Zentrum für Technologiefolgen-Abschätzung
Centre d'évaluation des choix technologiques
Centro per la valutazione delle scelte tecnologiche
Centre for Technology Assessment

TA SWISS

Driving the future

The place of electromobility in the Swiss traffic system of the next decades

Abridged version of the TA-SWISS study «Chancen und Risiken der Elektromobilität in der Schweiz»

www.ta-swiss.ch

The study «Chancen und Risiken der Elektromobilität in der Schweiz» was supported by the Swiss Federal Office of Energy SFOE, the Federal Roads Office FEDRO and Federal Office for the Environment FOEN.

Peter de Haan and Rainer Zah
with contributions by Hans-Jörg Althaus, Katrin Bernath, Frank Bruns, Denise Fussen, Marcel Gauch, Patrick Wäger, Rolf Widmer

Chancen und Risiken der Elektromobilität in der Schweiz

TA-SWISS, Zentrum für Technologiefolgen-Abschätzung (ed.). vdf Hochschulverlag AG an der ETH Zürich, Swiss Federal Institute of Technology, 2013.

ISBN 978-3-7281-3487-5

Also available in open access: www.vdf.ethz.ch

This abridged version can be downloaded at no cost at: www.ta-swiss.ch

Content

Electromobility: a brief guide

Electric cars are regarded as a beacon of hope for a less polluting mode of transport. The new electric cars to appear on the market have already proven a success: today, the Nissan Leaf is one of the 25 most widely sold car models worldwide. One of the major obstacles impeding their more prolific propagation is their limited battery range. Given the range of new technologies on the horizon, however, all this is about to change.

Its opportunities...

One of the key benefits of electromobility is that it reduces our dependency on fossil fuels and cuts down on harmful emissions – provided that the batteries are charged with electricity from renewable or low-CO_2 energy sources. The Swiss energy mix with its high proportion of hydroelectric power thus offers favourable conditions for electric cars in the long term. Where electric cars are used for local energy storage, they could even support the planned major expansion of renewable energy production.

For small and light electric cars in particular, information technology will play a decisive role in the field of security. The proactive use of new information technologies could also enable private transportation to be linked to public means of transport. Thus, electromobility could serve as a driver for innovative methods of combined transportation.

The advantages of electromobility will manifest themselves in the longer term as this mode of transport becomes more prevalent. Indeed, by 2025 only one in ten new cars in Switzerland will be an electric car. By 2035, however, it is expected that every second vehicle sold will be powered by electricity. If only the most efficient vehicles prevail, regardless of their form of propulsion, by 2050 overall motorized transportation will produce less than one half of the CO_2 emissions it does at present.

...its risks...

Amid all the euphoria surrounding electric cars and the lower emissions they produce, it is easy to forget that manufacturing them is harmful to the environment. Mining the raw materials and manufacturing the batteries and electronic components both have a negative impact on the environment. Thus, to a certain extent electromobility shifts the negative effects of Swiss transportation to those countries where the vehicles are manufactured or the raw materials required to manufacture them are mined.

If vehicles are powered by electricity instead of by petrol or diesel, the income the state derives from fuel duties will necessarily decrease. This will mean there is less money available for maintaining the road network. The more efficient traditional combustion engines become, the more this situation will be exacerbated. In the medium term, therefore, funds for transportation are likely to be in short supply.

If cars are available that can be operated more cheaply or have a less harmful impact on the environment, this will discourage people from thinking twice before making unnecessary journeys or using public transportation instead. Experience shows that if something is inexpensive and does not produce feelings of guilt, people consume more of it.

...and the most important recommendations

The study conducted by TA-SWISS recommends introducing mobility pricing models in order to offset the dwindling income from fuel duties.

Duties relating to driving performance should therefore be structured in such a way that they foster efficient vehicles and the combined usage of public and private modes of transport.

Efficient vehicles should also be given preferential treatment when granting approval for passenger cars. This should take into account not only the vehicle›s energy consumption during its operational lifetime, but should also assess its environmental impact over its lifecycle as a whole.

In order to prevent negative feedback effects, an increase in the general cost of mobility is needed to ensure that more environmentally friendly and less expensive vehicles do not result in an increase in general traffic.

Last but not least, design and recycling guidelines need to be drawn up so that the materials used can be recycled and our dependency on primary raw materials can be reduced.

1 Various development paths for transportation

The future is plagued with uncertainties. The study on the opportunities and risks for electromobility in Switzerland takes account of this fact and analyses our country›s transport system from today until 2050 based on three different scenarios.

How will our transport system cope with the increasing requirements placed on it? This question has been the subject of constant conjecture ever since people and goods began to be conveyed in large quantities. A much-cited article from the London Times in 1894 predicted that, in view of the rapid increase in horse-drawn carriages on the streets, the city would be buried underneath a good two-and-a-half metre thick layer of manure within the space of fifty years. This forecast soon fell by the wayside as a result of new technical innovations. The prediction made by Gottlieb Daimler around the turn of the 20th century did not fare much better. He said that the number of cars built would max out at 5000. His reasoning: there would not be enough chauffeurs to drive them.

In spite of all the uncertainties that cloud our vision of the future, the study commissioned by TA-SWISS on electromobility in Switzerland makes assumptions about the transport system over the next 40 years. However, the analysis does not content itself with extrapolating established trends. Indeed, projecting the current course of development into the future is only one of the three scenarios examined. The projections are all within the realms of possibility and depend on the framework conditions set by political decision-makers. In addition, the study investigates how well founded its results would prove to be should major influential factors evolve differently than anticipated – for example, if technological progress were to grind to a halt or accelerate more quickly than originally forecast (sensitivity analysis).

Scenario 1: Business As Usual

The «Business as Usual» scenario carries forward development trends from the past and works on the assumption that Switzerland›s automotive future will be driven primarily by technological developments and prevailing market forces, with the state determining efficiency enhancements for new cars in line with the pace of technological progress and consumers not having to get used to smaller cars. This would already constitute a considerable advancement for traditional combustion engines. By becoming significantly more efficient, petrol engines would also become much cheaper to drive, despite not getting any smaller. Or, put another way, even if the current oil price of around USD 120 per barrel were to rise to a maximum of USD 200 per barrel, the price per kilometre driven by car would still fall. The technical optimization of combustion engines required by the «Business as Usual» scenario also applies to the other two projections investigated.

Under the «Business as Usual» scenario, large saloons and off-roaders with conventional combustion engines are still well represented on the streets. Electric cars catch on in niche markets, for example as city cars or rental vehicles. New types of electricity-powered compact cars remain an unusual sight, but electric bikes prove popular.

The rising level of wealth around the globe means that more and more people worldwide are on the move and that demand for electricity and fuel is increasing – with corresponding repercussions for the environment. Switzerland, like other industrialized nations, accords the topic of climate protection only secondary importance and accepts that the target of achieving maximum global warming of two degrees will be missed.

The technical infrastructure for electric cars (e.g. electric filling stations and quick charging stations) develops without any influence from the state. There is no real drive to implement an energy policy focused on improving sustainability; in accordance with the «Business As Usual» scenario from the Swiss Federal Office for Energy, power plants remain connected to the network, while renewable energy sources are slow to get off the ground and are to a large degree developed abroad.

Scenario 2: Spotlight On Efficiency

As the name suggests, the «Efficiency» scenario is all about making cars as efficient as possible – regardless of whether they are powered conventionally by fuel or by electricity. The overriding aim is that transportation should make a greater contribution to saving energy than it has before. Average vehicle sizes become smaller than they are today and hybrids become commonplace. The car fleet can largely be broken down into two categories: saloons that are used for longer distances, and smaller e-vehicles (including three-wheelers) that are used for shorter stretches.

Government efficiency diktats are backed up by a widely accepted climate policy. Switzerland, in line with the package of measures for Energy Strategy 2050 proposed by the Federal Council, strives to limit its dependency on imports from abroad by promoting the more efficient use of fuel and electricity. The country is regarded as a pioneer in terms of its guidelines on energy-efficient buildings, equipment and processes in international comparison, and it champions the development of renewable energy sources.

The tax authorities favour efficient vehicles by issuing preferential conditions, and the higher energy prices mean that people start buying more efficient cars even though the costs of procuring them are higher. The charging infrastructure for electric vehicles establishes itself largely without any government intervention, while the public sector also steers clear of any research programmes into forms of propulsion.

Scenario 3: Networked and Flexible Mobility

The world around us is becoming smarter, and the transport system is continually gaining in intelligence. In Switzerland, smartphones that can connect to the Internet have long taken over from traditional mobile phones, putting previously inaccessible information right at our fingertips. Passengers in buses and trains can call up timetables when they are travelling. Rental cars can be booked from home or while on the move, and information technology makes the vehicles themselves safer and more user-friendly. The «Networked Mobility» scenario links these approaches to transport telematics and sketches out how the transport system might look in a highly evolved information technology society. The various modes of transportation will increasingly be integrated with one another more closely. Longer stretches will be covered by train or bus and lightweight electric cars, some of them with only three wheels, will be used for shorter distances, the fact that their range is limited by their batteries not being an issue in such a scenario.

Smart information systems also ensure that everyone who is on the move always receives the latest information, updated in real time, about available parking spaces, the nearest charging stations and valid timetables. This information technology will also be used «at the tank» to determine flexible electricity pricing that is adjusted for supply and demand, while, at home, the same technology enables users to charge vehicle batteries when electricity is at its cheapest.

The large number of electric cars in use means that the public sector collects the money it needs to maintain and develop the transport infrastructure no longer through taxes on petroleum, but rather through so-called dynamic road pricing, which means that people who use congested roads during rush hours have to pay more for the privilege, and inefficient cars are subject to higher rates than efficient ones.

In this scenario, the state plays a key role in developing the infrastructure required; it determines the standard for quick charging connectors and plans quick charging stations along the motorways. It attaches a great deal of importance to climate policy and promotes the development of renewable sources of energy.

Interdisciplinary project team – multifaceted analysis

The study by TA-SWISS on «Opportunities and risks for electromobility in Switzerland» bundles the competences of the engineering and consultancy firm Ernst Basler + Partner (EBP) and the Swiss Federal Laboratories for Materials Science and Technology (EMPA). Headed up by Peter de Haan (EBP) and Rainer Zah (EMPA), the project team modelled various scenarios for the transport system of the future and determined the associated environmental impact. In addition to their own calculations, the project group also incorporated federal government statistics and forecasts. The latest Energy Perspectives from the Swiss Federal Office of Energy (SFOE) served as a basis for this analysis; these were subsequently substantiated by the calculations performed.

2 From private vehicles to integrated transport

The repercussions of electromobility on society and the environment are multiple and varied. The scope of the study was equally broad: for example, it analyses the technical data pertaining to various vehicle models and form of propulsions, takes account of foreseeable trends in car production and also factors in electricity generation.

Various models of electric car are already available for purchase. However, their limited battery life and comparatively higher procurement costs are standing in the way of them becoming more widespread. Given the range of new technologies on the horizon, however, this is set to change.

Batteries offer better performance

Lithium-ion batteries are most frequently used for electric cars, although sodium-nickel chloride cells are also integrated into various models. The battery is the most expensive component of an electric car. The acceptance and proliferation of new vehicles will thus be heavily dependent on battery range and costs.

Lithium-ion batteries were only introduced into the electric car market in 2011. They have an estimated lifespan of between ten and twelve years. Opel provides a guarantee of eight years or 160 000 kilometres for the battery used in its Ampera five-door hybrid, compared to five years or 100 000 kilometres by Nissan and Mitsubishi for the smaller Leaf und iMiev, respectively.

The development and production of the next generation of batteries will take four to five years. The aim is to create a greater energy density and to lower production costs. Specialists estimate that by 2035 battery capacity will increase from the current 100 to 300 Wh/kg, while costs will fall from USD 900 to 250 per kilowatt of storage capacity. For an accumulator weighing 300 kilograms, this means that its range will increase from around 150 kilometres today to 600 kilometres – a substantial gain.

If electric cars are powered by electricity derived from renewable or low-CO_2 energy sources, they will produce fewer pollutants. Manufacturing the batteries will continue to harm the environment, however – indeed, this can account for up to one fifth of total CO_2 emissions. This underlines how important it is when assessing the ecological impact of electromobility to consider the entire lifecycle of the vehicle, from manufacture all the way through to disposal.

Lots of potential for optimization

The engines and engine control units of electric cars, unlike their batteries, have come a long way since the early days. The calculations contained in the study work on the assumption that, today, an electric-powered engine has an efficiency factor of 89 percent when travelling outside the city. This will increase gradually by another three percentage points by 2050, to an efficiency factor of 92 percent outside the city and 87 percent in city traffic with lots of starts and stops.

In contrast to electrically-powered engines, traditional combustion engines still harbour considerable potential for improvement. Today, petrol-powered vehicles have an efficiency factor of 17 percent in city traffic and 27 percent in non-urban areas, on average. Based on the prevailing specialist literature, the models used in this analysis assume that the efficiency factor will increase by three or two percentage points every fifteen years. Thus, in 2050, this factor will rise to 26 percent in city traffic and 33 percent in non-urban areas.

Efficiency is continually on the rise

Not only engines, but bodywork, safety and comfort systems – including features such as headlights, windscreen wipers, air conditioning and entertainment systems – also offer considerable potential for improvement. With cars having continually increased in weight over the decades, in recent years a change in trend has begun to emerge The study anticipates that improved construction, materials and processes will lead to further slight reductions in weight, with energy requirements for security and comfort features also set to decrease.

By combining the various improvements, the analysis models the possible efficiency gains for vehicles of the future: a compact electric car that currently requires 24 kWh to travel 100 kilometres will in 2035 require only 16 kWh – an energy saving of 30 percent. Petrol-powered vehicles belonging to the same class will see even greater gains: a compact car that today uses 7.5 litres of petrol per 100 kilometres could, according to these calculations, be using only 4.8 litres by 2035 – a reduction of 36 percent. This greater optimization potential of combustion engines is reflected in a higher efficiency gain.

Supply and demand – assembly and purchase

In order to assess the environmental impact of transportation as a whole, we need to shift our focus from individual cars to the entire vehicle fleet. To this end, the study models the prevalence of the various vehicle types, including compacts, compact saloons and large, heavy vehicles. In the electric car segment, lightweight vehicles such as the Renault Twizy are also taken into account.

The modelling process is based on two key factors: the development of demand for new cars, and the time-consuming increase in production capacity for electric cars. This ensures that the estimates pertaining to the future vehicle fleet in Switzerland are derived from realistic assumptions. The TA-SWISS study forecasts annual technical progress, makes hypotheses about new vehicles coming onto the market and proposes a virtual buyership, what makes it different from other analyses is that it does not make speculations on the market share of electric cars without taking into account consumer preferences and the ongoing improvements made to petrol-powered cars.

Transport trends and energy production

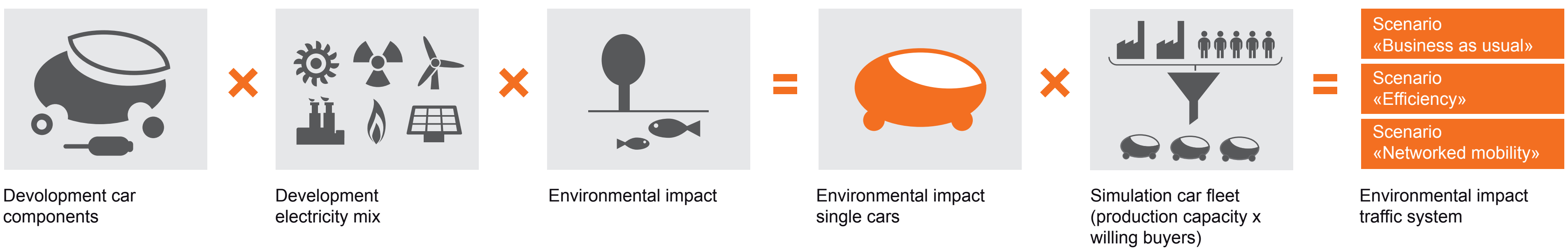
How severely transportation will harm the environment going forwards depends not only on how much people travel, but also on the energy form they use to power their vehicles.

The study draws on statistics and forecasts from the federal government. Calculations regarding foreseeable population trends, transportation forecasts, and the perspectives and strategies of the Federal Offices for Statistics, Spatial Development and Energy form the indispensable basis for modelling the future of private transportation and the associated energy requirement.

Various levels of electrification

Electric vehicles as defined in the TA-SWISS study refers to cars that are powered primarily by an electric motor and derive the majority of their electricity from a stationary source. Small vehicles that for registration purposes are classified as motorcycles or light vehicles are also taken into consideration. In addition to cars that are powered exclusively by electricity, the classification also comprises hybrid vehicles that have both an electric and a combustion engine. The study only includes those models that can be charged directly from the electricity grid and can travel at least 20 kilometres when operated by battery power alone. Experience shows that, based on this range, more than half of the mileage required for day-to-day city travel can already be covered by electricity from the grid.

Electromobility study: Various steps to a complex structure



3 En route to sustainable mobility?

Combustion engines are becoming more and more efficient, and electric cars are already emitting fewer pollutants. A key factor in this equation, however, is that these cars should be powered by electricity that is not derived from fossil fuels.

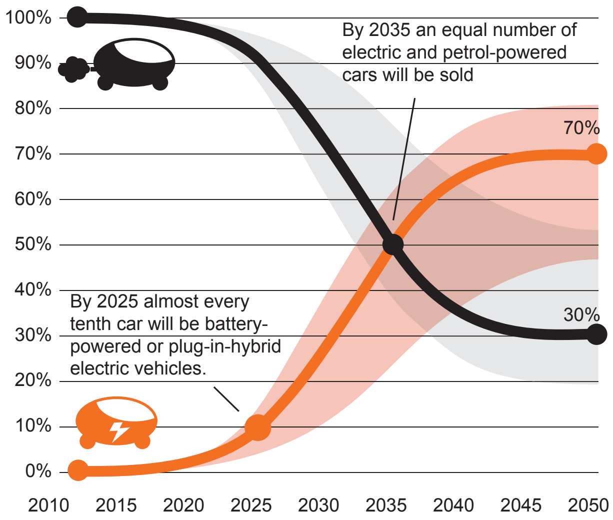
Even if individual cars become more energy efficient, this does not mean that mobility overall will have less of an impact on the environment. With that in mind, separate lifecycle analyses are used for individual cars and for overall traffic. The comprehensive mobility analysis is again based on the three scenarios outlined above.

A lifecycle analysis describes the evolution of a product from its manufacture right through to its disposal, drawing a distinction between various «life stages» and determining in particular which materials and how much energy are required to produce, operate and dispose of a good. This study highlights the changes that occur over time by analysing the lifecycle of the various vehicle types and overall mobility within the context of the three scenarios at four specific points in time – 2012, 2020, 2035 and 2050.

Different engines, different life stages

Viewed from the perspective of the entire lifecycle, the carbon footprint of conventional combustion engines is approximately 70 percent higher than that of electric cars powered by electricity generated at home. One of the main reasons why plug-n-gos compare so favourably, however, is that the Swiss electricity mix consists to a significant degree of hydroelectricity and nuclear energy, with only a small proportion being derived from fossil fuels. By contrast, if the electric car is charged using the average EU electricity mix, of which 52 percent is derived from fossil fuels, the CO_2 reduction compared with a conventional car is reduced to just 20

Sales percentage



The percentage of electric cars on Swiss roads will increase, whereas the percentage of petrol-powered cars will slowly decrease.

percent. Powered by electricity like this, electric cars are barely any environmentally and climate-friendlier than cars with optimized combustion engines.

Since traditional combustion engines have such a high potential for improvement, they will begin to catch up with engines that run on electricity as time goes on. By 2050, therefore, the difference in terms of the resources consumed by electric and traditional compact car models will be cut in half.

While cars with conventional drives emit the majority of CO_2 during the operating phase (that is, when they are being driven), in the case of electric vehicles the CO_2 impact occurs much earlier – that is, when the electricity that powers the vehicle is produced. The manufacturing process for the batteries also plays a crucial role. Viewed from this perspective, 90 percent of greenhouse gas emissions for purely battery-operated vehicles are generated during the production phase; this creates a carbon footprint roughly one quarter greater than for the construction of a conventional petrol-powered vehicle. Here, too, however, the picture is shifting: while in the case of conventional combustion engine currently 25 percent of harmful emissions occur during the production phase, in the longer term this figure will rise to 40 percent – not because production is becoming more environmentally harmful, but rather because engines are becoming efficient, thus reducing the pollutants generated during the operating phase and increasing the comparative contribution of the other life phases.

Consumption of materials and repercussions for health and the environment

If electromobility increases, so will the demand for lithium, an important component of the batteries currently on the market. Rare earth elements are also indispensible in the construction of electric cars, such as neodymium and dysprosium for the permanent magnets in electric engines or lanthanum for certain types of battery.

The problem here lies not in the geological availability of these materials, but rather in their concentration at just a few locations. This effectively results in monopoly-like situations where individual countries and a handful of companies control supply. The situation is compounded yet further by the low recycling rates and lack of alternatives for these materials. An increase in demand can be counteracted by various strategies. From the point of view of the car manufacturers, special attention needs to be paid to improved recycling options and the more efficient use of raw materials or possible alternatives for their replacement.

If more electric cars are circulating on the streets, it is probable that road safety will improve. Electric vehicles tend to be smaller and lighter. In order to offset any shortcomings in terms of the strength and stability of their bodywork, more active security systems could be developed, such as early detection programmes for pedestrians or other electronic assistance systems. Electric engines are also smaller compared to conventional ones. This enables different front-end configurations so that pedestrians are less at risk of sustaining severe head injuries in the event of a crash. A growing degree of electrification also goes hand in hand with lower maximum speeds, which should result in a reduction in the number of road accidents caused by speeding. The fact that electric cars are quieter to drive is a mixed blessing. Whereas people who live next to busy streets will no doubt welcome the reduction in traffic noise, the risk to those who are visually impaired and who rely primarily on hearing to alert them to oncoming vehicles will increase. Acoustic orientation also plays an important role in quiet areas with little traffic. In the US, the possibility is being discussed of installing acoustic warning devices on hybrid cars, while in Japan a guideline was introduced with effect from January 1, 2010 on measures to make hybrid vehicles easier to hear.

Our mobility harms the environment in various ways. As far as their impact on the landscape and urban settlements are concerned, vehicles powered by petrol or diesel are no different from those powered by electricity in terms of their demands on our transport infrastructure. It is also difficult to compare the methods of producing the various propellants with one another: while in the case of fossil fuels it is primarily the extraction of crude oil that scars the landscape, electricity production requires large decentralized or numerous smaller local facilities that mar the view for those living nearby.

A significant ecological advantage of electromobility lies in the fact that the efficiency factor of engines powered by electricity is significantly higher than that of combustion engines. Electric motors thus have the potential to reduce greenhouse gas emissions. The life cycle analysis for private vehicles confirms that the environmental impact of electric cars is 40 to 50 percent lower than the environmental impact of cars powered by fossil fuels. However, this difference will become smaller over time. Electric vehicles also consume around half of the resources of those with combustion engines. The key factor that tips the balance in favour of electromobility is Switzerland›s opportune electricity mix.

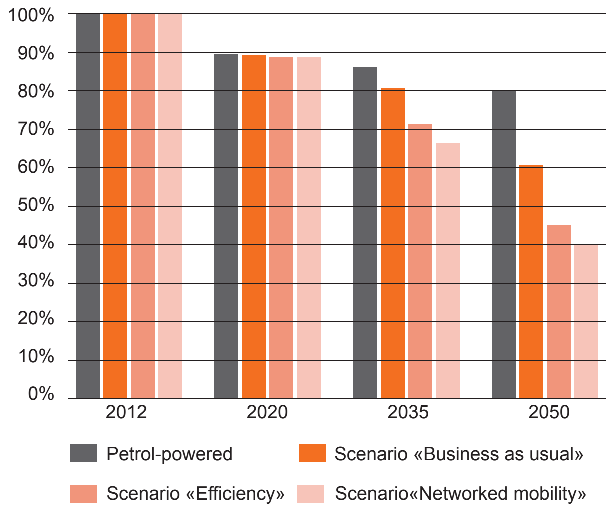
It should be borne in mind, however, that in the case of electric-powered cars it is not their operation but rather their manufacture that is the main source of pollution. In a country like Switzerland that does not manufacture any cars, this means that electromobility helps export the negative effects of transportation to other countries.

Lifecycle analysis for overall traffic

Alongside its own calculations, the study incorporates various traffic and energy forecasts from the federal government in its lifecycle analysis for overall traffic, in particular the Energy Strategy 2050 proposed by the Federal Council (as of end-2012) containing analyses on the future electricity mix in Switzerland.

The vehicle fleet has a large influence on how the individual scenarios play out. In the «Business as Usual» scenario, the proportion of the three vehicle classes examined - compacts, compact saloons and large vehicles - remains constant. In the «Efficiency» scenario, by contrast, there is a shift towards greater numbers of small vehicles - a shift that is amplified yet further in the «Networked Mobility» scenario. The composition of the vehicle fleet also has an impact on the fleet kilometres: Under the «Business as Usual» scenario, 59 percent of journeys will still be made using combustion engines

Greenhouse gas emissions (car fleet), compared to 2012



«Normal» technical progress alone will lead to a reduction of carbon emissions. A high percentage of electric vehicles will reduce the emission of greenhouse gas in an even more significant way.

in 2050, compared to 46 percent under the «Efficiency» scenario and 39 percent under the «Networked Mobility» scenario.

In the final analysis, all three scenarios will entail a massive decrease in overall greenhouse gas emissions of at least 40 to 60 percent by 2050 – despite the fact that mobility will increase by 24 percent during the same period. The reduction in harmful emissions can be attributed in part to the massive technical progress made with combustion engines, and on the other to the growing proportion of electric cars.

Even if the differences seem rather pronounced in the long run, the scenarios differ very relatively little until 2020. By 2035 the difference in CO_2 reduction between the conservative «Business as Usual» scenario and the optimistic «Networked Mobility» scenario is 17 percent. By this time, every second new car will be an electric car. Since older vehicles are only eliminated from the fleet on a gradual basis, the technological trend reversal is subject to a delay of five years; it takes over ten years for the entire vehicle fleet to be replaced.

The differences between the two scenarios therefore only begin to manifest themselves more clearly in the middle of the 21st century – at a point when electromobility has broken through on the market and more than two thirds of new cars have an electric drive. By this time, the «Efficiency» scenario produces 25 percent less greenhouse gas emissions than the «Business as Usual» scenario. The difference between the «Efficiency» and «Networked Mobility» scenarios, by contrast, is 13 percent.

How reliable are the results?

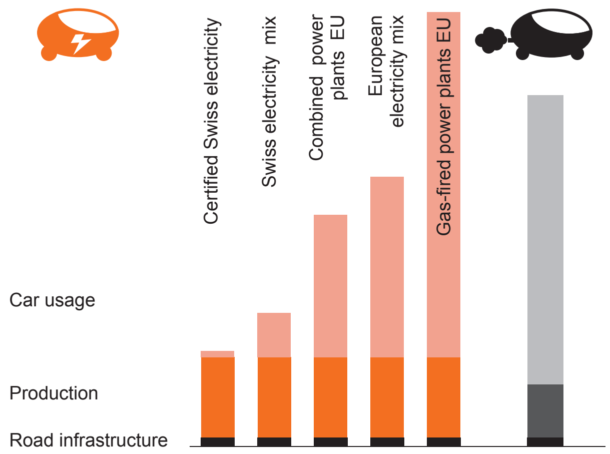
The study compares the results from its calculations with values from literature and also variegates certain assumptions that serve as a basis for the modelling as part of a sensitivity analysis.

In contrast to other specialist publications, this analysis assumes a lower reduction in greenhouse gas emissions enabled as a result of electromobility. This is due to the fact that most studies limit themselves to the operating phase of vehicles. It is inevitable that an analysis that also takes into account the environmental impact resulting from the vehicle manufacturing process will come to a more pessimistic – or rather realistic – conclusion.

The reliability of the simulation was also questioned by varying some of its basic assumptions. In one scenario it was assumed that the technological advances that were anticipated for electric cars would fail to materialize. Even if these technical advances do not materialize, however, the carbon footprint of electric cars will still be significantly lower than that of cars with combustion engines.

Finally, the impact of the operating energy used is also assessed. The results confirm that the degree to which electric cars are environmentally friendly is to a large extend dependent on the type of electricity used. While a compact electric car powered by the Swiss electricity mix now emits 70 percent less CO_2 than a comparable petrol-powered car, this advance is reduced to 20 percent if the battery is charged with a European electricity mix containing a higher proportion of fossil fuels. The negative repercussions of the European electricity mix will in future become even more pronounced: a car powered by this type of electricity would only produce 10 percent less CO_2 compared with a conventional vehicle by 2050.

Greenhouse gas emissions per kilometer



If electric vehicles are powered by fossil fuel electricity they do not perform better in environmental terms than combustion engine vehicles.

4 Efficiency will lead the way

The advantages of electromobility clearly outweigh the disadvantages for a country like Switzerland with its specific electricity mix. Its risks can also be limited by instigating the right measures.

The greenhouse gas emissions produced by vehicles will decline over the coming decades and electromobility could make a vital and significant contribution to this reduction in Switzerland, not least because the Swiss electricity mix consists to a large degree of hydroelectric power and nuclear energy. While the official Energy Perspectives from now until 2035 anticipate increasing electricity imports from gas-fired power plants in order to offset the losses from decommissioned nuclear power plants, electric cars will continue to do well, and after 2035 the proportion of electricity from gas-fired power plants will again fall in favour of electricity from renewable sources.

Even if more electric cars are on the roads in future, according to the Energy Perspectives the amount of electricity available will be more than sufficient to cover the associated increase in demand. This is due to the fact that - thanks to their higher efficiency - electric-powered vehicles require relatively little electricity. Thus, in 2050, nine percent of Swiss electricity production could meet the needs of 65 percent of motorized personal transport.

Electromobility also harbours significant potential for the economy. Swiss firms are today already manufacturing specific components for electric vehicles in research-oriented sectors - creating jobs for qualified staff and enhancing Switzerland›s attractiveness as a business centre. However, the Swiss economy needs to keep pace with the latest developments so that it does not lose touch with other innovative areas of the economy. If electromobility takes off, this should be welcomed not only from an ecological perspective, but also from an economic standpoint.

Alternative financing models for infrastructure

Alongside the opportunities created by electromobility, it will also exacerbate the difficulties that are already starting to emerge in terms of financing the road infrastructure. Until now, the funds required to maintain the roads have come from the fuel duties that have flowed into the state coffers. This financing model is now on shaky ground as it allows electric cars to use an infrastructure they are not helping to support. What is more, with conventional vehicles using ever less petrol or diesel, this source of income risks running dry completely.

From a technical perspective it is almost impossible to separately record and tax the electricity used to charge electric cars in the same way as when filling up at the petrol tank. This makes the switch to a kilometre-based system of taxation all the more urgent. Ideally, driving performance-dependent taxation would be staggered according to vehicle efficiency in order to favour cars that are especially efficient. Such an approach would also have the desired effect for cars with combustion engines in that efficient models are given preferential treatment and therefore become more attractive to consumers.

No promotion of specific form of propulsion

A comparison of the three scenarios clearly shows that the greatest gains for the environment are to be achieved by improving efficiency. The «Networked Mobility» scenario (the objective of which to advance the promotion of electromobility) results in only a comparatively small gain on the «Efficiency» scenario – a clear indication that technology-specific development measures should be avoided due to their minimal marginal benefit

Measures such as minimum requirements, maximum values and sales-weighted averages relating to the overall energy efficiency of passenger cars make a lot more sense, however. Such provisions make an indirect contribution to fostering electromobility. Another advantage of this strategy is that there is no risk that it will have unwanted or even counter-productive repercussions as a result of difficult-to-predict technical innovations.

Focus on the entire lifecycle

However exciting the prospect of low-pollution electric propulsion may be, this should not make us lose sight of the environmental damage caused by manufacturing electric vehicles. Energy labelling for the purposes of assessing vehicle efficiency should therefore take into account the entire lifecycle of the vehicle.

In order to prevent us from becoming dependent on raw materials, attention should be paid right from the outset to the subsequent recycling of the materials used.
The rental or reuse of batteries could give rise to new business areas – areas whose advancement should be subject at least to initial investigation.

If electric cars are to make a meaningful contribution to sustainable transportation, ultimately we must ensure that transportation does not increase more than the environmental gain that is generated by more efficient vehicles. Here, we need to have the courage to take unpopular measures such as cutting subsidies for commuter traffic. A broad debate on the future of our transport system could encourage public acceptance of such measures.

Study «Opportunities and risks of electromobility in Switzerland»

Supervisory group

Ruedi Jörg-Fromm, Zürich, TA-SWISS Steering Committee (chairman of supervisory group)

– Heidi Blattmann, Science journalist, Herrliberg, TA-SWISS Steering Committee
– Christian Bühlmann, Swiss Federal Office of Energy SFOE, Ittigen
– Volker Fröse, Federal Roads Office FEDRO, Bern
– Lino Guzzella, ETH Zürich, Swiss Federal Insitute of Technology, Zürich
– Stefan Hirschberg, Paul Scherrer Institute PSI, Villigen
– Kurt Hug, University for Applied Science of Bern, Vaufflin
– Christian Jahn, Federal Roads Office FEDRO, Bern
– Mario Keller, INFRAS, Bern
– Dieter Kraft, Bosch, Stuttgart
– Cornelia Moser, Federal Roads Office FEDRO, Bern
– Tobias Ott, ETH Zürich, Swiss Federal Insitute of Technology, Zürich
– Felix Reutimann, Federal Office for the Environmnet FOEN, Bern
– Martin Schiess, Federal Office for the Environmnet FOEN, Bern
– Fridolin Stähli, University for Applied Science Northwestern of Switzerland, Windisch
– Daniel Wachter, Federal Office for Spatial Development ARE, Bern
– Michael Weber, Federal Office for the Environmnet FOEN, Bern

TA-SWISS project supervisor

Lucienne Rey

Impressum

TA-SWISS (ed.) Driving the future. The place of electromobility in the Swiss traffic system of the next decades.

Abridged version of the TA-SWISS study «Chancen und Risiken der Elektromobilität in der Schweiz», TA-SWISS, Bern 2013.

TA 59A/2013

Author: Lucienne Rey, Bern
Editing: Christine D'Anna-Huber, TA-SWISS
Translation: CLS Communication, Basel
Layout: Hannes Saxer, Bern
Printed by: Jordi AG – Das Medienhaus, Belp

TA-SWISS – The Centre for Technology Assessment

New technology often leads to decisive improvements in the quality of our lives. At the same time, however, it involves new types of risks whose consequences are not always predictable. The Centre for Technology Assessment TA-SWISS examines the potential advantages and risks of new technological developments in the fields of life sciences and medicine, information society, nanotechnologies as well as mobility, energy and climate. The studies carried out by the Centre are aimed at the decision-making bodies in politics and the economy, as well as at the general public. In addition, TA-SWISS promotes the exchange of information and opinions between specialists in science, economics and politics and the public at large through participatory processes, e.g. PubliForums and publifocus. Studies conducted and commissioned by the Centre are aimed at providing objective, independent, and broad-based information on the advantages and risks of new technologies. To this purpose the studies are conducted in collaboration with groups comprised of experts in the relevant fields. The professional expertise of the supervisory groups covers a broad range of aspects of the issue under study. TA-SWISS is a centre for excellence of the Swiss Academies of Arts and Sciences.

TA-SWISS
Centre for Technology Assessment
Brunngasse 36
CH-3011 Bern
info@ta-swiss.ch
www.ta-swiss.ch

A Centre for Excellence of the
Swiss Academies of Arts and Sciences

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Federal Office of Energy SFOE
Federal Roads Office FEDRO
Federal Office for the Environment FOEN