Forschungsprojekt „E-Scooter“
IKAÖ Interfakultäre Koordinationsstelle für Allgemeine Ökologie
Universität Bern, Schanzeneckstrasse 1, Postfach 8573, 3001 Bern

E-Scooters Research Project: Executive Summary

E-scooters: Social and natural scientific contributions to promoting light electric vehicles in Switzerland

Background and aims

The past two or three years have seen increasing government and public interest in energy issues generally and in electromobility (use of electric vehicles) as a source of hope for less environmentally harmful mobility. Scooters propelled by electric motors (e-scooters) have considerable potential for reduction of energy demand, greenhouse gas emissions, air pollution and traffic noise (Buwal 2004). But even though e-scooters have been on the market in Switzerland since the 1990s and were promoted in a large-scale fleet test with lightweight electric vehicles (LEV) in Mendrisio and the partner communities (1995-2001), there has been as yet no breakthrough. This interdisciplinary research project aimed to contribute towards the technical development of e-scooters[1], support the market launch of these new vehicles through research evidence, and analyse their impacts on energy, environment and mobility behaviour. The work on the research questions was structured in the following six work packages:

- “Players and Market Development” examined global market developments and the needs and opportunities of the market players (dealers, manufacturers, importers).
- “Technology” conducted studies on suitable e-scooter battery types, electric vehicle charging infrastructure and traffic safety.
- “Promotional Measures” evaluated existing and other conceivable measures.
- “Energy and the Environment” developed lacking bases in the area of e-scooter life cycle inventory (LCI) and life cycle assessment (LCA), focusing on manufacture, use and disposal/recycling.
- “User Behaviour” studied e-scooter users’ energy consumption, travel distances, charging habits and mobility behaviour.
- “Project Management and Communication” comprised the content and administrative management of the entire research project, coordination of the work packages and joint representation vis-à-vis third parties.

[1] There is no uniform, standardised definition of e-scooter in the literature. For this reason, the research team used the following working definition at project start in 2009: *E-scooter is a collective term for motorcycles and motorbikes with electric motors*. Over the duration of the project (2009-2013), there were significant changes on the vehicles market: New three- or four-wheeled electric motor vehicles were approved in Switzerland and made available for purchase, and they were also assigned to the category “e-scooter”.

Procedure and methods

The methods used in the research project are described in the following for each work package.

Work package: Players and Market Development

The global and national market development of e-scooters was followed and documented using a number of different and coordinated approaches (including participation at trade fairs and exhibitions, visits to national and international conferences, diverse newsletters and personal contacts). For analysis of the previous diffusion process in Switzerland, a comparative niche analysis based on the technological innovation system (TIS) approach (see Walter 2012) was conducted and Rogers' (2003) diffusion theory applied. In addition, interviews were conducted with e-scooter and motorcycle dealers on their assessment of e-scooters.

Work package: Technology

The focus here was on reliability, electric vehicle charging infrastructure and traffic safety. The reliability of e-scooters was recorded and evaluated with an e-scooter user questionnaire (see below). For regions that wish to support the use of e-scooter, a guide to developing a charging station concept was prepared. For examining traffic safety, we conducted electro-technical studies of e-scooters in cooperation with Electrosuisse2 and analysed aspects that are specific to e-scooters—low noise level, inexperienced new drivers—in cooperation with the Swiss Council for Accident Prevention (bfu).

Work package: Promotional Measures

This work package analysed the different promotional measures for targeted development, market introduction and market penetration of e-scooters. Previously implemented promotional measures (in the framework of the "NewRide" programme, for example) and planned measures were collected, evaluated and assessed through desk research and written up in various reports.

Work package: Energy and the Environment

Here, previously lacking bases were created for: (1) measurement of energy consumption of e-scooters, and (2) life cycle inventory (LCI) analysis and life cycle assessment (LCA) of e-scooters. Most of the inventory data were integrated into the world's largest LCA and LCI database, the ecoinvent database v2.2.

[2] Electrosuisse is the Swiss professional association for electrical, energy and information technology.

Work package: User Behaviour

To analyse user behaviour—that is, the effect of an e-scooter purchase on mobility behaviour and the specific energy consumption of the e-scooter in practical use—a written survey of 55 e-scooter users in the German-speaking and French-speaking parts of Switzerland was conducted.

Results

(1) Work package: Players and Market Development

Global and national market development

Our analyses show that first global scooter manufacturers (such as Peugeot, Yamaha, PGO, Piaggio) have put e-scooters on the market, and others (BMW, for example) have announced that they will do so in the future. In addition, diverse specialised manufacturers of e-scooters have been present on the market for years but have had little success, with the exception of the Swiss company Kyburz with its DXP model. The e-scooters produced in large quantities in China and other Asian countries do not yet meet the quality requirements of the European market. However, at international exhibitions the Asian manufacturers are presenting more and more products that are being developed specifically for the European market. It is thus only a matter of time before high-quality e-scooters from Asia are available for purchase in Europe.

Since 2008 the Swiss Post has been transforming their entire scooter fleet from fossil fuel-powered to electric vehicles, ordering 1,600 units each year. These vehicles are demonstrating the reliability and cost effectiveness of the e-scooters and the technology.

Analysis of the previous e-scooter diffusion process in Switzerland

In Switzerland the market growth of e-bikes is considerably ahead of e-scooters, even though they have been on the market for about the same length of time. Possible explanations for the differing diffusion of e-bikes and e-scooters were found: The TIS analysis reveals that beyond the initial “protective space” that shielded the two niche innovations from inhibitory selection pressures, the interplay between product characteristics, niche characteristics and the selection environment was critical for the two different diffusion pathways. For further growth of e-scooters, it is important to strengthen in a targeted way the two TIS functions “creation of legitimacy” and “strategic steering and orientation”. Also Rogers’ (2003) diffusion theory perspective interprets the different diffusion potential of e-bikes and e-scooters: The following characteristics of innovations are stronger for e-bikes than for e-scooters: “observability” (the extent that the effects of an innovation are visible to others), “trialability” (you can try out the vehicle before purchasing it) and “relative, personal advantage” (e-scooters have strong personal advantages over other products).

Dealers as the most important players

Dealers are the most important players in the process of demand growth of e-scooters. However, they meet the requirements of sales-boosting communication, such as advertising and sales promotion, only in part. Both the e-scooter dealers (N = 20) and motorcycle dealers (N = 102) surveyed find the most important disadvantages, or problem areas, of e-scooters to be their high purchase price, the battery and the limited vehicle range. Interest, know-how and willingness to attend continuing education courses on e-scooters are very low among all actors overall. There is currently no trust in the technology and in today's importers of e-scooters, and all of the dealers surveyed demand technological development of the product.

(2) Work package: Technology

Reliability of e-scooters

Evaluation of the e-scooter user questionnaire shows that the most frequently named sources of error are the electrical components and the vehicle battery. According to dealers, the manufacturing quality and the reliability of the components have definitely improved, and the number of warranty cases has decreased. The cause of battery defects is often not the battery cells themselves but rather their protection circuits (battery management system) and/or the charger.

Battery charging infrastructure

With some e-scooter models the batteries, depending on weight, can be detached from the scooter for charging. Thanks to advancements in battery technology and division of the battery capacity in several (detachable) packs, this will become possible for larger and larger motor vehicles. Built-in batteries in e-scooters are mainly charged at home. If that is not possible, the lack of a battery charging infrastructure can be a purchase obstacle. At present, the main function of public charging stations at parking places for two-wheeled vehicles is to draw attention to e-scooters. At this time we do not see a demonstrated need for public charging stations.

Traffic safety

"Motorcycles" is the motor vehicle category with the highest accident rates. In addition to the dangers entailed with all motorcycles, for e-scooters there are new possible dangers as well, such as cables lying around in public spaces (stumble danger) and external charging devices (dampness). It is still unclear whether accident rates for e-scooters differ overall from the rates for traditional motorcycles. Like all electric vehicles, e-scooters, too, cannot easily be heard at speeds below 30 km/h. In the spring of 2012 the Federal Council added a new regulation to the ordinance on Technical Requirements for Road Vehicles (VTS), according to which electric

vehicles may be equipped with noise generators to ensure that they are heard; the noise level is limited and does not constitute a noise emission.

(3) Work package: Promotional Measures

Financial incentives

Full-coverage and coordinated (with regard to subsidies among the municipalities) promotion through purchase incentives does not exist. The size of the purchase incentives varies greatly from about 5% to 25% of the purchase price. According to our analyses there have been no big windfall gains. In addition to one-time purchase incentives provided by the municipalities, in most cantons e-scooters are also promoted through motor vehicle tax rebates. But compared to purchase incentives, motor vehicle tax rebates are of secondary importance, because they are modest in amount and are not visible once, at purchase, but rather yearly on the tax bill.

E-scooter exhibitions and SWISS-MOTO 2009-2013

At the national level, motor vehicle trade shows and exhibitions that allow test drives are a central activity of e-scooter promotion. In this research project, we evaluated both the E-Scooter-Testtage (e-scooter test drive days held by NewRide) and the special e-scooter shows at the SWISS-MOTO Motorcycle, Scooter and Tuning Show. Overall, the Testtage proved to be an excellent instrument for publicising the e-scooter. Evaluations of the e-scooter shows held since 2008 at the SWISS-MOTO reveal that the great effort entailed is justified, as shown by the very positive response by the public, with visitor attendance figures from 30,000 to 40,000 and about 1,000 test drives on average each year. Even though the various actor groups (exhibitors, dealers, visitors) expressed high satisfaction with the special e-scooter shows, it must be noted that (also) the SWISS-MOTO provided no decisive boost for market growth.

Further promotional measures

In Switzerland and in other countries, the promotional measures have focused exclusively on measures that may support the market uptake of e-scooters through a “pull” effect. These pull measures are financial incentives, information and communication measures and possibly the test drive opportunities. This mix of measures alone has not been shown to stimulate the market launch of e-scooters to the desired extent.

(4) Work package: Energy and the Environment

Energy requirements and range

We collected energy consumption data for e-scooters, since consumption and range are essential for determining realistic life cycle consumption of vehicles. The data show that the energy

demand of the e-scooters tested on a roller dynamometer and in normal operation correspond well to the modelled values. The models used and the analyses based on them in MS Excel and MatLab are available. We also found that the grid energy demand is in part clearly higher than the operating energy requirements—that is, the charging process often involves losses (10%-30%). Some charging devices and battery management systems are apparently inefficient, especially when the battery is already almost fully charged.

Specific life cycle inventory (LCI)

Life cycle inventories of selected examples for all relevant components of the powertrain and chassis were produced and have been made available for free (in tabular form in MS Excel and in the LCA software SimaPro). A comparison of the LCI of functionally identical components but different types and sizes (for example, very different electric motors) shows a mostly insignificant dependency of weight-specific environmental impacts on fundamental design parameters. For instance, the global warming potential per kilogram of all electric motors examined over the entire life cycle is approximately the same, regardless of rated power, torque and design principles. In addition, we further developed noise emissions theoretically as a new indicator and as one that is relevant for electromobility.

Specific life cycle assessment (LCA)

Concerning environmental impacts, using an e-scooter is more favourable than practically any other means of transportation for which calculations are available; even public transport scores worse than e-scooters (due to long ways around and low occupancy, for example; see Figure 1). One of the most important factors is the “cleanness’ of the electricity used. If it is “clean”, environmental damage of vehicle manufacture is far higher than the environmental damage of vehicle operation. The in part considerable manufacturing costs of e-scooters result in long “pay back periods”, particularly if the e-scooter is used as a second vehicle.

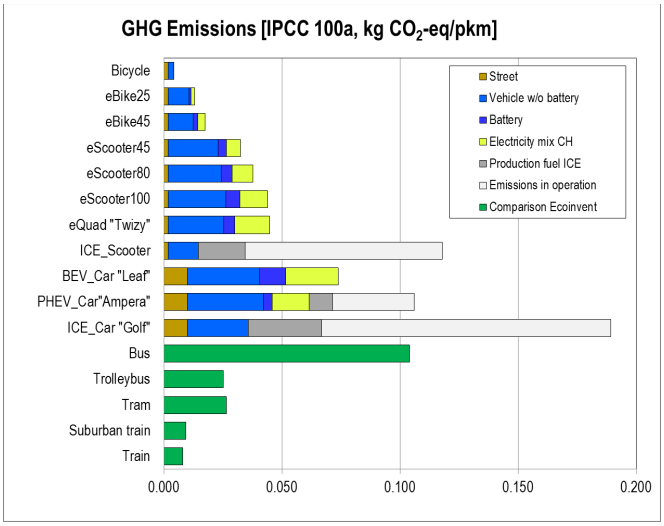

***Figure 1*. Greenhouse gas emissions per person-kilometre for different vehicle categories of private transport and public transport, presented differentiated by different causes of the emissions, the energy demand at household power outlet (yellow) is the Swiss electricity mix.**

(5) Work package: User Behaviour

Mobility behaviour

We surveyed 55 e-scooter users (84% men, average age 48) on their mobility behaviour. The respondents had slightly above-average incomes and educational attainment. Ninety-three per cent of the e-scooter drivers are “satisfied” or even “very satisfied” with the e-scooter. An average e-scooter trip was 15 km and 25 minutes long, with wide variation; 54% of the trips were commutes to work, 23% were leisure-time trips, 13% were trips for helping others and 9% were for business purposes. The purchase of an e-scooter leads to an only very small increase (5%) in travel distances. Almost half of the e-scooter trips replaced trips by car (33%) or petrol scooter (15%); 36% of the e-scooter trips replaced trips by public transport and 9% replaced trips by bicycle. For 11% of the respondents, the e-scooter purchase replaced a car, and 58% of e-scooter purchases replaced a petrol scooter. In all, 73% of the respondents reported that they purchased the e-scooter as a replacement for or instead of another means of transport. The e-scooter increased a person’s fleet of road vehicles among only 27% of the respondents.

Energy consumption

E-scooter diaries revealed that the average grid energy demand (energy consumption from a power outlet) corresponded well with the modelled values (see *Figure 2*). From the trials on the roller dynamometer and the investigations on charging devices, it can be concluded that the driving energy demand are clearly lower due to the increased charging losses (see *Figure 2*).

E-scooter classes	Average grid energy demand	Driving energy demand
E-scooter ca. 45 km/h	4 kWh/100km	2-4 kWh/100km
E-scooter ca. 80 km/h	6 kWh/100km	4-6 kWh/100km
E-scooter ca. 100 km/h	8 kWh/100km	6-8 kWh/100km

Figure 2. **Energy consumption: (a) average grid energy, and (b) driving energy demand.**

The energy draw data in the e-scooter diaries show no clear consumption increase in the winter. That is, in contrast to other electric vehicles that have air-conditioned/heated driver cabins, the total energy demand for the driving and charging losses remains approximately constant (lack of a heater). However, in cold weather the available battery capacity decreases, and range decreases.

Synthesis

(1) Numerous obstacles to rapid growth of e-scooters in Switzerland

- *Small, unknown importers with small budgets; insufficient quality of some products*

The majority of today's e-scooter importers are small, little-known companies in the motorcycle line of business. They have no existing, well-functioning network of dealerships. In addition, they cannot provide their dealers with professionally designed promotional and communication materials or make attractive sales promotion offers (such as rebates). Experience in recent years has also shown that e-scooters manufactured in China and other Asian countries do not yet meet the quality standards of the European market.

There has been a positive change in this situation recently; several global motorcycle manufacturers are going to put e-scooters on the market in 2014. For Europe and Switzerland it is relevant that the popularity of e-scooters has been steadily increasing in Taiwan, for the Taiwanese scooter industry is working to high quality industrial standards and thus close to the European market. It is only a question of time before high-quality e-scooters from Asia will also be available in Europe.

- *Dealers' scepticism about the product*

As seen from a diffusion theory perspective, dealers are the central players in the diffusion process in the current market situation. At this time in Switzerland, e-scooters are being offered by very few motorcycle and bicycle dealers who tend to be sceptical about the e-scooter. One reason for this is the dealers' lack of trust in the quality and competitiveness of e-scooters and in the reliability of the present e-scooter importers. Almost all dealers—partly also out of igno-

rance—call for technological development of the product. Another reason for dealers' scepticism is economic: The dealer margin is small, and our survey revealed in addition that selling an e-scooter entails considerable more expenditure due to the higher information needs (due to gaps in knowledge, for instance).

- *Lack of personal advantages*

For individuals the e-scooter has little personal relative advantage (added value) over a petrol scooter. The foremost advantage for purchasers up to now has been societal (lower emission of pollutants and noise). Today's e-scooter users state that important advantages over petrol scooters are the e-scooter's environmental friendliness (for example, reduced CO2 emissions) and noiselessness. E-scooters are not seen as new vehicles but as (expensive) replacements for traditional scooters and have to compete against their mainstream strengths.

- *Cost savings are not (yet) apparent to consumers*

The investigations indicate that compared to petrol scooters, service and maintenance costs are lower for e-scooters. Many players (dealers, potential buyers) are unaware of this economic advantage.

- *High purchase price*

An e-scooter can easily cost more than twice the price of a traditional scooter with comparable power and equipment. In some municipalities, the price differences are in part reduced through financial incentives (10%-25% of the purchase price). It is reasonable to assume that when large motorcycle manufacturers enter the market, unit prices will decrease and e-scooters will thus become less expensive.

- *Lack of clarity/uncertainties concerning battery disposal recycling*

Under current law, retailers must offer their customers simple, secure and legal ways to dispose of batteries. However, the survey of dealers found that they are only insufficiently informed about responsibilities and procedures in the disposal and recycling of e-scooter batteries.

- *Swiss Post fleet changeover to e-scooters not yet sending a strong signal to other companies*

The Swiss Post is replacing its entire petrol scooter fleet (ca. 7,000 vehicles) with e-scooters. Their experience up to now is that the e-scooters are very reliable and that there are no cost

disadvantages. However, Swiss Post is not (yet) serving as a role model for other Swiss companies. Possible reasons for this are that vehicle costs may not be very important to companies, the rate of the replacement of the fleet vehicles is slow and the use of the e-scooters is post office-specific.

- *Weak political commitment and no strong lobby*

There is little media coverage on the topic of e-scooters. No strong political commitment is discernible, and there are no advocacy groups that could generate pressure in this direction.

(2) E-scooters are desirable from an environmental perspective

- *E-scooters are energy efficient and environmentally friendly*

The analysis of the mobility data shows that 61% of e-scooter kilometres would have been driven by car or by petrol scooter. The average distance driven by e-scooter per year is approximately 2,500 km, resulting in savings of 1,500 car or motorcycle kilometres. The survey respondents did not make extra trips with the e-scooter (that is, there was no appreciable additional traffic): Over 90% trips by e-scooter would have been made also without the e-scooter. Further, it was found that with regard to environmental impact, driving e-scooters is worth it compared to practically all other motor vehicles. Here it is important that “clean” electricity is used for e-scooter operation.

- *E-scooters as commuter vehicles for short and medium distances*

The survey respondents made mainly short and medium-long trips in the city and urban agglomerations: The average distance per trip was 15 km. Evaluation of the e-scooter diaries also shows that the range of e-scooters was sufficient for the majority of uses.

If all Swiss car and motorcycle commuter trips were replaced by e-scooter trips, considerable negative environmental impacts could be avoided: The study shows that compared to petrol scooters, the greenhouse gas emissions of e-scooters (per person-km) are about three time less and compared to cars, as much as five times less. This would achieve not only a considerable reduction in greenhouse gas emissions but also positive impacts on the ecosystem and resources.

(3) Insufficient mix of promotional measures

At the global level, only very little money has been put into promotion of e-scooters up to now, and government offices and agencies lack awareness of e-scooters as a replacement for car

traffic in congested urban areas. As a consequence, electromobility with e-scooters is neglected in the vast majority of government promotional programmes. The analysis of Swiss e-scooter promotional measures reveals that the accent is on financial incentives (in the form of subsidies) and communication and diffusion instruments (mainly in the form of exhibitions).

The evaluation of various exhibitions and trade fair presentations shows that the communication and diffusion instruments were competent and used efficiently but that the effective number of e-scooter purchases could not be increased. For example, the e-scooter presentations at the SWISS MOTO did not succeed in stimulating the market and accelerating market growth. Assessment of the other promotional measures led to the conclusion that the promotional strategy chosen in recent years in Switzerland, which is very similar to the successful e-bike promotion and focuses exclusively on pull measures, has not achieved its goals.

(4) Vehicle reliability, electric vehicle charging infrastructure and traffic safety

Vehicle reliability

According to the dealers surveyed, the reliability of the components used today has definitely improved and the number of warranty cases has declined.

Evaluation of the e-scooter diaries with regard to need for repairs shows that e-scooter repairs are most frequently needed for the electrical system, followed by the battery and lastly the mechanical components. For success on the market, the reliability of e-scooters must be further increased and dealers' and interested persons' trust in the products strengthened.

Electric vehicle charging infrastructure

The results show that charging stations for electric vehicles are being installed in Switzerland only hesitantly. At present, the main function of public charging stations at parking areas for two-wheeled vehicles is to call attention to e-scooters. We do not see a demonstrated need for them, because the distances driven by e-scooter are rarely longer than 30 to 40 km. Moreover, the two-wheeled vehicle parking areas are frequently so full that it would probably be difficult to reserve enough space for e-scooters next to the charging stations.

Developments in Taiwan are interesting; a uniform battery is being developed to make possible battery swapping stations instead of battery recharging stations.

Traffic safety

Motorcycles and e-scooters belong to the motor vehicle category with the highest accident rates. One of the most important risk factors is insufficient motorcycle-specific driving experi-

ence and technical driving skills (as a result of insufficient education and training). The evaluation of our user survey shows that one-half of today's e-scooter drivers are experienced drivers with many years of driving experience. The other half of the survey respondents has no scooter experience. It is interesting that none of the persons surveyed (N = 55) reported collision accidents.

(5) Life cycle assessment as important basis

One aim of this research project was to draw up an eco-balance or life cycle inventory for all relevant components of the powertrain and chassis of e-scooters. The data are now available to the public for free use. The evaluation shows, for instance, that the greenhouse gas potential per kilogramme over the entire life cycle is approximately equal in all of the electric motors examined, regardless of rated power, torque and design principles.

In addition, we worked on further theoretical development of noise emissions as a new indicator and one that is relevant for electromobility. With regard to noise emissions, the use of e-scooters in urban areas has definite advantages over petrol scooters.

E-scooter users today do not see the noiselessness of e-scooters as a problem: Two-thirds of the survey respondents reported that the absence of engine noise never or only rarely leads to dangerous situations with pedestrians or other road users. And a survey of the subgroup "former motorcyclists now driving e-scooters" indicates that e-scooters' very noiselessness is a significant factor in the decision to change over to an e-scooter. According to the respondents, the e-scooters' "floating", "flying" or "gliding" sensation is a positive driving experience.

(6) Increased energy requirements due to poor quality of the charging devices

In contrast to petrol-powered vehicles, where practically the entire filled tank contents are available for the motor, electric battery-powered vehicles definitely have charging losses. The energy requirements of e-scooters are therefore the sum of driving energy demand and charge loss. Due to the losses in the charging process, the grid energy demand (important in terms of energy costs) are higher than the battery energy demand (important for range).

(7) The role of e-scooters in a sustainable mobility concept

It is apparent that e-scooters can play an important role as an element of sustainable mobility and should receive more attention in future mobility concepts. With their low energy consumption and low environmental impacts, and because they produce much lower noise emissions,

and because they require little space in congested inner cities and belong to the fastest means of transportation, they have important advantages over other motor vehicles.

In addition, the possible uses of e-scooters are increasing through an extension/widening of the motor vehicle categories in Switzerland. About three years ago significant changes were made on the motor vehicle market that made new vehicle categories possible: New electric three- or four-wheeled electric vehicles were approved in Switzerland and made available for purchase, and they were also assigned to the category “e-scooter”.

Recommendations (top 10)

In the following, we present the most important (top 10) recommendations based on the results of our interdisciplinary “E-scooters” research project.

Recommendation 1: Build a political network

Our investigations show that the diffusion of e-scooters is desirable from an ecological perspective and that e-scooters can play an important role in sustainable mobility concepts. However, there is at present no discernible clear political commitment to e-scooters (such as in the framework of a future-oriented transport strategy for agglomerations), and there are no strong special advocacy groups that could build up political pressure.

→ We therefore recommend interested parties to build up a political network, so as to join forces and pool resources. This network could play a part in political debates and in this way increase the pressure to give e-scooters an appropriate role in future-oriented transport concepts and to ensure that also “push” measures (for example, tougher emission limits for traditional motorcycles) are added to the mix of promotional measures[3]).

Recommendation 2: Create trust

For acceptance and diffusion of e-scooters in Switzerland, significant advances are needed in technology and in the purchase cost. Technical development should be given priority. However, our studies also show that the reliability of today’s e-scooter components has improved significantly in recent years. The main thing is for these advancements to be clearly

[3] The Federal Council intends to adopt the new EU regulations in Switzerland from 2016/2017: Along with an effective reduction in emission limit values, the new EU regulations also contain new, additional requirements pertaining to on-board diagnostic systems, durability of pollution control devices, and evaporative emissions. The new standards are planned to take effect in 2016 for the type-approval of new motorbikes for 2017 (see http://www.parlament.ch/d/suche/seiten/geschaefte.aspx?gesch_id=20134006; retrieved 2 December 2013).

communicated, in order to reduce still existing inhibitions (mistrust, scepticism) on the part of dealers and potential users.

→ We recommend that manufacturers and importers continue to follow the global technical development of e-scooters and actively publicise the information in the Swiss motorcycle sector. The technical improvements and innovations should be communicated effectively to target groups and to the specialised media in the motorcycle sector.

Recommendation 3: Call for improvements

The market analyses conducted reveal, for one, that the current sales volume of e-scooters is very modest. For another, global motorcycle manufacturers are not yet active on the e-scooter market. To committed and interested e-scooter dealers, we therefore suggest a bottom-up strategy:

→ We recommend that e-scooter dealers offer their knowledge (for example, of customer needs) to manufacturers for further development of e-scooters. If direct contact between dealers and manufacturers is not possible, a route via other players (importers, NewRide) must be chosen, so that product improvements can be demanded.

Recommendation 4: Identify interested dealers and address them specifically

Examination of today's e-scooter network reveals that the players have not yet set up any long-term cooperation. For this reason, up to now there has been hardly any of the exchange and interaction among the players that is necessary for diffusion of innovations.

→ For building up and developing the e-scooter dealer network, we recommend targeted addressing of dealers who are aiming for economic and strategic advantages in the niche market. Our research indicates that specialist and similar dealers who have that interest and who do not have brand allegiances with any large motorcycle suppliers should be identified and addressed. These niche market dealers can be bicycle, motorcycle, car or electric vehicle dealers. The goal is to provide the dealers with information on e-scooters and e-scooter development via neutral platforms (such as NewRide).

Recommendation 5: Provide information on battery recycling and disposal

Our research shows that there is still a great need for information on the correct handling of e-scooter batteries.

→ We recommend calling dealers' attention to the regulations on storage, transport and disposal of batteries (safety precaution). As soon as there is a sufficient sales volume of e-scooters, this information provision will probably be taken over by the importers and manufacturers, since management of battery disposal is their duty. As an interim solution, howev-

er, other actors (such as NewRide, EnergieSchweiz, “Battery Disposal Interest Grouping” Inobat) should provide this information.

Recommendation 6: Provide information on correct charging process

Proper charging results in prolonged battery life and greater safety.

→ We recommend informing dealers and users about proper charging procedures for e-scooter batteries. Courses for interested specialist and similar dealers could be offered via a neutral platform such as NewRide.

Recommendation 7: Continue to offer financial incentives

Prior and existing promotional measures (financial incentives, information and communication measures, test drives) have not been sufficient to stimulate the market introduction of e-scooters to the desired extent. Considering the positive energy and environmental balance sheet of e-scooters as compared to all other motor vehicles, continued promotion on the part of policy makers and public administration makes sense. We advocate expanding the promotional mix through including additional measures, especially also push measures. Cities and also electricity suppliers could be included more. The creation of a separate fund should be considered.

→ We recommend continued support of the market introduction of e-scooters through financial incentives. We call for comparatively rather high subsidies (10%-20% of the purchase price), which, however, are temporary and also capped with regard to the number of subsidised vehicles. Since dealers play a key role in the distribution chain, it would also make sense to pay a part of the subsidy to dealers, according to an appropriate system.

Recommendation 8: Send targeted messages to commuters and operators of vehicle fleets

Especially in agglomerations and during times of the day with high traffic congestion (rush hour), there is a high potential for shifting from car to e-scooter transport.

→ We recommend the public authorities at the different government levels to focus on two target groups, car commuters and fleet operators. Car commuters in agglomerations should be addressed specifically. In addition, in the short and medium term we see a great unused potential in the area of business/commercial traffic in agglomerations. The promotional mix should therefore be tailored more to the needs of vehicle fleet operators.

Recommendation 9: Communicate comprehensive information on e-scooters

Our research shows that comprehensive communication on all aspects of e-scooters is important.

→ We recommend that policy makers and public administration in particular also communicate that:

- when purchasing an e-scooter, high-quality, durable products should be chosen;
- clean electricity should be used for operation of e-scooters;
- there is a difference between the energy drawn from the power outlet (important with regard to cost and environment) and the energy needs for travel (important for range);
- the use of e-scooters has a positive impact on mobility behaviour: Approximately two-thirds of kilometres travelled by e-scooters replace car and motorcycle kilometres, and e-scooters cause no appreciable additional traffic (outperforming e-bikes in this regard);
- the life cycle assessments show clearly that e-scooters are less polluting than traditional scooters;
- a number of cities and electricity companies offer financial incentives;
- for new buildings, pre-wiring for charging stations should be provided.

Recommendation 10: In an image campaign, emphasise the personal advantages of e-scooters

This study shows that for the individual, the personal relative advantage (added value) of e-scooters as compared to petrol scooters is small. Based on the high purchase price, potential buyers assume that e-scooter costs generally are high—and as our analyses show, this is not always justified. In addition, up to now e-scooters have not been seen as trendy lifestyle products. E-scooters are not seen as new scooters but rather as (expensive) replacements for traditional scooters, and they have to compete against their mainstream strengths.

→ We recommend that the federal government launch a nationwide e-scooter image campaign in Switzerland to publicise the e-scooter's new type of positive driving experience, reliability and economy, and suitability for commuter trips. The communication campaign should also highlight the success and good experience that companies have had with e-scooters (such as the Swiss Post or small and medium-sized enterprises).