

Along with countries all over the world, Switzerland seeks to emit net-zero greenhouse gases by the middle of this century. This goal has massive implications not just for the transportation sector, but also for the entire energy system. It is what drives much of our research at the PSI Laboratory for Energy Systems Analysis (LEA). Now we are launching the **PSI Energy Compass** to provide context and analysis for understanding the energy transition.

The energy transition touches so many aspects of life, from how we power our homes and businesses to how we move, produce goods, and design our cities. In the **PSI Energy Compass**, we will look at one topic in each issue, providing science-based analysis with a focus on Switzerland and wider relevance to many other countries. Our goal is to provide readers with the knowledge to make well-informed decisions related to the energy transition.

This first issue deals with passenger ground transportation. Passenger transportation is a major contributor to greenhouse gas emissions in Switzerland, and the demand for mobility will continue to grow with the population. On the road to the net-zero goal, major changes in passenger ground transportation are needed. In the coming pages, we dive into our research on these changes and explore the options for realising them.

We first provide background information to understand how we perform energy modelling and analysis. Then we look at the transition to battery-powered mobility, exploring charging infrastructure as well as how hydrogen and synthetic fuels stack up against electric batteries for passenger cars. Following that, we evaluate the systemic implications and costs of the mobility transition and examine the advantages of shifting from personal cars to public transportation. In an interview, we hear perspectives from the automotive industry and the Swiss federal government. Finally, we close this issue with an outlook and open questions that urgently need to be addressed.

The basis for this new publication was the popular **Energie-Spiegel**, published by our lab from 1999-2015. We welcome your feedback via email at lea-info@psi.ch. If you are not yet a subscriber and would like to continue receiving future issues of the **PSI Energy Compass**, please subscribe.

We look forward to the exchange of ideas with our readers over the coming years and wish you happy reading!

Editorial team
Laboratory for Energy Systems Analysis
Paul Scherrer Institute PSI

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Cover photo
Highway in the night, Lavaux, Switzerland
Photo: Adobe Stock

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Modelling the mobility transition

In our modelling team, we systematically explore possible technological and fuel supply options for achieving energy system objectives, together with their consequences for economy, society, and environment.

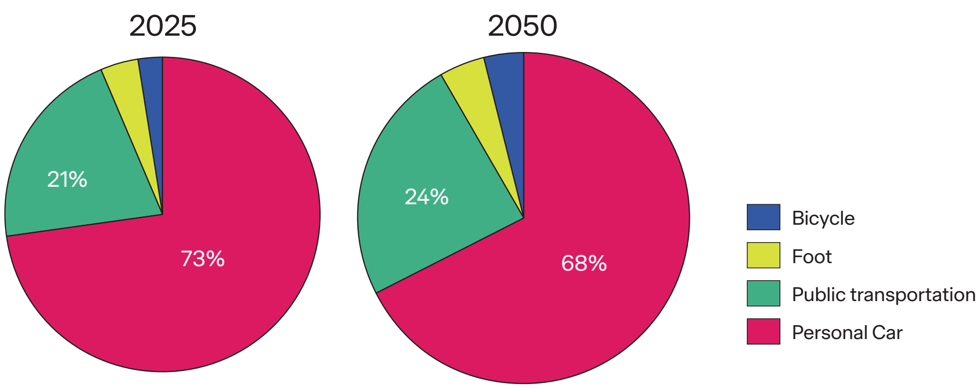


Figure 1: **Modal split by passenger-kilometres in Switzerland in 2025 and 2050**

Expected distribution of transport modes in years 2025 and 2050. By 2050, the total distance travelled is projected to climb from 129 to 138 billion passenger-kilometres, whilst the population also increases from 9 to 10.4 million. In addition to assuming growth in demand for public transit, ARE also projects an increase in cycling from 2.3 % to 3.8 % of total passenger-kilometres.

(Source: Bundesamt für Raumentwicklung ARE)

To examine the different options for our energy system, we create so-called "what-if" scenarios. For example, we have developed multiple scenarios to demonstrate how Switzerland can achieve net-zero greenhouse gas emissions by 2050. Our work in this area uses one of the most detailed computational energy models, the Swiss TIMES Energy Systems Model (STEM). This comprises the entire Swiss energy system today and into the future. While scenarios can provide valuable support to decision-makers in politics and business, it is important to understand that they are not predictions.

For the analyses in this publication, we use one of our net-zero scenarios for 2050. Our input data on social and economic drivers, such as population growth and gross domestic production (GDP), come from the Swiss Federal Offices. Our car fleet analyses partially rely on mobility demand data from the Swiss Federal Office for Spatial Development (ARE). ARE assumes that driving private vehicles will become more expensive starting around 2035, due to a combination of public transit subsidies and measures to compensate for the external costs of private car use. Thus, their primary scenario anticipates a shift from private car use to public transportation (see Figure 1). Despite this change in modes of transportation, commonly referred to as modal shift, the number of cars on the road continues to increase in ARE's Basis scenario, in which two out of every three kilometres are still travelled by car in 2050. This is in part due to the country's expected population and economic growth, as well as consumers' preference for cars.

In our net-zero scenarios, we assumed the same modal split as outlined in the ARE scenario, that is, Swiss residents will continue to rely heavily on personal cars (see Figure 1). If this is indeed the case, the transition to battery-powered mobility will be even more critical to achieving our net-zero goals.

33 %

The percentage of greenhouse gas emissions attributable to the transportation sector in Switzerland.

77 %

of those emissions come from passenger ground transportation, mostly cars.

(Source: Bundesamt für Umwelt)

Shifting gears: the transition to electric mobility

If Switzerland is serious about achieving net-zero greenhouse gas emissions, a technological shift in personal vehicles is needed.

Most cars on the road today are internal combustion engine vehicles (ICEVs) fuelled by diesel or gasoline. To achieve net-zero greenhouse gas emissions by 2050, our research shows that the majority of cars will have to operate using an alternative power source (Figure 2). The alternatives to ICEVs fuelled by diesel or gasoline include battery electric vehicles (BEVs), hydrogen fuel cell vehicles, and ICEVs run on synthetic fuels.

In much of the world, including Switzerland, a transition to electric mobility has already begun. Governments are implementing policies specifically to encourage BEV adoption, including various financial benefits for owning "clean" or highly efficient vehicles. We will explore the reasons for why manufacturers and consumers might prefer BEVs to other powertrains in the column "What kind of juice?" In addition, from 2035, the EU is banning the sale of new petrol and diesel cars, unless they run on alternative fuels. However, many new car buyers are delaying making the switch, and this transition is not happening as swiftly as laid out in our net-zero scenario. Though BEVs are technologically ready for widespread adoption, there are several barriers to switching right now.

The first barrier is price. Today, expensive batteries drive up the purchase price of BEVs. However, despite requiring upfront investment, BEVs are cost-effective. In fact, over their entire lifetime, BEVs are competitive with internal combustion engine

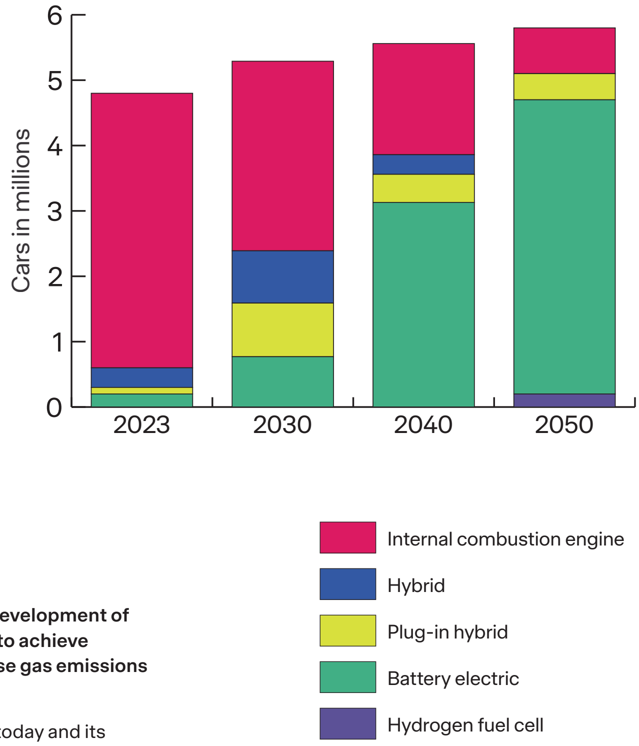


Figure 2: **Possible development of the Swiss car fleet to achieve net-zero greenhouse gas emissions by 2050**

The Swiss car fleet today and its possible development through 2050 to achieve net-zero greenhouse gas emissions. The total number of cars is expected to increase from 4.7 million to 5.9 million by 2050. Although the number of cars increases, the annual mileage per car is lower than today; on average, cars are driven less. In a net-zero society, remaining internal combustion engine vehicles (ICEVs) must be operated with synthetic fuels, which can replace gasoline and diesel and have a much smaller carbon footprint.

(Source: PSI Laboratory for Energy Systems Analysis)

0.2 million

The number of battery electric vehicles on the road in Switzerland in 2024, representing 3 % of the total car stock.

(Source: Bundesamt für Statistik)

4.5 million

The projected number of battery electric cars needed on the road in Switzerland by 2050 according to our net-zero scenario. This would be 76 % of the total car stock.

(Source: PSI Laboratory for Energy Systems Analysis)

vehicles, taking into account expenses like insurance, service, tyres, fuel, and purchase cost. But most consumers looking to buy a vehicle do not take a life-cycle costing approach, meaning BEVs are still perceived as non-competitive without some form of subsidy.

A second barrier is misinformation about the low-carbon and sustainability credentials of BEVs in comparison with other types of private vehicles, including concerns about their batteries. Potential buyers might be discouraged from buying BEVs if they believe that the batteries end up as toxic waste. Recycling will play a crucial role in mitigating both problems. To provide an idea of the extent of these recycling programs, the EU aims for 73 % of electric car batteries to be recycled by 2030. In addition, low-cobalt and entirely cobalt-free battery technologies are gaining momentum, helping to reduce demand for this rare, toxic, and often unethically sourced element.

Another barrier to BEV adoption is concern about charging infrastructure availability, which we examine in detail next.

The charging challenge: infrastructure for battery electric vehicles

The availability of chargers is an important criterion for consumers considering purchasing a battery electric vehicle.

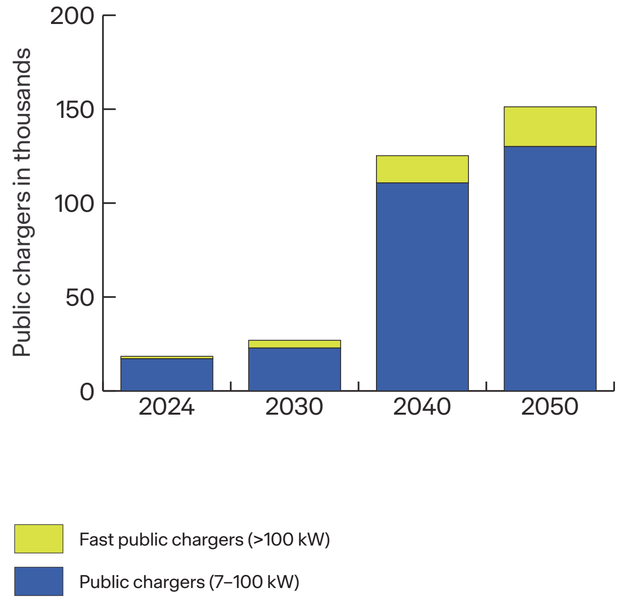


Figure 3: **Public charging infrastructure needs in Switzerland**

The minimum number of public charging stations required to accommodate the growth of battery electric vehicles in our net-zero scenario. The numbers reflect a distribution of station sizes similar to what we have today. In addition to public chargers, we will need over **1.6 million home chargers** to support home charging by 2050. The current standard public charger is 22 kW.

(Source: PSI Laboratory for Energy Systems Analysis)

Overall, two out of three non-BEV owners cite access to charging infrastructure as the main barrier to purchasing a BEV.

Home charging is a big part of this. Among BEV early adopters, the majority installed a private charging station. Today, with the improving access to public chargers, the proportion of Swiss BEV owners with private chargers has dropped to just one in three. Home charging with a private charger is convenient, time efficient, and inexpensive, given that the residential electricity tariffs come without the public chargers' fees. Our research shows that providing overnight charging access through private home chargers or public chargers in residential areas helps increase BEV penetration by 12–20% during the period between 2040 and 2050.

In addition to home charging, charging on the go and during the day is also important. Among drivers without private home charging, a 24% higher BEV uptake is observed when public infrastructure in non-residential areas is significantly improved, rather than when it is not. This includes chargers in public parking garages, store parking lots, and highway charging stations, for example.

Figure 3 shows how the number of charging stations in Switzerland needs to increase substantially to support BEV uptake. According to our analysis, each BEV needs about 5 kW total charging capacity, split into around 2 BEVs per private charger and between 25 and 30 BEVs per public charger. This means that, by 2050, Switzerland will need more than eight times as many regular public chargers and sixteen times as many fast public chargers as today.

BEV charging infrastructure needs to be extended on multiple fronts. The installation of home chargers remains an issue, especially since most people in Switzerland rent their homes, and tenants in Switzerland do not have the right to install BEV chargers in their buildings. Public chargers in residential areas can mitigate this issue. A combination of public chargers to use on the go, in commercial areas, and at workplaces can also help fill the gap.

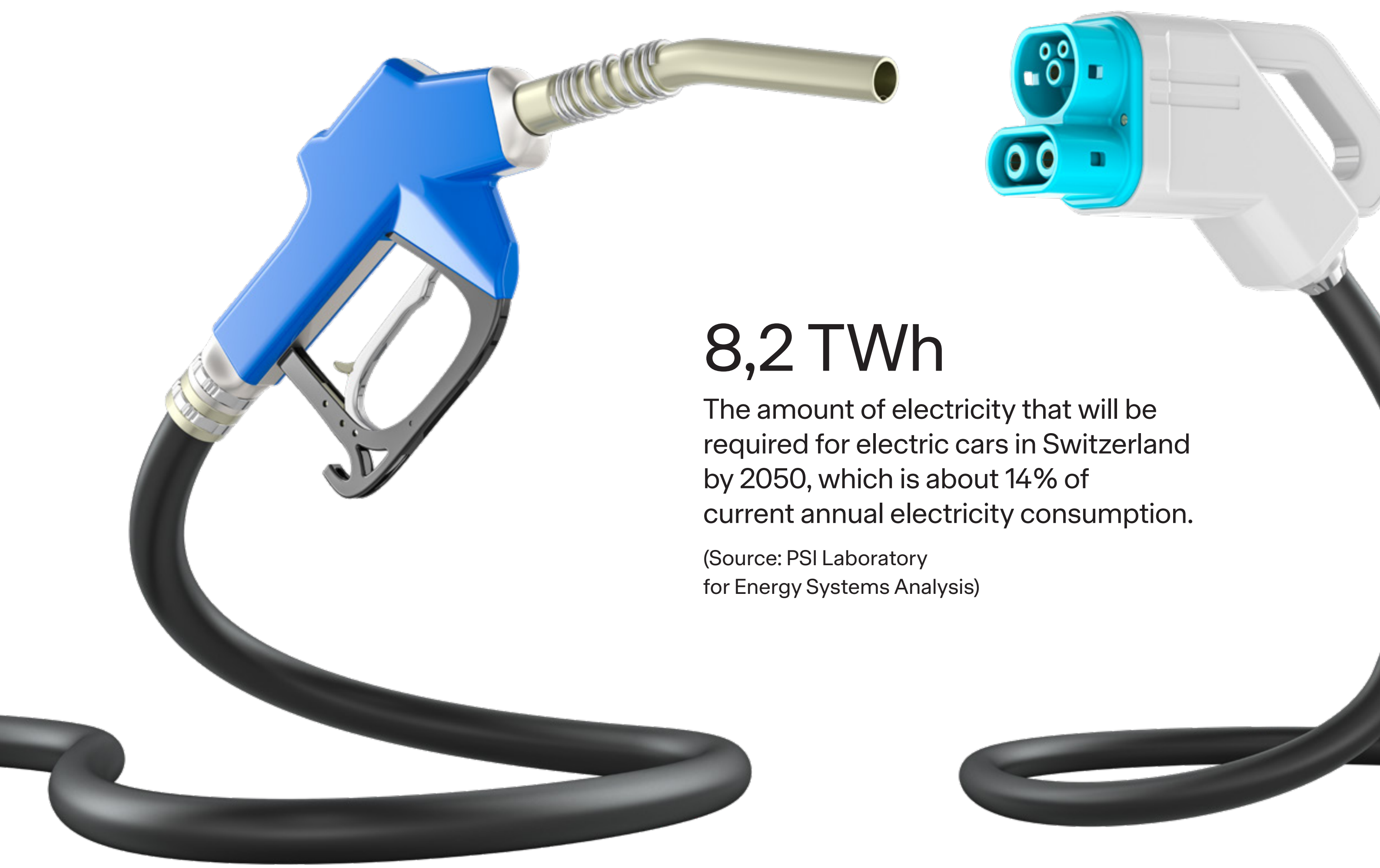
These findings underscore how important charging infrastructure is to maintain the BEV trends. As we will see next, inadequate charging infrastructure for BEVs today could lead to costly inefficiencies down the road.

What kind of juice? Electric batteries, hydrogen, or synthetic fuels

Battery or hydrogen cars? Or conventional combustion engines running on so-called “e-fuels”, synthetic fuels produced from carbon dioxide, water, and electricity from renewable sources? What makes the most sense for future individual road transport to achieve climate targets?

If we want to decarbonise the transportation sector as efficiently and economically as possible, our research shows that BEVs are the best option for personal cars. BEVs are the most energy efficient, cost-effective and ready for adoption of the above options. In addition, hydrogen and e-fuels are urgently needed for other purposes than passenger cars.

Let’s first look at efficiency. BEVs are about 60 % efficient, looking at the energy they consume “from well to wheel”. Hydrogen cars are approximately 25 % efficient, taking into account the energy lost as unusable heat during both hydrogen production with electrolysis, as well as while operating the car. ICEVs running on e-fuels achieve only about 10 % efficiency,



8,2 TWh

The amount of electricity that will be required for electric cars in Switzerland by 2050, which is about 14 % of current annual electricity consumption.

(Source: PSI Laboratory for Energy Systems Analysis)

largely due to the inherent inefficiency of combustion engines and the energy-intensive process of e-fuel production. This means that a hydrogen car needs two and a half times as much electricity, and an e-fuel car around six times as much, as a BEV to cover the same distance. Consumers would notice the higher power requirement when they needed to refuel, since hydrogen and e-fuels are significantly more expensive than electricity for direct battery charging.

When it comes to reducing greenhouse gas emissions, time is of the essence. BEVs are the technology most ready for adoption. Indeed, they are already a viable alternative to gasoline and diesel cars today. The same cannot be said of hydrogen fuel cell cars, nor of e-fuels: in Switzerland, only one model of hydrogen fuel cell car is available, the present number of hydrogen filling stations is 17, and e-fuels may not be viable for years.

Moreover, there are far more sensible applications for both hydrogen and e-fuels than using them to fill the fuel tanks of passenger cars. In specific industries as well as in fertilizer production, there is no low-carbon alternative to hydrogen. E-fuels will only be available in limited amounts, and they will be needed in aviation and shipping, use cases in which battery-electric drivetrains are not feasible, due to the weight of the batteries.

Certain constraints could lead to different technology choices, however. If drivers continue to face hurdles in accessing charging infrastructure, the need for hydrogen fuel cell cars could increase to achieve the net-zero goal. Compared to switching to BEVs, this would be more expensive and would require additional electricity for hydrogen production. In countries with much lower electrification and less reliable power grids, electrification of personal mobility might be disproportionately expensive, meaning that substituting gasoline and diesel with e-fuels in ICEVs might be a more economical option. This would be less efficient overall but might be cheaper from the perspective of the whole energy system. This is just one example of how mobility must be considered in the broader context of the energy transition, as we will look at next.

The bigger picture: systemic implications and external costs

The aforementioned shifts within the transportation sector will lead to significant changes across the whole energy system.

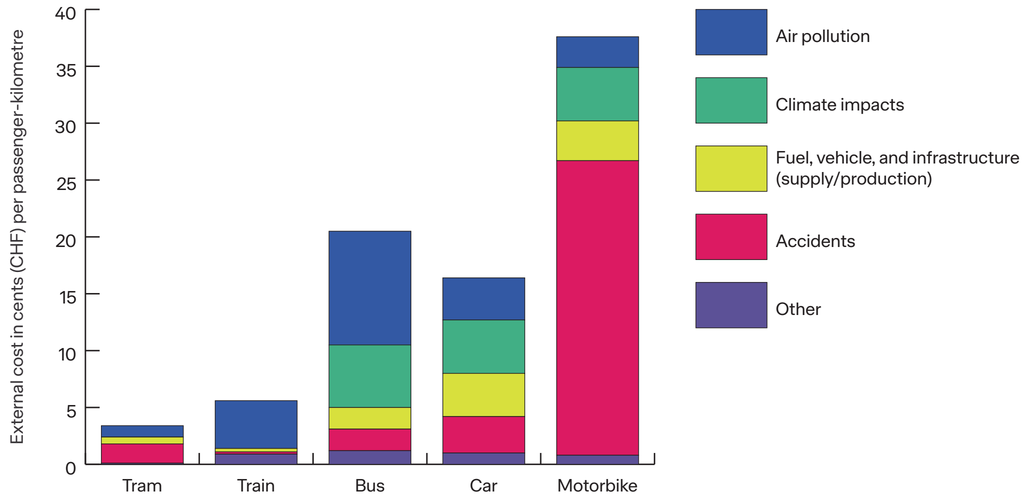
The shift to electric mobility will lead to an increase in electricity demand. Our work shows that the electric cars on the road in Switzerland by 2050 will consume approximately 8.2 TWh of additional electricity per year, which is about one-seventh of today's consumption. Some of this increase in demand will be made up for in other areas, such as through better-insulated buildings. However, electricity demand will increase overall, and in part this is due to electric vehicles.

Between now and 2050, we estimate that Switzerland's annual electricity demand will increase from 60 to 71 TWh. Though this overall increase is not dramatic, it is made more difficult by the planned phase-out of nuclear power, which today provides roughly 30 % of the country's electricity. Replacing this nuclear capacity with other low-carbon electricity sources presents a more substantial challenge than accommodating the additional demand from BEVs, which remains comparatively modest. To address both aspects, Switzerland will likely need to continue expanding photovoltaic (solar) capacity at a significant pace while also considering other low-carbon energy sources, such as new hydropower, wind energy, and waste incineration with carbon capture and storage.

Figure 4: **External costs of passenger ground transportation**

This chart shows the external costs of selected modes of transportation in Switzerland, calculated in cents in Swiss francs per (passenger-kilometre). Bus travel is calculated to be costly in comparison with car travel for two main reasons: a low level of bus electrification (this is for a diesel bus) and a low occupancy rate (16 %).

(Source: Ecoplan / INFRAS for ARE)



The successful integration of these low-carbon electricity sources will require additional investments for stronger grids, increased storage capacities, and backup plants. Since our analytical model does not represent the electricity grid in detail, it is important to acknowledge that the integration of additional renewables and electric vehicles may involve some grid-infrastructure constraints that have not yet been fully assessed.

Building a resilient and low-carbon electricity system will not only depend on domestic infrastructure but also on Switzerland's ability to coordinate its energy transition with the rest of Europe, particularly its neighbouring countries. Greater market integration would enhance supply security and provide access to a broader and more diversified energy market.

How much will it cost?

We estimate that the energy transition will cost Swiss residents an average of 530 Swiss francs per year between now and 2050. However, this estimate can vary widely. Depending on factors such as national policy on energy imports and consumers' openness to changing technologies, our research suggests that the energy transition could cost Swiss residents anything between 320 and 1390 Swiss francs per year. This includes expenses in the transportation and building sectors, as well as continued expansions in low-carbon electricity supply.

It is important to note here that climate change mitigation is most likely much cheaper than adaptation in the long run. In other words, these costs are almost certainly lower than the cost of "doing nothing". The external costs of burning fossil fuels, those costs we do not pay directly but rather pay for in the form of damage to the environment and human health, are becoming clearer.

In the mobility sector, greenhouse gas emissions represent the main contribution to these external costs, followed by air pollutants. Overall, passenger cars cause external costs of nearly 16 billion Swiss francs per year in Switzerland, as estimated in the Federal Office for Spatial Development ARE's most recent report on the external costs of transportation (Ecoplan / INFRAS for ARE). A comparison of different modes of transport shows that the external effects of electrified public transport are significantly lower than those of vehicles powered by fossil fuels. Estimated external costs of cars amount to over 16 cents (in Swiss francs) per passenger-kilometre, while those of trains add up to under 6 cents per passenger-kilometre. Figure 4 shows a breakdown of these.

Finally, reducing greenhouse gas emissions in personal mobility will allow Switzerland to avoid implementing more costly measures to meet the net-zero target, such as expensive new technologies for freight transport, renovations to difficult-to-retrofit buildings, and additional carbon capture and storage. One way to reduce external costs in the personal mobility sector would be to continue electrifying public transportation and, in parallel, mobilize a modal shift from cars to biking, walking, and public transportation. The next section deals with how that might be achieved.

Rethinking personal mobility: shifting from cars to public transit

Achieving net-zero emissions in passenger mobility will require a significant modal shift, or a change from one mode of transportation to another.

Though electric vehicles do not have any direct greenhouse gas emissions, there are still significant emissions associated with their production and operation, as Figure 5 illustrates. To fully decarbonise the entire BEV life cycle, carbon capture and storage (CCS) and carbon dioxide removal (CDR) technologies will be needed. Today, however, these technologies are still immature and expensive.

Soft mobility options, including e-bikes, are much cheaper than cars and can be used on shorter trips to help reduce greenhouse gas emissions. Public transit is a lower-carbon option for distances and conditions for which a bike does not suffice.

To encourage this shift, it is important to understand the factors beyond cost that influence individual transportation choices. These include comfort, habits, and, most critically, travel time. Non-monetary factors are in fact the primary drivers behind the choice of mode of transportation. Many people prefer to drive their cars because they find them more convenient than public transportation. In Switzerland, where car drivers tend to have a low sensitivity to price, travel time is particularly decisive. Swiss residents are about four times more likely to choose a mode of transport based on travel time than on cost.

One of our analyses integrates consumers' travel time duration and valuation — in other words, how long their trips are, and the degree to which they wish they were shorter. It shows that a combination of slightly faster public transportation and slightly slowed-down cars on medium- and long-distance trips could promote a 5–10 % higher public transport demand between 2030 and 2050. Overall, improving the efficiency, frequency, and digital integration (including a variety of mobility apps and services) of public transport can make it more attractive to travellers. Improving public transit travel times, combined with targeted policies for different trip distances, could encourage greater public transit usage.

The regulatory framework needs to reflect geographic and socioeconomic disparities among travellers, as these factors influence responses to travel time and cost changes. Policies to reduce public transit travel costs, particularly for low-income consumers with a higher price sensitivity, could help ease modal shift for those individuals.

Finally, there would be several significant advantages to this modal shift beyond lower CO_2 emissions, such as healthier lifestyles and a more efficient use of urban space. As we saw in the previous article, the external costs of cars to our health and the climate are significant.

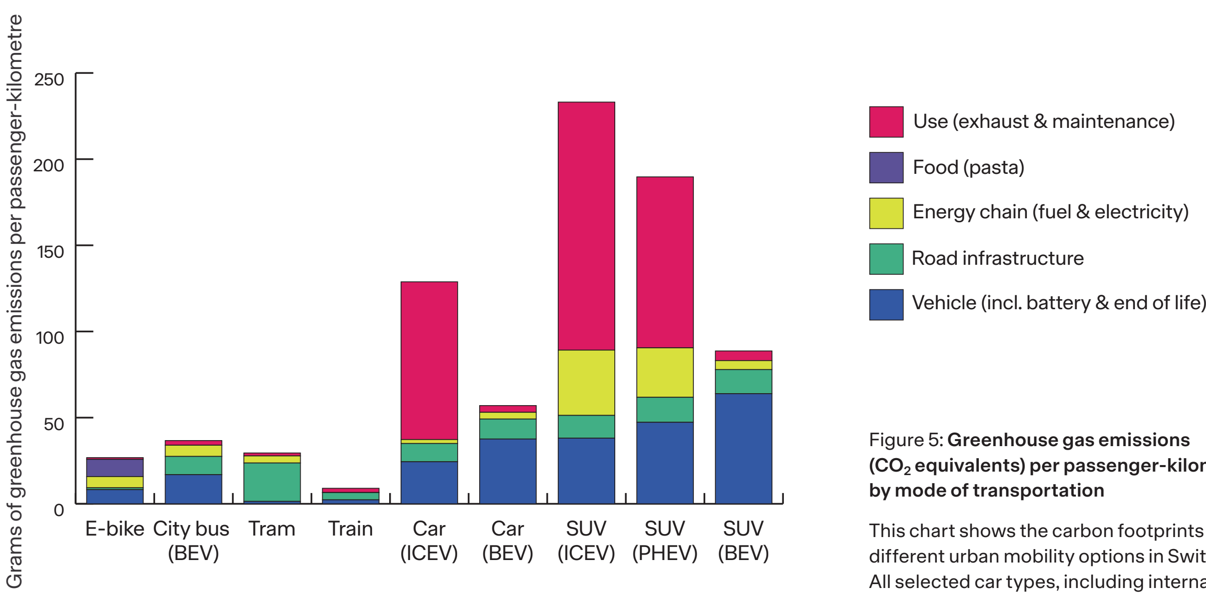


Figure 5: **Greenhouse gas emissions (CO_2 equivalents) per passenger-kilometre by mode of transportation**

This chart shows the carbon footprints of different urban mobility options in Switzerland. All selected car types, including internal combustion engine vehicles (ICEVs), battery electric vehicles (BEVs), and plug-in hybrid vehicles (PHEVs) cause higher greenhouse gas emissions than public transit options. "Car" refers to a mid-sized car. BEVs cause lower greenhouse gas emissions over their lifetime than vehicles powered by gasoline or diesel, but the emissions are still considerable, especially for large BEV-SUVs. The occupancy rates of the city bus and the tram are 16 % and 29 %, respectively, representing Swiss averages.

(Source: PSI Laboratory for Energy Systems Analysis)

How many greenhouse gas emissions can I save with a battery electric car?

Check out our **carculator** tool or download a copy of the **Mobitool** spreadsheet model to compare the carbon footprints of different vehicles, see the effect of charging electric vehicles with photovoltaic power from your own roof, and calculate the environmental benefits of choosing a smaller car. You can also use it to check out environmental performances regarding other burdens than GHG emissions.

carculator: https://carculator.psi.ch
Mobitool: https://mobitool.ch/

“Our wish is for people to become more multimodal.” Regina Witter

A conversation with Regina Witter and Peter Schmid

The very first question: what was the last mode of transport you used?

Regina Witter
I travelled to work by train. I work in Bern and live in Neuchâtel right next to the railway station, though I would prefer to live even closer and cycle or walk to work.

Peter Schmid
I travelled to the office today in my fully electric company car. I could also cycle to work, but naturally, as an electric mobility specialist, I drive my car.

RW: Electric mobility is clearly a blessing when it comes to decarbonising transport. But there is also a major space problem, especially in cities, which has not yet been solved. With the growing population in Switzerland, we need space-efficient solutions such as public transport.

And we need interfaces between different means of transport. We are working a lot on so-called "transport hubs". The idea is to better connect different means of transport. Our wish is for people to become more multimodal and try to use whichever means of transport is most suitable. But we humans prefer to be comfortable. Once we're in the car, we tend to stay in the car until we reach our destination. We all have our habits and usually only change them gradually.

PS: I also believe that urban areas are becoming too crowded for everyone to drive their own car. Perhaps there will be alternatives so that instead of everyone driving their own car, carsharing or autonomous services will be used. I think there is still a lot to come.

If we perhaps take two more steps back: mobility is a basic human need, and it will never be perfectly efficient or completely climate friendly. The question is, what are the best compromises? The electric vehicle is simply a better alternative than the combustion engine. Does that solve the problem? No, but it is a step in the right direction.

RW: In 2018, the Federal Government launched the "Electric Mobility Roadmap", which now comprises 74 organisations from all levels of government and the private sector. Everyone agrees that it should be possible to charge your car everywhere – at work, when travelling, and, above all, at home. Tenants in apartment buildings don't have it easy. In addition, we always hear from cities that it is a challenge to install charging stations in public spaces due to a lack of space. Space is a fundamental challenge, especially for motorised private transport. More space for roads and car parks means less space for people travelling on foot or by bike, as well as for greenery. It is a weighing of interests: how is the scarce space in cities best utilised?

> “Mobility is a basic human need, and it will never be perfectly efficient or completely climate friendly.”
>
> Peter Schmid

A few obstacles that stand in the way of the switch to sustainable mobility have already been mentioned. Do you see any other obstacles that need to be removed when it comes to switching to electric cars or public transport?

PS: One of the big issues now is charging infrastructure in residential areas. People who live in rented flats often have no way of charging an electric car at home, including street parking.

What also doesn't help is the current product range. They tend to be premium vehicles, which are more expensive to buy. However, cheaper electric models will soon be launched.

PS: I believe that modes of transport must be intelligently networked and interact with each other – then exciting models are possible. Model regions are needed where new ideas can be tried out. After an evaluation, model regions can be expanded. At AMAG, we offer mobility solutions with a selection of different vehicles, such as electric cars, bicycles or cargo bikes, to companies or housing developments. These take you to the next level of public transport integration.

How do you see the situation in different European countries, such as Norway or Germany? What can we learn from other countries?

RW: In Norway, there are strong tax incentives for electric vehicles. In Switzerland, however, we have a completely different starting point with our excellent public transport system. Hardly any other European country has such comfortable and punctual trains.

PS: Norway is a special case. Electromobility was promoted there with massive state subsidies and it is now cited as an example, knowing full well that this does not work in other countries.

Unfortunately, Germany is a worse example. Germany has invested massively in electromobility, with subsidies of up to 9,000 euros per electric vehicle. What happened? The electric vehicles were first registered in Germany, the subsidies were received, and then the vehicles were re-sold in Norway.

Plug-in hybrids were also subsidised in Germany. Companies were motivated to switch to plug-in hybrids and collected the subsidies. In the end, very few people drove electrically and then of course it makes no sense to buy a plug-in hybrid vehicle.

There must be a natural and market-driven development in the field of electromobility. What is a bit of a shame in Switzerland is the lack of predictability, such as the fact that electric vehicles are suddenly no longer exempt from import tax from 2024. This sends the wrong signals to industry and consumers. The same applies to the discussion about the ban on combustion engines in 2035, which is unsettling those interested in electric cars.

What's the best way to get consumers to play along?

PS: We know from various studies that 83% of consumers who drive an electric car would not switch back to a combustion engine. Unfortunately, there is still a lot of misinformation about electromobility. That is also the approach we are taking – to really educate people: is an electric car more sustainable than a combustion engine? What happens to the batteries when I no longer need them? A lot of education is still needed.

As Mr Schmid mentioned, there are ongoing discussions in the EU about phasing out new registrations for ICEVs. To what extent are these framework conditions decisive for Switzerland?

PS: By 2035, the majority of vehicles on the market will be electric. Should the state intervene with tough regulations? At the moment, it looks like the market will regulate itself. VW has decided that

Regina Witter

has been working as a transport and spatial planner in Switzerland and abroad for 20 years. She has been Deputy Head of the Urban Transport Programme at the Federal Office for Spatial Development (ARE) since 2019. With the programme, ARE supports cantons and municipalities in financing transport infrastructure that is coordinated with housing development.

Peter Schmid

has worked in the automotive industry for over 30 years in the areas of marketing, sales, and consulting in Switzerland, Germany, and the USA. He heads AMAG's New Mobility Hub at the Circle at Zurich Airport.

the brand will go electric. Mercedes has done the same. BMW may still be a little more open to technology. However, I believe that the market will regulate itself and Switzerland will probably not need to intervene too much.

RW: It works well in Switzerland to explain to people what the positive incentives are. An attractive public transport offer also encourages people to use public transport. It may not work quite as quickly as with restrictive measures, but it is more sustainable because people support it.

Does car traffic in Switzerland have to decrease or is it not a problem if it continues to grow?

RW: Due to the space required, it is certainly not without problems. Transportation infrastructure already accounts for a third of the total settled area in Switzerland. We are reaching our limits in urban areas and it is therefore very important to find alternatives. It is worrying that the car industry is moving more in the direction of large SUVs that need a lot of space. That goes against the idea of efficient land utilisation. It would help a little if more people travelled together in the car. Today, the average occupancy rate in commuter traffic is only 1.09 people per car and journey, which is very low.

I believe that the key solution is to coordinate transport and spatial development. Spatial planning can specify where and how much should be built, but the realisation is almost always up to the private sector. It must come down to the fact that there are also economic reasons to build denser urban areas so that people can enjoy travelling by bike and public transport and don't see it as a problem. It's not that cars are inherently bad. The idea is to see which means of transport is the most suitable and perhaps also the fastest, depending on the area. The fastest in urban areas is the bicycle – up to five kilometres in any case, and with the e-bike even up to 15 kilometres. Most people probably don't realise that.

Do you think that the measures currently being implemented or announced will be sufficient overall to achieve the climate targets in the transport sector?

RW: In my view, things are moving a little too slowly. If everyone took public transport or cycled from time to time, then a great deal would already have been achieved.

PS: I take a similar view. We are probably a little behind schedule, but I don't think anything should be changed now or can be changed in the short term. When the time comes, people in Switzerland will adapt. It may be a slow process, but it is moving in the right direction and is therefore much more sustainable.

In other words: the carrot will be enough, and you don't need the stick.

RW: Certain rules are set. Almost all cities have a management system for parking; you can't just park everywhere for free. Owning a car in cities is not cheap either, and it is becoming increasingly expensive. Let's put it this way: it goes without saying that clear rules are needed to ensure that living together in society works. This also applies to transport and space. Nevertheless, we still live in a democracy. I believe that coercion does not work in Switzerland and tends to have the opposite effect of what we actually want.

Mr Schmid, if you had one wish for the Swiss federal administration in the transport sector, what would it be?

PS: As I mentioned, we need predictability.

And Dr Witter, what would you like to see from the automotive industry?

RW: I think it would be good if more small cars were on the market. I also wonder to what extent AMAG, for example, could get involved in carsharing. Not just selling each owner their own car but offering a model in which several people would use one car together. However, if carsharing were to catch on, it would probably go against your business model of selling more cars.

PS: Of course this would be against the original business idea, but we need to evolve with the times. Every transformation has a learning phase, but alternatives are urgently needed, because simply carrying on as we have done over the last few decades is not an option.

Outlook: realizing net-zero emissions in personal mobility

From manufacturers to policymakers, housing developers to local governments, renters to homeowners, everyone can contribute to making the mobility transition successful.

Agreeing on what the future should look like is the first step towards coordinated action. In this issue of the PSI Energy Compass, we have showcased research and highlighted challenges that show:

- The widespread adoption of battery electric vehicles is the most straightforward and efficient path towards achieving net-zero greenhouse gas emissions in the mobility sector,
- The systemic impact and costs of the mobility transition are manageable in comparison with the external costs of a business-as-usual scenario, and
- Modal shift and increased multimodality come with environmental and economic benefits.

Open questions remain, of course. More research needs to address aspects such as consumer acceptance of new technologies, rebound effects of digitalisation, and modal shift. Many aspects of individual charging behaviour remain unclear. How exactly to secure the electricity supply is also yet to be determined. Another area that urgently requires answers is the topic of recycling and circular economy, especially when it comes to BEV batteries.

Advancing personal mobility within the energy transition demands a holistic approach – one that carefully balances technology, infrastructure, and behavioural change to build a low-carbon society that is both equitable and resilient. At the Laboratory for Energy Systems Analysis, we bring this approach to all our research, aiming to support informed decision-making. We look forward to sharing more in-depth analysis in our next issue.

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Paul Scherrer Institute PSI
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Editorial team
Christian Bauer, Vinh Dang,
Carolyn Kerchof, Russell McKenna
and Kannan Ramachandran

Additional research contributors
Sandro Luh, Romain Sacchi

Editorial support
Melissa Catoja, Martina Gröschl

Translation German edition
Christian Bauer,
Intermundos GmbH (Deutschland)

Translation French edition
Romain Sacchi, Catherine Riva

Layout
Monika Blétry

Photos
Adobe Stock except
page 3: Paul Scherrer Institute PSI,
page 17: ETH Zürich /
Michel Büchel (Regina Witter),
AMAG (Peter Schmid)

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The Laboratory for Energy Systems Analysis (LEA) conducts holistic, analytical research on diverse energy technologies and systems, including nuclear, fossil, and renewables. Our mission is to conduct challenge-driven research that supports decision-making, builds capacity, raises awareness, and advances education in energy systems analysis.

PSI Laboratory
for Energy Systems Analysis
www.psi.ch/en/lea
lea-info@psi.ch

Connect with us on LinkedIn
@PSI Laboratory for
Energy Systems Analysis
(LEA)

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Paul Scherrer Institute PSI
Forschungsstrasse 111
5232 Villigen PSI
Switzerland
www.psi.ch