eGUTS

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Table of Contents

HIGHLIGHTS

For charging of electric vehicles, three practical technological solutions exist. All of the provided technologies can be implemented as stand-alone facilities or integrated into other street furniture, such as street lighting or parking meters.

While municipalities have full power to decide about public charging stations on public domain it is quite different for all other possibilities. Thus it is very important that municipalities work closely with all stakeholders involved in e-mobility on different levels.

It's a fact that the availability of fuelling infrastructure is important for the choice of alternative fuel vehicles. Several studies have determined that the availability of charging infrastructure plays a bigger role in the purchase decisions for electric cars than for cars with other fuels. Studies also show that 95% of users of electric vehicles want to charge their cars either at home or at work. Therefore it is a challenge to implement solutions in order to satisfy the needs of all costumers without effecting shortages.

Reducing the anxiety of running out of power by having many charging points available is one of the important parts of triggering electric vehicle adoption in mass market. Ease of access, technical characteristics and the spatial setup of electric vehicle charging infrastructure in urban areas are crucial for strengthening the electric vehicle adoption in mass market.

To present an overall overview of the current condition and development of charging infrastructures a status quo description of nine European countries is presented within this study. Included countries are: Austria, Croatia, Czech Republic, Hungary, Romania, Slovak Republic, Slovenia, Serbia and Montenegro.

Key barriers, which could be observed, are that the majority of consumers aren't adapting to or adopting the new technology for a variety of reasons such as e-vehicle price, limited range, price of oil, availability of charging stations, charging time and inconsistent nature of subsidies/incentives.

For the deployment of charging infrastructure, the main barriers for key stakeholders and investors can be seen in investment costs, billing technologies and systems, unpredictable share of electric vehicles in the mobility market, consumer behaviour and uncertainty about future market players.

It can be said that e-mobility and its infrastructure are already a topic that goes beyond the regions of the project partnership, which is also shown by the number of documented done projects and studies exemplary described in chapter 3 dealing with the above-mentioned barriers.

Plans and incentives for further development should include research in recharging time and infrastructure, wall boxes, highway car parks, public refuelling, regional target groups and location planning.

List of abbreviations

AC - Alternating current

CS - Charging station

DC - Direct current

eGUTS – Acronym of the project "Electric, Electronic and Green Urban Transport Systems"

E-REV - Extended range electric vehicles

EU - European Union

EV - Electric vehicles

HEV - Hybrid electric vehicle

ISO - International Organization for Standardisation

LEV - Light electric vehicles

PEV - Plug-in Electric vehicles

RON - Romanian Leu (currency)

V2G - Vehicle-to-grid

Introduction

In recent years, the development of electric vehicles and charging technology has progressed strongly. The electric vehicle cannot anymore be considered only as a vehicle concept for purely urban use as even long-distance journeys with electric vehicles are possible provided that proper charging infrastructure is available. It remains to be seen whether advanced e-vehicle concepts will be introduced to the market in the upcoming years, which will have long-term suitability. If these vehicles will be able to replace conventional fossil fuel driven vehicles due to their improved performance, the demand for quick-charging stations will also increase rapidly. Comparing the small proportion vehicles with their use of the rapid-loading columns, an increased demand for this technology, especially on motorways and expressways, is expected in the future.

This includes the location and geographical distribution of the charging infrastructure, charging concepts and connection performance, standardization and standardization of charging cables, plugs and communication facilities, charging stations safety requirements and possible network effects by the rectifiers of the charging units of the batteries. The establishment of the charging infrastructure is a critical factor in the initial phase of electric mobility, in particular, when it comes to reducing the advantage of the low energy costs of electrically driven vehicles by means of cost-intensive charging infrastructure. This also applies to billing systems at public charging stations.

Within the framework of eGUTS the current situation concerning charging station in all regions of all project partners including related projects and studies will be elaborated.

Furthermore this study emphasizes statements dealing with advantages – disadvantages of charging stations and suggestions for further development related to charging stations. This feasibility study is the basis for the preparation of local action plans, as well as for the assistance of pilot activities in eGUTS cities. Thus, the feasibility study takes EU standards, as well as national specificities of each participating country into account. The final version of this study will be included in the pilot activities and in the development of eGUTS standards of within work package WP3.2.

The topic “development of charging stations in urban areas” is divided into five chapters. In the first chapter the starting points and basic information of a charging infrastructure are presented. The second chapter includes an overview of the regional and national development of charging stations and defines key barriers and recommendations for charging stations. The third chapter includes an overview and description of existing studies/projects. The fourth chapter provides guidelines and vision for the future development of charging stations in urban areas. The final chapter contains a short conclusion.

1 Charging infrastructure

1.1 Charging infrastructure technologies / characteristics of charging infrastructure[1]

For the charging of EVs with electric power, three practical technological solutions exist: charging the vehicle with a connector (conductive charging), via electromagnetic induction (inductive charging), or by taking the depleted battery out and replacing it by a charged battery (battery switching). Such charging facilities can be implemented as stand-alone facilities or integrated into other street furniture, such as street lighting or parking meters.

Conductive charging

Conductive charging means that electric power is transferred to the vehicle by using an electric cable and a connector. The actual charging of the battery within the vehicle must take place via a direct electric current (DC). The alternating current (AC) from the electricity network can be directly passed into the electric vehicle, where it is rectified to DC for charging the batteries. This is referred to as AC charging, or on-board charging because the charger/rectifier is located inside the vehicle.

Alternatively, the current can be rectified outside of the vehicle and DC fed into the vehicle. This is called DC charging, or off-board charging because the charger/rectifier is located outside the vehicle. In the following, first different forms of conductive charging facilities in general will be presented. Then the discussion will focus specifically on AC charging and DC charging respectively.

There are different ways in which battery electric vehicles or PHEVs can be charged via plug-in charging. Four 'modes' of charging technology are commonly available. Each of them can involve different combinations of power level supplied by the charging station (expressed in kW), types of electric current used (alternating (AC) or direct (DC) current), and plug types.

The power level of the charging source depends on both the voltage and the maximum current of the power supply. This determines how quickly a battery can be charged. The power level of charging points ranges widely, from 3.3 kW to 120 kW. Lower power levels are typical of residential charging points[2].

- **Mode 1 (slow charging):** allows vehicle charging using common household sockets and cables. It is commonly found in domestic or office buildings. The typical charging power level is 2.3 kW. Household sockets provide AC current.
- **Mode 2 (slow or semi-fast charging):** also uses a non-dedicated socket, but with a special charging cable provided by the car manufacturer. A protection device that is

[1] Wirges, 2016: Planning the Charging Infrastructure for Electric Vehicles in Cities and Regions
[2] European Environment Agency (2016): Electric vehicles in Europe, EAA Report No 20/2016

built into the cable offers protection to the electrical installations. It provides AC current.

- **Mode 3 (slow, semi-fast or fast charging)**: uses a special plug socket and a dedicated circuit to allow charging at higher power levels. The charging can be either via a box fitted to the wall (wall box), commonly used at residential locations, or at a stand-alone pole, often seen in public locations. It uses dedicated charging equipment to ensure safe operation, and provides AC current.
- **Mode 4 (fast charging):** also sometimes referred to 'off-board charging', delivers DC current to the vehicle. An AC/DC converter is located in the charging equipment, instead of inside the vehicle as for the other levels.

One disadvantage of high-power, fast charging is that the stronger currents mean that more electricity is lost during transfer, i.e. the efficiency is lower. Moreover, fast charging can decrease battery lifetime, reducing the number of total charging cycles. Fast DC charging points are also around three times as expensive to install as a simple AC charger, so many users are reluctant to invest in the additional costs. While some new electric vehicle models are provided with a DC charging facility, others require the purchase of an additional charging device

Conductive charging facilities are built in diverse forms. Two basic forms can be identified. **Wall-boxes** are mounted on walls or posts. This is a cost-efficient solution for private or public parking garages, or parking spaces next to buildings. If charging facilities are to be installed at curb side parking spaces or in big open-air parking spaces, more expensive **charging posts** (also called charging pillars) must be used.

Each charging facility can have several socket outlets or connectors. Wall-boxes usually have 1 or 2, and charging pillars 1, 2, or 4 socket outlets or connectors. If wall-boxes or charging pillars are installed outdoors, the body housing needs to provide protection from weather and other environmental influences. These requirements are stated in the rule of application VDE-AR-N 4102 and the norm DIN VDE 0100-722. For an installation outdoors, a protection level of at least IP44 has to be implemented. This IP (intrusion protection) level stands for protection from intrusion by small objects bigger than 1 mm and protection from splash water. Charging facilities located next to roads have to be constructed in a way that they are protected from collisions. Such a protection can also be installed in front of the charging facility, for instance in the form of a bollard.

If the facility is installed in a special environments with, for instance, extreme temperatures, high humidity, or possible flooding, the type of the casing has to be agreed upon by the distribution network operator.

Electricity can be distributed using single-phase or three-phase systems. Households commonly use single-phase power for lighting and powering appliances. It allows only a limited power load. Commercial premises commonly use a three-phase system, as it provides higher power.

Inductive charging

Electric vehicles can also be charged via induction. In this case an electromagnetic field is created in a primary coil, which transfers energy to a secondary coil integrated in the vehicle. Inductive charging faces the obstacle that the development of a generally accepted standard is even more delayed than in the case for conductive charging.

What makes this technology so interesting is that it allows making the charging facilities and potentially even the charging process itself totally invisible to the user. The inductive coil can be integrated invisibly into the parking ground. The driver of the vehicle simply needs to park his vehicle on the equipped parking space to charge his vehicle. Authorization and start of the charging process can be automatized. Thus, this seems to be a convenient solution.

The fully automatized charging process also allows recharging during very short parking times of a few minutes only. Additionally, this implementation is safe for users, as there are no open electric contacts.

There are, however, also drawbacks from a technical viewpoint. This technology requires an induction coil and further electrical components to be built into the vehicle. Also, the energy losses during inductive charging are generally higher than when charging via a plug. If the driver parks carelessly and the two induction coils are not well aligned, the power transfer becomes even less efficient.

Inductive charging systems are already in use for small vehicles in logistic and production halls and for low-speed short-range EVs in business compounds. Inductive charging is also used for public electric buses in the city of Turin in Italy and in Gumi in South Korea. The technology seems interesting where vehicles are driving in closed compounds or circuits. Once the issue of standardization is resolved in the future, this technology also bears high potential for use in public charging.

Battery switching

The third relevant technological solution for the recharging of EVs is battery switching (or battery swapping). This means that the depleted battery is taken out of the vehicle and replaced by a charged battery.

For this purpose specially designed battery switch stations are needed (company Better Place presented its specially designed battery switch station in May 2009). The price for such a fully automatized station amounts to about 500 000 US$. A similar automatized battery exchange station has also been developed within a German research project (NEXT ENERGY) and by the car manufacturer Tesla (battery swap program have been discontinued in favour of Superchargers).

To be able to switch batteries freely, they have to be of exactly the same format. For an application of battery switching in the large scale, manufacturers of EVs would therefore have to agree on a common standard or a selection of standards for batteries for EVs. This would limit their liberties in the design of vehicles, so it is unlikely that such standards will be developed.

An interesting approach which might combine switchable batteries with the flexibility of differently sized battery packs is to use smaller modular elements. Several projects are working on this topic one of them being “Battery in motion” planning to specifically equip EVs with many small modular batteries instead of a single big one. An EV’s battery pack can thus be adapted to the actual use of the EV, and unnecessary weight due to unnecessary batteries can be avoided. This concept might also lead to additional benefits of intelligent battery switching, by lowering the energy consumption of EVs by this weight reduction.

A battery switching facility is convenient from the user’s point of view. Alike to refuelling with gasoline today, the vehicle is recharged and ready to drive on within minutes. A battery switching station performs this task fully automatically, similar to a drive-through car wash, so that the driver himself does not have to take care of anything. A single facility could serve several hundreds of vehicles per day, and thus a few such facilities would be sufficient to cover the charging demand arising in an area. The surplus batteries stored at the switching station can potentially be used as a buffer between the electricity system and the suddenly arising demand for recharging from the users. The batteries can be charged slowly at night during times of overall low electricity demand, and they can even be used to feed electricity back into the grid.

Charging infrastructure for light electric vehicles

For the charging of light electric vehicles (LEVs), such as electric bicycles and electric scooters, two possibilities exist: they can also use EV charging facilities for cars as those described above, if a household-type or smaller plug connection is provided. Alternatively they can use charging facilities dedicated to LEVs.

As with bigger EVs the three technological solutions of conductive and inductive charging, and battery switching can be applied.

For the conductive AC charging of LEVs, several manufacturers of electric bicycles, batteries, and charging infrastructure already use the EnergyBus plug standard. This standard includes a specification of a plug system, with magnets for attachment, as well as a communication protocol. In 2014 work has started to transfer the EnergyBus system into an international IEC/ISO standard.

With most LEV models the user can easily take the battery out and take it into his home or working place for recharging at a household socket. This possibility and the fact that LEV are mostly used for short-range trips indicates that the demand for public LEV charging facilities will probably be low. But special applications are interesting, such as integration of conductive charging into electric bicycle rental stations. The simplicity of battery handling of LEVs makes the installation of battery swapping stations for electric bicycles and electric scooters interesting for touristic regions.

Division of charging infrastructure ownership

Charging points for electric vehicles are usually characterised by their degree of accessibility for drivers. The main categories of charging points are generally defined as private, semi-public and public.

Private/domestic charging points

Such charging points are found in homes and business premises. They include dedicated charging boxes or common household plugs. Home charging is a simple option for electric vehicle owners, since no subscription or membership fees are needed to access the charging point. Private charging also occurs when companies install charging points for use by employees on business premises. Home charging naturally tends to be more common in suburban or rural areas than in urban neighbourhoods, as it requires the car owner to have access to a private garage or be able to connect the electric vehicle to a household socket. In cities, where vehicles are normally parked on public streets or in semi-public car parks, it is more difficult to access a private charging point.

Semi-public charging points

These types of charging points are situated on private ground, but can be accessed by external users. Examples include charging points located in commercial car parks, shopping centres or leisure facilities. Access to these charging points is typically restricted to clients or customers.

Operators often regard the charging points as a complimentary service or an opportunity to advertise, so they do not charge customers for the power used. In other cases, the electricity used is included in the customer's parking bill, or in the utilisation fee for car-sharing schemes. Most fast-charging facilities are semi-public and, like conventional petrol stations, are built on private ground but open to all paying users.

Public charging points

Public charging points are usually placed alongside roadside parking spaces or in public car parks. While private or semi-public charging points are often wall boxes, the public infrastructure usually consists of standalone charging poles. In some cases, municipal utilities provide these charging points. However, local authorities are increasingly commissioning commercial providers to facilitate the construction and operation of public charging infrastructure.

1.2 The demand for (public) charging infrastructure and expected use

Despite the extent of research on planning of a charging infrastructure for electric vehicles in the last few years, the actual demand for such a public infrastructure is still not fully understood[3]. Yet the European Parliament and the Council have agreed on a directive on the deployment of alternative fuels infrastructure in 2014[4]. The directive obliges EU member states to implement a minimal charging infrastructure for EVs. Such an infrastructure is described by:

> "Member States should ensure that recharging points accessible to the public are built up with adequate coverage, in order to enable electric vehicles to circulate at least in urban/suburban agglomerations and other densely populated areas, and, where appropriate, within networks determined by the Member States. The number of such recharging points should be established taking into account the number of electric vehicles estimated to be registered by the end of 2020 in each Member State. As an indication, *the appropriate average number of recharging points should be equivalent to at least* ***one recharging point per 10 cars****,* also taking into consideration the type of cars, charging technology and available private recharging points. *An appropriate number of recharging points accessible to the public should be installed, in particular at public transport stations*, such as port passenger terminals, airports or railway stations. Private owners of electric vehicles depend to a large extent on access to recharging points in collective parking lots, such as in apartment blocks and office and business locations. *Public authorities should take measures to assist users of such vehicles by ensuring that the appropriate infrastructure with sufficient electric vehicle recharging points is provided by site developers and managers*."

It is not explained how the lower limit of one charging point per 10 EVs was determined.

This puts an obligation on public authorities to actively plan charging infrastructure but in order to do so basic understanding of factors influencing demand for charging infrastructure coupled with number of electric vehicles is needed.

Before getting further in to the subject it is important to distinguish between different combinations of public and private with regard to charging infrastructure:

1. **Public charging** station on **public domain** (e.g. roadside/sidewalk);
2. **Publicly accessible charging station on private domain** (e.g. commercial areas such as shopping malls);

[3] Wirges, 2016: Planning the Charging Infrastructure for Electric Vehicles in Cities and Regions
[4] European Parliament and Council. Directive 2014/94/EU of the European Parliament and the Council of 22 October 2014 on the deployment of alternative fuels infrastructure

3. **Semi-public charging station on public or private domain** (e.g. car sharing CS, hotels or business parking for visitors and customers);
4. **Privately accessible charging station** (e.g. home or office locations).

The above classification discloses different combinations of public and private and consequently the authority (decision making right) over different types varies between public and private. While municipalities have full power to decide about public charging stations on public domain it is quite different for all other possibilities. Thus it is very important that municipalities work closely with all stakeholders involved in e-mobility on different levels.

Going back to the demand - studies have shown that the existence of interdependency between the availability of public charging infrastructure and the uptake of EVs by customers. It is often referred to as an chicken-and-egg-problem derived from the philosophical question “Which came first, the chicken or the egg?”, which poses a dilemma due to its circular dependency. The problem is seen not only for electricity, but for all kinds of alternative fuels including hydrogen, compressed natural gas, and liquefied petroleum gas. The Council of the European Union describes the problem for alternative fuels infrastructure: “In this vicious circle refuelling stations are not being built because there are not enough vehicles. Vehicles are not sold at competitive prices because there is not enough demand. Consumers do not buy vehicles because they are expensive and the stations are not there.”

The fact is that the availability of fuelling infrastructure is important for the choice of alternative fuel vehicles. Several studies have determined that the availability of a recharging infrastructure plays a bigger role in the purchase decisions for electric cars than for cars with other fuels. This seems to be due to the shorter range of today’s EVs in comparison to other types of vehicles. Additionally a psychological component to the demand exists. EV drivers seem to perceive a public charging infrastructure as a safety net and fall-back option, which they require in order to take advantage of the full range of their EV. This psychological demand for a public charging infrastructure is hard to quantify.

Acknowledging the psychological importance of public charging infrastructure, it is not only important to provide the infrastructure, but also to communicate its availability. For this, charging stations can be set up at well visible locations. Their availability can be communicated to EV drivers via satnav and smartphone applications.

Public charging as a public service

Public charging of EVs can be seen as a public service, similar to services such as public transport, water supply, garbage collection, and others. For such public services, minimal levels of service can be defined which guarantee the availability of a service to all citizens, independent of the actual level of utilization and profitability of the service. Municipalitie can decide to commission a charging infrastructure to provider In this case following detailed service levels can be agreed and set up as a binding contract.

- **Quantity of charging points for an area**: e.g. at least 0.1 (or 0.05, 0.025) public charging points available for every registered EV in the area.
- **Quantity of charging points for individual parking facilities**: e.g. every publicly accessibly parking facility with more than 50 parking places should provide at least 1 and for every parking facility with more than 100 at least 2 charging points for EVs.
- **Areal coverage**:
  - e.g. within the central city area, all locations need to be within a 5 (or 10) min walking distance to a public charging point. For a walking speed of 4 km/h this corresponds to a maximal distance of about 330 (or 660) m to a charging point.
  - e.g. number of charging point per square kilometre (covering an area so that the distance to the next charging point is never bigger than 330 m would require 3 charging points per km2.
- **Temporal availability**: e.g. between the time of 9:00 and 18:00 h on weekdays, an arriving EV driver has an average chance of at least 70 (or 80) % of finding a free public charging point (i.e. in that time the average occupancy of a charging point is below 30 (or 20) %). If average availability is lower, further charging points need to be installed in the area and/or policies put in place that require EV drivers to move their vehicles, once the charging operation is completed.
- **Fast repair / low down times**: e.g. if a charging point is reported to be broken, a service technician arrives at the site within 24 (or 48) hours, and the charging point is repaired within 48 (or 72) hours.
- **Distribution of fast charging stations along traffic corridors**: e.g. along a traffic corridor connecting two big cities, fast DC charging stations are available every 50 (or 75, 100) km, from both sides of the motorway.

When charging stations have been implemented in a city or region, a second phase begins: the infrastructure has to be maintained and operated. Among the diverse involved activities are the regular electro-technical servicing and testing, the repair, cleaning, retrofitting, and upgrading of charging facilities needs to be planned and a dedicated control centre with a hotline should be operated.

1.3 Advantages and future needs

As depicted in previous paragraphs, the public charging infrastructure plays important role in increasing the share of EVs used for mobility. In favour of unrestricted e-mobility in the future, charging points will need to be accessible in private households but more importantly they need to be accessible in public places. Public charging infrastructure has to form dense network with strategically positioned charging points that can be easily located, with sufficient capacity and availability (including energy supply) in order to accelerate e-mobility. Significant electro mobility penetration of the vehicle stock cannot be achieved without the large-scale provision of charging infrastructure. In general the EV owners mainly charge their vehicles at home as this is convenient and cost effective. In future vehicle-to-grid (V2G) technology will allow EV owners to sell some of the stored energy back to the grid.

However for many city residents home charging is not an option – in residential neighbourhoods with apartment blocks it is quite challenging to charge EV as no mass charging infrastructure exists. Thus accessible charging infrastructure is of vital importance in urban areas while for inter urban journeys charging infrastructure on highways is a necessity. At present many charging points are built either alongside motorways or at points -of-interest (such as shopping centres etc.) enabling drivers the convenience of charging their vehicles while working, eating or shopping. Nowadays, with charging point network still not fully developed, EV drivers will go where they can charge. In combination with the fact that the EV owners have higher spending capacity it should be in interest of local businesses to attract these customers also with readily available charging infrastructure. In addition to benefits related to electro-mobility, following advantages of charging infrastructure operations have to be exposed to stakeholders in order to stimulate investment:

- **Customer Attraction and Retention**

  Offering charging is a direct way to attract and retain new, EV-driving customers. In addition, many consumers believe it is important to purchase products with environmental benefits and to frequent environmentally responsible companies. Hosting a charging station is a highly visible way for organisation to state its environmental values, which may help contribute to a "green" image that attracts and retains customers who share these values.

- **User Charging and Parking Fees**

  Charging-station hosts have the opportunity to generate revenue directly from people who use their services (subscription-based, pay-per-charge, and pay for-parking systems). Complementary services can also be offered (park-and-ride).

- **Benefits deriving from innovative technologies**

  Solar powered (photovoltaic) charging infrastructure, EV's batteries in combination innovative technologies of smart grids can enable supply energy back to grid brining profits/benefits to infrastructure/EV owner

- **Employee Attraction and Retention**

  Companies that offer charging may be able to attract and retain employees who want to charge PEVs during the day. In addition, it is very important to many employees — even those who don't drive EVs — that their employers are proactive with transportation planning.

- **Fleet Cost Savings**

An organization may want to serve its own fleet with charging stations in addition to serving the public. A EV fleet can realize substantial operating cost savings.

- **Advertising Opportunities**

  Each time a EV driver visits a charging station is an opportunity to advertise to that driver. A station host could advertise its own products or services in this way or sell advertising space to another organization.

- **Improved image**

  Installation of charging infrastructure can improve the image of a city or establishment and enhance its sustainability initiatives.

- **Value of Avoided Carbon Emissions**

  With a growing number of local and regional carbon reduction policies, charging station owners may be able to benefit from the value of carbon emissions offset by their stations.

- **Improved Public Health**

  Governments have a responsibility to protect public health, and facilitating the pollution-reduction benefits of EVs (depending on the source of electricity) by hosting charging stations can contribute to this aim.

Future needs

Innovative mobility concepts such as electric mobility, “Park and Ride”, and carpooling, which meet the needs of urban residents at the same time are already making their way into urban centres. It is not feasible to plan infrastructural mobility concepts only focusing on the technical requirements (of charging infrastructure) without taking into consideration future mobility needs and new mobility concepts (mobility as a service). The impact of new mobility concepts can already be observed with car sharing implementation, impact of UBER, while the impact of autonomous vehicles can only be imagined.

With tendency of cities towards smart cities (with mobility being part of it) plans for future charging infrastructure need to accommodate enough flexibility to accommodate new requirements (e.g. incorporation into smart grids) and changed mobility demands deriving from behaviour changes. It is expected that urban residents of the future will most likely use vehicle sharing services or using services on demand (including autonomous vehicles) coupled with advanced public transport services and move away from owning the vehicles.

While planning for immediate future and investment into charging infrastructure it is strongly recommended that cities identify and actively involve stakeholders related to mobility (not only e-mobility). Additionally involvement of its citizens and two-way communication in necessary in order to develop cities in a way to suit its residents.

1.4 Community readiness

Community readiness is the degree to which a community is ready to take action on an issue. That readiness can range from none at all (the community has never even heard of the issue in question – think of AIDS in 1982) to already having successful programs in place and making real headway. Community readiness has some specific characteristics that are important for community builders to understand[5]:

- **It's issue-specific**. A community can be more than ready to address one issue, while being at the very earliest stages of readiness in relation to another.
- **It's measurable**. It's measurable across multiple dimensions. Not only can an accurate assessment of community readiness be measured, it can accurately be measured where the community is on various elements of readiness.
- **It can vary across dimensions**. A community may be more ready to address an issue in some ways than in others. It may know a great deal about the issue and realize it's a problem, for instance, but be unable to conceive of having any effect on it.
- **It can vary across different segments of the community**. Some groups – those directly affected by the issue, for example – may be far more ready to deal with it than others. It can be increased successfully for there are ways to move communities toward higher levels of readiness.
- **It is essential knowledge for addressing an issue**. Pushing community into something it's not ready for can easily doom and effort. People will only support what they see as reasonable, logical, and doable. It may be that something that's all of those is proposed, but if the community's perception is otherwise, it's unlikely to succeed.

An understanding of community readiness allows tailoring an intervention or strategy to what the community is willing to accept and get involved in. By taking small steps forward – by setting goals that necessitate a stretch for people, but not so great a stretch as to be beyond their current ability and understanding of the issue steady progress can be made. Several different tools can be used for assessment of community readiness, one of them is The Community Readiness Model developed by the The Tri-Ethnic Center for Prevention Research at Colorado State University. The model identifies the dimensions and levels of community readiness. The model also comprises an instrument for determining community readiness that can be easily used and scored by community members.

[5] University of Kansas, Center for Community Health and Development: Community Tool Box

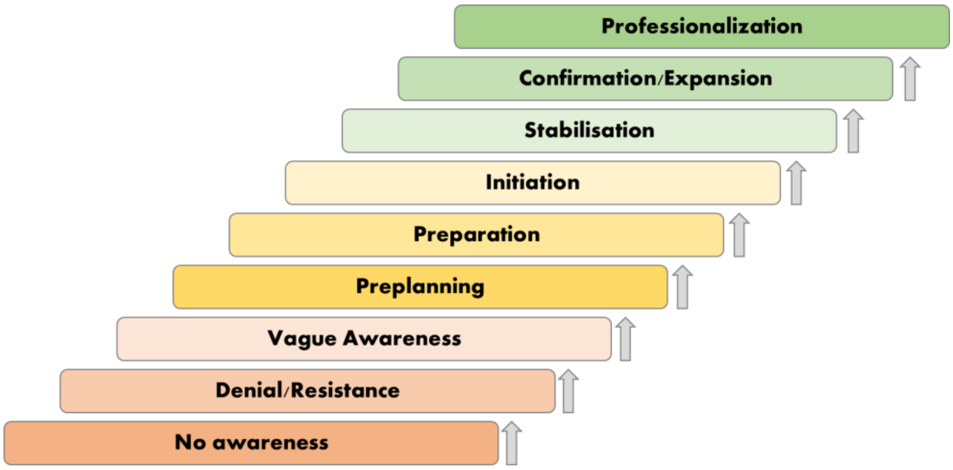


Figure 1: Stages of Community readiness[6]

The model's key components include:

- A set of survey questions consisting of open-ended questions about the community's attitudes, knowledge, beliefs, etc. about the issue (eBuses)
- A small number of interviews of key respondents using this survey.
- Scoring of the completed interviews using scales provided for each dimension of community readiness.
- Calculation of readiness scores on 5 dimensions using the interview scores.
- Use of these final readiness scores to develop a plan for action.

The detailed Model[7] and Tool[8] is freely available at Center for Community Health and Development in Community Tool Box

Concerning the readiness of communities in terms of implementation of charging stations based at the analysis and the collected information within EGUTS different point of views have to be considered:

- **Ecological behaviour of communities**: Worldwide it can be recognised that several Cities start to set measures promoting e-vehicles based at ecological reasons which are often combined with taking care for air quality and the quality of life for the citizens. As far as concerned in next future more and more cities will set measures for "clean mobility" because the citizens will demand it.

[6] University of Kansas, Center for Community Health and Development: Community Tool Box
[7] http://ctb.ku.edu/en/table-of-contents/overview/models-for-community-health-and-development/community-readiness/main
[8] http://ctb.ku.edu/en/table-of-contents/overview/models-for-community-health-and-development/community-readiness/tools

- **Business reasons**: Many communities are owner of energy service companies or net infrastructure companies and have therefore interest to sell power or related services to their citizens. Especially in combination with the parking business additional services can be created.
- **Funding possibilities**: In several countries there exist direct regional or national funding possibilities for communities if communities implement charging infrastructure.
- **Traffic knots**: especially within huge traffic knots like shopping malls, big railway stations, park and ride knots the readiness of cities for implementing of charging stations can be recognised.
- **Special interest in Energy efficiency**: A lot of communities have special interest to join energy efficiency programs (European Energy Award, e5-communities, etc.) and they are ready to invest in charging stations and even in programs to enlarge the use of e-vehicles in their area.

In general it can be assumed that the awareness of »clean« mobility which means anyway e-mobility in communities is relatively high. The bigger the community is (Cities, Capitals) the higher is the awareness and readiness of implementing charging stations. Anyway, additional support and promotion for fostering of e-mobility and therefore charging stations in urban areas is recommended.

2 Charging stations in urban areas

The electric vehicles (EVs) are more and more present in urban mobility whether in form of personal e-vehicles (e-cars, e-bikes) or as public transport (e-buses). In order to stimulate use of EVs the availability of charging stations needs to surpass the demand for it. Reducing the anxiety of running out of power by having many charging points available is one of the important parts of triggering EV adoption in mass market. While in sub-urban and rural areas EV owners charge their vehicles overnight using existing outlets in their homes, the situation in urban areas is quite different. In urban areas EVs need to rely in much higher rate on publicly accessible charging locations. Easy access, technical characteristics and the spatial setup of EV charging infrastructure in urban areas are crucial for strengthening the EV adoption in mass market.

In this context the European commission and European Union countries are investing significant funds to expansion of current charge point infrastructure and to enable the opportunity to supply each customer with electrical fuel at any given place.

Figure 2: Top 10 countries in absolute number of charging stations:

Country	**Charge stations**	**Connections**
France	9.069	38.984
Netherlands	6.885	13.016
Germany	6.500	18.524
United Kingdom	2.700	9.071
Switzerland	2.055	5.407
Norway	2.047	8.983
Austria	1.743	5.686
Italy	1.339	3.326
Canada	1.051	1.649
Sweden	1.011	2.992

Source: **https://de.chargemap.com/about/stats**

There are basically different concepts for "refuelling" with electricity.

Table 1: Main EV charging concepts and their characteristics

Tank design	Features
Slow charging	Adequate service time is required
	Technically uncomplicated
	Small public parking space required if Charging in private car park
Quick charging	Special technical requirements (high current energy)
	Energy efficiency lower
	Low battery life is shortened
Battery replacement	Technically complex operation: automated exchange in a short time
	High stock of replacement batteries required
	Customers lack Control over battery performance
	Travel space for USP the car manufacturer is reduced

Source: https://www.bmvit.gv.at/innovation/downloads/einfuehrungsplan_elektromobilitaet.pdf

A route to the electric vehicle leads via the plug-in hybrid, when a resting phase for the charge is given. Together with the quick charge and the battery change in pure electric vehicles, the plug-in-hybrid cars relatives the range topic. Speeding-up and battery changes, which are also rather seen sceptically to vehicle manufacturers, are limited from a technical and economic point of view. They are therefore only suitable for certain applications.

In the case of user groups without "range-wide concerns", pure battery-electric mobility can be accelerated in the short term. In this context, it is appropriate to examine the complementarily of application areas with respect to battery changing systems. Vehicles for different purposes would be driven by means of a battery pool and would be a central point ("beehive") for battery replacement. The charge could thus be slow.

For a closer look, regional conditions, technical developments of stations and vehicles as well as the user behaviour must be considered. Overall challenge is the feasibility and deployment of “easy and fast to use charging stations”, especially in the urban areas.

2.1 Austria

According to the Internet platform Charge map[9], 1743 charging stations with 5686 charging connections are registered in Austria to satisfy the increase demand for e-vehicles. At the moment, there are offers that can handle a high proportion of electric vehicles. The supply sources for electricity for refuelling electric vehicles are at least partly available through the existing electricity connections of households and companies.

[9] https://de.chargemap.com/about/stats

However, a concept of "intelligent charging", which includes the integration of "intelligent energy and data networks" as well as reference sources for "simple" regional networks or household feeds, has not yet been achieved.

Another condition for the introduction of electro mobility is the coupling with the use of renewable, ideally domestic energy. The total electricity requirement can be covered by around three quarters of domestic production. A quarter of the electricity consumed in Austria is imported. The demand for electro mobility can lead to a reduction in the import of fossil fuels, but also to an increase in the import of non-renewable final energy. The nature and extent of the energy supply and the availability of renewable energy for electro mobility are therefore to be considered in parallel within the framework of the overall concept; the mutual effects must be explored and controlled.

Electro mobility as a "regional" form of mobility can be used to use models of decentralized energy generation and supply, e.g. ("From the house roof") or wind energy for households and municipal or small-scale user groups (e.g., operational fleets). In addition, electro mobility forms provide a concrete reference to the type and extent of the total energy consumption of "daily life". Mobile and stationary consumers will be comparable to end users for the first time, since energy consumption in kWh is the basis for both. Electro mobility can thus become part of an overall energy concept for households and structures that extend beyond them, such as municipalities and regions. This topic is probably easier to deal with in accessing the implementation regions. In addition, the energy rating also offers a further development compared to current model regions. All in all, this issue has to be dealt with politically and in research.

Proposed measures in the urban area are:

- Clarifying the legal situation "Electricity trade for charging stations"
- Presentation of the energy balance of the electric mobility
- New models for the supply of electricity from renewable energy for "electric mobility", also at the local / regional level - Coupling the use of electric vehicles with reference or production of electricity from renewable energy generation
- Of market rules for the provision and use of electricity and charging infrastructure for electric mobility according to the following principles:
  - general accessibility of the charging infrastructure
  - possible use of existing infrastructures, including upgrading with charging stations in order to avoid additional land consumption
  - establishment of universal system utilization rates
  - own accounting circles for Electro mobility
  - Consumption-based, transparent billing
  - Regulation of network access charges
- Study "Use of current traction for charging stations"

- Study "Medium / long-term availability of energy" Display of energy consumption in kWh at dispensing pumps

Vienna as Urban Area

At present more than 500 public and private charging stations are located in Vienna. Already in 2016 the community of Vienna was elaborating a concept for an urban e-charging network which will include more than 1.000 charging stations in Vienna. It is goal of Vienna to existing infrastructure as good as possible in order to avoid additional investment. The Implementation of the charging stations in Vienna will depend on the increase of e-vehicles. This means that there is a <u>direct connection between the numbers of e-Vehicles and the implementation of charging stations</u>.

Figure 3: Charging stations in Vienna Area:

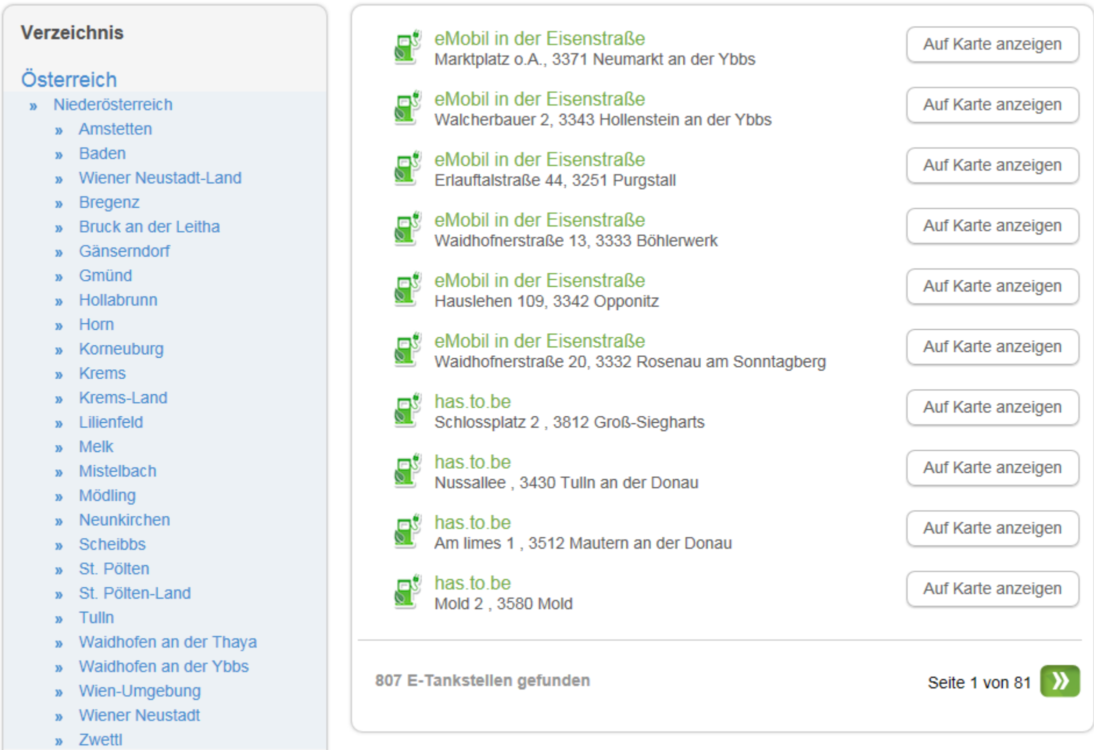
Source: E-Charging stations of Vienna (https://www.tanke-wienenergie.at/unsere-tankstellen/)

The community of Vienna is reserving parking space for e-vehicles in a special manner: Up to 4 hours are e-Vehicles aloud to use parking space for free in order to load up their batteries. After that time they are e-vehicles have to leave the parking space.
An important goal for the urban area of Vienna is use a special App in smart phones in order to find the e-charging stations and to be able to pay their loading up of the batteries.

Charging stations in Towns of lower Austria

The province of Lower Austria is also very active in promoting e-mobility in the whole region. For all towns and communities there is an e-charging finder installed where e-vehicle customers can find their charging station they prefer. All together there are more than 8.000 charging stations installed all over Lower Austria so far.

Figure 4: Charging stations in Vienna Area:



Source: E-Charging finder of Lower Austria (https://e-tankstellen-finder.com/at/de/catalog/)

The Network of charging stations of Lower Austria is being permanently enlarged. The situation is similar in all provinces of Austria. It is important to notice strong dependency between growth of new e-vehicles and enlargement of charging station network.

2.2 Croatia

The charging infrastructure in Croatia in the last 6 years has experienced a dramatic increase in the number of charging stations. The first official launch of an open to public charging station was on the 2nd of July 2011 in Zagreb, at the premises of the Croatian institute specialized in energetic "Hrvoje Požar". The installed station was a type 1 charging station suitable for charging most of the electric vehicles that were offered on the Croatian market at that moment.

Figure 5: Presentation of the first public charging station[10]

The station was installed in the scope of the initiative eMobilnost that had the goal of popularising the use of electric vehicles in Croatia. At the beginning the station was used mostly by the official vehicle of the project, due to the lack of electric vehicles in Croatia.

After that event, the largest Croatian electric company HEP started to develop their own programme, called HEP ELEN. HEP, as the largest electricity provider in Croatia, was the first large company in Croatia that started to develop the charging as a business activity. The first charging station the company has installed was in Labin, Croatia in 2012. The charging station had a type 2 socket (AC), 22 kW (32 A) and 400V.

10 www.jutarnji.hr

The mentioned charging station was opened for use at the beginning of the operational phase, no RFID cards of other identification documents were needed so that every user that had an electric vehicle could charge this vehicle on the charging station. The electricity that was distributed through the charging station was/is free of charge. After that, the HEP Elen company started to install charging stations in all parts of Croatia.

Figure 6: First HEP Elen charging station in Labin[11]

After the installation of the charging station in Labin, a number of smaller stations were installed but a more serious breakthrough was not possible due to the small number of electric vehicles. In 2012, the City of Koprivnica started the FP7 project "Civitas Dyn@mo".
One of the measures that were implemented in the scope of this project was the establishment of a car sharing system with 5 full electric vehicles and a public transport system with two electric buses. Since this was the first larger number of vehicles on one place in Croatia, the HEP company and the City of Koprivnica have signed an agreement of setting up 5 fast charging stations in the administrative area of Koprivnica.

The charging stations have a maximum output of 50 kW, and three charging type possibilities; Chademo, fast DC and Combo 2. These charging protocols cover all of the vehicles that the car manufactures offer today on the market, from the Japanese and

[11] www.hep.hr

American producers that use Chademo and fast DC, and the European producers that use Combo 2. The charging station do not use, due to infrastructural (lack of available power) and financial (price of purchasing 1 kW of power is rather high) reasons, the full capacity, instead the available power is 22 kW. This allows the charging of the full electric vehicle, the Mitsubishi i-Miev in approx. 25 min, from 20% up to 80%.

These were the only fast charging stations in Croatia for a period of two years. The stations are used regularly by the City of Koprivnica and its administrative staff that uses electric vehicles, electric buses that operate in the public transport operations. Also, a great deal of private users use these stations since they are the only fast charging option in the surrounding area of 50 km distance.

Figure 7: Charging process in Koprivnica[12]

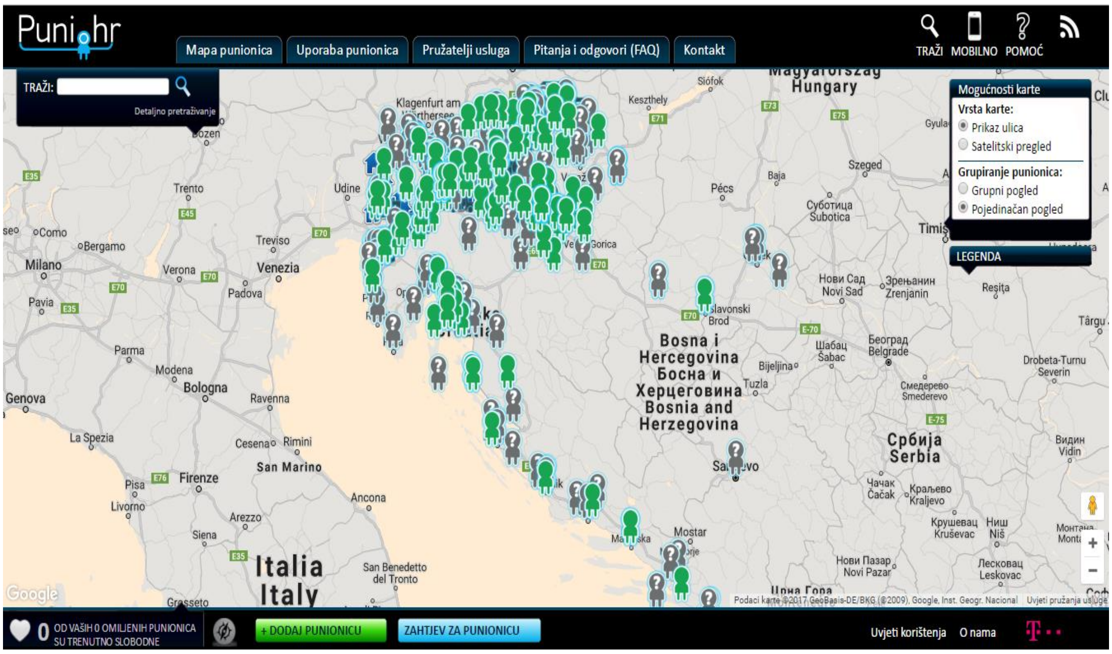
Soon after the HEP Elen started its business activities in Croatia, the company Hrvatski Telekom started also to operate in the field of providing charging services. Hrvatski telekom today is the largest operator operating on the Croatian market with a total of 90 charging stations.

It is recognized by the e-mobility portal www.puni.hr which offers a complete overview of charging stations in Croatia from each service provider that is operating in Croatia. The portal is offering users the possibility to see the current availability of every charging station in Croatia together with the basic characteristics of the station. It also provides the information on the possibility of payment.

Figure 8: puni.hr portal screenshot[13]

[12] www.koprivnica.hr

[13] www.puni.hr



On 6th of April 2017 the Government of the Republic of Croatia has adopted the decision on the National framework for the implementation of alternative fuel vehicles. The decision was made that charging stations have to available every 50 km on national highways and in all cities above 20000 inhabitants. Also, the decision defined plan for the total number of charging stations:

By the year 2020 – 296 charging places (222 AC min.power 22/(11) kW, 74 DC min. power 50 kW); on 164 charging stations.
By the year 2025 – 602 charging places (434 AC min. power 22/(11) kW, 168 DC min. power 50 kW); on 348 charging stations.
By the year 2030 – 806 charging places (554 AC min.power 22/(11) kW, 252 DC min. power 50 kW); on 479 charging stations.

Based on the latest data, there are in total **160 charging** stations currently installed in Croatia. Out of the 160 charging stations, only 11 of them allow the charging on DC protocols, Chademo and Combo. Besides that, there are 5 Tesla superchargers that are located on one charging point. Regarding the number of charging station of the providers, the largest provider is Hrvatski Telekom with 90 charging stations, followed by HEP ELEN with currently 34 stations.

Majority of charging stations are located within/near urban areas, especially in touristic centres while very few charging stations are located on the highways.

2.3 Czech Republic

The first charging station in the Czech Republic was opened in the town of Desná on 28 April 2007. The station was equipped with a standard industrial outlet 400V, 32A and the consumption could be paid through a text message. The public and non-public infrastructure has developed significantly since then. The charging infrastructure is prepared by 3 main distribution companies - ČEZ, E.ON and Pražská energetika. Other companies, e.g. Phaser, EVMAPA, build charging stations available without registration. Car manufacturers Nissan (CHAdeMO) and Volkswagen (Combo2) require publically available DC charging stations for all their distributors in the Czech Republic.

Figure 9:Charging stations, 14 March 2017

Power	DC 50kW	DC 130kW	AC 20-40kW	
Plug	CHAdeMO/Combo	Tesla	Type2 (men)	Total
ČEZ	26	0	45	71
PRE	1	0	30	31
EON	5	6	6	17
Green24	0	0	5	5
NetDataComm	19	0	0	19
Nissan	3	0	0	3
ABB	2	0	0	2
Innogy	1	0	0	1
Eltodo	1	0	1	2
Siemens	1	0	1	2
InChaNet	4	0	4	8
Other non-public				151

The above mentioned table contains types and numbers of charging stations in the Czech Republic on 14 March 2017. Although many charging stations still fail to meet technical and legislation requirements for public stations, they offer charging services.

The first direct current (DC) charging station was supplied by ABB in 2013. Later on, ČEZ purchased charging stations DBT with CHAdeMO connectors. Since 2016 three-connector DC charging stations for CHAdeMO have been installed - Combo2 and AC Type 2, either 32A or more recently 63A. Efacec and Polyfazer companies entered Czech market in 2016.

The funds for enterprises and innovations support the acquisitions of electric vehicles and non-public charging stations (75% of purchase price). The charging station can become a public station after the end of the implementation project phase. Therefore, their number is expected to rise. The Ministry of Transport has prepared a substantial call, which should be used for the construction of fast charging stations at main road routes.

Figure 10: Development of charging infrastructure

Year	Public	Non-public	Total
2006	0	2	2
2007	1	4	5
2008	2	49	50
2009	10	110	120
2010	25	120	145
2011	30	150	180
2012	40	160	200
2013	66	154	220
2014	96	154	250
2015	117	163	280
2016	148	152	300
2017	161	151	312

The number of non-public stations, which were operated by enthusiasts, has even decreased. Some of them were discontinued, since they failed to have a good payment system for services and were unable to offer free services for the ever growing number of users. Some of them have been transformed into professional public charging stations.

The Czech Republic has an advanced distribution network and sufficient sources of electricity. It would have been possible to charge more than 1 million electric vehicles in 2015, in case there had been a sufficient number of charging sites and electric vehicles. The costs for the reservation of the input power supply make up to 30 % of the construction costs for fast charging stations. The increase in power supply is a long process and may take up to 2 years from the time the application is submitted with the distribution company. Therefore, battery fast charging stations appear in 2017 with a low constant input power from the network and high charging output.

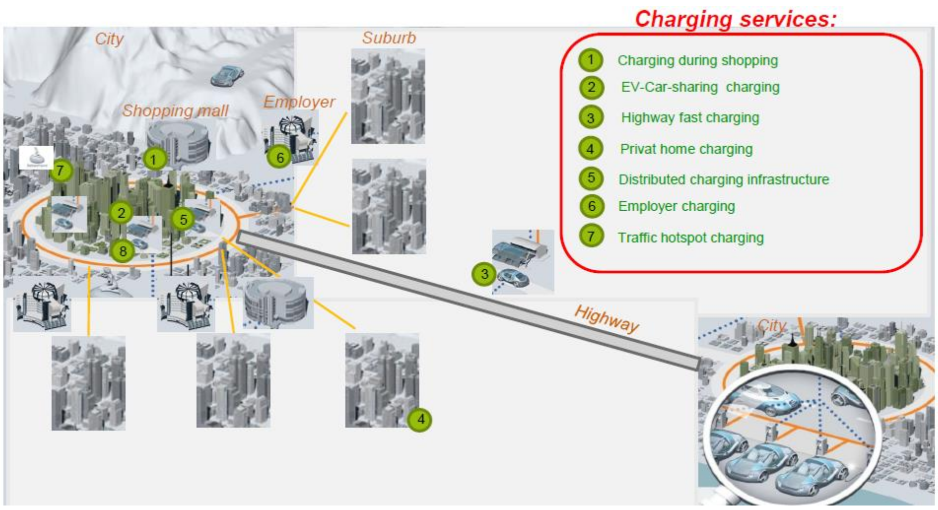
2.4 Hungary

The charging network is still to be developed in order to achieve that every part of the country can be reached by electric vehicles. In Hungary currently there are **only 164** charging points available for the public. In long-term a few thousand charging points are required to make electric vehicles a real alternative. As part of the Jedlik Plan, business associations will be given the opportunity to locate charging points, supposing that offering an appropriate parking place with charger may generate commercial and service increase.

Also local municipalities may have areas that can provide alternative locations for charging points.

- Lightning chargers shall be located like spider's web, moving away from the cities. The charging period of these chargers is 20-25 minutes.
- In the cities service centres or parking lots shall be equipped with fast chargers with charging period of 90-150 minutes.
- At home the normal chargers also can be appropriate. Charging time is around 6 to 8 hours and the chargers are functioning through the household plug-ins.

Figure 11: Charging services in Hungary



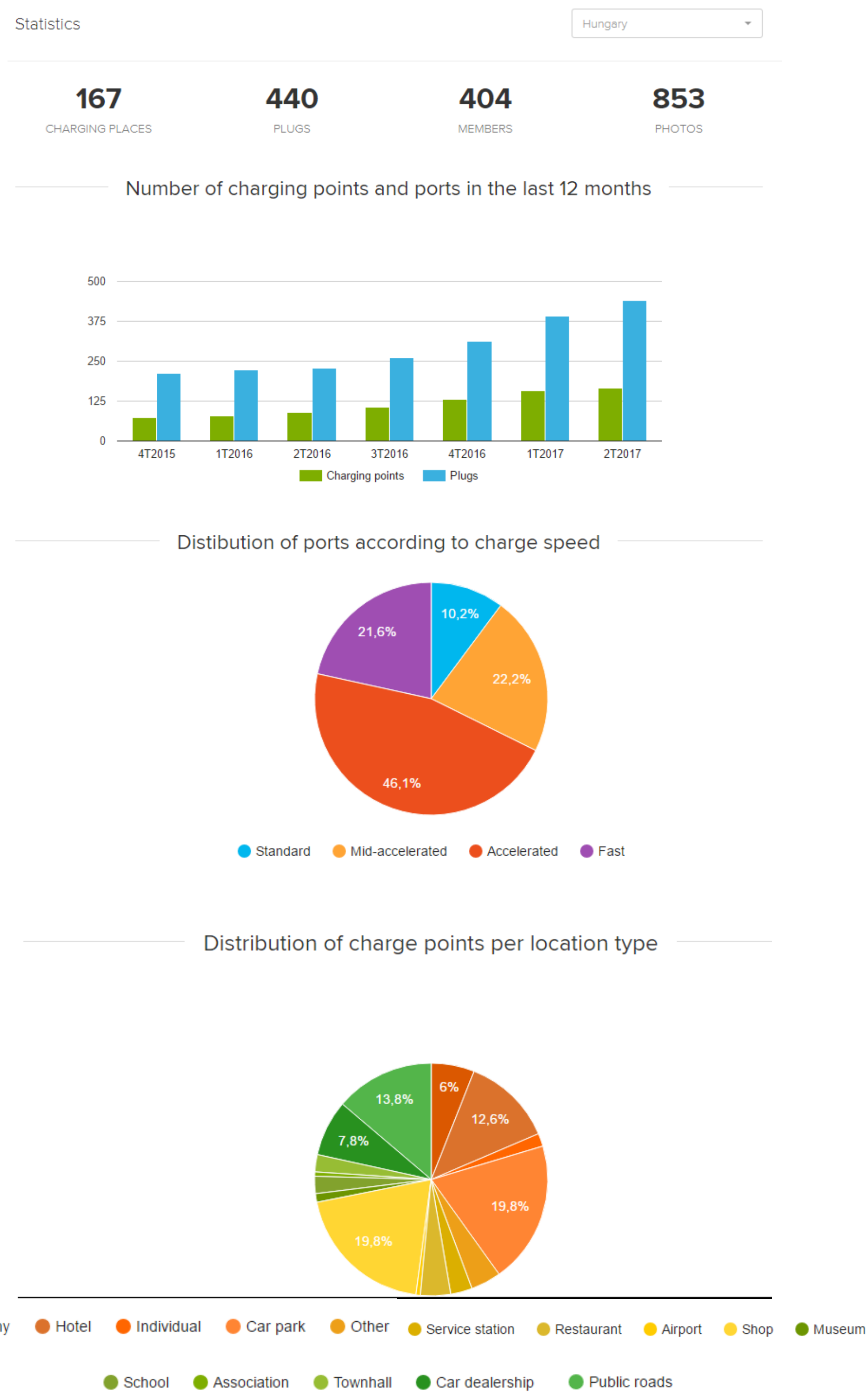
Initial charger deployment: The first steps of providing charging opportunities for e-car drivers were motivated by EU programmes like the "Green Vehicle Initiative", and the business participants were guided mostly by promotional and marketing considerations. The German-owned electric utility company RWE-ELMÜ, for example, set up some public charging points in Budapest, as did the MOL Hungarian Oil and Gas Company at one of its premium-category filling stations. In the past few months the process of the setting up of charging stations has been accelerating, mostly due to the involvement of charger producing OEMs like ABB and DBT, and partly owing to the fact that quite a few Nissan Leaf models have been sold, and this fact encouraged decision makers to see more charging facilities with Nissan-specific CHAdeMO rapid charging options.

Still, the existing charging point do not make up a unified system: most of the provide electricity basically for free, though some mobile applications are necessary to use the service. According to the latest figures, **there are 167 public charging stations** in Hungary, but their **geographical locations are sporadic and random**.

Planning the national quick charging network: The most important factor, however, is that the Hungarian government is required by the 2014/94 EU Directive to establish a national framework strategy on the deployment of alternative fuels charging infrastructure. Currently, the Ministry of National Economy is entitled to finance the preparatory work for this project. The JAK Cluster is closely involved in this process. According to the latest indications, a network of approximately 150 rapid chargers would make up the backbone of the future national e-mobility infrastructure, mainly along the major highways and in the big cities. It is expected that the implementation of this project will be financed from the "Greening Economy" facility of the Ministry of National Economy. It is an important goal of this project to secure reliable connections to the similar networks of other EU Member States, so interoperability and roaming capability will be of crucial importance.

Equally, decision must be made on the relevant charging standard: right now it is an open question whether the national rapid charging network will be equipped with only the mandatory EU-accepted CCS Combo 2 connectors or it will use the CHAdeMO chargers, too, in the spirit of technological neutrality. The Cluster is closely monitoring the deployment of the CORRI-DOOR network in France and the SLAM network in Germany.

Figure 12: Number, distribution and type of charging stations



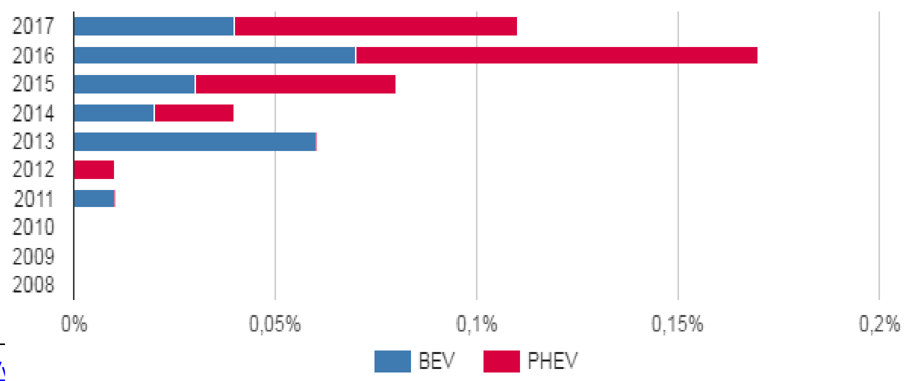
2.5 Romania

In Romania, the Government has approved Order 60/2017 entitled: Financing programme guide regarding the reduction of greenhouse gases in transportation by promoting green and energy efficient vehicles to be implemented in period 2017-2019.
The amount of 160.000 lei (app 35.000 EUR) was granted for the location of charging stations for electric vehicles and hybrid electric vehicles with plug-in. More over the Ministry of the Environment is implementing a scheme for the greenhouse gas emissions reduction in transportation to ensure instalment of 6.000 charging stations in Romania. Beneficiaries of the scheme:

- territorial administrative units of municipalities with more than 50.000 inhabitants;
- public institutions with headquarters or functional structures within the category a);
- economic operators having their registered office or work points with direct access to highways, European roads and national roads.

Number of EVs in Romania is on the rise, in 2016 the sales of hybrid cars rose by 88,7% year-to-year whereas the sales of electric cars went up by 129,4% compared to the same period in 2015. Green cars accounted for 0,8% of the number of new cars sold at national level during this period, the numbers are looking promising also for 2017[14]. Due to different programs (like RABLA plus) it is estimated that in 2017 the numbers of electric vehicles will increase considerably compared to the previous years.
Increased subsidies offered by Ministry for Environment for private persons and companies for purchase of electric or hybrid vehicles has proved successful.

Figure 13:PEV (Plug-in Electric Vehicles) market share in Romania; BEV-Battery Electric Vehicles; PHEV-Plug-in Hybrid Electric Vehicle



[14] https://\
http://www.business-review.eu/news/sales-of-electric-hybrid-cars-up-by-108-percent-in-first-nine-months-of-2016-in-romania-122466

Alongside increased sales of EVs the number of charging stations in Romania has increased, predominantly in larger urban areas of Romania (Bucharest, Timisoara, Cluj-Napoca), reaching now to a new stage of development. 16 fast charging stations will be installed in in 2017: AC50kw, AC22kw, AC22kwZ in: Timisoara, Deva, Severin, Petrosani, Sibiu, Valcea, Pitesti, Ploiesti, Cluj, Bucharest.

Figure 14: Number of publicly accessible charging positions[15]

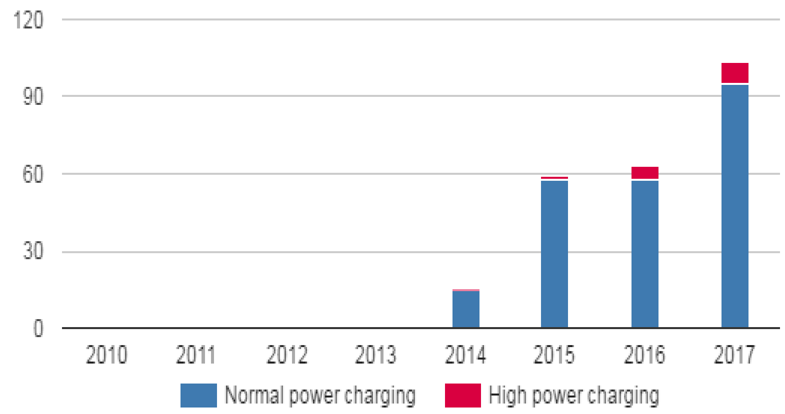
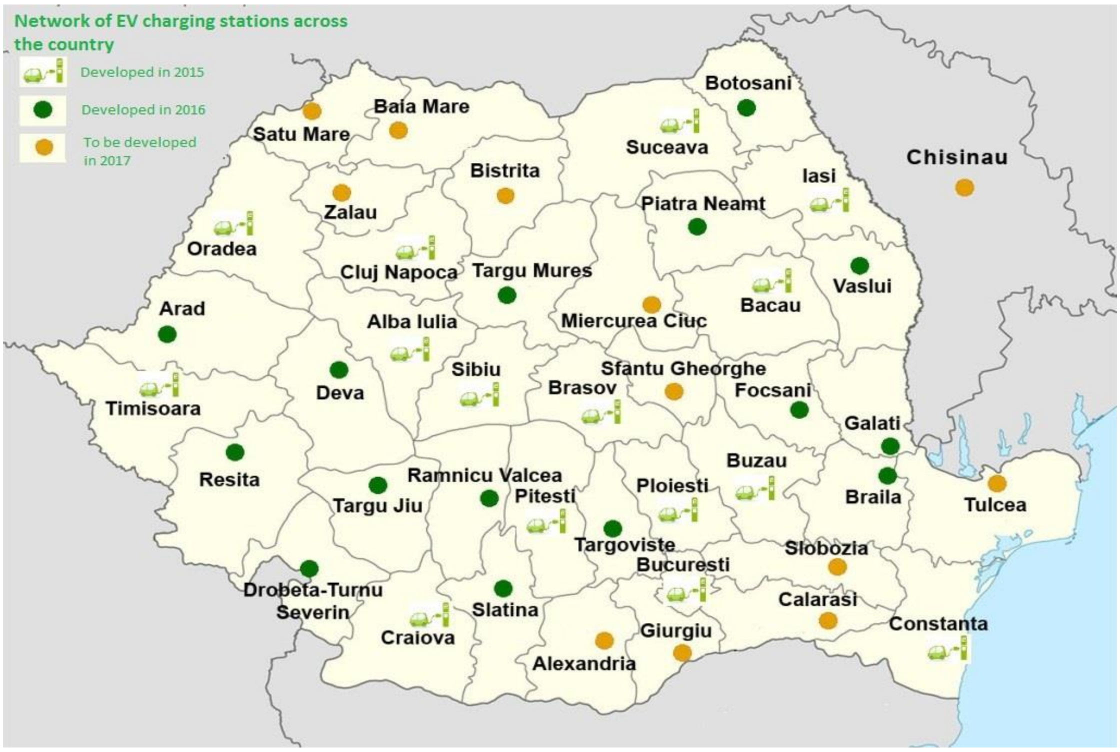


Figure 15: Charging stations in Romania

[15] http://www.eafo.eu/content/romania#country_pev_market_share_graph_anchor



Source: http://evconnect.ro/retea/

The "Green Charging infrastructure program", launched by Ministry of Environment, Waters and Forests, is intended to overcome the lack of charging infrastructure inhibiting e-mobility. Within the programme grants funds to local administrations of urban areas with more than 50,000 inhabitants, public institutions and economic actors from urban areas to invest into charging infrastructure. Charging points are to be installed in public parking spaces, highways, national roads, commercial centres, hotels, train stations, airports and special destinations that can be easily accessed. Indicative target is 6.000 charging stations installed by 2020. For the year 2017, about 16 million EUR are to be granted for about 400 stations with quick charging and 400 stations with slow charging. The "Green Charging infrastructure program" complements the Rabla Plus Program, that allocates special grants for the procurement of Electric Vehicles or hybrid cars. The program is granting about 1,000 EUR for hybrid cars procurement and up to 4,500 EUR for electric vehicles.

Romanian municipalities are also considering charging stations for both private and public transport e-vehicles. Some mayors have already started to cancel projects for extending conventional public transport infrastructure, in anticipation of full electric technology development.

Timisoara city

In Timisoara city there only 3 charging points are in place:

a. Kaufland Hypermarket Parking

Equipment Details: Renovatio e-charging; Number of stations/bays: 2

Connection Type	Level	Operational status	Usage cost
CHAdeMo	Level 3 –High (over 40 kW) 50 kW DC 1 present	Operational	Free Operator: Business owner at location
Mennekes (Type 2)	Level 2 – Medium (over 2kW) 32A/400V/22 kW AC (Three Phase) 1 Present	Operational	Free Operator: Business owner at location

b. Autoklass Center

Equipment Details: Token operated charger only during business hours
Number of stations/bays: 1

Connection Type	Level	Operational status	Usage cost
Mennekes (Type 2)	Level 2 – Medium (over 2kW) 32A/400V/22 kW AC (Three Phase) 1 Present	Operational	10 RON/hour – aprox. 2 EUR Operator: Business owner at location
Mennekes (Type 2)	Level 2 – Medium (over 2kW) 16A/230V/3.6 kW AC (Single Phase) 1 Present	Operational	10 RON/hour – aprox. 2 EUR Operator: Business owner at location

c. Lidl – Str. Ferventia

Equipment Details: Number of stations/bays: 2

Connection Type	Level	Operational status	Usage cost
CHAdeMo	Level 3 –High (over 40 kW) 125A/400V/50 kW DC 1 present	Operational	Free Operator: Business owner at location

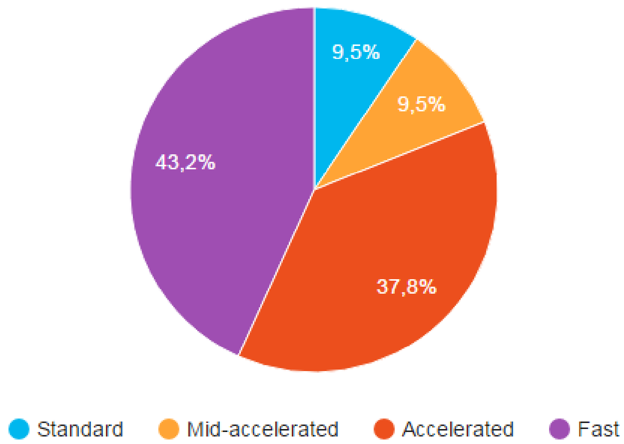
Mennekes (Type 2, tethered connector)	Level 3 – High (over 40kW) 63A/400V/43 kW AC (Three-Phase) 1 Present	Operational	Free Operator: Business owner at location
CCS (Type 2 version of combined coupler)	Level 3 – High (over 40kW) 125A/400V/50kW DC 1 Present	Operational	Free Operator: Business owner at location

Source: www.openchargemap.io

2.6 Slovak Republic

According to the international source of information, the portal www.chargemap.com, in the Slovak Republic 74 charging stations with 212 plugs (connections) are installed at present time.

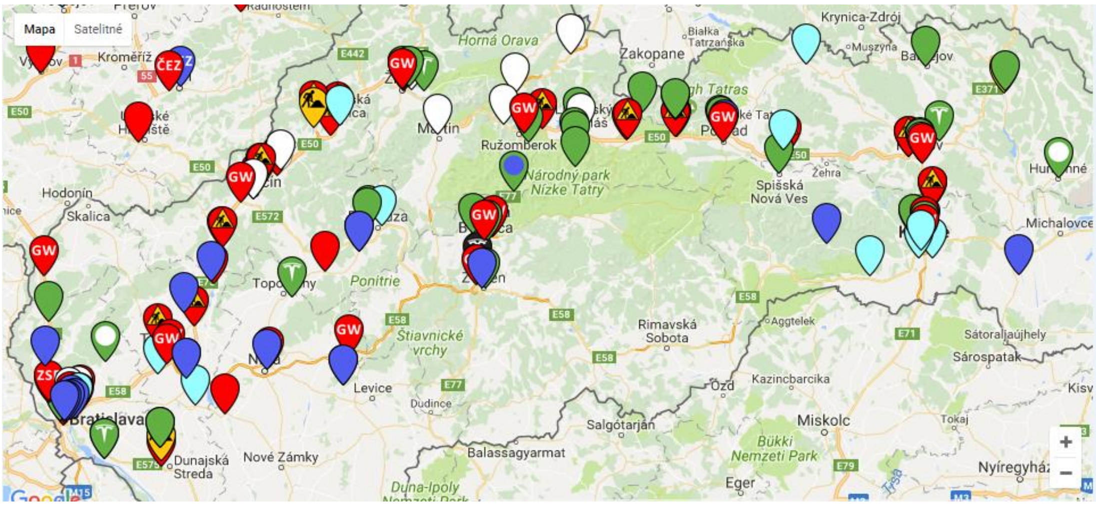
Figure 16: Distribution of charging ports in Slovak Republic according to charging speed



Next picture shows the distribution and location of all kinds and types of charging stations in Slovakia (from standard 3,7 kW socket up to the fast charging stations equipped usually by triple chargers CHAdeMO/COMBO/Type 2 Mennekes).

Figure 17: Most comprehensive map of charging stations (all kinds and powers) in Slovakia[16]

[16] *http://nabky.com/*



GreenWay (private company) operates the most comprehensive network of public electric vehicle charging stations in Slovakia. Its network enables users to enjoy the use of their electric vehicles comfortably through out of Slovakia and abroad. Greenway fast charging stands are conveniently located near the motorway and highway exits and roads in Slovakia (mostly on underground parking in big Shopping Centres) and Greenway's fast charging stations are some of the most modern and fastest on the European market.

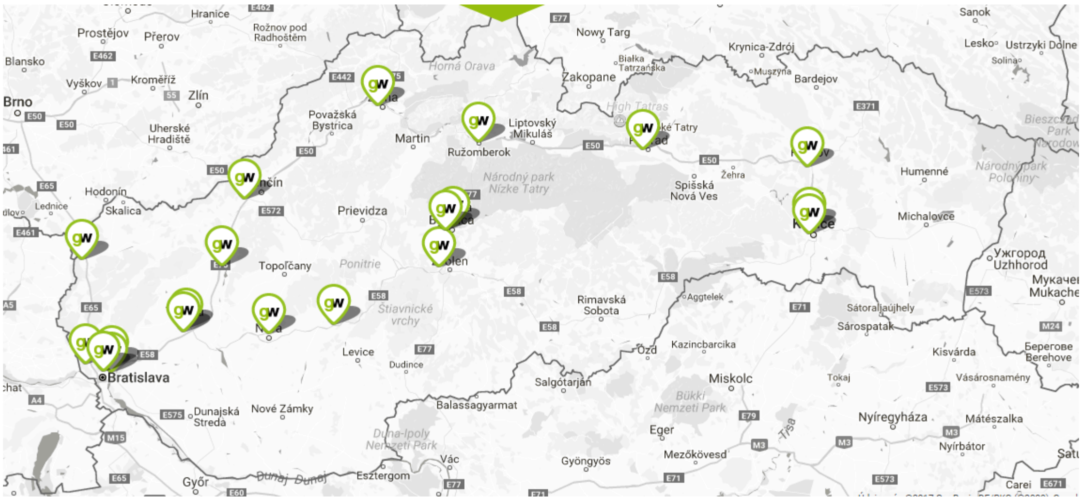
Greenway cooperates with charging station operators in Austria (Smatrics) and Slovenia (Petrol) to allow all of its users to comfortably and conveniently drive in each of our countries.

On May 15, 2014 Greenway introduced into operation a network of 15 fast charging stations for electric cars throughout the route between Bratislava and Košice, thereby effectively connecting the two metropoles of western and eastern Slovakia, making clean transport with electric vehicles available throughout the country without restrictions.

The Greenway charging infrastructure, powered by NISSAN, is moving ahead of government objectives as set in the Development Strategy of Electro mobility in the Slovak Republic and its impact on the national economy of the Slovak Republic, which assumes that by 2020 one charging station should be built per every 60 km of long distance roads in Slovakia. The document was approved by the Government of the Slovak Republic (September of 2015), while the company Greenway (private company) is gradually introducing its individual objectives into practice.

Figure 18: Map of Greenway fast charging stations within the Slovak Republic[17]

[17] http://www.greenway.sk/



Currently (of 29/3/2016, the last update) GreenWay operates 34 public electric vehicle charging stations at 20 locations (stands) all-over the Slovakia, of which 20 are fast charging stations and 14 are accelerated charging stations. All fast charging stations are equipped by the three-combination of most conventional charging standards CHAdeMO/Combo/Type 2 (plugs), i.e. each provides 3 charging points (with the power of 44 kW). 14 accelerated charging stations are equipped by the socket of Type 2, of which 12 have the combination of 3,5 kW/11 kW charging (i.e. each provides two charging points) and 2 of them have only one socket (1 charging point) with 11 kW or 22 kW.

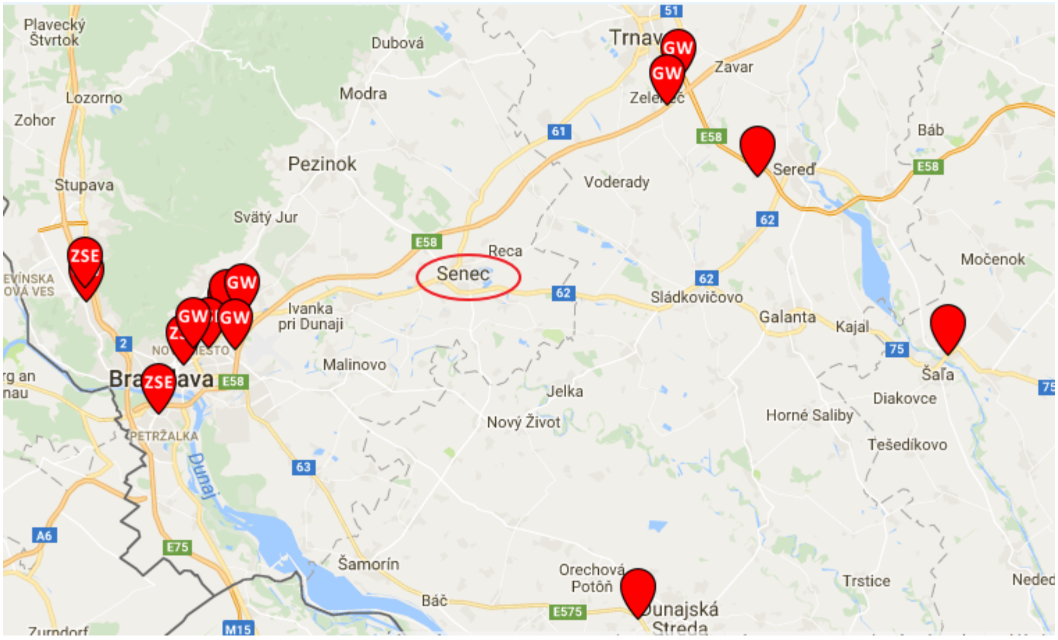
Slovenské elektrárne ENEL (Slovak electricity company ENEL) installed and in October 2014 put in public use 6 fast charging stations located in the vicinity of its power plants or administrative buildings, mostly equipped by 1 plug CHAdeMO (44 kW), resp. Type 2 (22 kW). ZSE (Western-Slovak Energy Company), energy seller and distributor operating in Western Slovakia) is another owner and operator of fast charging stations in Slovakia. It currently owns and operates 4 fast charging stations at 4 locations (stands)in the Slovak capital Bratislava, of which 3 are equipped by the three-combination of charging standards CHAdeMO/Combo/Type 2 (plugs) with power 50 kW (i.e. provides three charging points) and 1 charging station is equipped by 1 CHAdeMO plug (i.e. 1 charging point).
Except of this, ZSE operates 1 accelerated charging station in Bratislava equipped by Type 2 plugs (2 charging points).

According to information from „fast E-project (CZ/SK)“, in which ZSE is the partner, they should installed other 14 fast charging stations in SR by the end of the year 2017 (probably mostly along the highways in Western Slovakia).
VSE-RWE (Easter-Slovak Energy Company*)* operates 20 accelerated charging stations mainly in eastern part of Slovakia, equipped by the charging standard Type 2 (IEC Mennekes) with usual power of charging 11/22 kW. VSE installed very first charging station in Slovak Republic in 2010 in Košice.

Tesla Motor Company has installed up today 11 of its own charging stations in 7 different locations in SR, most of them in connection to accommodation facilities (only for their guests).
They are equipped by the Tesla universal chargers (Type 2, 22 kW) in case of 7 charging stations and 4 charging stations are equipped by Tesla Supercharger (1 location with 4 charging columns) .

There are other 11 fast charging stations situated mainly in Western Slovakia, installed by various different individual entities (usually Car-sellers, Warehouses etc.). They are mostly public free with various conditions for their usage.18

Figure 19: Map of the fast charging stations close to Senec – place of eGUTS pilot action in SR (source: www.kdenabijat.sk)

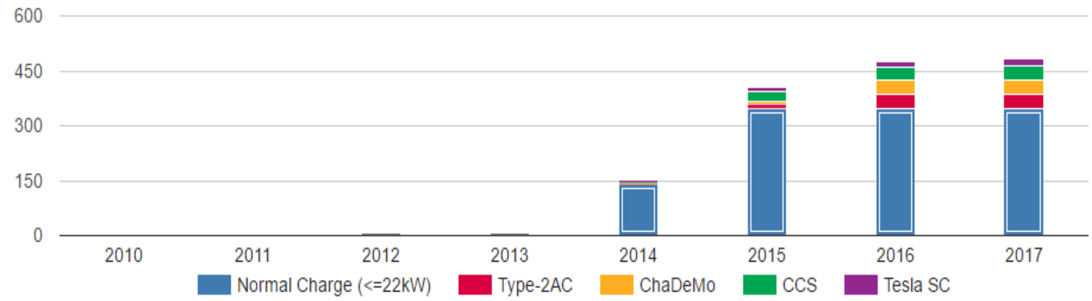


2.7 Slovenia

In Slovenia electric cars are still in minority, compared to classic internal combustion type of cars. With the growing popularity of electric vehicles, also the demand for public charging stations started to grow. At the moment there are **483 electric charging station in Slovenia**. 348 have the nominal charging power lower than 22 kW and 135 have the nominal charging power higher than 22 kW.

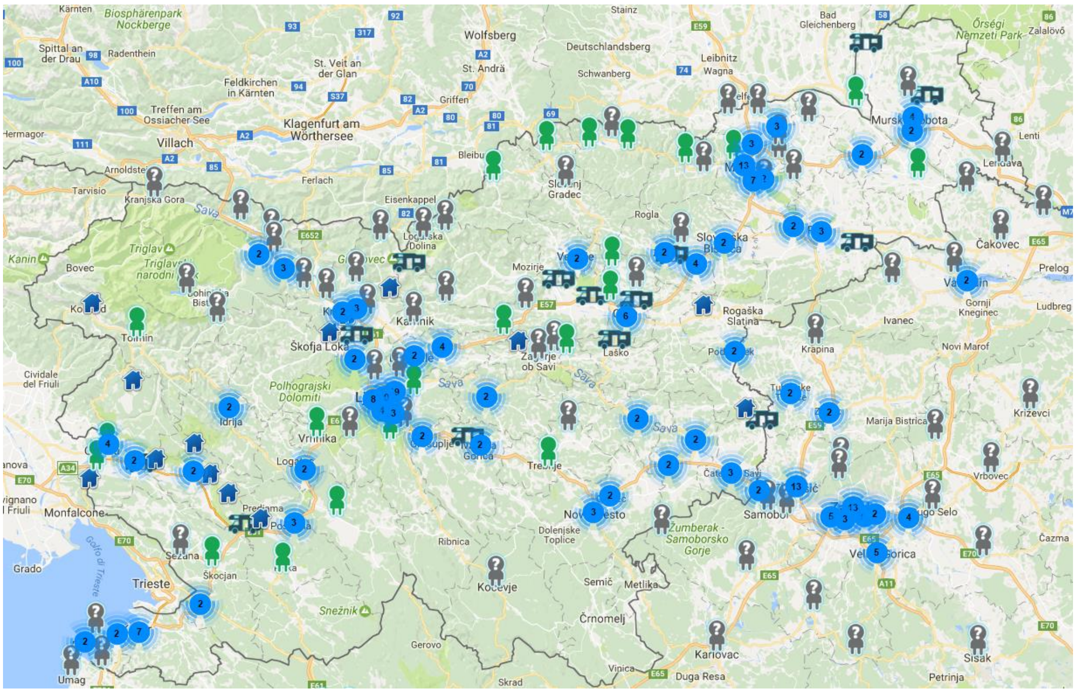
Figure 20: Growth of electric charging stations in Slovenia

[18] http://nabky.com/zoznam-nabijacich-stanic.php *, **(web portal of SK-Tesla Club fans)***



As already mentioned 348 are normal charging stations with power less than 22 kW. 38 charging stations are Type-2AC, 40 ChaDeMo, 37 CCS and there are also 20 Tesla super chargers in Slovenia. 19

Figure 21: Locations of charging stations in Slovenia



Source: http://www.eafo.eu/electric-vehicle-charging-infrastructure

It can be seen from the picture that the majority of charting stations is located near the two biggest cities in Slovenia, Ljubljana and Maribor, and along Slovenian highways. There is still a big lack of charging stations in the south part of Slovenia[20].

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[19] http://www.eafo.eu/electric-vehicle-charging-infrastructure

[20] http://www.polni.si/#

Conclusion

As for the Danube region it is evident that north-eastern part of the region has the densest network of charging infrastructure while the situation in the southern and eastern part is not favourable for e-mobility. However with existing plans for investments in charging infrastructure the situation will improve.

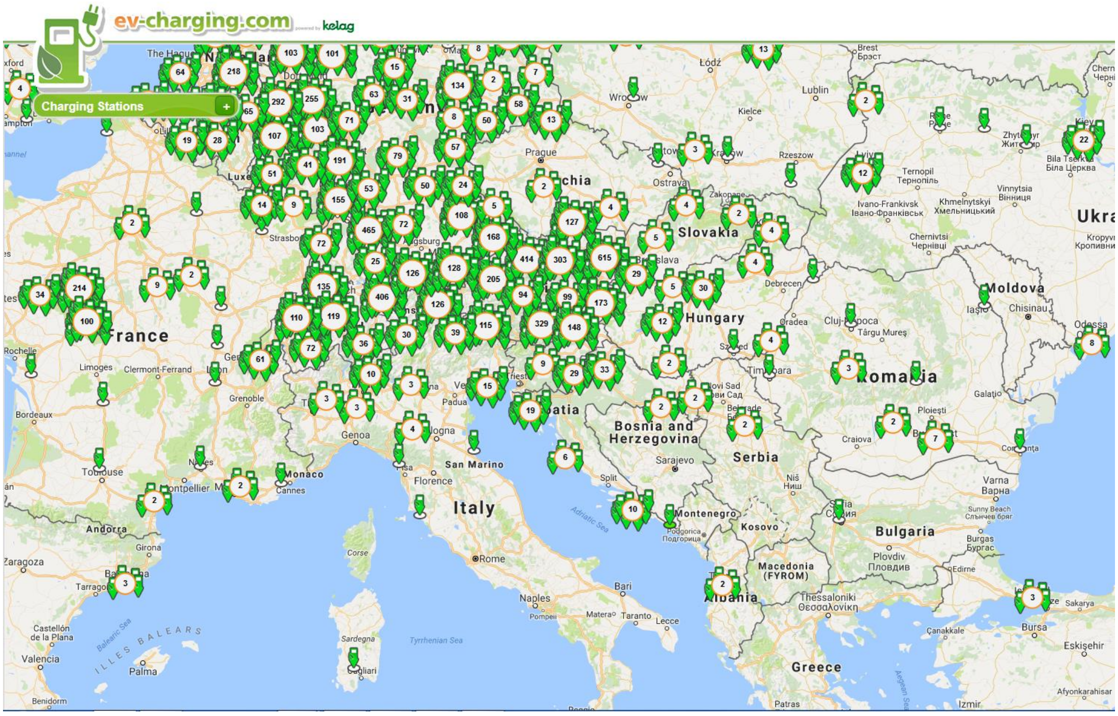


Figure 22: **Charging station network in Europe (source: https://ev-charging.com)**

2.8 Montenegro

In Montenegro no electric charging stations are used within the country and there are no official initiatives in terms of introducing electric charging stations for electric vehicles within urban areas. There are great advantages in the use of electrical charging stations for electric vehicles, yet the country of Montenegro is in a very low level of development, in terms of use of electric vehicles and charging stations altogether, which nowadays unfortunately aren’t applied at all within our country. All of these are effected by the slow administration on national level within the context of introducing law regulations reform and not recognizing the importance of electric charging stations and electric vehicles as a whole. Having no national legislatives in force for use of electric vehicles and charging stations, will lead to lack of use of electric vehicles and charging stations. It is considered that applying electric charging systems powered by solar panels would be a great solution for the country of Montenegro, if the fact is remembered that the country of Montenegro is known for the average of 200 sunny days per year (Municipality of Ulcinj – 240 sunny days on average per year). The community in Montenegro is ill-informed about use of electric transportation as well as charging stations as a whole. There is a general lack of adequate or proper knowledge or information and also lack of awareness of the advantages that these systems offer.

The starting point which will lead towards the development of electric transportation and electric charging systems must be the initiation of studies, assessments, analysis, legislatives, policies on national level, which will kick-start the application of these systems, followed by an awareness raising campaign informing the public about the long term advantages that the deployment of these systems offer. Montenegro has no defined strategy at local, nor at national level for the development of electrical charging stations for electric vehicles and the existing national legislative barely considers this field. Hence, our further steps as participants within the eGUTS project would be addressing the relevant Ministries and the central Government with the initiative for reform of legislatives in the field of vehicles and also proposing the ratification of decrees on offering incentives for construction, production and/ or use of electric charging stations e.g. electric vehicles.

2.9 Serbia

At the moment there is no adequate charging infrastructure in Serbia. There are two public chargers installed. One at the border crossing with Macedonia and one on a toll ramp at "Bubanj potok". The plan is to install two charging stations at the border crossings with Hungary and Bulgaria by the end of the year. It is intended to install the latest charger model that fits the vehicles of all world manufacturers and allows the battery to be recharged in 25 minutes. In addition there are three public charging stations in Belgrade In a public garage for 6 vehicles. Also, several hotels in Belgrade have installed chargers (Holiday Inn, IN Hotel, Square Nine Hotel, Courtyard Belgrade, City Center hotel). Owners of the vehicles are charging them in their garages, with the chargers they bought with vehicles. Experts estimate that Serbia, as a transit country, should install about a thousand public chargers for different types of vehicles in cities and road corridors by 2020 to cover the first electric demand of EV.

2.10 Key barriers for deployment of charging stations and recommendations for overcoming them

It can be observed that majority of consumers aren't adapting to or adopting the new technology for a variety of reasons:

- **E-vehicle price** – the average cost of a new vehicle is around 30,000 € while some other models are much pricier ("Volt" 40,000 €, "Fisker Karma" close 100,000 €, "Tesla" Model S 62,400 € to 87,400 €).

- **Limited range** - Gasoline has a great energy density, which means the amount of energy in a given volume of space. However, it must constantly be replaced. Batteries can be recharged, but they have a low energy density, which generally means that an electric car can travel on shorter distance without recharging than car can do on a full tank of gas. This is an inconvenience that most consumers seem unwilling to put up with.

- **Battery issues** - Not only is there the question of how much energy the battery can store, but its life span. Batteries only recharge a certain number of times. There is the potential for this expensive component to need replacement after a number of years, although the models haven't been out long enough to see.

- **Price of oil** - Automobile technologies are like solar power: they get hot every time global oil prices significantly soar. Remember that oil prices jumped in 2008. Now that they are much lower again, consumers feel less pressure to make the move.

- **Availability of charging infrastructure** is important for the choice of alternative fuel vehicles. A psychological component exists - EV drivers seem to perceive a public charging infrastructure as a safety net and fall-back option, which they require in order to take advantage of the full range of their EV

- **Charging time** - In addition to developments to improve the (still) low range of e-vehicles, a reduction in the duration of the loading processes is an important research objective. Rapid charging stations (for example, Tesla superchargers) provide the prerequisite for comparatively long travel distances with short charging times (250 km vehicle range, 30 minutes charging duration.

- **Inconsistent nature of subsidies/incentives** - subsidies/incentives for purchase of a new electric car can advance the uptake of e-vehicles. But that sort of public policy move is hardly guaranteed to remain. Once critical number of e-vehicles is achieved, the subsidies/incentives will be discontinued..

All these also influence the deployment of charging stations as mobility and charging behaviour has an influence on the infrastructure requirements and the use of the charging network. Following key barriers for deployment of charging infrastructure in urban areas were identified (based on inputs received from project partners' regions):

1) **Investment costs**: While the costs for "slow" charging stations are quite affordable the investment costs for "quick" charging stations with high performance are quite high. Therefore the pay back rate for the investment costs of public charging stations is quite risky. Together with the uncertainty of the increasing of numbers of e-vehicles communities and many investors are waiting with their investments.

Especially for larger cities investment costs for deploying required number of charging stations can be relatively high. It is recommended that the cities are defining locations and possibilities for charging stations as a long term goal as it is already done in some EGUTS cities. Based at the increase of e-vehicles step by step the charging infrastructure could be implemented. In order to avoid business risks for communities this business could be offered to private investors to ensure that charging stations will be erected and operated in time

2) **Billing technologies and systems**: Different technologies and different billing systems for charging stations are present at the market. It is still unclear what kind of technology and what quality of charging procedure will be accepted by the market. Wrong decisions can lead to stranded investments. The same is true for billing systems. At present a lot of providers are offering charging service with different systems and costs. Many providers are therefore hesitating in order to avoid investments in "wrong" system as it is unclear what kind of system will be accepted at the market.

The larger the community the larger is its potential utilisation of charging stations. In cooperation with private companies it is recommended to carefully plan implementation of appropriate system with enough capacity for flexibility to ensure sustainability in long-term use as well as in upgrading or downsizing. Still the risks of technology jumps and emergence of new technologies will remain and cannot be completely avoided.

3) **Unpredictability of EVs' share in mobility market**: Different news and changing opinions what kind of mobility system will win the race in future occur. Main competitors of e-vehicles can be recognised as vehicles driven by fuel cells or with natural gas. Big companies are investing in different technologies which lead to uncertainty concerning growing numbers of e-vehicles which is a barrier for deployment of charging stations

A strategic approach and concept for deployment of charging stations can help to minimize uncertainty of EV's share in mobility market. A step by step implementation based at an overall strategy and relaying at the number of e-vehicles can lower the risks of the uncertainty of the growing number of e-vehicles.

4) **Consumer behaviour**: It is still uncertain to predict how consumers will behave if EV take over as predominant transport technology. What kind of behaviour will be adopted with regard to charging practices? How will the market react to

higher energy costs? Will consumers switch public transport? What kind of Service (e.g. charging time) will be accepted?

Involving citizens and providing detailed and understandable information on e-mobility and its benefits should be undertaken as a long term activity, integrating all kind of the population. If possible, it should be combined with additional benefits like cheaper parking costs, funding possibilities or tax benefits etc.

5) **Uncertainty about future market players**: Who will be the market players of the future in charging infrastructure market? Will it be shopping malls, energy providers, vehicles' manufacturers (like Tesla) and under what conditions charging infrastructure will be available (free of charge, included in parking costs, included in parking costs)?

Main key players should be involved in city's strategy definition and planning with regard to deployment of charging infrastructure and planning of e-mobility. Flexibility has to be allowed in order to allow adaptation to new conditions and future needs. Long term commitments are necessary.

As a general recommendation it can be assumed that an overall long term deployment strategy for charging stations should be elaborated for communities. This strategy would be the background for investments and cooperation with private investors in order to build up a suitable charging station infrastructure in time by taking into consideration the uncertain development of e-mobility.

3 Review and a brief description of existing projects and studies

This section covers an overview and description of existing projects and studies on the development of charging stations in urban areas.

3.1 EU projects and studies

Austria

3.1.1.1 Charge Lounge[21]

In industry and research, the significance of charging stations for the future of electric mobility has already been recognized. An example of an (inter-) urban fast-charging infrastructure is provided by "Charge Lounge". The concept consists of two room modules in which the technology is accommodated for 3 charging stations and a lounge with W-LAN and beverage machines. Its own business area allows business meetings, as well as telephone and video conferencing. Three AC / DC multiladers are provided for charging, which support all current charging standards (CCS, CHAdeMO, Tesla, and Type 2 AC). A buffer battery allows high charging capacities even with a standard power supply connection. A field test with 10 prototypes is planned. The aim of the project is to spread the loading stations in Germany, Switzerland and Austria with over 1000 batch lounges by 2020.

3.1.1.2 eflott – electro mobility in the Munich test region[22]

Project partners Audi, E.ON, Munich's municipal services and Technical University of Munich put 20 Audi A1 e-tron cars on the road and construct around 200 charging stations. This project is called eflott and is part of a program, supported by Germany's transport ministry, to test electro mobility solutions in the Munich region. One aspect involves the transfer of data between drivers, cars and charging points and also explores options such as the use of smart phones as a central interface for drivers. E.ON is installing 100 charging stations as part of the eflott project. Most of them are in the region around the Bavarian capital, and all of them supply renewable energy generated at E.ON's hydroelectric power plants. In line with the information obtained in previous projects, most charging stations will be installed at existing parking facilities such as private garages, park & ride sites and multi-level parking garages. As it still takes a long time to recharge batteries, vehicles have to be charged at locations where they will be left standing for some time. In city driving, it enables the cars to cover over 50 kilometres using electricity alone.

[21] http://www.chargelounge.eu
[22] http://www.eon.com/content/dam/eon-com/en/downloads/2/2011_01_EON_Factsheets_September_2011_engl.pdf

Project website: (https://www.wze.mse.tum.de/forschung/projekte/eflott/)

3.1.1.3 Ultra-Fast-Charging for electric vehicles starting in Europe[23]

The European industries have the chance to strengthen their technology leadership with a new generation of Ultra-Fast-Charging for electric vehicles:

- Ultra-Fast-Charging along TEN-T core network corridors connecting the Netherlands, Belgium, Germany and Austria
- Charging time for 300 km reduced from 1.5 hours to 20 minutes

Another important milestone is set for e-mobility and for an ecological future of transportation. This project will deploy, for the first time in Europe, a network of 25 Ultra-Fast-Chargers using also the CCS-connector with a charging power of up to 350 kW on TEN-T core network corridors. This network will connect the Netherlands, Belgium, Germany and Austria. The Ultra-Fast-Charging technology will be assessed for charging passenger vehicles, buses, and trucks (intermodal services).
This Ultra-Fast-Charging network will be fully interoperable and complementary to the already deployed 50 kW fast chargers thereby extending the availability of charging infrastructure for electric vehicles today and in the future. The Ultra-E project will enable open access and marketplace for innovative services and will facilitate long distance and cross border driving. It will prepare for the full pan-European-network deployment of Ultra-Fast-Chargers towards the arrival of long distance electric vehicles from 2018 onwards.

3.1.1.4 A probabilistic approach to combining smart meter and electric vehicle charging data to investigate distribution network impacts[24]

This work uses a probabilistic method to combine two unique datasets of real world electric vehicle charging profiles and residential smart meter load demand. The data was used to study the impact of the uptake of electric vehicles on electricity distribution networks. Two real networks representing an urban and rural area, and a generic network representative of a heavily loaded distribution network were used. The findings show that distribution networks are not a homogeneous group with a variation of capabilities to accommodate electric vehicles and there is a greater capability than previous studies have suggested. Consideration of the spatial and temporal diversity of charging demand has been demonstrated to reduce the estimated impacts on the distribution networks. It is suggested that distribution network operators could collaborate with new market players, such as charging infrastructure operators, to support the roll out of an extensive charging

[23] https://www.allego.eu/ultra-fast-charging-for-electric-vehicles-starting-europe/
[24] http://www.sciencedirect.com/science/article/pii/S0306261915001944

infrastructure in a way that makes the network more robust; create more opportunities for demand side management; and reduce planning uncertainties associated with the stochastic nature of electric vehicle charging demand.

3.1.1.5 Optimal allocation of electric vehicle charging infrastructure in cities and regions[25]

A geospatial analysis of electric vehicle charging infrastructure allocation within a city and a region, based on open source GIS tools, is described. A methodology was developed to provide optimal locations of electric vehicle infrastructure (charging stations) within a spatially extended region. Two different cases were identified: placement in a city network (urban road network) and in a regional or national network (rural roads and highways).
For a city and a regional network, the methodology identifies high-potential areas for the installation of charging station. In contrast, for a highway network the methodology provides explicitly suggested locations: the charging stations should preferably be placed in already built areas, gas stations or rest areas, to minimize additional investment costs. A pilot study was made for the city of Bolzano/Bozen (city road network) and the province of Alto Adige/Südtirol (rural and highway network). The municipality and the province gave positive feedback on the suggested locations.

3.1.1.6 SLAM[26]

The German large-scale project called SLAM with BMW, Daimler, Porsche and VW, as well as energy and research companies want to explore the fast-charging network of the future. At the hotspots in the German transport network, it should be possible to charge an electric vehicle with up to 150 kW in the future, which corresponds to a tripling of the charging capacity of the previous fast charging network. The shortened loading times are intended to significantly improve comfort on long journeys. Within the next two years, the first high-performance charging stations will be set up and used as a platform for a rapid-charging network. The charging infrastructure provided is intended to provide important inputs for the future demand for rapid-charging columns. Supported by simulation tools and the development of site concepts. In addition, the effects of the high-capacity charging system on the power grid regarding energy and load management will be examined.

Project website: http://www.slam-projekt.de

[25] http://publications.jrc.ec.europa.eu/repository/bitstream/JRC101040/allocatechargingpoints_sciencepolreport_eurreport_online.pdf
[26] http://www.slam-projekt.de

Hungary

3.1.1.7 E-mobility plan of Hungary → Ányos Jedlik Plan

The most important study is the Jedlik Anyos Action Plan (a national plan) approved in 2015. Main aim of the study is the intended change from internal combustion engine vehicles to plug-in hybrid (PHEV), extended range electric vehicles (E-REV) and to 100% electrical vehicles.

Main topics of the Ányos Jedlik Plan

- System of incentives (financial and non financial);
- Adequate regulatory environment;
- Expansion of charging infrastructure;
- Research, Development and Innovation;
- Electrified community transport;
- Pilot projects.

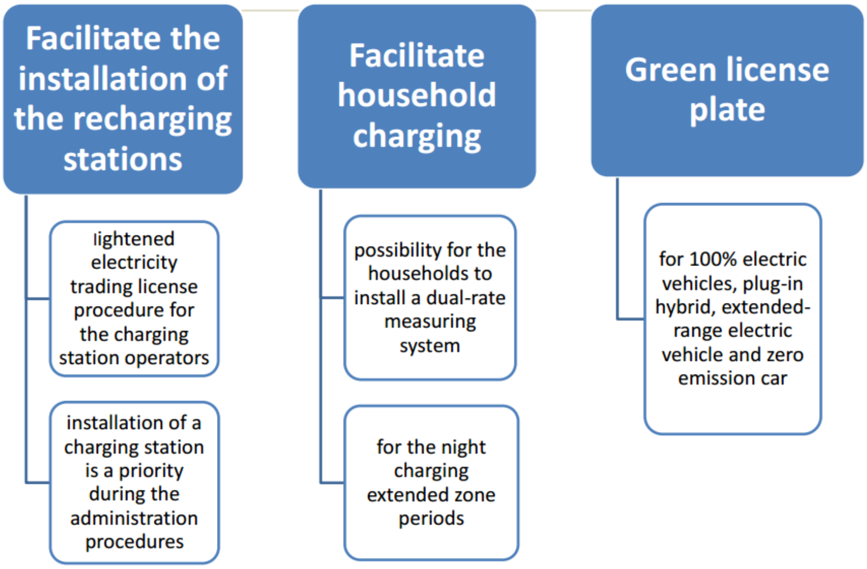
Ányos Jedlik Action Plan Incentive scheme

Direct incentive:

- no registration fee,
- company car tax is zero,
- VAT on electricity of charging can be reclaimed by companies,
- allowance for night time charging,
- support for purchase of electric vehicles,
- establishment of charging infrastructure.

Indirect incentive:

- free parking for the period of charging,
- overall free parking in some cities,
- traffic allowance during smog alert,
- free transit rights for restricted and protected areas,
- bus lane usage for 5 years.



Vision of the government

The vision of the government is to establish electro mobility in Hungary by providing all the possible circumstances that will lead to the more common usage of electric vehicles. Prices of electric vehicles are currently higher, but provided by identifying and collecting in a cluster for the possible participants of this long-term plan the government has taken the first step to execute a project of broad social acceptance. The further steps of Jedlik Plan will be developed in line with the intentions of the European community but on the bases of highly anticipated rise of the Hungarian electro mobility industry. Bus manufacturers are ready to make an impact on the market with the capability of providing high-technology vehicles and suppliers are also waiting for the opportunity to develop in an innovative way and be capable of entering the supply chains in the electric vehicle sector.

Most of all the concept of establishing electro mobility is making the future liveable, making transportation comfortable while not contaminating the cities and the countryside. This is the idea behind the concept which has been and will be taken very seriously by the government and will be continued with the utmost confidence of being able to take part in the development of future transportation.

Slovakia

3.1.1.8 Fast-E[27]

Fast-E (DE/BE) aims at the creation of a minimum viable scale cross-border pilot network of multi-standard fast chargers in Germany and Belgium, seamlessly connected with other initiatives. The objective is to enable comprehensive studying of user behaviour and technical and business considerations, ahead of a larger roll-out of charging infrastructure in

[27] http://www.fast-e.eu/

Europe. A dedicated focus is given to study intermodality, based on the deployment of up to 30 intermodal hubs.

Driven by leading European utilities, car manufacturers, and public entities, the project connects, in both a geographical and technical sense, interoperable to other fast charging infrastructure projects. Besides the realization in Belgium and Germany, the cross-border traffic will also be enabled through the synchronisation with the other fast charging initiatives, most notably the sister-project under the complementary action fast-E (SK/CZ) (Cohesion Specific Call). Drawn together, the deployment pilots of the joint action will support different types of electric vehicles by using multi-standard chargers and will enable long distance travel in Germany and Belgium with cross-border connections to Slovakia and the Czech Republic. Furthermore, it will also assess new locations and connections to Poland and Hungary and increase connectivity to other existing fast charging networks in the Netherlands, Denmark, and Austria, filling a gap in the fast charging network of Europe, and allowing the creation of a larger roll-out preparation plan.

Project website: http://www.fast-e.eu/

3.2 National studies and projects

Austria

3.2.1.1 100% electricity from renewable energies for e-mobility[28]

This study shows that an introduction of e-mobility using 100% renewable energies is not only environmentally beneficial, but also offers several economic advantages. Positive economic effects comprise a considerable reduction in imports of fossil fuels, a more favourable balance of trade and the creation of workplaces in the field of renewable energy production. Quantified this means total cumulated savings due to a reduction in imports of fossil fuels of approximately 5.4 billion EURO, the creation of around 1.773 additional workplaces and a contribution of additional 231 million € to the GDP in 2030. From an ecological point of view, the use of 100% clean energy for e mobility significantly decreases the emission of CO2 while increasing the share of renewable energy and overall energy efficiency. Cumulated savings of CO2 emissions amount to 2.5 million tons CO2 in 2030. The study illustrates that an implementation is feasible, as the required potential of renewable energy sources is available in Austria.
The forecasted power demand for e-mobility is only a moderate part of the planned additional capacity of renewable energy and represents 7% of the total renewable energy production in 2030.
Moreover, the introduction of e-mobility allows for a potential decline in the total energy consumption. Additionally, the study demonstrates that the demand for charging the

[28] Compare : AT Kearny TU Wien - E-Mobilitaet 100 % Erneuerbare Energien (2012)

electronic vehicle can be regulated to a certain extent and thus can optimize the use of renewable energy production.

3.2.1.2 Impact of future electro mobility on the Austrian electricity industry[29]

The issues concerning installation of public loading infrastructure are analysed in respect to the involved challenges for distribution grid operators. Factors which are relevant for future management decisions are highlighted. These factors are possible locations and geographical distribution of installations, different loading concepts and power requirements, ongoing standardization processes regarding cables, plugs and communication concepts, safety requirements and system perturbations of rectifiers. Especially during the introduction phase of electric mobility it might be a critical factor not to reduce the economic benefit of low energy costs by the installation of cost-intensive loading infrastructure. This fact is equally significant for accounting systems at public battery charging stations. The most common accounting systems are compared and their practicability for electric mobility regarding process management and cost structures is investigated in the study.

3.2.1.3 Electro mobility - Opportunity for the Austrian economy[30]

The structure of the study is based on a fundamental analysis of the value chain of electro mobility in the two thematic strands "Value added" and "general conditions".

The area of added value creation is devoted more to the analysis of the details technological distinction features with a focus on different car vehicle concepts as well as the loading infrastructure as an interface to the energy network. In addition to qualitative considerations regarding the necessary raw materials and their availability are described in detail in the production costs of the vehicle components and subcomponents, as well as those related to the production.

3.2.1.4 Project SEM - Smart Electric Mobility[31]

The project SEM is dealing with energetic and user oriented challenges and possibilities for e-mobility for individual mobility.
The following topics were elaborated:

- User behaviour of customers and their needs according acceptance
- Requirements at vehicles and batteries

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[29] https://www.tugraz.at/fileadmin/user_upload/Institute/IEE/files/ENDGUELTIG___Elektromobilitaet_Studie_ENDVERSION_hoheQualitaetiw290610.pdf
[30] http://www.e-connected.at/userfiles/elektromobilitaetsstudie_kurz.pdf
[31] http://www.ea.tuwien.ac.at/fileadmin/t/ea/projekte/E-Mobility/SEM-821886_PublizierbarerEndbericht_final_120131.pdf

- Integration of e-mobility into the energy delivering system

In the field of user behaviour, results with respect to the driving behaviour and distribution of charging stations results can be achieved according to different kind of analysis – both - long term and spot analysis.
Electric vehicles are provided and they will be used for an evaluation of conventional driving profiles in order to identify typical "electric vehicles profiles", as well as storage-dependent battery aging.
Analyses in regard to charging conditions (location selection, uncontrolled loading profiles and simultaneity) rely on the prior knowledge and lead to verified Results.
For a production oriented charging control using only renewable energy (e.g. photovoltaic), two methods are developed in particular.

A further focus of the SEM project is the energetic and thermal fulfilment of the driving profiles.
The influencing parameters are determined by a sensitivity analysis with a different configuration of the loading infrastructure.
In addition to the standard loading systems in the parked state of the vehicles, there will be alternatives discussed such as quick charging along ways, the method of long - distance displacement, and the use of Range extenders.
Based at the results comprehensive statements regarding the future expansion of charging infrastructure can be elaborated.

Croatia

3.2.1.5 ELEN

Project of development of charging stations in Croatia was done by national energy company HEP group. Their goal with this project is to lead European energy strategy and the basis of the project is the idea that electricity from renewable sources is used as fuel for electric vehicles. Long term plan of the project is to make an infrastructure of charging stations in Croatia, so that traveling through the country with electric cars won't be a problem. The first charging station the company has installed was in Labin, Croatia in 2012. The charging station had a type 2 socket (AC), 22 kW (32 A) and 400V. The mentioned charging station was opened for use at the beginning of the operational phase, no RFID cards or other identification documents were needed so that every user that had an electric vehicles could charge his vehicle on the charging station. The electricity that was distributed through the charging station was/is free of charge. After that, HEP Elen started to install charging stations in all parts of Croatia. After the installation of the charging station in Labin, a number of smaller stations were installed. A more serious breakthrough was not possible due to a small number of electric vehicles. In 2012, the City of Koprivnica started the FP7 project “Civitas Dyn@mo”. One of the measures that were implemented in the scope of this project was the establishment of a car sharing system with 5 full electric vehicles and a public transport system with two electric buses. Since this was the first larger number of vehicles on one place in Croatia, the HEP Company and the City of Koprivnica have signed an agreement of setting up 5 fast charging stations in the administrative area of Koprivnica. This charging stations have a maximum output of 50 kW, and three charging type possibilities; Chademo, fast DC and Combo 2. These charging protocols cover all of the vehicles that the car manufactures offer today on the market, from the Japanese and American producers that use Chademo and fast DC, and the European producers that use Combo 2. The charging stations do not use, due to infrastructural (lack of available power) and financial (price of purchasing 1 kW of power is rather high) reasons, the full capacity, instead the available power is 22 kW. This allows the charging of the full electric vehicle, the Mitsubishi i-Miev in approx. 25 min, from 20% up to 80%. These were the only fast charging stations in Croatia for a period of two years. The stations are used regularly by the City of Koprivnica and its administrative staff that uses electric vehicles, electric buses that operate in the public transport operations. Also, a great deal of private users use these stations since they are the only fast charging option in the surrounding area of 50 km distance. On 6th of April 2017 the Government of the Republic of Croatia has adopted the decision on the National framework for the implementation of alternative fuel vehicles. The decision was made that charging stations have to available every 50 km on national highways and in all cities above 20000 inhabitants. Also, the decision defined plan for the total number of charging stations:

By the year 2020 – 296 charging places (222 AC min.power 22/(11) kW, 74 DC min. power 50 kW); on 164 charging stations.

By the year 2025 – 602 charging places (434 AC min. power 22/(11) kW, 168 DC min. power 50 kW); on 348 charging stations.

By the year 2030 – 806 charging places (554 AC min.power 22/(11) kW, 252 DC min. power 50 kW); on 479 charging stations.

Based on the latest data, there are in total 160 charging stations currently installed in Croatia. Out of the 160 charging stations, only 11 of them allow the charging on DC protocols, Chademo and Combo. Besides that, there are 5 Tesla superchargers that are located on one charging point. Overview of charging stations in Croatia can be viewed on e-mobility portal www.puni.hr.

3.2.1.1 EAST-E[32]

European project from CEF programme (Instrument of Connecting Europe Facility). Total worth of the project is 5,05 million euros for placement of 62 multi-standard fast charging stations along TEN-T corridors. Project consortium consists of HEP (energy company from Croatia), E.ON (energy company from Czech Republic) and GO4 (energy company from

[32] https://ec.europa.eu/inea/sites/inea/files/fiche_2015-eu-tm-0204-s_final.pdf

Slovakia), Zapadnoslovenska energetika (energy company from Slovakia). Start of the project was in March 2016 and end of the project will be in 2018. Plan is to implement 57 charging stations, 27 of them will be placed in Croatia, 20 in Slovakia and 15 in Czech Republic. With placement of 57 charging station in mentioned regions, existing charging station network will expand and the connection with surrounding countries will be easier. Project will enable connection of countries on Atlantic coast, North Sea, Mediterranean with countries on east towards Poland, Ukraine, through newly developed charging station network in EAST-E project. Project is also focused on intermodality (combining multiple types of transport) with 20 airports locations (Zagreb, Prague, Bratislava) and railway stations. Project goal are:

- To decrease the dependency on fossil fuels and to mitigate negative effects of these fuels on environment.
- To accelerate the market to increase a demand for electric vehicles and use of infrastructure.
- To elaborate policy and best practices in infrastructure deployment.
- To develop continuously the consistent charging infrastructure.

Multi-standard charging stations are selected because average charging time is between 20-40 minutes, depending on battery capacity of the vehicle in question.

3.2.1.2 NEXT-E

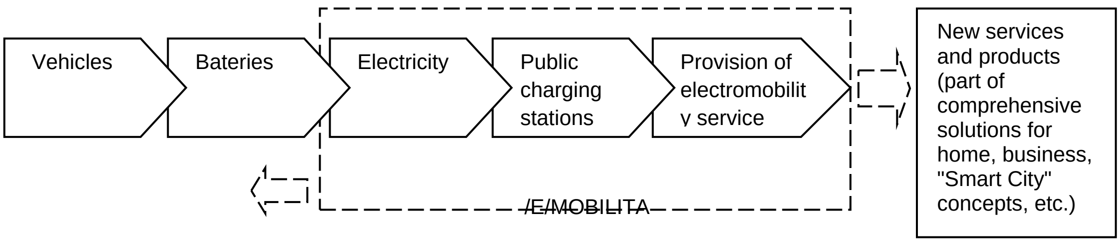
The European Commission has approved co-funding of the NEXT-E project which foresees setting up of 252 charging stations in six EU Member States in the Central Europe, including Croatia, Slovenia and Romania. Start of the project was in the beginning of year 2017. The end of the project is end of the 2020. The co-funding of the project was approved by the European Commission in the second half of June 2017. The project duration is three years and 222 fast and 30 ultra-fast charging stations will be built in Czech Republic, Slovakia, Hungary, Croatia, Slovenia and Romania. The project will be implemented by the international consortium of energy companies from six Central European countries. The consortium consists of the Mol Group, E.ON, Croatian power company HEP, PETROL, BMW Group and the Hungarian Nissan subsidiary. The funds are secured from the Connecting Europe Facility (CEF) which supports the development of sustainable and efficiently interconnected trans-European networks in the fields of transport, energy and digital services. The project will be co-funded with EUR 20 million, which is the biggest amount ever granted from CEF to e-mobility development. This amount will cover up to 85 percent of costs for each consortium member. As part of the project, HEP will set up a total of 30 new charging stations – 26 fast ones (minimum capacity of 50 kW) and 4 cutting-edge ultra-fast charging stations (minimum capacity of 150 kW) along the Goričan-Rijeka, Zagreb-Split and Bregana-Lipovac motorways. All charging stations will be multi-standard i.e. they will provide the charging option to all existing as well as new electric vehicles.

Czech Republic

3.2.1.3 /E/MOBILITY

/E/MOBILITY is the most important project in the field of electro mobility in the Czech Republic. Since its beginning in 2010, it has been mainly focused on a construction of the public charging stations network. From the beginning of the project to the present almost 70 stations have been completed (25 of them are fast-charging ones). Its aim is to build a backbone network of quick- charging stations on the whole territory of the Czech Republic. Also more than 35 electric vehicles have been put into operation with their total mileage exceeding 1.000.000 km. This project involves over 50 partners (private companies, ministries and municipalities) and partnership with nine world´s leading car factories has been established.3334

Figure 23:Definition and linkages of the project /E/MOBILITA



3.2.1.4 e-FEKTA The assistance to municipalities of Litoměřice and Dresden in the area of a sustainable mobility[35]

In the project of the cross-border cooperation, the awareness of officials and municipal authorities of principles and practical aspects of a sustainable mobility will be enhanced and the efficiency of car fleets, used by above mentioned municipalities, will be increased through the introduction of electrical cars together with new information technologies. In addition, the system of the solar energy accumulation for effective use of renewable energy will be verified in a pilot projects held in both towns. Dresden, the capital city of the Freistaat Sachsen, will introduce an innovative on line reservation system of rides within this project.

Both towns will make installation of systems of energy accumulation which enable to use solar energy also for recharging of electric cars. The system of energy accumulation will be

[33] Chmelík, T. (2016). Projekt elektromobilita ČEZ [Online]. In Efektivní elektromobilita v organizacích. Praha: Ing. Jakub Slavík, MBA – Consulting Services. Retrieved from http://www.smartcityvpraxi.cz/konference3.php

[34] Kaňák, R. (2017). Elektromobilita skupiny ČEZ [Online]. In Podpora a rozvoj nízkouhlíkových technologií . Zlín: Energetická agentura Zlínského kraje.

[35] https://www.dataplan.info/cz/litomerice/rozvojove-zamery/projekty-vse?id=64fc479e4a8f8426204a794b73fe8ace

connected to electrical network and that between a photovoltaic power station and an external rechargeable station (5 buildings in Litoměřice and 2 buildings in Dresden) which will allow use of the solar energy at a time when it is unavailable. By this measure the operational costs of municipal car fleet will be reduced and an overloading of electrical distribution network will be limited too. These pilot installations will provide also valuable experiences and data which will be exploited for further development of e-mobility in both cities. New experiences will be presented to the representatives and the public of the both cities during the project.

The aim of this project is through awareness campaigns, educational events, conferences and workshops enhance knowledge within key target groups (officials of municipalities, political representatives, public, young people) on principles of sustainable traffic and in particular on aspects of electro mobility in different conditions of both towns. There is also a challenge represented by the cooperation between two towns of a different size which allows estimating an applicability of experiences in other towns and cities in Czech-Saxon area and also outside of it.

Hungary

3.2.1.5 SMART-MR project

Within this project idea a metropolitan region of tomorrow should provide its residents with a safe, functional and resilient environment. Low-carbon transportation and mobility are vital components of such smart urban areas.
However, transportation in metropolitan regions today generates congestion and vast greenhouse gas emissions. This imposes enormous challenges upon local and regional authorities in providing healthy living conditions for inhabitants and a supportive environment for businesses.

SMART-MR finds solutions and helps local and regional authorities improve transport policies.
The key project outputs include a guide on sustainable measures for achieving low-carbon and resilient transportation in metropolitan regions, selected good practice descriptions, and policy recommendations. Through these outputs, as well as dissemination events (such as political meetings, the final conference, and regional stakeholder meetings), SMART-MR contributes to Europe 2020 goals, Cohesion Policy, and the Interreg Europe Program.

7 workshops were organised by the project partners in order to find solutions by sharing experiences in transport and mobility planning. For each workshop, the partners will issue

an in-depth analysis, describe good practices and organise a study visit. Practical experiences will be presented and discussed, and policy recommendations developed.

The partner metropolitan regions will also prepare and implement action plans to improve the implementation of regional transport policies and instruments by:

- Creating sustainable mobility plans
- Promoting low-carbon network-oriented urban development relying on public transportation and development of nodes
- Including stakeholders in project activities and in the design and implementation of the action plans

SMART-MR brings together 10 project partners from 8 metropolitan regions (Oslo, Göteborg, Helsinki, Budapest, Ljubljana, Rome, Porto and Barcelona).

3.2.1.6 E-mobility Hungary

The "E-mobility Hungary" was developed to get feedback about customer's expectations for e-vehicles, charging infrastructure and to get information about charging behaviour and load profiles. Analyses of requirements of charging infrastructure are made to define home charging infrastructures and develop new tariffs.

3.2.1.7 Green eMotion projekt

The Green eMotion project was the largest ever initiative launched by the European Union in the field of e-mobility. It aimed at spreading the European model of electro mobility throughout regions and analyzing its effects. The project was covering ten countries, with a budget of EUR 42 million, supported by the European Union with EUR 24 million.

3.2.1.8 VIBRAT-e Project

The VIBRAT-e project was created by E.ON's Slovakian subsidiary, Západoslovenská energetika, and the energy provider in Lower Austria, EVN, in order to build an e-charging station network between Vienna and Bratislava. The fast-charging point in Vienna opened in June was the first step, and the charging station opened today in Bratislava will make it possible to use electric vehicles throughout the entire region.

3.2.1.9 AC Centrope II

The project was commenced with a partnership between Austria and Slovakia and is now to be extended to Hungary.
As part of the project, the following tasks will be carried out:

- Establishing the an Automotive Academy in Hungary according to the model provided by the Automotive Academy Vienna Region
- Requirement and acceptance analysis of the new e-mobility course of study
- Development of a curriculum for a joint degree programme
- Development of an application for the new e-mobility degree
- Selection of the lecturers, as well as trainers, drawing up the content with reference to that tat the AAVR, determination of the accreditation
- Designing and developing infrastructure for the delivery of the study content
- Creation and running of a bilingual project website
- Press statements, presentations, events and trade fairs

3.2.1.10 ELIPTIC – Pillar A

Pillar A - Replacing diesel bus lines by extending trolley bus network with trolley-hybrids.
The Szeged study models the case of replacing diesel bus lines with extension of the trolley bus network with trolley-hybrids without the need for additional infrastructure. The charging in this use case comes from the existing catenary network and the battery trolley buses run in accumulator mode in between the existing and extended network. Possible/alternative route definitions, the effects of such a system on the traffic as well as external effects are explored at first. Then, the stakeholders will select the test route from the alternatives and define the transport service and required vehicle fleet. Activities in Szeged are led by SZKT with support of University of Szeged.

3.2.1.11 Pillar C - Multipurpose use of infrastructure for (re)charging trolley-hybrids & e-vehicles

The aim of this use case is to test the first public electrical multipurpose charging station for trolley-hybrid-buses, e-bikes and e-cars in the city of Szeged. It includes localisation of the station, testing its use with trolley-hybrid-buses, e-cars and e-bikes, which will eventually lead to developing concepts for electric intermodal e-mobility. This first multipurpose charging station supports the long term transport strategy plan of the Municipality in Szeged, promoting e-traffic mobility modes.

Romania

3.2.1.12 Association for promoting electric vehicles in Romania (AVER)[36]

During the last years, in all countries, the urban transportation raised specific problems and caused important political, social and environmental problems: pollution, noise and stress. That is why the research and technological development activities are encouraged to provide clean and efficient transportation, especially in the European countries, USA and Japan. The laws regarding the environmental protection aim at limiting the greenhouse effect and Romania must and wishes to follow the same direction.

Founded in 2005 as a non-profit organization AVER is locally the biggest promoter in EV field. The main activities are related to dissemination, networking, monitoring, lobbying, research and development, among other. In public policy advocacy AVER presents the electric drive industry and R&D bodies concerns to the Romanian Government.

AVER has inherited the oldest Romanian research on electric cars. Since 1970's, a R&D team was established in the field of electric cars with great results.

A large number of researchers from the R&D team are now honorary members of AVER and share their experience in all its projects.

The organization has a big experience on research and development in electro-mobility finalizing a large number of experimental. Below it is a list of a few of the projects developed by AVER:

- Light Electric Vehicle
- Propulsion systems for electric vehicles
- Electric DACIA Solenza
- Electric Bus
- Electric Boat
- Electric Submarine
- Electric Scooter
- Electric VW Beetle
- Mobile photovoltaic EV charging station

3.2.1.13 Rabla Plus[37]

2017 come with the new Scrappage Rabla Plus incentives of EURO 10.000 for BEVs. Scrappage program, otherwise the expected program run by the Environment Fund Administration in 2017, could start at the beginning of the second trimester of this year and Scrappage program +, for the purchase of electric cars and plug-in hybrid cars.

[36] http://aver.ro/about.html
[37] http://aver.ro/05052017.html

Funding for Scrappage program is at the same level as last year. The novelty is that it begins much earlier. Last year it was released in June. Anyone who wants to apply can receive that ticket worth and can have access to an eco-bonus, depending on the respective vehicle emissions. Referring to Scrappage + the ticket value has doubled since 2016 and the total budget of the program is enough to purchase a number of 1.000 electric cars.
This program comes bundled with another measure, the release of grants for those who want to make electric charging stations, said the former Minister of Environment. In doing so, charging stations for electric cars program of incentives has an own national budget, and the beneficiaries are administrative units, public institutions and legal platforms.

The Ministry of Environment has budgeted 80 million for purchase of electric buses and construction of charging stations for the cities of Bucharest (at least 28 buses and 28 charging stations), Brasov (minimum four buses and four charging stations) and Lasi (minimum eight buses and eight charging stations).

Rabla Plus will be of a multi representing strategy for a period of three years developed by the Environment Fund Administration who aims to help encourage the purchase of new electric cars which are becoming more efficient in terms of environmental impact. According to the source, the scrapping premium will be paid according to the amount of CO_2 / km generated by the new vehicle power train. Thus in 2017, the first granted for new vehicle whose propulsion system generates up to 130g CO_2 / km.

In 2018, the first will be paid for the new vehicle whose power train generates a maximum 120 g CO_2 / km, and in 2019 was granted for vehicles that generate up to 110g CO_2 / km. The scrapping premium applicants can add an eco-bonus. For a new vehicle equipped with propulsion system generates a maximum amount of emissions of 98g CO_2 / km in mixed mode operation is given an eco-bonus for 2017.

In the same year, 2018, an additional bonus is granting to purchase a new vehicle that generates a maximum amount of emissions 96g CO_2 / km in mixed mode operation.
In 2019, cars that generate a maximum amount of emissions of 95g CO_2 / km in mixed mode operation will again receive an eco-bonus and for vehicles with hybrid drive.
Scrapping premium and eco-bonus deducted by producer retail price including VAT of new car and scrapping premium may be added to an eco-ticket awarded under the program to promote road transport vehicles clean and efficient energy in conditions laid down in the guidelines of the two programs. In this case, accumulation eco-bonus is excluded.

More than 400 electric and hybrid cars were bought in the first trimester of 2017 before the Rabla Plus launched on May 2017 according to AVER.
Even though Rabla and Rabla Plus programs have not yet become operational, the automotive market segment - electric and hybrid - continues to grow last year, recording a

1.7% share in the first three months in 2017 of the total market. Thus, in the firths months of this year, over 40 electric and hybrid cars were purchased. BMW leads the top of the most traded 100% electric cars with 14 units, followed by Mercedes-Benz, 8 units, Audi, 6 units, Volkswagen, 4 units, Volvo, 3 units and Porsche, 2 units. Toyota retains its leading position in the hybrid segment. From March 2016 to March 2017, the brand sold 328 units in Romania. Long range Lexus is ranked, 32 units, Kia, 3 units, Land Rover, one unit, Mercedes Benz, one unit, Ford, one unit.
Concerning the sale of "green" cars, year 2016 was marked by doubling the volumes, respectively 1,183 units compared to 496 units in 2015. It is also noted that the number of electric cars (BEV, EREV, PHEV) tripled (237%) compared to year 217 (167 units in 2016, 46 units in 2015).
There is also Scrapping premium provided for classic cars older than 8 years and is granted for the purchase of a new car that generates no more than 130 g CO2 / km. To this an eco-bonus can be added if the new car is hybrid or generates no more than 98 g CO2 / km.
Regarding the participation of the population in the Rabla Plus program, this is not conditional on the Rabla Classic and scrapping of a used vehicle. Thus, those who want to buy a pure electric car can benefit from an eco-ticket and those who optional buy a hybrid electric car. Also, the two programs can be cumulated so that a person can benefit both from the eco-tickets awarded for the purchase of a pure electric / electric hybrid electric vehicle and from the Classic Rabla only if the customer carries and radiates a car older than 8 years.

3.2.1.14 Public transportation[38]

Solaris Urbino 12 all-electric bus was declared "bus of 2017 in Europe," and now is in a period of tests Brasov Autonomous Transport. For a week Solaris Urbino 12 will travel different routes in the city, to convince local authorities that an effective solution for urban public transport. It may not carry passengers because it is registered in Poland and this contravenes the regulations. Even so, authorities said they were excited by the possibility to adopt an electrical solution. It is ideal for the regenerative braking system using the bus or highly elevated route as Brasov-Poiana Brasov.
The bus has a range of 200 kilometres and declared a price of EURO 450.000,--. But beyond the financial side it raises the issue of infrastructure necessary for charging such a fleet. Thus, to obtain a full picture of the investment, the authorities need to discuss specific routes and decide together with AVER and the manufacturer for the final solution.
This is because charging can be done over time and at the end of the line where stops are somewhat higher. According to the manufacturer, a full charge takes from two to six hours.
Solaris Urbino 12 is already in operation in countries such as Germany, Austria, Italy, Spain, Poland and Sweden, which certifies an efficient solution.

[38] http://www.nineoclock.ro/premiere-in-romania-six-electric-cars-have-crossed-romania-from-bucharest-to-timisoara-in-the-electric-drive-caravan/

It would be great if Romania would be put on the selected list of countries, which are beginning to adopt electrification of public passenger transportation.
Solaris Urbino 12 is produced by the Polish company Solaris Bus & Coach near Poznan in Poland. Fully electric version went into production since 2013 and was adopted initially in Germany at the end of that year, in a project conducted by the German Federal Ministry of Transport.39

3.2.1.15 Renovatio[40]

Austrian energy group Renovatio is one of the pioneers of the renewable industry in Romania, being the company that developed the first wind farms and photovoltaic in Romania. The company's activity has two fundamental parts: the commitment to the continuous innovation and care for the environment.
Renovatio e-charge is the first network for rapid charging dedicated to all the users of electric vehicles in Romania. From 2015, Volkswagen, with Renovatio support, installed the first Quick Charge station in Romania, which is available to all Volkswagen clients. Alongside the opening of the Constanta – Timisoara axis, Renovatio and Kaufland announced the opening of the Bucharest – Brașov – Targu Mures – Cluj – Oradea network.
In 2016, Renovatio, in partnership with Kaufland (e-charge stations are located in Kaufland parking lots), has completed the first public network of charging stations for electric cars in Romania. As of now, it is possible for owners of electric cars to drive between Arad, Bucharest and Constanta. The completion of the network was marked by the start of Electric Drive, on 22nd October 2016. During the drive, six e-Golf electric cars participated in the longest electric car race ever held in the country, in order to highlight the fact that the new infrastructure provides extended autonomy to eco-friendly cars.
With the completion of the infrastructure for electric cars on the Constanta – Bucharest – Timisoara – Arad corridor, it became possible to break city boundaries and to leave the comfort zone offered by the charging solutions at the office or from home and to drive larger distances with electric cars between cities. Specifically, the Electric Drive caravan aimed to show that, by developing the public infrastructure, The charging stations are located in Arad, Timisoara, Deva, Sebes, Sibiu, Pitesti, Bucharest and Constanta.

3.2.1.16 Electro mobility- Electric vehicles for a green municipality[41]

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39 http://aver.ro/19042017.html

40 http://www.business-review.eu/news/renovatio-completes-first-public-network-of-charging-stations-for-electric-cars-in-romania-122364

41 http://www.fonduri-structurale.ro/stiri/15741/suceava-vehicule-electrice-pentru-o-municipalitate-verde-prin-programul-de-cooperare-elvetiano-roman

The project that has been implemented in the city of Suceava (North East Romania) in 2016 to raise awareness about the use of electric vehicles, also installing a total number of 14 slow charging points and 14 fast charging stations. Through this project the city hall of Suceava managed to create 56 parking stations for EV next to the charging stations as well as procuring 15 e-vehicles for public use.

Slovakia

3.2.1.17 National project of National Highway Company

National Highway Company (NDS a.s.) recently announced a public tender for the most appropriate proposal for the conclusion of a lease for a part of selected motorway rest-places for the construction and operation of a network of fast-charging electrical stations for charging electric vehicles. The competition runs until 05.05.2017. All together 26 locations (rest-places) should be developed on the motorways D1 and D2.
The successful participant in the competition undertakes to ensure the continuous operation of the charging stations, which will enable all types of electric cars to be charged with electricity with a minimum power of 40 kW with the possibility of charging two electric cars at the same time using connectors in particular CCS, CHAdeMO and Mennekes type 2.
The first stage (the "Stage I") of the charging stations construction must be completed by a successful participant of the competition by no later than 31.10.2017 at 16 motorway rest-places and the second stage, charging stations on 10 rest-places must be finished no later than 31.10.2018.

Slovenia

3.2.1.18 Green corridors of Slovenia[42]

The project Green Corridors of Slovenia has helped enable the development of electro mobility in Slovenia. It was held within the framework of the European project "Central European Green Corridors (CEGC)", whose aim was to establish a dense network of fast charging stations for electric vehicles on the Slovenian motorway network until the end of 2015. The project started in year 2014. Within the project, co-founded by the European Union, 26 fast electrical charging stations were placed along the Slovenia motorways. Charging stations allow users to charge electric vehicles with 50 kW DC or 43 kW AC. Under the auspices of the project CEGC 115 modern fast charging stations were positioned in Slovakia, Austria, Germany, Slovenia and Croatia. All new charging stations ensure

[42] https://www.sodo.si/hitre-polnilnice/o-projektu

interoperability and have the roaming system enabled. Installation of 26 fast charging stations in Slovenia was completed and hand over into use in year 2015.

3.2.1.19 Electric trip in Gorenjska region [43]

The extremely rapid growth in the use of electric vehicles in all developed countries shows that such vehicles will soon be more numerous or even predominant. This applies to smaller electric vehicles (electric bicycles) as well as to larger electric vehicles (cars). One of the major shortcomings and reasons that electric cars are not more prevalent in the Gorenjska region, lies in the fact that the area didn't have a network of charging stations for electric vehicles. The main activity of the project was to prepare a comprehensive analysis of the potential of introduction of electric charging stations in Gorenjska region while also analysing the appropriateness of the placement in this area. Another aim of the project was to raise awareness of the rural population about electric vehicles and present options that are in some EU countries already a part of everyday life (e.g. for transport in closed areas, where only use of electric vehicles is allowed). In the framework of the project a network of 5 charging stations was set up (among others Lake, Preddvor, Kranj).

3.2.1.20 ALTERENERGY (Energy sustainability for Adriatic small communities)

ALTERENERGY (Energy sustainability for Adriatic small communities) promoted energy efficiency and renewable production across the Adriatic area. The project was implemented in period 2011–2016 in partnership of 18 organizations, regions, ministries and energy agencies from Adriatic area

Through the project ALTERENERGY an electric charging station was built in the Municipality of Divača together with purchase of 3 electric bicycles, which are available to tourists and citizens in Divača. The power of the electric charging station is 24 kW.

3.2.1.21 SMARTV2G[44]

The aim of SMARTV2G was to develop a smart charging infrastructure for electric vehicles and to demonstrate the integration of the charging station, along with the process of charging an electric vehicle, into operation of a smart electricity grid.

Within the project communication modules and data processing systems have been developed, with the constantly present emphasis on safety in the use of charging stations. The electric vehicle were connected to the network through smart charging stations, which will exploit the advanced communication technology and allow power control charging from the control centre to manage the charging infrastructure.

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[43] http://www.ctrp-kranj.si/portfolio/gorejnsko-elektro-potovanje/

[44] http://www.smartgrids.si/index.php/sl/projekti

The purpose of the advanced V2G system is to allow charging of electric vehicles by participating in V2G services, which will allow efficient managing of electricity grids.

In the course of the project also a smart fast AC charging station was developed and tested. As a part of the laboratory test work also a DC charging station, which allows the return of electrical energy to the electricity grid in accordance with the requirements of the simulated distribution control centre, was developed.

3.2.1.22 ICT 4 EVEU[45]

ICT 4 EVEU was developed with the aim of deploying an innovative set of ICT services for electric vehicles in different and complementary pilots across Europe. The scope of the ICT services is the integration of different management systems operating on the existing electric vehicle infrastructures in the cities where the pilots will be run, so that related services are deployed making use of these interconnected infrastructures. One of the pilots was also based in Slovenia, within the main cities, Ljubljana and Maribor.

As a part of the Slovenian pilot some existing charging stations for electric vehicles were upgraded with so-called smart functionalities. Upgraded charging stations support direct communication channels with the control centre, which enables identification of users, remote control of the station from the control centre, remote monitoring of each station, remote reading of metering data of electricity consumption at the station and other advanced services.

3.2.1.23 MOBINCITY[46]

The aim of the project was to optimize the route from point A to point B with the aim of reducing energy consumption and harmful emissions. Intermodal forms of transport, with an emphasis on the use of electric vehicles and public transport were used in the project. On the physical level, the data from different databases (location and status of charging stations for electric vehicles, weather and traffic conditions, the state of the energy networks, transport timetables…) is used with help of mobile devices in order to select the most appropriate form of transport from initial to the final location.

Montenegro

In Montenegro no national studies were carried out, nor any other EU projects implemented in terms of studies, construction, production, installation or use of electrical charging

[45] http://www.smartgrids.si/index.php/sl/projekt & http://www.ict4eveu.eu/
[46] http://www.smartgrids.si/index.php/sl/projekti

stations in urban or rural areas. The topic of charging stations is there at the beginning and is in need of public awareness and implementation.

Serbia

Similar to Montenegro there have been no studies and projects in the Republic of Serbia on the topic of electric charging stations. The development of the first document under the name "Strategy installation of chargers for electric vehicles in the Republic of Serbia" is in progress.

4 Plans and incentives for further development

4.1 Recharging Time and infrastructure

Short charging times require high charging capacities, which present new challenges both battery technology and charging infrastructure. Furthermore, the mobility behaviour of the customers significantly determines the requirements for vehicles and infrastructure. Thus, the design of high-frequency charging stations (e.g. on motorways or public parking lots) is faced with new challenges, as a number of e-vehicles have to be refuelled as quickly and comfortably as possible and high local charging capacities have to be provided. For example if there are sufficient loading stations with high loading capacities on high-frequency motorways and highways, the disadvantages are reduced by technologically caused, relatively small ranges of electric vehicles. From the point of view of a petrol station operator, the question now arises as to the impact of increasing e-vehicle numbers and their long-term use on the filling station infrastructure, and what customer frequency and duration of the customer should be expected.

Tesla is considered to be the pioneer in the development of long-distance charging infrastructure. There are 445 supercharger charging stations with over 120 kW charging capacity in strategically important traffic points. The size of the Tesla Model S electric energy storage unit with up to 85 kWh47 allows several hundred kilometres of range, and the availability of the company's fast-charging infrastructure is successfully trying to offset the car's long-term reliability. Free use of the loading stations can be an additional incentive. The Tesla charging stations, which are mainly designed for long-distance transport, are extremely well received, not just for long journeys. The availability of a "supercharger" in closer vicinity also causes Tesla owners, who are not on long-distance trips, to load their vehicle there rather than at home. The literature already contains reports of temporary bottlenecks, overloads and waiting times at Tesla rapid access stations.48
The largest and most efficient e-filling station in Austria is currently in Villach and was erected by the KELAG (Kärntner-Elektrizitäts-Aktiengesellschaft) in cooperation with Tesla-Motors; vehicles can be loaded with a maximum output of 830 kW. A specially constructed transformer station with two transformers provides the required power supply.49

According to a study only 10% of the respondents travel daily a distance of over 100 km; Distances over 250 km are only 1.2% of the users surveyed.

[47] https://www.tesla.com/de_AT/models
[48] http://www.autobild.de/artikel/e-ladestation-tesla-supercharger-6028561.html
[49] http://www.ots.at/presseaussendung/OTS_20150618_OTS0297/kelag-und-tesla-die-groesste-und-leistungsfaehigste-e-tankstelle-in-oesterreich-bild

Tracks of more than 500 km are driven only 5 times per year.50 Despite these facts, customers place high demands on the long-term reliability of passenger cars. If the range reaches a considerable improvement in the coming years, the long-distance mileage with E-vehicles will increase strongly, which could lead to a higher utilization of the fast-charging networks. In the scenarios where electric vehicles can replace conventionally operated vehicles, the demand for fast-charging stations near high-frequency roads is also increasing strongly.

4.2 Wallbox for recharging electric cars

More and more motorists are turning to electric cars as an alternative way to make the daily commute to work. These vehicles are particularly popular with environmentally conscious commuters living around big cities who cover 50-100 kilometres a day. Commuters benefit in particular from the relatively low energy costs entailed in the long distances they cover – using electricity costs less than half the money needed to run a comparable, fuel-efficient car with an internal combustion engine. Most of these electric cars are recharged in people's own garages, something confirmed by all of the data gathered as part of pilot projects, which have now been completed.

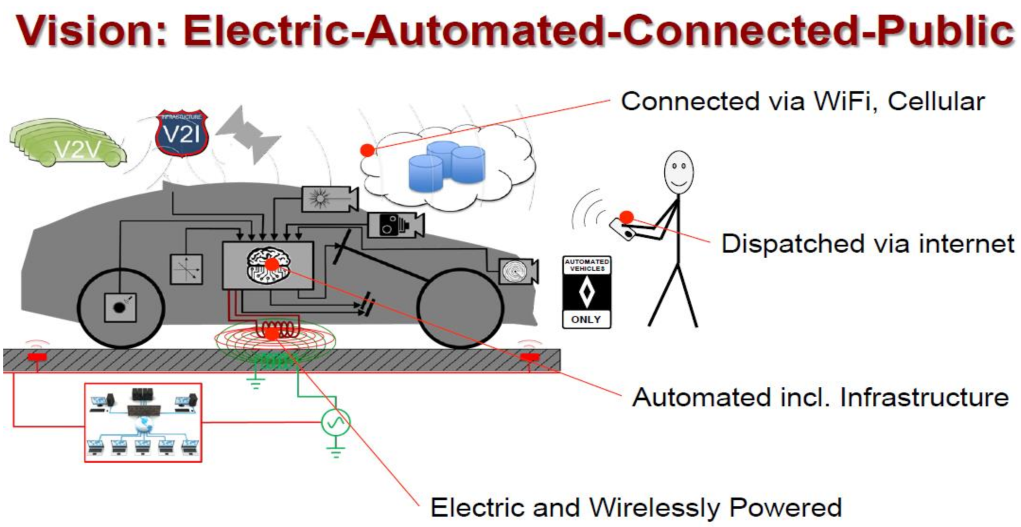
4.3 Highways, car parks and public refuelling

Actual research and analyses show an increased demand for fast-loading stations. Studies on long-range behaviour are still rare due to the limited availability of corresponding long-range electric vehicles. However, findings from a Fraunhofer study51 show that e-vehicles can also be useful for long-haul flights, subject to compliance with certain peak periods. If the range of reach of the electric vehicles increases to an extent which is acceptable for long distances and the loading times are comparable with those of a conventional tank and pause operation, will e-vehicles can also be used on long-haul routes.
Customers at public filling stations for electric vehicles prefer fast-access stations and spend about 20 minutes on average for the charging process. Within just one year the energy demand doubled at public fast-food stations; No rising demand could be found on type 2 charging columns with a charging load of only 3.6 kW. A trend shows that users of electric vehicles like to refuel their vehicles during a coffee break or a shopping trip, and recharge less at home.

[50] Compare: K. Bozem, A. Nagl: „Elektromobilität: Kundensicht, Strategien, Geschäftsmodelle", 2013, Springer Verlag, Wiesbaden
[51] https://www.springerprofessional.de/fahrzeugtechnik/ladeinfrastruktur/sind-elektrofahrzeuge-langstreckentauglich/6562310?redirect=1

In order to meet customer requirements after short charging times (<30 min), future E-filling stations must offer corresponding charging capacities and a sufficient number of charging stations. This corresponds to an acceptable waiting time for a sufficiently long journey.
If the range of long-distance electric vehicles increases, the need for quick-charging stations in the next few years can rise very sharply; especially for trips on highways, where only short loading times are accepted. In order to be able to fill many vehicles at the same time as quickly as possible, high charging capacities are necessary, which must be provided by the power network.
In order to be able to carry out location-specific forecasts of the service requirement for an e-filling station, an analysis of the vehicle charging frequencies as well as of the mobility behaviour is necessary. Furthermore, a more detailed local analysis of the described influencing factors is necessary.
The electric vehicle driver will plan ahead a long way ahead and deal with the additional offers of the service station during the loading breaks. Thus the e-mobility will also change the gas station of the future in the direction of the service offerings.

Figure 24: Possible Future of automated charging



Source: http://web.stanford.edu/group/peec/cgi-bin/docs/events/2013/5-31-13%20Beiker.pdf

The self-contained car park search is one of the most important functions that consumers expect in the future of vehicles 52 with 66.3% of all respondents from a study for consumer research. Through the future networked communication of the driver, vehicle and infrastructure, the charging process could also be automated with the help of the self-propelled and -parking car. Conductive DC quick-charger can provide high performance, but require new technologies and approaches for an automated charging process.

[52] http://de.statista.com/statistik/daten/studie/

4.4 Target groups

Commuters is a quantitatively well assessable, periodically occurring traffic demand over a generally constant distance, for which one-lane or multi-lane electric vehicles are suitable. In the long run, multimodal thinking and mobility chains are to be pursued in parallel, and a close link with public transport, for example via innovative mobility packages, is decisive for success.
The theoretical shifting potential to more environmentally friendly means of transport (electric vehicle) or the linkage in the environmental network (individual electric vehicle and train or bus) is considerable.

Taxis combine a wide publicity with a challenging employment profile. They enable low-threshold access for consumers to electro mobility. At the same time, Austrian technology creates concrete potential for the improvement of environmental impacts.
The choice of the right technology option is of particular importance because of the high driving capacities and 24-hour operation even at low stand times at the stands. On the other hand, the high driving performance is also an opportunity, since low consumption reductions also result in high financial savings. As a result, full-hybrid vehicles such as the Prius are already being used by many taxi companies not only for reasons of marketing as an environmentally conscious company but also for financial reasons. A clear and hitherto unrealized innovation leap would be the use of plug-in hybrid vehicles, where a rightful docking of charging stations at the stands also opens up very interesting potential for innovation on the infrastructure side.
Due to the high driving performance, however, this would be possible with vehicles operating around the clock without longer service times instead of with slow charging only with technology options connected with rapid energy recharge.

The quick charge has certain disadvantages in terms of comfort for the driver, the time required for the quick charge and a possibly necessary cooling time when charging with high current intensities as well as possible safety risks at the stands. For this reason, fully automated battery replacement at the stands is an option if this technology is also to be tested in real operation. In principle, however, slow charging at normal current intensities is preferable because of the higher energy efficiency. The infrastructure is in this case is also much cheaper than with battery replacement or quick-charging systems. Innovative would be systems that use the short rest phases of the vehicles as completely as possible.

In the medium and long term, the experience of model regions will facilitate a comprehensive implementation. The definition and selection of conversion regions for electro mobility can be linked to existing model regions or models for sustainable mobility as well as a focus on the development of new regions with particular potential for implementation. The selection should take account of the regional management options (countries, regional and mobility associations).

4.5 Location planning of an EV charging infrastructure[53]

Planning the charging infrastructure for EVs in a city or region involves solving a location planning problem: where should how many charging points of which type be placed?

The problem can be broken down into two sub problems for easier handling. First, locations need to be decided on a macro scale of city quarters or in proximity of specific points of interest. Then, individual locations can be planned on the micro scale, taking the specific urban surroundings of parking spaces in the specific street into account.

Wide range of different methodological approaches to location planning of charging infrastructure for EVs are used today. Different methods vary in the aspects that are taken into account for determining suitable locations for charging stations. The majority of models includes the users' demand for EV charging. However, many different indicators are used to quantify and locate this demand. Data that is used, often in combination, includes sociodemographic data (such as population, occupation, income), employment data, building data, data on registered vehicles, proximity to public transport connections, proximity to major motorways, origin-destination traffic data, traffic flow data for roads, and parking data.

Besides the demand for charging, other factors taken into account are connection costs and/or impacts on the electricity distribution grid, and the cost or economics of building and/or operating the infrastructure.

Yet all these methods are not subject of this study thus we will not go into further details. Once the location planning of charging points on the level of regions is complete, micro planning comes into focus. Where exactly in city districts or communes, or near specific points of interest charging infrastructure is to be built has to be decided. The charging facility and further components, such as associated signs and protective pollards, have to be integrated into the existing parking spaces and local streetscape.

The criteria for location planning on the micro level are rather diverse and qualitative in form. Thus, it is not practicable to do this location planning in a structured mathematical manner, as has been done before for the location planning on the macro scale. Instead, it is reasonable to use only semi-formalized location planning frameworks, which allow urban planners to take the decisions in a partially intuitive form.

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[53] Wirges, 2016: Planning the Charging Infrastructure for Electric Vehicles in Cities and Regions

Below are some of the site and equipment issues to be considered when installing a charging station are depicted[54].

Complying with Regulations

Charging station installations must comply with local, state, and national codes and regulations, and installation requires a licensed contractor. Relevant codes and standards have to be considered and proper obtain approval from the local building, fire, environmental, and electrical inspecting and permitting authorities before installing electric vehicle supply equipment have to be obtained.

Convenience

Locate electric vehicle supply equipment and associated EVs parking as close as possible to the electric service while accommodating other activities at the site. Keep in mind that EVs can be parked for hours at a time for charging.

Avoiding Hazards

Cords and wires associated with electric vehicle supply equipment should not interfere with pedestrian traffic or present tripping hazards. EV charging spaces should not be located near potentially hazardous areas.

Ventilation

Although most of today's advanced batteries do not require ventilation during charging, some older types emit gases during charging. If the station will be enclosed, there must be adequate ventilation, which may include installation of fans, ducts, and air handlers.

Battery Temperature Limits

Because some EVs batteries have operating- and charging-temperature limits, electric vehicle supply equipment may need to be located within an enclosed, climate-controlled area in extreme climates.

Pooled Water and Irrigation

Electric vehicle supply equipment is designed to operate safely in wet areas. However, users will be more comfortable if it is not located where water pools or where irrigation systems spray.

Preventing Impact

Curbs, wheel stops, and setbacks should be used to prevent EVs from colliding with electric vehicle supply equipment. However, accessibility issues must also be considered when using these strategies.

Vandalism

[54] U.S. Department of Energy, Energy Efficiency & Renewable Energy (2012): Plug-In Electric Vehicle Handbook for Public Charging Station Hosts

Assess the risk of vandalism and minimize risk through use of preventive strategies, such as motion detectors, security lighting, tamper alarms, locked enclosures, anti-vandalism hardware, and graffiti resistant coatings.

Signage

Signs are particularly important for public charging stations. Mark EV parking/charging areas clearly with distinctive patterns on the ground and signs that can be seen over parked vehicles.

Accessibility

Evaluate and address requirements for complying with the regulations as well as state, local, and organizational accessibility policies. Compliance measures may include adjusting connector and receptacle heights, cutting curbs, and providing accessible parking spaces.

Lighting and Shelter

Provide lighting and shelter as necessary for the safety, comfort, and convenience of charging infrastructure users. Lighting should enable users to read signs and instructions and to operate the electric vehicle supply equipment easily. Although not typically required, shelter that blocks rain, snow, and wind can increase convenience and comfort.

Payment for Charging Services

If the station will require payment for charging, a payment system must be established. A payment system also can be used to collect data on station use. Some electric vehicle supply equipment products have integrated payment and data collection/communication systems that might require network communications.

Aesthetics

The aesthetics of charging stations can be important, especially for businesses trying to portray a positive image to customers. Where necessary, landscaping or walls can be used to screen equipment from view.

Maintenance and problem reporting

Station users who have problems with the electric vehicle supply equipment should be able to report it or contact support. For example, telephone number or the number of a service that monitors multiple public stations must be displayed.

4.6 Incentives for the development of charging stations infrastructure – example Slovenia

Incentives for the development of e-mobility in Slovenia are founded through the Slovenian environmental public found – Eco Found. Different incentives for purchase of electric

vehicles or development of the network of charging stations are meant for three categories of final consumers – citizens, legal entities and local government. There are two types of incentives in the form of grants and loans.
Public tender 45SUB-EVOB16 is a about non-refundable financial incentives to individuals for purchase or investment into electric vehicles. An individual is eligible for a grant:

- *in case of purchase of a new electric vehicle,*
- *in case of purchase of a new hybrid vehicle,*
- *in case of purchase of a new electric vehicle with a range extender or*
- *in case of processing a vehicle with internal combustion engine into an electric vehicle.*

Grants may be awarded for the purchase of vehicles in categories L7e, L6e, N1 and M1 with electric propulsion without CO2 emissions. Incentives can also be granted for the purchase of hybrid vehicles and vehicles with a range extender, however CO2 emissions must not exceed 50 g of CO2 emissions per km.

The amount of the financial incentive is:

- *7.500 € for a new or a processed electric vehicle without CO2 emissions in the category M1*
- *4.500 € for a new or a processed electric vehicle without CO2 emissions in the category L7e*
- *4.500 € for a new hybrid vehicle or an electric vehicle with a range extender with CO2 emissions less than 50 g of CO2 emissions per km*
- *3.000 € for a new or a processed electric vehicle without CO2 emissions in the category L6e.*

Each natural person that has a permanent residence in Slovenia is entitled to the mentioned financial incentive.

Public tender 38SUB-EVPO16 is almost the same as the one mentioned above, with the difference that it is meant for legal entities. The subjects of the public call are loans, for environmental investments, of the Eco Fund. Among the environmental investments also fall:

- *Purchase of an electric vehicle with zero CO_2 emissions.*
- *Purchase of a hybrid vehicle or a vehicle with a range extender. CO2 emissions of the mentioned vehicle types must not exceed 110 g/km.*
- *Installation of bicycle sheds, charging stations for charging electric vehicles (legal entities only).*

The highest amount of loan for citizens is 40.000 €. The maximum repayment period of the loan is 10 years with interest rate id EUROBOR+1,3 %. For legal entities the maximum repayment period is the same or shorter than the return of investment. In the case of legal entities the minimum amount of the loan is 25.000 € and the highest amount of the credit is 85% of the recognized investment costs.

Public tender 57LS16 is meant for loans for environmental investments of local communities. Under environmental investments of local communities are among other:

- *Purchase of an electric vehicle with zero CO2 emissions.*
- *Purchase of a hybrid vehicle or a vehicle with a range extender. CO2 emissions of the mentioned vehicle types must not exceed 110 g/km.*
- *Installation of bicycle sheds, charging stations for charging electric vehicles.*
- *Implementation of measures related to the promotion of sustainable mobility, in accordance with the adopted municipal transport strategy, as the promotion of multi-modality, introducing systems like "bike sharing" or "car sharing ", construction of bicycle paths, bicycle purchase or other similar measures.*
- *Purchase of electric labour machines.*

The amount of funds for this public tender is 5 million € and is intended only for local communities. Interest rate for this loan is EUROBOR+1,0 % and the maximum repayment period is the same or shorter than the return of investment.
The amount of each loan is limited to the minimum amount of the loan, amounting to 25.000 € and the maximum amount of loan amounting to 2 million €. Public tender 44SUB-EVPOL16 is about charging station for electric vehicles in protected natural areas and Natura 2000 areas. The subject of the public call are non-refundable financial incentives for the establishment of infrastructure (new charging stations) for electric vehicles, designed to promote electric mobility as an important element of sustainable mobility in protected natural areas and Natura 2000 areas. The aim is to promote sustainable mobility of residents and staff and to establish proper infrastructure of charging stations for visiting these areas. This will in the long term contribute to reducing greenhouse gas emissions, improving air quality, environmentally-friendly visits to these areas and, consequently, to the preservation of nature. At the same time coverage of protected areas with infrastructure of charging stations for electric vehicles will be provided.

Interest rate for this loan is EUROBOR+1,0 % and the maximum repayment period is the same or shorter than the return of investment. In any case the repayment period should not exceed 15 years. The amount of each loan is limited to the minimum amount of the loan, amounting to 25.000 € and the maximum amount of loan amounting to 2 million €.[55]

[55] https://www.ekosklad.si/fizicne-osebe/nameni/prikazi/actionID=141

5 Conclusion

Within a short scale of time a huge amount of projects and studies concerning E-mobility and necessary charging infrastructure to support e-mobility could be detected. The range can be set from test regions for e-mobility up to ultra-fast charging possibilities until combination of e-mobility with smart meter technologies. Studies and pilot actions were done in all partner regions of eGUTS.

A closer look at the development of numbers of charging stations in the project regions shows that nearly everywhere a strong increase of charging stations was recognised especially in the urban areas. It's interesting that even car companies (Tesla, Nissan) established charging stations in order to push the proper use of electric vehicles. In all the studies additional demand of charging stations was detected and a continuing increase of charging stations is estimated.

Studies show that 95% of users of electric vehicles want to load their cars either at home or at work. Therefore it is a challenge to implement solutions in order to satisfy the needs of all costumers without effecting shortages. Another challenge is to set cross-industry standards for electric vehicle and charging station interfaces including "simple standardized" billing. These are challenges which can be solved and turned into advantages for the increase of usage of electric vehicles.

The main disadvantages and barriers which were detected are still the high cost of electric vehicles, the limited range and the sufficient number of strategically well located charging stations. Obstacles which can be overcome if the process for batteries and the sufficient number of charging stations will lower as foreseen and the user behaviour will turn into the needs of electric vehicles (lower speed, car sharing, good planning of long distance routes by optimised use of charging stations etc.)

Plans and incentive concerning pushing of e-mobility are done by different key players. Tesla will increase as well as the number of charging stations as well as the range of their electric vehicles. The number of installed wall boxes will increase especially around big cities. There are recommendations that fast loading charging stations will be installed for long distance driving mostly on the highways.

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