Case Study on System Innovation: E-mobility in Austria

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report prepared for the Austrian Federal Ministry of Transport, Innovation and Technology

in the framework of the OECD – TIP project on "System Innovation"

August 2014

Contents

1. Main objectives

This country case study was compiled within the OECD TIP project on ‘System innovation’ as part of the TIP’s contribution to the CSTP Intermediate Outputs 1.3 and 1.4. [See DSTI/STP (2012)1/REV1 and DSTI/STP/TIP (2012)3]. Aims of the TIP project are the clarification of the concept of system innovation and the identification of common good governance approaches. The main objectives of the country case study is the identification of key self-reinforcing mechanisms that can act as drivers / bottlenecks and of a suited ‚policy-mix‘, as well as potential ‚policy gaps/bottlenecks’.

2. System innovation

System innovation is a rather new topic in innovation policy that can be understood as an addition to tradition innovation policy (Gassler et al. 2008). Interest in system innovation stems mainly from the grand challenges (ageing society, climate change, energy and resource scarcity etc.), as system innovation is seen as a promising strategy to cope with these challenges.

System innovation is a broad concept about changes in the way societal functions are met, often related to societal challenges that cannot be achieved with incremental technological change alone but require transitions in the socio-technical systems (that is in production and consumption patterns). It can be understood as a change from one socio-technical system to another where the direction of change matters. It is generally characterised by long-term processes.

Geels (2004) differentiates three relevant aspects in system transition:

- technological substitution comprising the emergence of new technologies, the diffusion of new technologies and the replacement of old technologies,
- coevolution of changes not only in technologies but also in elements such as user practices, regulation, industrial networks, infrastructure, and cultural meaning and
- the emergence of new functionalities related to radical innovations.

This makes clear technological developments alone are not sufficient when system innovations are concerned. System innovation requires the interplay of different actors at different levels and is about the linking of multiple technologies reinforcing each other. In addition to technology it involves changes in things like regulation, infrastructure etc. (Geels 2004). This implies an important role for policy. However, system innovation is a political challenge itself as it has to cope with different – often vested - interests of firms, departments etc. in a framework of uncertainty.

Typical barriers that hinder system innovation towards less carbon intensive socio-technical systems (like e-mobility) are that

- new technologies are in general more expensive than established technologies that profit from scale effects,
- uncertainties for producers are particularly high (often hype cycles) and
- a mismatch with established usage pattern exists (Unruh 2000).

To overcome lock-in that hinders system innovation, generally a double strategy is required: the stimulation of innovation in niches (that means the creation of variety) and simultaneously the adaptation of the selection environment by specific incentives (Geels 2014).

3. E-mobility in Austria

E-mobility has been a key focus area of socio-technical change in Austria for a number of years, in terms of attention from policy makers as well as from industry and the public. The societal challenges ahead, in particular climate change put increasing pressure on the current mobility system, due to its tremendous environmental impact. Furthermore e-mobility is seen as major economic opportunity (or threat in case of failure) for the automotive industry in Austria.

The starting point of this project is the development and diffusion of electric vehicles. However, as this case study will show electric mobility goes way beyond the electric vehicle as such. Thus, the relevant system to study e-mobility is the mobility system as a whole. This wide perspective becomes necessary in order to take into account the interesting and controversial perspectives in the field, where the boundaries of innovation and transition activities concerning e-mobility are and where they should be. Moreover this wider perspective on e-mobility follows the current understanding by most prevailing (policy) approaches that e-mobility is more than a 'technology fix' (a simple replacement of combustion engines by batteries and electric motors).

Our analytical framework understands e-mobility as one element of a wider transition of the mobility system towards more (ecological) sustainability including elements like changes of car use pattern, ownership models or intermodal mobility systems.

This case study draws upon a general analysis of e-mobility activities and policies in Austria, and the study of three local experiments in Austria. These three experiments cover a broad range of different regions and approaches to e-mobility. The 'VLOTTE' project in most western province of Vorarlberg started already in 2009, the two other local experiments 'Electrodrive Salzburg' and 'e-morail' started in the following years 2010 und 2011. Even though all three projects emphasize the role of electric mobility in the mobility system in cooperation with public transport, e-morail has probably the strongest interlinkages with public transport since it is a project coordinated by the Austrian railway company ÖBB. Thus, the three local experiments being part of this case study represent different approaches not only in terms of geography but also in terms of business models.

We argue that, the case of e-mobility in Austria is very relevant to study as a case of an envisioned and already ongoing system innovation. Although it is not yet clear how the mobility transition of the future will look like and what role electric mobility will play in this mobility transition, there is a widespread consensus that electric mobility will probably be a part of the future mobility system. Nevertheless since the transition of the mobility system and the introduction of electric mobility being of this transition goes beyond a single technological innovation. Starting from the technological characteristics of e-mobility, which require a system approach, since the electric vehicles have to be charged; there are many more dimensions in the case of e-mobility to take into account to enable a system transition.

As our case study will show the numerous facets and related governance challenges make clear the necessity of a policy approach going beyond conventional technology and innovation policy, a system innovation approach.

Criterions for selecting socio-techno-economic system case studies

E-mobility is regarded as a key area of socio-technical change in Austria and has received a lot of attention in recent years in the public as well as in industry and government. The reasons for this high interest are twofold. First of all, concerns about environmental issues and climate change are quite high on the policy agenda in Austria, and e-mobility is seen as one of the most promising options for tackling these issues. With its high share of hydropower and other renewable forms of power generation, Austria is well positioned to pursue such a strategy. Second, the strong automotive industry in Austria perceives e-mobility as a major economic opportunity, and one where Austrian firms can draw on their competences in the field of developing and designing powertrains. E-mobility, in the Austrian context, is not confined to the traditional car industries, but covers also other electrically propelled vehicles such as trains and bicycles.

Industrial and other stakeholders have created platforms of cooperation to move e-mobility agendas forward (e.g. AMP Austrian Mobile Power), complemented by policy-led platforms to facilitate information exchange and support relevant policy initiatives (e.g. A3PS Austrian Agency for Alternative Propulsion Systems).

Concerning the common criteria for the selection of cases by the OECD TIP working group, it becomes clear that e-mobility fulfills the following criteria:

a) Addresses highly desirable societal benefits

Electric mobility has the potential to achieve highly desirable societal benefits. Electric mobility can be regarded as a system innovation which can contribute to a reduction of CO2 emissions, reduction of local air pollution and to reduce the dependence on fossil energy resources.

b) Links to major global business opportunities and is of importance to Austria in terms of capabilities and competences

Electric mobility is expected to become a major business opportunity, as the automotive industry is a global industry. Austria has a comparatively large automotive supply industry including a large share of activities in the field of propulsion technologies. Depending on different estimates 150 000 to 200 000 people are employed in the automotive industry. As such, electric mobility represents a major challenge and opportunity for the Austrian automotive industry at the same time.

c) Requiring considerable system transition to reach desirable performance

Since e-mobility as discussed in the case study is understood more than a “technological fix”, it requires considerable system transition. Furthermore the build-up of a new infrastructure is necessary and potentially a transition of the whole mobility system.

d) Involving substantial policy involvement

A number of policy fields are highly relevant for the development of e-mobility, for instance transport policy, RTI policy, climate policy, environmental policy, industrial policy, etc.

e) Involves public-private partnerships

There are a number of public private partnerships active in the field of e-mobility.

f) Covering different layers of systems - Social, Technological, Industrial, Economic, Policy

E-mobility is a field which requires the coordination of various layers. E-mobility has to be understood as a socio-technical system, thus the social and technological layer are both important. Moreover, there are different motivations and policy rationales observable (see above).

g) Covering different layers of policy governance Local, Regional, National, International

In the field of e-mobility all layers of policy governance are involved. Examples can be found from local communities providing incentives like dedicated parking spots for electric vehicles, regional governments subsidizing the purchase of electric vehicles to national governments running RTI policy programs to support e-mobiltiy. Moreover EU emission regulations are regarded as an important driver for e-mobility.

h) Political backing and stakeholder support

Political targets for the diffusion of electric vehicles are established, major stakeholders from different parts of the society are involved. The political key strategy is an Implementation Plan for E- mobility that was launched by the Austrian government in 2012, detailing a range of necessary measures to make e-mobility really happen over the years to come. It is complemented by targeted Austrian funding programs in the field of mobility, aiming to support research on both technological and social innovations. Moreover, pilot projects with e- mobility solutions are under way in several Austrian cities and regions.

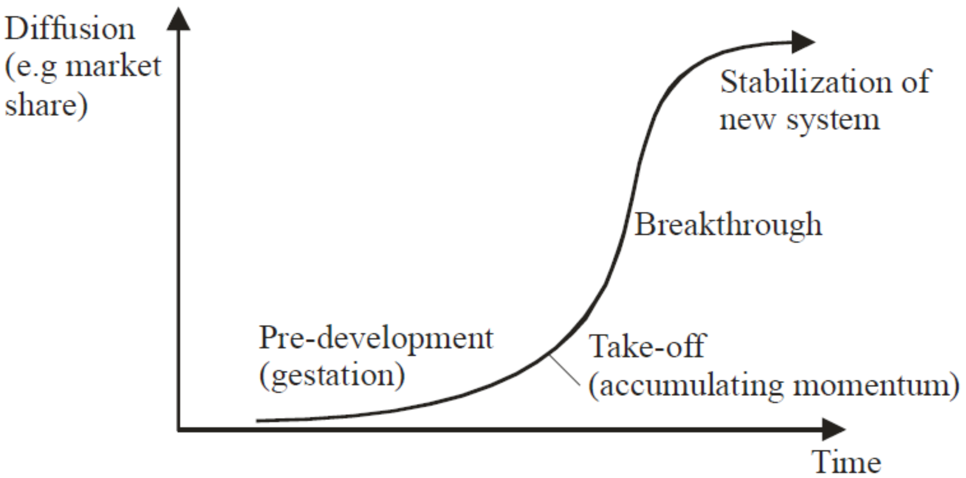
i) Critical level of change agents and accumulated experience in transition approaches

Potentially yes.

4. Characterization of System Transition Stages

System Transitions ideally follow an s-curve type diffusion curve. Even though most of the actual transitions exhibit quite complex dynamics and follow different pathways including setbacks, five stylized phases of a transition can be identified.

Figure 1: Stylized phases in systems innovation and transitions



Source: Rotmans et. al., 2001, from System innovation: Concepts, dynamics and governance, DSTI/STP/TIP(2013)3, p.14

What is the actual stage of transition?

- Embryonic
- **Early**
- Middle
- Advanced
- Front-runners

Following the ideal type s-curve, we argue that the transition is an early stage; however lacking clear indicators, the characterization remains difficult.

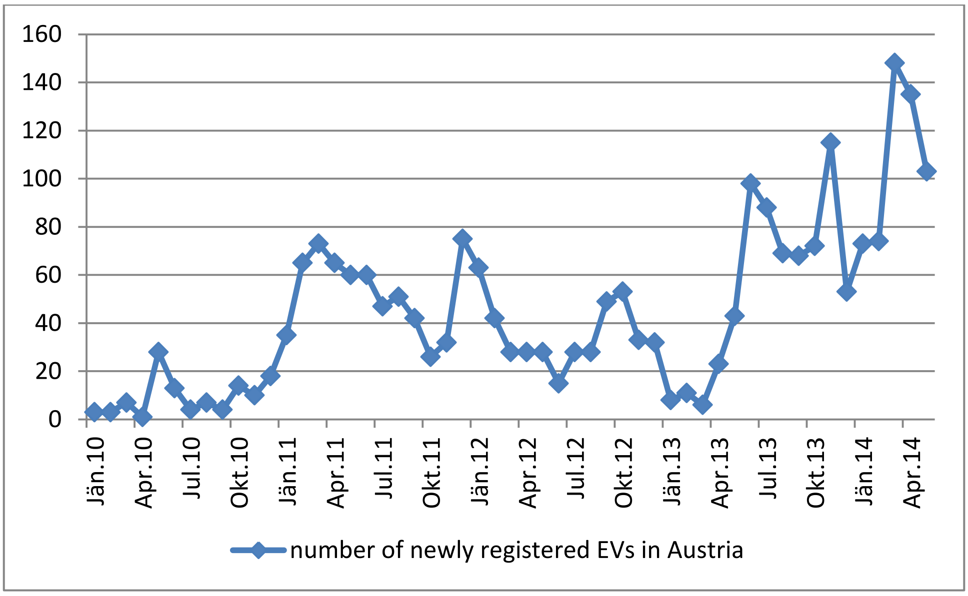
However, indications exists that e-mobility has left the embryonic stage of transition, since a larger number of vehicles become available on the market. Although the number of vehicles on the street remains rather low at the time, there is a broad variety of activities (see other sections of this template) currently underway. Thus we come to the conclusions that e-mobility is currently in an early stage. End of April 2014, 2508 electric cars were registered in Austria, which represents a share of 0.1% of the overall fleet. Thus, electric vehicles represent only a small share of vehicles in Austria. Nevertheless especially in recent months the variety of electric vehicles offered on the Austrian market by international car manufacturers was steadily rising. Furthermore the market appears supply side limited, since a number of vehicles are only available in limited numbers in Austria, thus potential customers face long waiting times.

Figure **2** shows the number of electric vehicles registered in Austria on a monthly base from January 2010 to April 2014. The number of electric vehicles remains rather low; Nevertheless the number of new registrations of electric vehicles appears to increase from spring 2013 onwards. The share of registrations of electric vehicles among all registrations of new cars shows a similar pattern. However, as discussed in the section in impact analysis registration numbers are too simplistic to capture the development of the e-mobility transitions.

An analysis of expert interviews conducted shows a more nuanced picture: It is argued that e-mobility is currently on the brink of widespread market diffusion. Even though registration numbers are still relatively low a lot of progress has been made in recent years in terms of cost reductions, increased efficiency and the preparation of serial production lines. Whereas e-mobility will probably remain a very research intensive topic, there are indications that market adoption will accelerate within the next years, since a number of car manufacturers have announced a variety of new electric vehicles. In addition there will be more variety concerning the type of electric vehicles on sale, ranging from relatively small pure battery vehicles to plug-in hybrid electric vehicles having an additional range extender in case the battery is empty to electric vehicles in the high end market (e.g. Tesla).

Moreover in terms of policy and regulation a number of measures have been taken to reduce uncertainty and thus the risk for investment in e-mobility projects (e.g. Clean Transport directive on the EU level).

Figure 2: Number of newly registered EVs in Austria per month



Source: Statistik Austria

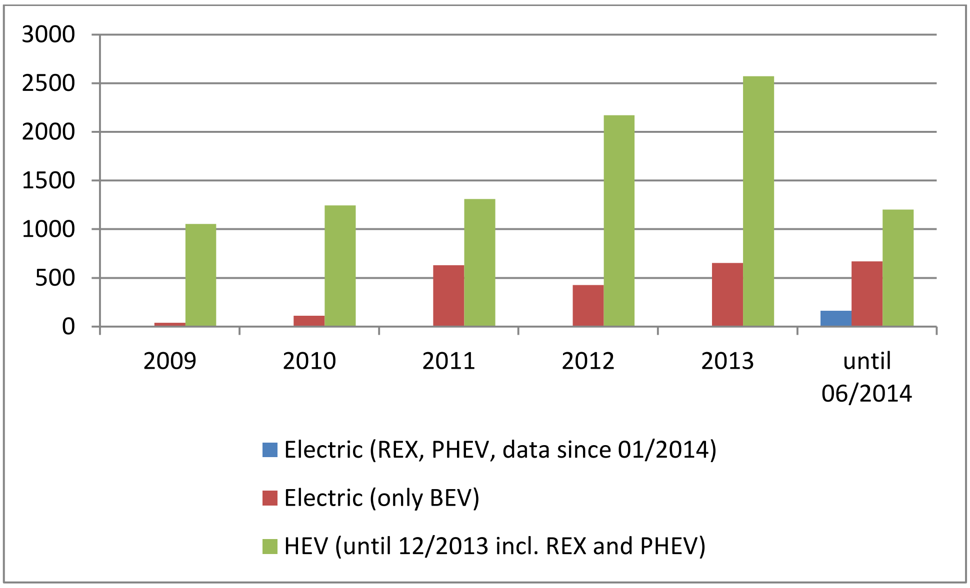
However numbers of newly registered electric vehicles are already considerably higher, if hybrid electric vehicles are taken into account. These vehicles use both a battery/electric engine and a conventional combustion engine and are available in different configurations. Whereas a large share of hybrid electric vehicles (HEV) cannot be plugged in and charged from the grid (e.g. Toyota Prius, except a specific configuration, which was introduced more recently), some other configurations are able to be charged from the grid. These vehicles are often referred to as plug in hybrid electric vehicles (or REX which refers to the range extender on board). PHEV and REX are meant to be operated most of time on electricity and only in case the range of the vehicle would be not sufficient a combustion engine would ensure the further mobility of the car.

Figure 3 illustrates a comparison between 'pure' battery electric vehicles (BEV), plug in hybrid electric vehicles (and REX), and HEV since 2009.[1] As the numbers show, HEV are still more popular than pure BEV or PHEV/REX, which supports our hypothesis that the e-mobility transition may be in an early stage, where the variety of technological configurations and

[1] However REX and PHEV vehicles were counted as HEV until the end of 2013.

designs is still relatively high and no 'dominant design' (Abernathy and Utterback, 1978) has emerged yet.

Figure 3: Number of newly registered EVs and HEVs in Austria



Source: Statistik Austria

Policy-makers' perceptions of development and transition

Conceptually the term „system innovation" is not a widely understood term among policy makers involved in innovation and transition activities in the field of e-mobility. However, policy makers refer frequently to key characteristics of e-mobility which require a more systematic approach beyond 'conventional' innovation policy approaches. These characteristics are widely shared among policy makers from different policy fields:

Thus e-mobility is generally perceived as being:

- not only an incremental innovation
- not only related to technological challenges
- requiring (or inducing) changes in the mobility system as such (use patterns)
- requires integration in the energy system
- requires new infrastructures, thus "systemic"
- requires involvement of different stakeholders and policy fields

The source of policy maker’s system analysis, there are different sources and rationalities for developing policy interventions. Thus, the source of policy maker’s system analysis is depending on specific policy field and policy rationale of the policy field.

The underlying system analysis in innovation policy is more focused on the research and development aspects, thus following implicitly or explicitly an innovation system framework. Moreover innovation policy in the mobility sector in Austria is usually in principle ‘technology-neutral’, thus avoiding early lock-ins. Time horizons in innovation policy are usually longer term. Environmental policy in the other hand is more focused on the reduction of the environmental burden caused by transport, through e-mobility. Thus, a main rationale is to maximize the environmental benefits of e-mobility in terms of reduced emissions (mainly CO2 but as well local pollutants). Hence the focus of environmental policy is stronger on the diffusion side, since the diffusion of electric vehicles eventually realizes the emission reduction potential.

From an industrial policy perspective e-mobility is perceived as an opportunity and as a challenge at the same time. On the one hand e-mobility represents an opportunity to the automotive industry in Austria; on the other side betting on the wrong technology or missing the technological development could potentially lead to a loss of competitiveness. Thus, the main rationale of industrial policy is to facilitate the utilization of competences with a high level of international competitiveness to ensure the overall competitiveness of the (Austrian) industry.

Even though the perception of e-mobility differs between the policy fields there is some more general pattern observable over the past years. Although e-mobility has been on the policy agenda already since the 1990s, attention for electric vehicles was at least modest until the mid-2000s. Around the year 2008/09 however, attention regarding e-mobility was rising and expectations about future technological development and the potential of electric vehicles were very optimistic. This period of very optimistic expectations, many experts and policy makers refer to this time period as ‘hype’ was followed by the implementation of a number of policy programs (klima:aktiv mobil, Model regions Electric Mobility, see below) even though a number of policy makers were not sharing the initial optimism. Within this timeframe falls as well the aim announced by the minister for the environment (BMLFUW) at the time, to have at least 250.000 electric vehicles on the road by 2020. However, in subsequent years it became clear that the system innovation towards electric mobility will take longer than expected by some actors, due to the high prices of electric vehicles, range anxiety and the lack of electric vehicles on offer. Even though some disappointment was setting in, several experts interviewed in context of this case study indicated that there is again building up some momentum for electric mobility after a period of consolidation and announcements by automotive manufacturers about the market introduction of electric vehicles would appear more realistic than in the past.

However, perceptions concerning e-mobility are still diverging, starting from the question how e-mobility is defined and how should it be designed. Whereas some actors understand by e-mobility primarily ‘pure’ battery electric cars and their infrastructure other definitions go as far as including public train services (powered by electricity) in the definition of electric mobility. Nevertheless there is a general understanding among policy makers that electric mobility should be seen in context of electric vehicles, charging infrastructure, the mobility system as such and the energy system. Nevertheless expectations probably diverge how fast and to what degree electric mobility will diffuse in the future. These discussions include the question which kinds of vehicles are best suited to meet the demand of different customer groups while providing the largest environmental benefits. From an environmental policy perspective, ‘pure’ electric vehicles solely powered by renewable electricity would offer the largest benefits, whereas other industry experts argue that Plug In Hybrid Electric Vehicles (PHEV) or range extenders (REX) would be the right answer to the issue of range anxiety. In short, PHEV and REX are in principlpe electric vehicles which can be charged from the grid, however when the battery runs low they have a conventional combustion engine to ensure the continued operation of the vehicle. Other discussions focus on the question if fuel cell vehicles should be considered as a part of electric mobility or not.

Nevertheless there is a general acknowledgement that the transition to e-mobility will not be about replacing one technology (combustion engine) with another (battery & e-motor). This is also reflected in some funding schemes, which require an integration of the use of electric vehicles and public transport and/or renewable energy. However, such couplings are sometimes perceived as an innovation barrier, e.g. the requirement to use new, in the sense of additional, renewable energy capacities to charge electric vehicles to ensure their operation is CO2 neutral. However, such requirements make the operation of electric vehicles even more complex and expensive. Therefore this requirement, although important from an environmental perspective and key for the credibility of use models for early adopters, can be perceived as additional innovation barrier by other actors involved.

Although the principle rationalities differ between the policy actors involved, there are policy activities such as the Implementation Plan Electric Mobility (see policies below) which take up questions of definition and the perception of electric mobility, relevant opportunities and barriers in order to provide a common reference point for all policy makers involved.

5. Identifying Transition Mechanisms and Bottlenecks

In Austria – as in all highly developed countries - the current transport system is largely based on motorized individual transport. This transport system is associated with cultural values as freedom and choice (Kemp et al. 2011), but at the same time it is responsible for considerable CO2-emissions, local air pollution, noise and impacts in the settlement structure that are (indirectly) harmful for the environment.

Given the current transport system, the main driver for a transition towards a transport system including a higher share of battery-electric and hybrid-electric vehicles is the potential to reduce negative transport impacts, particularly transport related CO2-emissions and local air pollution. Particularly overall CO2 emission reduction targets (Kyoto protocol: reduction of 13% from 1990 to 2012; EU: reduction of 16% from 2005 to 2020) and air pollution regulations (Immissionsschutzgesetz-Luft: reduction of 20% in period 2018-2020 relative to period 2009-2011) are a driver for policy makers, EU targets for CO2 fleet emissions (120g/km in 2015, 95g/km in 2020) are an important driver for the automotive industry and environmental concerns for users.

Transport related CO2 emissions and air pollution are a concern in many countries globally and measures are implemented to reduce negative environmental impacts of transport, with potentially negative impacts on currently conventional propulsion technology. Therefore, an additional driver for policy makers to support innovation and transition activities in the field of electric mobility in Austria and for the automotive industry to engage in this field is an expected technological change towards electric drivetrains, which could cause problems for large parts of the automotive industry in Austria. Since many of the companies in the automotive industry in Austria are highly competitive with regard to current drivetrain technologies. Thus, electric drivetrains pose challenges to the current position of these actors in global value chains in order to maintain their current competiveness. Therefore a major driver of e-mobility activities is to maintain or improve the competitiveness of the Austrian industry in case of technological change. Key actors in the generation of new ideas and concerning the technological development are the universities, research institutes and the automotive industry itself.

However, on the industry side, electric mobility is not restricted to the automotive industry. Although for consumers e-mobility is in most respects a direct substitute for conventional motorized individual transport, the implementation of e-mobility solutions also requires system and service providers. System providers include the providers of ICT-related services (for ticketing, charging etc.), service providers offer mainly electricity. Therefore (regional) power supply companies play an important role in implementing e-mobility in Austria, but they also engage in e-car-based car sharing etc. In contrast to the automotive industry, system and service providers are not dominated by globally active enterprises and local framework conditions play a more important role for their development. Hence, the regional and national level plays a more important role. This can also be seen when the "mobile power regions"[2] in Austria are considered: Local power supply companies are key players in the model regions as they are actively trying to establish themselves as key actors in the field of e-mobility. Also public transport providers play an important role, particularly as e-mobility concepts are tested that enhance interoperability with public transport respectively non-motorized individual transport.

Most of the key actors in Austria from the different relevant actor groups (policy makers, representatives of research organizations and demonstration projects, commercial actors, and representatives of intermediaries, associations and platforms) know each other. Various fora for coordination are established.

What would be key mechanisms in driving and continuing the transitions?

In Austria – as in all highly developed countries - the current transport system is largely based on motorized individual transport. This transport system is associated with cultural values such as freedom and choice (Kemp et al. 2011), but at the same time it is responsible for considerable CO2-emissions, local air pollution, noise and impacts in the settlement structure that are (indirectly) harmful for the environment.

[2] "Mobile power regions" are large demonstration projects taking place in Austria that enable learning and idea generation on a more practical level concerning real life problems and solutions, experimenting with different e-mobility approaches (commuter transport, logistics, multi-modal urban transport etc.) and the target to mobilize actors. They have been established as one of the key measures to support e-mobility in Austria.

Given the current transport system, the main driver for a transition towards a transport system including a higher share of battery-electric and hybrid-electric vehicles is the potential to reduce negative transport impacts on the environment, particularly transport related CO_2-emissions and local air pollution. Particularly overall CO_2 emission reduction targets (for Austria: Kyoto protocol with a reduction of 13% from 1990 to 2012; EU target of a reduction of 16% from 2005 to 2020) and air pollution regulations (Immissionsschutzgesetz-Luft: reduction of 20% in period 2018-2020 relative to period 2009-2011) are a driver for policy makers, EU targets for CO_2 fleet emissions (120g/km in 2015, 95g/km in 2020) are an important driver for the automotive industry and environmental concerns for users.

Transport related CO_2 emissions and air pollution are a concern in many countries globally and measures are implemented to reduce negative environmental impacts of transport, one of them the support of electric mobility solutions. This has potentially negative impacts on providers of currently conventional propulsion technology. Therefore, an additional driver for policy makers to support innovation and transition activities in the field of electric mobility in Austria and for the automotive industry to engage in this field is an expected technological change towards electric drivetrains, which could cause problems for large parts of the automotive industry in Austria. Since many of the companies in the automotive industry in Austria are highly competitive with regard to current drivetrain technologies. Thus, electric drivetrains pose challenges to the current position of these actors in global value chains in order to maintain their current competiveness. Therefore a major driver of e-mobility activities is to maintain or improve the competitiveness of the Austrian industry in case of technological change and to use economic opportunities that arise from a change in the transport system. Key actors in the generation of new ideas and concerning the technological development are the universities, research institutes and the automotive industry itself.

However, on the industry side, electric mobility is not restricted to the automotive industry. Although e-mobility is in most respects a direct substitute for conventional motorized individual transport for consumers, the implementation of e-mobility solutions also requires system and service providers. System providers include the providers of ICT-related services (for ticketing, charging etc.), service providers offer mainly electricity. Therefore (regional) power supply companies play an important role in implementing e-mobility in Austria. They also engage in e-car-based car sharing etc. In contrast to the automotive industry, system and service providers are not dominated by globally active enterprises and local framework conditions play a more important role for their development. Hence, the regional and national level plays a more important role. This can also be seen when the “mobile power regions” in Austria are considered: Local power supply companies are key players in the model regions as they are actively trying to establish themselves as key actors in the field of e-mobility. Also public transport providers play an important role, particularly as e-mobility concepts are tested that enhance interoperability with public transport respectively non-motorized individual transport.

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What would be key mechanisms in driving and continuing the transitions?

Before discussing driving forces and bottle necks for system transition, it is necessary to mention that these differ according to the specific actor groups involved in e-mobility activities. Whereas for some actors the expected environmental benefits are the main driving force and positive incentive concernign electric mobility, incentives for industry actors differ.

So far demonstration projects played a very important role in fostering e-mobility in Austria, as it was possible to establish attractive packages for users in the context of these projects. The attractiveness was mainly related to prices well below market prices and additional benefits for users (e.g. access to reserved parking spots for commuters). However, the attractiveness of additional benefits varies greatly from region to region and depends on the actual shortcomings in the transport system (e.g. public parking space, usage of bus lanes, higher speed allowances (when conventional motorized vehicles are restricted due to air pollution) etc.). An interesting observation with respect to the different mobile power regions is that well-functioning e-mobility models are not restricted to urban areas, e-mobility is functioning equally well in densely populated rural areas.

Technologies play a key role. In contrast to the situation at the start of the demonstration projects in 2008, the increasing availability of e-cars by global OEMs can be considered as an important driver (although the shortage for some models that came to market in recent years is a barrier). In addition to the general attractiveness, the price plays a key role. Given current market prices, e-car costs are not competitive for the majority of usage patterns. Only a small share of early adopters is willing to pay the current e-car-premium. The experiments in Austria also highlight that most users prefer ownership models to models that allow the use of vehicles without ownership (sharing or pooling models).

One of the main perceived barriers of e-mobility are range restrictions and consequent reductions of freedom – even if they only limit a very small fraction of trips. Therefore the development of battery technology is expected to play a key role in the transition, particularly as there are no indications that mobility patterns of users are to change dramatically. However, different expectations concerning the cost and performance of future batteries exist. This uncertainty about technological developments is a barrier for investment. Range anxiety and general anxiety about the functioning of e-mobility is a barrier for users, particularly as investments in e-cars are relatively expensive. Therefore it is important to give potential users the opportunity to find out how e-mobility works - and that it works without problems. In the model regions users got the chance to experience e-mobility and feedback of these early adopters was positive.

In addition to battery technology, ICT plays a role concerning new business models (that go beyond the mere substitution of conventional vehicles), related to car sharing and pooling, mobility services, the interregional use of public charging infrastructure and intermodal transport solutions. So far public charging infrastructure availability and interoperability are limiting factors. Interoperability is thereby limited mainly because different companies (supported by local power supply companies) established their own proprietary systems.

Many consumers that were (and are) early adopters in e-car-usage are motivated by the reduction of negative environmental effects, for business users the creation of a positive image plays an important role. Therefore the availability (and the combined offer) of e-mobility-solutions with electricity from renewable sources was also a key mechanism for the acceptance of e-mobility. For the current target group, e-mobility cannot be dissociated from renewable energy. For industry this is however sometimes considered as a barrier as it adds complexity.

For providers of e-mobility solutions, uncertainties about dominant (future) business models and lacking standards (charging and billing) are barriers to system change. Hype-dissapointment cycles that could be observed in this field (see Kemp et al. 2011) also act as a barrier as does the lack of transparency and continuity with respect to subsidy schemes (that is key for the demand of (private) users).

For the automotive industry key barriers are a lack of commitment (against the background of vested interests of established manufactures) and the uncertainty about the availability of lithium for batteries.

For public authorities a barrier to system change towards increased use of of battery-electric and hybrid-electric vehicles is the fact that this still is a form of individual motorized transport (and hence in contradiction with transport policies in many cities). E-mobility is also not very relevant politically, it is no topic with public pressure and hence not very relevant for election results. State aid rules by the EU are also a barrier as there exist unresolved topics and uncertainty about certain diffusion oriented subsidies.

6. Describing related Policy Agendas and Measures

The basic motive for the Systems Innovation project is to understand how innovation policy can influence Systems innovation. Therefore this section encompasses a general description and a summary of the most influential policies in Austria regarding e-mobility.

As proposed by the OECD TIP working group on System Innovation we will use the analytical framework provided (see below) to distinguish policy makers, programme managers and project leaders. Typically policy makers located in ministries are responsible for the general development of policy portfolios, the definition of programme rationales and monitoring. The actual daily management of the programme frequently takes place in agencies which are responsible for the administration of the policy programmes, which are led by individual project leaders in research performing organisations.

Figure 4: Policy, program and project management

Source: Arnold and Boekholt, 2003:11, from System innovation: Concepts, dynamics and governance, DSTI/STP/TIP(2013)3, p.30

Policies in the field of e-mobility in Austria follow a similar pattern in terms of division of labor. The two ministries (BMVIT & BMLFUW) are responsible for most relevant innovation and transition policy programmes directly supporting research, development and the diffusion of electric vehicles. Moreover the Austrian Climate and Energy Fund (KliEn – 'Klima- und Energiefonds') has a special role stimulating low carbon innovation through the provision of financial resources and the development of (policy) strategies. The funds itself is governed through the two ministries above which both delegate a representative in the board. Thus, the Climate and Energy Funds contributes also to the coordination of these two ministries which are both active in the field of low carbon innovations, such as e-mobility.

The responsibility for administration of the several policy programmes depends on the specific programme. Whereas the 'lighthouses e-mobility' programme (see below) is managed by the Austrian Research Promotion Agency (FFG), the programme 'model regions' e-mobility is managed by KPC Public Consult a specialized provider of services to public authorities specialized in the development, implementation and management of support programmes. Although other funding schemes initiated by the KliEn are managed by several other organisations, FFG and KPC are the two most important organisations involved in the administration of e-mobility support programmes. The projects itself are managed by individual project leaders from academia, extra-university research institutes and industry.

To conclude, division of labor in the design, implementation, management and administration of policy programmes in the field of e-mobility follows in principle the division of labor with policy makers in ministries responsible for the more strategic tasks and programme managers in research agencies or supporting consultancy companies. However, as a deviation from this model the Climate- and Energy funds has a complementing role located between the strategic level ministries are active on and the administration of the programmes. Due to its institutional links to two ministries (BMVIT and BMFLUW) it facilitates the coordination between the two ministries.

Which policy agendas and measures have been important?

Austria is following an implicit transition approach since the late 1990s in the mobility domain. One important policy rationale has been to address industrial policy objectives ('strengthening competitiveness') and societal needs & challenges ('environmental and social goals') at the same time, thus achieving a 'double dividend'.

Historically one of the starting points for the more recent innovation policy programmes regarding e-mobility was a wider mobility and transport research and innovation programme, emerging at the turn of the millennium (I2VS – Intelligent Transport Systems and Services). Research and development in the field of alternative propulsion systems, such as electric mobility became an important element of I2VS and the subsequent I2VS plus programme. In 2005/2006 the Austrian Agency for Alternative Propulsion Systems (A3PS) was founded as a public-private partnership to support innovation activities regarding all kinds of alternative propulsions technologies.

In the following we will give a short overview of important policy programmes regarding e-mobility in Austria.

One important policy programme initiated by the Climate and Energy Funds are the 'model regions electric mobility'. The programme is running since 2008 and aims for a wide diffusion of electric vehicles in commercial and private contexts. The main focus of the programme is the demonstration of e-mobility in practice in certain regions and to show the functionality and attractiveness of electric mobility. New mobility concepts in combination with renewable energy should be integrated in future transport concepts eventually strengthening technological competences of Austrian companies (see Ausschreibung, Modellregion Elektromobilität, March 2010). At the moment seven model regions electric mobility are funded by this support scheme. The figure below gives an overview of this seven model regions. The two model regions VLOTTE (in the most western province of Vorarlberg) and ElectroDrive Salzburg (in the center) taken as examples for local experiments to compile this case study of e-mobility in Austria have been financed by these policy programme. One major requirement for projects within this framework is the development of an integrated mobility concept which takes into account walking, cycling and the use of public transport to integrate these mobility forms with e-mobility in order to minimize the environmental impact while satisfying the mobility demands of the users in the specific region. The primary focus of the programme is to facilitate and accelerate the diffusion of e-mobility solutions in Austria.

Figure 5: Overview model regions in Austria (source : Austrian Climate and Energy Fund)

VLOTTE has been the first model region, followed by ElectroDrive Salzburg, initiated in 2009. Other model regions are Vienna (‘e-mobility on demand’), Graz region (‘Großraum Graz), Lower Austria (‘e-pendler niederösterreich’ – e-commuter Lower Austria), Carinthia (E-LOG Klagenfurt) and Vienna with regard to postal services (E-Mobility Post). Interesting from an innovation and transition study perspective is that most of these regions experiment with different business and mobility models. Whereas some regions offer e-mobility solutions for private and commercial customers, other are focused on certain groups like commuters (Lower Austria) or the use of electric vehicles for the Austrian postal service (E-Mobility Post in Vienna).

The Austrian Climate and Energy Funds is primarily responsible for this subsidy scheme, while a specialized consulting company (see above) is operating the administration of the programme.

Another important programme is the “Technological lighthouses e-mobility” programme which was initiated in 2009/2010. The aim of this programme is to improve the energy efficiency of the transport system through interoperable e-mobility solutions. In contrast to the ‘model regions’ programme the focus of this programme is to support research, development and innovation activities. Thus the programme explicitly aims to support technological developments and to support technological innovations with a long term perspective. Furthermore the programs goals include the strengthening of the Austrian R&D competences and to improve the competitiveness of the Austrian automotive industry.

Thus the programme differentiates from the ‘model regions’ programme in so far as it explicitly aims to support technological development and innovation activities with a longer term perspective, whereas the ‘model regions’ programs primarily aims at the diffusion of e-mobility and the experimentation in ‘real world’ contexts. Innovations being developed in context with lighthouse projects are often not yet on the brink of commercialization. Consequently the Austrian Agency for the Promotion of Research (FFG) is responsible for the administration of the programme.

Another funding scheme relevant for e-mobility was the ‘Climate and Energy model regions’ programme, initiated in 2009. This programme aims to support regions in Austria so use the potential of renewable energy, to increase their energy efficiency and to enable a more sustainable economy. Accordingly the programme supports several kinds of innovations such as renewable energy, energy efficiency measures, buildings and retrofitting and e-mobility. Thus e-mobility can be one of the elements to establish a climate and energy model region. This programme, financed by the Climate and Energy funds aims primarily at the diffusion and implementation of low carbon innovations, not at supporting research and development activities as such, even though they can be part of the activities of such a region.

Another important funding scheme for research, development and innovation activities is the 'Mobility of the future' scheme, which supports different kinds of research regarding mobility. In particular the topic area 'alternative propulsion systems' provides the opportunity for research performing organisations to receive funding for their innovation projects. Although this program can be regarded as key for research and innovation activities in Austria, it will not be discussed in detail to provide enough room for the discussion of the e-mobility specific policy programmes.

Complementing these funding schemes, the platform 'e-connected' was founded with public support to facilitate the formation of networks among stakeholders. Moreover, within the framework of the e-connected platform several working groups were initiated to discuss important issues and innovations barriers for e-mobility. There were for instance working groups on business models, electric vehicles, charging points, framework conditions and system integration (how to integrate e-mobility in the mobility, respectively energy system).

Whereas these policy initiatives represent the major sources of financing for research and innovation as well as experimentation in several regions, the rest of this section will focus on policy initiatives at the strategic level.

In 2009 the ministry for transport, innovation and technology launched an initiative to draft an 'Introduction plan' (Einführunsplan) e-mobility (BMVIT, 2010: Strategie und Instrumente sowie prioritäre Anwender- und Einsatzbereiche für den Nationalen Einführungsplan Elektromobilität). This introduction plan was designed as a common framework for the numerous activities at the federal, provincial and community level regarding e-mobility. As such it can be considered as a first step to improve the coordination of different policy actors and to understand e-mobility more holistic than. Thus, the introduction plan was intended to improve the coordination of activities within the BMVIT, in particular the interface between innovation policy and transport policy which represent two different department within the ministry and as an 'invitation' to other ministries to join this strategic activity. The document as such discusses the perspectives of the BMVIT on e-mobility. As such it provides orientation and defines guiding principles such as that e-mobility should be understood in context of an optimization of the transport system putting emphasis on intermodality and public transport. Furthermore it states that sustainable mobility make most sense if they are well suited for the application and thus policy should take into account all technological options including hybrid vehicles, fuel cells or biofuels. Moreover it points out the need for a sustainable energy supply, thus the need for an integration of renewable energy and mobility solutions.

In addition the document contains a definition of different fields of action, including transport policy, legal framework conditions, subsidies and incentives for users, policy support for research and technology development, public procurement, infrastructure provision and business models, education communication and international networking among others.

Furthermore six priority applications concerning e-mobility are defined: commuters, taxis, public fleets, private fleets, model regions, (young) users of motorcycles and –bikes.

Furthermore a coordination process regarding electric mobility was setup in 2010, including an inter-ministerial steering group to coordinate policies with an impact on e-mobility. This steering group has been supplemented by an advisory board.

The next step towards a better policy coordination and integration was the drafting of the Implementation Plan 'Electromobility in and from Austria – the common path' published in 2012. The implementation plan is a common strategy document of the three ministries involved BMLFUW, BMVIT and the Ministry of Economy, Family and Youth (now: Ministry of Science, Research and Economy (BMWFW)).

The implementation plan defines the common vision of the three ministries regarding e-mobility in and from Austria as: '*State-of-the-art technology developed and produced in the 'innovation country' Austria contributes vitally to the gradual implementation of electromobility in domestic, European, and international transport systems, it strengthens the business location, creates new jobs, and helps to reduce, by the growing use of renewable energies, as well as an increased energy efficiency, emissions generated in transport, and thus to protect climate and environment*' (Implementation plan Electric Mobility, 2012, p. 5).

The implementation plan represents a form of a 'common road' for the three ministries involved and lists measures to support the further development of electric mobility in Austria. These measures were developed within a consultation process, trying to capture the perspectives and input from numerous stakeholders. These measures are clustered in 5 fields namely 'Electromobility in the overall transport system", 'energy system and charging infrastructure', ‘preparation of the market and incentives system’, ‘raising awareness and information’ and ‘effects on the environment and monitoring’.

The coordination structures already involved in the development of the implementation plan, namely the steering committee and its advisory board have also the task to further develop the implementation plan and to monitor the progress.

To conclude, this section provided an overview of the most important policies for e-mobility in Austria. These are in particular ‘model regions e-mobility’ a more diffusion oriented programme, ‘technological lighthouses e-mobility’ a more research focused scheme, ‘climate and energy model regions’ a more general policy programme aiming in particular for the realization of positive environmental effects and the more general mobility research programme ‘mobility of the future’. Concerning the policy coordination as such, the setup of the Implementation plan e-mobility with its support structures can be considered as a vital policy initiative. However, this is only a short overview of policy programmes in Austria, which cannot cover all policy initiatives at the federal, provincial and community level. In particular the EU level has also been important for the development of e-mobility. Even though this case study does not contain an explicit analysis of EU policies, it should be mentioned that the EU targets for the reductions of CO2 emissions from vehicles are a major driver for innovation activities concerning low or zero emission vehicles for the automotive industry. A number of experts even reported in the interviews, that these CO2 targets (often referred to as the 95g CO2/km target) is the solely most important driver for the automotive industry to act now and to investigate alternative propulsion systems such as e-mobility seriously (see as well the section of this case study on drivers of change).

Which governance structures and mechanisms have characterized the development?

The governance structures in the field of e-mobility in Austria are quite complex due to the large number of (policy) actors involved. Furthermore the governance of e-mobility in Austria cannot be fully understood without taking into account the European (policy) level. However, there are not only policy actors at different geographical scales involved, but also different policy fields, for instance research, technology and innovation policy, transport policy or environmental and climate policy.

Referring to the typology by De Bruijn et al. (1993), see the table below, the governance structure are best described by the third types, ‘policy networks’.

Figure 6: Different policy paradigms

	Classic steering paradigm (top-down, command-and-control)	Market model (bottom up)	Policy networks (processes and networks)
Level of analysis	Relationship is between principal and agent	Relationship is between principal and local actors	Network of actors
Perspective	Centralized, hierarchical organization	Local actors	Interactions between actors
Characterization of relationships	Hierarchical	Autonomous	Mutually dependent
Characterization of interaction processes	Neutral implementation of formulated goals	Self-organization on the basis of autonomous decisions	Interaction processes in which information and resources are exchanged
Foundation scientific disciplines	Classic political science	Neo-classical economy	Sociology, innovation studies, neo-institutional political science
Governance instruments	Formal rules, regulations and laws	Financial incentives (subsidies, taxes)	Learning processes, network management through seminars and strategic conferences, experiments, vision building at scenario workshops, public debates

Source: De Bruijn et. al., 1993:22, from System innovation: Concepts, dynamics and governance, DSTI/STP/TIP(2013)3, p.24

In contrast to classic steering approaches, the most important governance mechanisms are processes and networks. The reason for this approach lies in the necessity to involve a number of policy actors, respectively ministries, from different policies fields. Since ministries are usually not in a hierarchical order, the classic steering paradigm does not fit to this type of innovation. One of the most important governances processes the development of the implementation plan electric mobility (see above) shows this network approach quite well. The plan was developed, consulting experts and stakeholders by three ministries with stakes in e-mobility. As thus, there are as well mutually dependent, since the successful implementation system innovation e-mobility requires the coordination of these different ministries. To enable the development of the implementation plan electric mobility a steering group and an advisory board were established in order to enable continuous learning processes and information exchange between the actors involved. Due to the complexity of the system innovation, no single policy actor or ministry has the knowledge and competences to develop adequate policy interventions. Thus, there is a constant and growing need of information exchange and coordination.

In addition some elements of the market model can be identified in particular financial incentives such as subsidies, which play an important role in the more diffusion oriented programs to compensate for the high initial price of electric vehicles.

a) Policy organization – Horizontal and Vertical organization?

The implementation plan electromobility and its support structures & processes (steering group, advisory board) can be considered as the central platform for policy coordination in Austria. However, a duplication of activities was partly reported. Nevertheless the cooordination has improved and climate policy is for instance supplementing innovation policies (and vice versa) more effectively.

Although the introduction of the process as such has improved the coordination between the ministries experts interviewed identified potential for improvement. In many cases the different rationalities of policy fields cause challenges for the coordination efforts. On the one hand innovation policy with a focus on innovation and an increasing mission orientation, and on the other hand transport policy which primary task is to meet the mobility demands or climate policy which aims at the reduction of greenhouse gas emission beginning on the short term. In addition there are many topics where the responsibility is not clear from the start, since e-mobility is a cross-cutting issue. Moreover it was reported that there are still cultural divides between different policy fields present and some actors apparently apply form of 'silo-thinking'.

The interaction and diffusion of knowledge between the actors involved in the more research oriented programs and the more diffusion oriented programs does happen, however it was reported that in particular the diffusion of knowledge should be improved in the future.

Another challenge for coordination is that, there are many stakeholder groups involved having a different degree of influences in the ministries, thus the sheer number of stakeholders makes coordination a complex and challenging task. The role of the Austrian Climate and Energy Fund was assessed controversially, while some experts emphasized its important role for coordination, others demanded more coordination efforts and willingness for coordination. Moreover, some experts raised concerns about the effectiveness of the coordination processes and the implementation plans, stating that actors tend to refer to measures listed in the plan if it fits to their agenda; however tend to ignore the plan if the measures are of no interest to them.

To conclude, the horizontal coordination of policies is improving, and there are structures and processes in place to facilitate the coordination beyond specific policy fields, however there is still a lot of untapped potential to facilitate the e-mobility transitions through better coordinated policies.

Regarding the vertical coordination of policies, there is as well an enormous coordination demand through to the characteristics of e-mobility. Since (electric) mobility is by definition about the interaction of different places and humans and goods from different locations, it requires the interoperability of transport systems. Accordingly policies influencing the development of e-mobility have to be coordinated between the different geographical levels involved. Generally the federal level has the leading role for e-mobility in Austria, whereas some provinces have policy programmes for e-mobility in place, whereas other do not. However, the projects and model regions supported by policy programmes at the federal level, e.g. model regions e-mobility, are often important for the establishment of e-mobility at the level of provinces and communities. Nevertheless the coordination between the federal, province and the community level proves difficult due to long lasting positions by specific actors which require a compromise of all actors involved.

Thus e-mobility needs to be integrated in EU level, national, regional and local strategies and concepts in order to be successful.

7. Analyzing the role of Policy and Policy Measures

Policy Analysis

How have policy agendas, governance and measures impacted transitions and structures?

Austrian e-mobility policies and initiatives are generally already ‘systemic’ in their principle approach, however there is still a growing need for coordination of policy interventions from different policy fields and at different geographical levels. There is general awareness of the need for policy-mixes and the importance of non-technological aspects, such as new business models or public acceptance. However, the main challenge remains the implementation and up-scaling of existing projects and model regions to a wider set of users.

There are a number of policies initiated at different geographical levels and originating from different policy fields. In particular influential policy programmes are at the

- EU level: Even though not focus of this case study of e-mobility in Austria, the EU regulations concerning CO2 fleet emission are an important driver of innovation and transition activities. Climate policy can be considered a major driver for the transition towards a more sustainable transport system and e-mobility. There is on the one hand a regulation framework in place to enforce the car industry to reduce emissions caused by new cars, and on the other hand there are the more general EU climate targets, better known as the ’20-20-20 targets’, meaning a 20% reduction of EU greenhouse gas emission from 1990 levels, raising the share of renewable resources to 20% and enhancing the EU’s energy efficiency by 20% by 2020.
  The regulation addressing the automotive industry foresees the fleet average to be reduced for all new cars to 95g CO2/km by 2021 (Regulation (EU) No 333/2014 of the European Parliament and of the Council of 11 March 2014 amending Regulation (EC) No 443/2009). Moreover, the opportunity to gain so called ‘super-credits’ for vehicles emitting less than 50g CO2/km are an incentive for the automotive industry to diffuse electric vehicles to fulfill the regulation requirements. Each of these low-emitting cars, such as electric vehicles will be counted with a certain factor, for instance as 2 vehicles in 2020, 1.67 in 2021 and 1.33 in 2022. Thus the diffusion of electric cars could help automotive manufacturers to fulfill their obligations even though they might not reach the targets otherwise.
  Even though there are as well a number supply side oriented policies in place, for instance the ‘green-cars initiative’, supporting innovation and transition activities considerably, the upcoming CO2 targets were reported to be most influential for e-mobility activities in Austria.
- On the national level there in particular there is a mix of more research oriented (e.g. ‘technological lighthouses e-mobility’) and more diffusion oriented programmes (e.g. ‘model regions e-mobility’). In general these programs cover the needs of the e-mobility community rather well, however there were some reports concerning the untapped potential of a more coordinated approach between these two programs and the

different ministries responsible for them. It can be concluded that the innovation and transition programmes enabled the establishment of e-mobility in selected regions and for specific applications. The three projects studies within the course of this study, where supported by these policy programmes. Thus, the policy interventions helped to make a number of local experiments with different e-mobility solutions possible and helped to establish e-mobility as a part of the mobility system.

Nevertheless, there are a number of persistent problems which probably require further policy interventions. One issue a number of projects are confronted with at the moment is the lack of available and capable electric vehicles, so they could not diffuse as many electric vehicles as initially promised. Another even more important issue is the scaling up of these projects. Whereas e-mobility could be established as an alternative and more sustainable form of mobility within the context of specific projects it becomes clear that the total number of vehicles and the share of e-mobility remain very limited (see section on the stage of the transition). Thus, one of the most important questions is how to scale these current experiments up and implement e-mobility in the current mobility system.

- To conclude, the policies on the national level enabled the establishment of e-mobility experiments covering many aspects of the innovation cycles and helped to establish crucial networks between the actors, which can act as platform for future change.
- The regional and community level is active on the policy level as well. Furthermore many aspects which are important for the further diffusion of e-mobility (building codes, possibilities to install charging points, etc.) are regulated at the regional or community level. Furthermore the projects financed by programmes at the federal level, e.g. model regions are actually taking place in certain regions, thus regions and communities are an influential actor. Moreover, certain communities are highly interested in attracting e-mobility projects or installing charging points, in particular in tourist regions in order to demonstrate their commitment to sustainability. Nevertheless the regional or community level can act as well as a barrier for e-mobility, when policies are in conflict with interests by actors from the field of e-mobility or different visions of and approaches to e-mobility are in place. One example would be policies aiming for a massive reduction of the use of vehicles within a city and the demands by infrastructure providers to install charging points at prominent locations in the city center to raise awareness for e-mobility. Regulations, such ‘Environmental’ or ‘Low Emission Vehicle’

zones which could be implemented at the regional/local level could be a large incentive for users to transition towards e-mobility. There are ongoing discussions that cities or regions could define certain areas where only low or zero emission vehicles, such as electric vehicles could be allowed.

Impact Analysis

Impact analysis of policies aiming at transition towards e-mobility is a complex and challenging task. Currently there is a lack of adequate indicators to measure progress as such and in particular to measure the impact of (specific) policy interventions. An indicator often used to measure the progress are registrations of electric vehicles, however from the perspective of this case study it becomes clear the registrations numbers are too simplistic to measure the progress of a system innovation such as e-mobility. Registration numbers, frequently used in public and/or policy discourses to discuss the progress for e-mobility or to define targets cover only a small aspect of the e-mobility transition, since they strongly focus on the diffusion of vehicles. However, particularly in the early phases there are a number of activities which are a prerequisite for the long term prospects of e-mobility, however they are neglected when registration numbers are used as the solely indicator.

Moreover, even when going beyond a single indicator such as registration numbers, there are a number of principal problems for the design of indicators and impact analysis:

Different stakeholders and policy actors act accordingly to different rationalities. Whereas some policy actors follow an innovation orientation, others follow an environmental orientation or are primarily interested in the economic effects. Thus, it has to be clearly defined what the aims of the transition which is going to be measured are. The assessment of current e-mobility innovation and transition activities will be completely different if recent results of innovation projects are assessed or if the assessment focusses on the actual environmental effects (reduction of CO2 emissions). Regarding research and innovation an assessment would probably look at patents and publications resulting from recent e-mobility projects and would come to an positive evaluation of a certain policy, whereas an evaluation of the actual emission reductions through e-mobility could come to the conclusion that the amount of emission reduction is only minimal. On the opposite an evaluation of a diffusion oriented project would come to the conclusion that the impact on technology development was only limited.

Therefore it is crucial to define what the aim of specific policy initiatives is to develop adequate indicators. Moreover there are different visions of how e-mobility should be implemented, thus diverging perspectives concerning the importance of different measures over time. Another problem which should be taken into account are repeating hype-disappointment cycles which could lead to an overly optimistic assessment of the situation in times of hype and too pessimistic perceptions during a period of disappointment.

Concerning the impact assessment of specific policies the not very clear relationship between policy interventions and indicators makes an assessment challenging ('attribution problem'). This holds in particular true for e-mobility in which case numerous policy interventions could have an influence on the development. In addition many policy interventions are reliant on each other, making the individual assessment of the impact of a certain policy intervention even more difficult. Only the coordination of different policy fields will probably lead to a transition towards e-mobility, however it will be hardly possible to distinguish or even quantify the specific share of a policy intervention or even policy field to the overall development.

Future policy perspectives

Which policy agendas and measures would be important in the future?

Better coordination and new governance mechanisms

This case study shows that system innovations such as e-mobility require a very high level of coordination and alignment of policies. Thus there is the need for new governance mechanisms and systemic instruments which take into account the different rationales for policy intervention depending on the policy field. Since policies are developed from different ministries according their rationality, coordination frequently remains challenging. It is important to understand, that these coordination challenges are often not caused by an unwillingness of (policy) actors to cooperate, but have a systemic reason. Every policy maker is eventually assessed by the policy goals, prevailing in the policy field he or she is active in. Thus it is only logical that environmental/climate policy actors are primarily interested to reduce emissions as soon as possible, whereas economic and industrial policy has the task to ensure the competitiveness of the automotive industry respectively system providers.

Although there have been promising approaches to improve the coordination of policies in Austria, there is still large potential for better policy coordination processes and structures which take into account the different rationalities of specific policy fields. The need for coordination can be expected to become even bigger in the future, when e-mobility enters a phase of a more widespread diffusion.

Maintaining and strengthening the acknowledgement that the transition to e-mobility will be more than a 'technology fix'

The analysis of the perceptions of key actors and strategy documents in the field shows, that the large majority of actors involved understand e-mobility as more than just replacing one technology (combustion engines) with another (battery & e-motor). Following the vision of sustainable mobility system, it is important to maintain and strengthen this perspective. This holds in particular true since a 'technology fix' would probably not be able to address the wide spectrums of challenges the mobility system is confronted with. E.g. replacing all vehicles powered by combustion engines with electric vehicles would not solve congestion problems and a general lack of space many cities in Austria respectively around the globe, are suffering from.

However the implementation of such perspectives remains challenging as the following example shows. A requirement for funding that e-mobility projects have to use 'new' (in the sense of additional) renewable energy for the operation of electric vehicles could be perceived as an innovation barrier, since renewable energy sources are in many cases more expensive than the electricity mix in the grid. Although this requirement is important from an environmental perspective and key for the credibility of models for early adopters, it may be criticized by other stakeholders. Policy actors designing future policy agendas should be aware that such irritations and controversial discussion will occur as well in the future due to the enormous complexity of a system innovation in comparison with a 'technological fix' only.

Policies and Business models have to be adjusted to the local situation

E-mobility is no direct substitute for conventional mobility. In addition to costs, limited range is generally perceived as a main barrier for the acceptance of e-mobility. However the analysis of the three case studies in the framework of this study made clear that the main shortcomings of the transport system differ from region to region. Whereas in some areas parking space is very scarce and business models including easier access to public parking space (e.g. in city centers) are very attractive if combined with e-mobility, such an additional benefit is not relevant in other regions. And whereas interoperability of charging and billing infrastructure (that is frequently not the case in Austria) is important when mobility structures are such that a relatively large share of trips leads to regions with public charging infrastructure provided by an alternative Electric utility company, this is not relevant in regions that are more closed with respect to transport patterns. And while public charging infrastructure is very important in highly frequented spots relatively distant from agglomeration (e.g. skiing resort), they are less so in suburban living areas where most people charge their vehicle at home.

Initiatives to foster e-mobility by offering additional benefits will therefore very often not work in different regions and contexts. Therefore policies and business models have to be adjusted to the local situation and at the same time it has to be guaranteed that policies in place are not so fragmented that e-car-users cannot know what is allowed and what is not.

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