Danube Transnational Programme
eGUTS

Electric, Electronic and Green Urban Transport Systems – eGUTS

Code DTP1-454-3.1-eGUTS

D4.2.2 Pedelecs vs ecars in urban transport system

Responsible partner

Transport Research Institute J.S.Co. - VUD

Version 2.0
October 2017

Dissemination level	***Public***
Component and Phase	D 4. 2.
Coordinating partner	Transport Research Institute (VUD)
Editor(s)	Soňa Šestáková, Katja Hanžič
Authors:	Soňa Šestáková (VUD) Christian Horvath (TOB) Daniel Amariei, Johannes Bachler (CERE) Libor Špička (CDV) Georgiana Birău (ROSENC) Dan Dumitrescu (UPT) Emese Tass-Aranyos (DDTG) Gregor Srpčič, Sebastijan Seme, Katja Hanžič (UM) Marta Milin (ZADAR) Milanko Damjanovic (ULCINJ) Dejan Jegdić (REDASP)
Due date of deliverable	01/08/2017
Actual date of deliverable	31/10/2017
Status (F: final, D: draft)	F
File name	eGUTS Pedelecs vs e-cars in urban transport system

HIGHLIGHTS

EVs adoption brings immediate benefits, such as air quality improvements and reduced noise, as well as climate change-related benefits, however they can be fully harvested only if EVs use is coupled with a decarbonised grid.

The 21st century will be the century of alternative propulsion and electric drive among them. In order to become competitive, lower production cost of electric vehicles needs to be achieved (mass production of all electic vehicles, not only for personal use), problem of unified charging has to be resoved and tools for supporting use of electric vehicles in normal operation have to be developed.

Still there are more and more vehicles on Europe's roads. While electric passenger vehicle sales have increased rapidly over past years, they represented just 1.2 % of all new cars sold in the EU in 2015. In all, approximately 0.15 % of all passenger cars on European roads are electric. Collectively, just six EU Member States account for almost 90 % of all electric vehicle sales: the Netherlands, the United Kingdom, Germany, France, Sweden and Denmark. The market share of EVs, in number of new registrations (sale), in the DTP region (eGUTS countries), with the exception of Austria, is below 1% and is counted in tens, maximum hundreds of vehicles sold per year.

Regarding the eGUTS (DTP region) countries, again with the exception of Austria, it can be said that the electric mobility in this region is indeed at the very beginning. To some extent, this is definitely related to the performance of the economy, and thus to the GDP and the purchase power of the country's population and also due to low e-mobility awareness of population.

A crucial point for greater e-mobility deployment in the eGUTS (resp. DTP region) countries could definitely be a well-chosen fiscal support mechanism and subsidies for e-vehicles purchase at national level.

Between 2006 and 2014, there was a steady growth of electric bikes sales in the EU. It is estimated that around 1.325.000 e-bikes were sold in the EU in 2014, almost 14 times as many as in 2006. (Just for comparison, the year 2015 saw the global threshold of 1 million electric cars on the road exceeded, closing at 1,26 million.)

Analogous to e-cars, e-bikes are still considerably more expensive than conventional bikes. While there have been a large uptake in several countries (Germany, Netherlands, Belgium), the development of e-bike market is still in the take-off phase in majority of countries. Purchase subsidy schemes could help to bridge this price gap.

E-bikes (pedelecs) allow for longer distances to be cycled with the same level of effort compared to conventional bikes and even for longer distances of up to 20 km the time difference with the car (electric or fuel-driven) is marginal. Additionally pedelecs (e-bikes) are option for solving problems with congestions and land-taken in limited urban areas (contrary to e-cars).

The psychological barriers preventing the spread of electric vehicles remain the same as before, namely the short driving range and the high cost of the batteries. The performance and cost of the rechargeable batteries will be crucial to the success of electric mobility. Life cycle analyses are another important element, i.e. the process of considering the total ecological and economic costs of the battery from the availability of the raw materials right through to recycling.

All this must go hand in hand with the support of innovative business models capable of generating revenues, necessary also for provision of a development fund (e.g. tailor-made rental of e-cars (e-vans) for business purposes; operative leasing; support and introduction of e-car sharing and e-bike sharing systems in the urban areas etc.).

EVs of all types lie at the heart of future sustainable transport systems, alongside the optimisation of urban structures to reduce trip distances and shift mobility towards public transportation.

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List of Abbreviations

AC	Alternating Current
AIA SR	Automotive Industry Association of Slovak Republic
BEV	Battery electric vehicle
CNG	Compressed Natural Gas
CONEBI	Confederation of the European Bicycle Industry
DB	Deutsche Bahn
DC	Direct Current
DTP	Danube Transnational Programme
EAFO	European Alternative Fuels Observatory
EC	European Commission
ECF	European Cyclists' Federation
EEA	European Environment Agency
EN	European Norm
EPACs	Electrically Power Assisted Cycles
EU	European Union
EV	Electric vehicle
FCEV	Fuel cell electric vehicle
FP7	7th Framework Programme (EU financial scheme)
FZOEU	Fund for energy efficiency and environmental protection
GDP	Gross Domestic Product
HDV	Heavy Duty Vehicles
HEV	Hybrid electric vehicle
ICE	Internal Combustion Engine
ICT	Information and Communications Technologies
ISO	International Organization for Standardisation
KET	Key Enabling Technologies
kW	KiloWatt
-L	Vehicle category (Motor vehicles with less than four wheels [but does include light four-wheelers], L1e-L7e)
LDV	Light Duty Vehicles
LEV	Light Electric Vehicle
LiFePO4	Lithium-Iron-Phosphate
Li-Ion	Lithium-ion (batteries)
LNG	Liquified Natural Gas
M	Vehicle category (Motor vehicles with at least four wheels designed and constructed for the carriage of passengers)
N	Vehicle category (Motor vehicles with at least four wheels designed and constructed for the carriage of goods)
NAP CM	National Action Plan Clean Mobility
O1	
PEDELECs	Pedal Electric Assisted Cycles

PEV	Plug-in electric vehicle
PHEV	Plug-in Hybrid electric vehicle
R&D	Research and Development
REESS	Rechargeable Energy Storage System
REEV	Range extender electric vehicle
SEVA	Slovak Electric Vehicle Association
SK	Slovakia
SWOT	Strengths-Weaknesses-Opportunities-Threats (SWOT analyse)
VAT	Value Added Tax
ZHAW	Zurich University of Applied Sciences

Introduction

Sustainable mobility concepts rely on having a multimodal transport mix, whereby different forms of mobility (private and public plus motorised and non-motorised) are combined to create one low-emission system. Electric mobility is regarded as a key building block for creating the mobility system of the future. However, the transition to electric mobility is about much more than simply introducing new vehicles. And it does not just affect the automotive industry and its suppliers. Rather, the actual implementation process brings various new players into the market. In the first instance, this naturally means the power industry, whose task it is to provide the power (preferably from renewable sources) and set up the appropriate charging infrastructure. In addition, information and communication technologies (ICT) are coming to play an increasingly important role. Intelligent concepts are required to enable the networking of users, vehicles, charging stations and power companies. The degree of complexity involved in setting up the necessary data links is considerably greater than has traditionally been the case, all the more so because that getting on board with electric mobility is a powerful force for promoting intermodal transport concepts. Given the many factors and stakeholders involved, a multitude of research fields associated with electric mobility are beginning to emerge. In addition to technological concepts and development activities relating to vehicle and infrastructure components, these also encompass system-related, political, economic and social aspects as well.

This feasibility study is focused on the topic of pedelecs and e-cars in urban transport system. It should serve as the basis for the preparation of local action plans, as well as assistance for pilot activities in eGUTS cities. Thus, the feasibility study has taken into account global, in the first place EU, trends that support the implementation of e-mobility, but on the other side, as well as the national specificities of each participating country and its current situation are important. Because of this, each chapter contains firstly the more general description of the sub-topic (e.g. development of e-cars and pedelecs, barriers and solution for implementation etc.) and subsequently country-specific information from every eGUTS country.

Feasibility study on pedelecs and e-cars in urban transport system is divided into six chapters. The introduction presents the starting points and basic information. ***The second chapter*** is focused on the technological development of e-vehicles (pedelecs and cars) in the last 20 years. Except this it includes short general definition and division of e-vehicles as well as look at the e-cars/pedelecs market development in EU and eGUTS countries. ***The third chapter*** includes an overview and a description of existing studies on the topic of pedelecs and e-cars in urban transport system on the EU level as well as in each participating country. They are mostly focused on the various e-cars/pedelec sharing systems and introduction of e-cars into vehicle fleet of public bodies, to enable better and wider popularisation of e-mobiliy concept. ***The fourth chapter*** is devoted to presenting the advantages, disadvantages and barriers concerning the use of pedelecs and e-cars. At the same time, the particular countries elaborated its own SWOT analysis regarding the deployment of e-vehicles (e-passenger cars and pedelecs). ***The fifth chapter*** provides overview of existing legislation, strategies, incentives and measures for increased use of pedelecs and e-cars in eGUTS countries. The final chapter is a short conclusion.

1 Development of pedelecs and e-cars

1.1 EU legislation and standards related to e-vehicles

E-cars

- Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.
    - This Directive establishes a common framework for the promotion of energy from renewable sources. It sets mandatory national targets for the overall share of energy from renewable sources in gross final consumption of energy and for the share of energy from renewable sources in transport. It lays down rules relating to statistical transfers between Member States, joint projects between Member States and with third countries, guarantees of origin, administrative procedures, information and training, and access to the electricity grid for energy from renewable sources. It establishes sustainability criteria for biofuels and bioliquids.
- DIRECTIVE 2009/33/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 April 2009 on the promotion of clean and energy-efficient road transport vehicles
    - This Directive requires contracting authorities, contracting entities as well as certain operators to take into account lifetime energy and environmental impacts, including energy consumption and emissions of CO2 and of certain pollutants, when purchasing road transport vehicles with the objectives of promoting and stimulating the market for clean and energyefficient vehicles and improving the contribution of the transport sector to the environment, climate and energy policies of the Community
- DIRECTIVE 2014/94/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 22 October 2014 on the deployment of alternative fuels infrastructure
    - This Directive establishes a common framework of measures for the deployment of alternative fuels infrastructure in the Union in order to minimise dependence on oil and to mitigate the environmental impact of transport. This Directive sets out minimum requirements for the building-up of alternative fuels infrastructure, including recharging points for electric vehicles and refuelling points for natural gas (LNG and CNG) and hydrogen, to be implemented by means of Member States' national policy frameworks, as well as common technical specifications for such recharging and refuelling points, and user information requirements.
- Directive 2007/46/EC of the European Parliament and of the Council of 5 September 2007 establishing a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles
- Regulation (EU) No 168/2013 of the European Parliament and of the Council of 15 January 2013 on the approval and market surveillance of two- or three-wheel vehicles and quadricycles.

- DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility

UNECE regulations (non-legislative acts)

- UNECE Regulation No. 100 Uniform provisions concerning the approval of vehicles with regard to specific requirements for the electric power train
  - Scope: Part I: Safety requirements with respect to the electric power train of road vehicles of categories M and N1 , with a maximum design speed exceeding 25 km/h, equipped with one or more traction motor(s) operated by electric power and not permanently connected to the grid, as well as their high voltage components and systems which are galvanically connected to the high voltage bus of the electric power train. Part I of this regulation does not cover post-crash safety requirements of road vehicles. Part II: Safety requirements with respect to the Rechargeable Energy Storage System (REESS), of road vehicles of categories M and N equipped with one or more traction motors operated by electric power and not permanently connected to the grid. Part II of this Regulation does not apply to REESS(s) whose primary use is to supply power for starting the engine and/or lighting and/or other vehicle auxiliaries systems.
- UNECE Regulation No.10 Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility [2017/260]
  - This Regulation applies to vehicles of categories L, M, N and O1[1] with regard to electromagnetic compatibility. Components and separate technical units intended to be fitted in these vehicles (with the limitation given in paragraph 3.2.1.) with regard to electromagnetic compatibility. It covers: (a) Requirements regarding the immunity to radiated and conducted disturbances for functions related to direct control of the vehicle, related to driver, passenger and other road users' protection, related to disturbances, which would cause confusion to the driver or other road users, related to vehicule data bus functionality, related to disturbances, which would affect vehicle statutory data; (b) Requirements regarding the control of unwanted radiated and conducted emissions to protect the intended use of electrical or electronic equipment at own or adjacent vehicles or nearby, and the control of disturbances from accessories that may be retrofitted to the vehicle. (c) Additional requirements for vehicles providing coupling systems for charging the RESS regarding the control of emissions and immunity from this connection between vehicle and power grid.

[1] As defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3), document ECE/TRANS/WP.29/78/Rev.2, para. 2.

- UNECE Regulation No. 12 Uniform provisions concerning the approval of vehicles with regard to the protection of the driver against the steering mechanism in the event of impact
    - This Regulation applies to the behaviour of the steering mechanism and to the electrical power train operating on high voltage as well as the high voltage components and systems which are galvanically connected to the high voltage bus of the electrical power train, of motor vehicles of category M1, and vehicles of category N1 with a maximum permissible mass less than 1,500 kg, with regard to the protection of the occupants in a frontal collision. 1.2. At the request of a manufacturer, vehicles other than those mentioned in paragraph 1.1. above may be approved under this Regulation.
- UNECE Regulation No. 94 Uniform provisions concerning the approval of vehicles with regard to the protection of the occupants in the event of a frontal collision
    - This Regulation applies to vehicles of category M1[1] of a total permissible mass not exceeding 2.5 tonnes; other vehicles may be approved at the request of the manufacturer.
- UNECE Regulation No. 95 Uniform provisions concerning the approval of vehicles with regard to the protection of the occupants in the event of a lateral collision
    - This Regulation applies to the lateral collision behaviour of the structure of the passenger compartment of M1 and N1 1 categories of vehicles where the "R" point of the lowest seat is not more than 700 mm from ground level when the vehicle is in the condition corresponding to the reference mass defined in paragraph 2.10. of this Regulation.

E-bikes (pedelecs, speed e-bikes...)

- DIRECTIVE 2002/24/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 March 2002 relating to the type-approval of two or three-wheel motor vehicles
    - This Directive applies to all two or three-wheel motor vehicles, whether twin-wheeled or otherwise, intended to travel on the road, and to the components or separate technical units of such vehicles. This Directive does not apply to the cycles with pedal assistance which are equipped with an auxiliary electric motor having a maximum continuous rated power of 0,25 kW, of which the output is progressively reduced and finally cut off as the vehicle reaches a speed of 25 km/h, or sooner, if the cyclist stops pedalling.
- REGULATION (EU) No 168/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 January 2013 on the approval and market surveillance of two- or three-wheel vehicles and quadricycles
- COMMISSION DELEGATED REGULATION (EU) No 3/2014 of 24 October 2013 supplementing Regulation (EU) No 168/2013 of the European Parliament and of the Council with regard to vehicle functional safety requirements for the approval of two- or three-wheel vehicles and quadricycles

- DIRECTIVE 2006/42/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast)
- DIRECTIVE 2006/66/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 6 September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EEC
- EN 15194 for EPACs, Electrically Power Assisted Cycles, has come into effect in 2009. The scope of the standard is EPACs with a voltage up to 48 DC, a maximum continuous rated power of 250 W and an output, which is progressively reduced and finally cut off as the vehicle reaches a speed of 25 km/h.
- EN 50604-1:2016 (published by the European Committee for Electrotechnical Standardization). It defines a unified, Europe-wide safety standard for lithium-ion batteries used in e-bikes and Light Electric Vehicles (LEVs)

1.2 Definition of electromobility, electric vehicles and infrastructure

Electromobility (E-mobility) is a transport system based on transport means that are powered by electricity. The central elements of such a transport system are electric vehicles, supplemented by a charging infrastructure, suitable information technology and legislation. Besides building a charging infrastructure, electromobility does not require any special interference in road infrastructure. Electromobility primarily involves the use of electric vehicles for various modes of road transport including individual, public or freight. In the broader sense of the word, this term is also used to refer to the transition to the new ecosystem of relations, which besides electric vehicles themselves, also includes their interaction with the energy network (electricity grid), road infrastructure or transport information systems. The development of electromobility includes a range of areas from the development of new materials for energy storage, new transport systems, greening the transport to the design of new cars themselves (Capgemini Slovakia, Ltd., 2014).

Electric vehicles

The electric vehicle is driven solely by an electric motor. Electricity is supplied to an electric motor from electricity storage (battery) that is charged externally from the electrical system or it can also be charged internally with the help of an internal combustion engine or the fuel cell system.

Electric vehicles include:

- electric cars (passenger or goods vehicles, buses),
- electric motorcycles (e-mopeds, e-scooters...),
- electric bicycles (pedelecs, “speed-pedelecs”, e-bikes...).

Electric cars (e-cars) are:

- BATTERY ELECTRIC VEHICLE (BEV) - Battery electric vehicles refer only to fully electric vehicles that use the battery as the only energy source.

- RANGE EXTENDER ELECTRIC VEHICLE (REEV) - Battery electric vehicles with extended range indicates vehicles equipped with both electric and internal combustion engine. The combustion engine is used exclusively to charge the battery in order to extend the range of vehicle.
- FUEL CELL ELECTRIC VEHICLE (FCEV) - Electric vehicles equipped with fuel cells indicates vehicles equipped with an electric motor that is electrically driven by energy produced in fuel cells. Electricity (along with water steam as another product) originates in fuel cells as a result of the reaction of oxygen (from air) and hydrogen (stored in a hydrogen tank).

In some publications, the concept of **plug-in electric vehicle (PEV)** is defined as common designation for the following electric vehicles: fully electric vehicle (BEV), battery vehicle with extended range (REEV) and Plug-In Hybrid Vehicle (PHEV).

- PLUG-IN HYBRID ELECTRIC VEHICLE (PHEV) indicates a vehicle with a partially electrified drive and the ability to recharge the battery from the electricity grid. These vehicles are an important technology in the transition to the electric vehicles usage.
- HYBRID ELECTRIC VEHICLE (HEV) designates a vehicle driven by an internal combustion engine, to which can assist the electric motor, in specific situation (e.g. when starting). The battery of these vehicles can not be recharged from the electricity grid and uses only the electricity generated at slowing down the car. Such vehicles are designed to utilize electric traction only as a complement to the combustion engine and therefore, in principle, it is not electric vehicles.

Hybrid electric vehicles, due to the absence of external charging from electricity grid, are not covered by this document.

Electric bicycles (e-bikes)

Pedelecs (Pedal Electric Assisted Cycles) or EPACS (Electric Power Assisted Cycles) are much like bicycles, however when pedalling the rider gets progressive assistance from the electric drive system. There are many different types of electric assisted bike, the most popular and highest selling pedelec is the sub ***250 watt pedelec/ sub 25 km/h bike***.

Pedelecs (= low - powered bicycles) are electric bikes that are propelled with physical strength (are equipped by pedals); additionally, up to a speed of 25 km/h, propulsion is assisted by an electric motor with a maximum power output of 250 W. Pedelecs differ very little from conventional bicycles in how they are operated. This ***lower power vehicle*** does not have to be type approved like motorised vehicles and is regulated through CEN standards (with work ongoing to make a global ISO standard), it is seen as essentially a bicycle by all public authorities. Insurance is not required for such bikes, and they can be ridden without a driving licence or moped certificate.

"Speed pedelecs" (= higher powered pedelecs) are regulated within type approval. Even though they are pedal assisted they are viewed as motorised vehicles by the EU authorities. Here are the two relevant categories for these vehicles:

- L1e-A "powered cycles" – of speeds up to 25 km/h and power cut out at 1000 watts
- L1e-B "mopeds" – of speeds up to 45 km/h and power up to 4000 watts

The relevant EU legislation is Regulation (EU) No 168/2013 of the European Parliament and of the Council of 15 January 2013 on the approval and market surveillance of two- or three-wheel vehicles and quadricycles. L1e-A deals mainly with cargo type bikes, while L1e-B deals with so-called 'speed' pedelecs. Due to their higher maximum speeds, speed pedelecs can compete on travel time with cars for even longer distances than low-powered pedelecs. With a top speed of 45 km/h, they can now replace up to 90% of car journeys and have excellent active transport credentials. On the other hand, they bring some safety and infrastructural issues which justify treating them as a category different from conventional bikes and low-powered pedelecs. (e-bikes) that must be licensed and registered, have a greater power output range and can be propelled without pedalling.

In some cases we meet with the definition of ***E-bikes*** as bicycles with electric motors that can be ridden without pedalling, i.e. entirely electrically powered. **E-mopeds and e-scooters** also run on an electric motor and need no pedalling. They usually allow higher speeds, 45 km/h or more, but require registration and a driving licence in some countries.

1.3 History of e-cars development process and e-cars EU market

History of e-cars development process

At the beginning of the 20th century, electric drive was among the 3 most widespread alternatives to steam and horse-powered transport. The other two alternatives were a gas turbine and a gasoline engine. When Ferdinand Porsche began the construction of vehicles at the turn of the 19th and 20th century, he initially focused on electric traction. Over time, the gasoline engine with internal combustion has started to dominate, and is dominating the whole 20th century in automobile industry.

The re-launch of an electric car began in 1990, when ***General Motors introduced its EV-1 electric vehicle***. This electric car has met with interest from the consumers, it has an attractive appearance and good technical parameters as well as user features. The limited number of cars has been available for several years through operating leases, but General Motors has not made it into sale or large-scale production.

An extremely successful electrified car in modern history has become the ***Prius model of the Japanese Toyota*** car company. Although Prius is not yet a pure electric vehicle, ***hybrid technology***, in which the electric motor assists the petrol engine in the take-off run, is a significant step. Currently, one or more of these models is available to most of the world's automotive companies.

Full-range electric production models are on sale, ***starting after 2010***. Volkswagen, the world's second-largest automotive concern, has placed production of its first Volkswagen e-Up electric vehicle in Bratislava (Slovakia).

It can be stated that each car group has at least one pure electric car model on offer. The ***most successful*** electric cars in terms of sales are ***Nissan Leaf, BMW i3, Renault Zoe and Tesla S***, which is currently the most powerful electric car in the market.

Just as in the transport the 19th century was a century of steam, the 20th century was a century of oil, it is likely that the ***21st century will be the century of alternative propulsion and electric drive*** among them. In order to become competitive, it is necessary to find ways of cheaper production of electric vehicles, to solve the method of unified charging and to introduce both direct and indirect support to the development of the mass production of electric vehicles, not only personal but also heavy vehicles, as well as tools to support the use of electric vehicles in normal operation.

Cutting down production costs and accepting an end-user price will make a significant difference in the widening of electric vehicles. It will also be important to gradually develop the infrastructure for electric vehicles, the availability of which is one of the most important tools to overcome the prejudices of consumers arising from the electric cars endurance distance.

E-cars market in EU

There are more and more vehicles on Europe's roads. While electric passenger vehicle sales have increased rapidly over past years, they represented just 1.2 % of all new cars sold in the EU in 2015. In all, approximately 0.15 % of all passenger cars on European roads are electric. Like passenger vehicles, sales of electric vans also made up a very small fraction of total EU sales in 2015.

Electric passenger vehicle sales[2]

Conventional (non-plug-in) hybrid electric vehicles have been available in Europe for almost two decades. Unfortunately, past sales numbers for these types of vehicle are not easily available from official EU statistics, as national authorities have generally categorised them simply as petrol or diesel vehicles.

Of the other types of electric vehicles, BEVs were the first type widely marketed in the EU, although sales in early years were very low. In 2010, fewer than 700 BEVs were sold across the EU. PHEVs have been commercially available since around 2011. Again, statistics for plug-in hybrid sales in those early years are uncertain, as many Member State authorities have categorised them as petrol, diesel or battery electric vehicles.

From 2013 onwards, petrol and diesel plug-in hybrid models became significantly more popular as both the range of vehicle models available for consumers increased and more

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2EEA, Electric vehicles in Europe, 2016

governments promoted various subsidies to encourage electric vehicle ownership. In that year, there were just over 49 000 electric vehicles sold in the EU, of which half were BEVs, and half PHEVs.

The number of electric vehicles sold has increased steeply in each year since. The latest preliminary data for 2015 indicate that almost 150.000 new plug-in hybrid and battery electric vehicles were sold in the EU that year (EEA, 2016b; EAFO, 2016). Almost 40 % of these were BEVs. Collectively, just six Member States account for almost 90 % of all electric vehicle sales: the Netherlands, the United Kingdom, Germany, France, Sweden and Denmark.

The largest numbers of BEV sales within the EU-28 were recorded in France (more than 17.650 vehicles), Germany (more than 12.350 vehicles) and the United Kingdom (more than 9.900 vehicles). The largest numbers of PHEV sales were recorded in the Netherlands (more than 41.000 vehicles) and the United Kingdom (more than 18.800 vehicles).

In Latvia, Lithuania, Malta and Romania, fewer than 50 BEVs and PHEVs were sold in 2015. None were sold in Bulgaria and Cyprus.

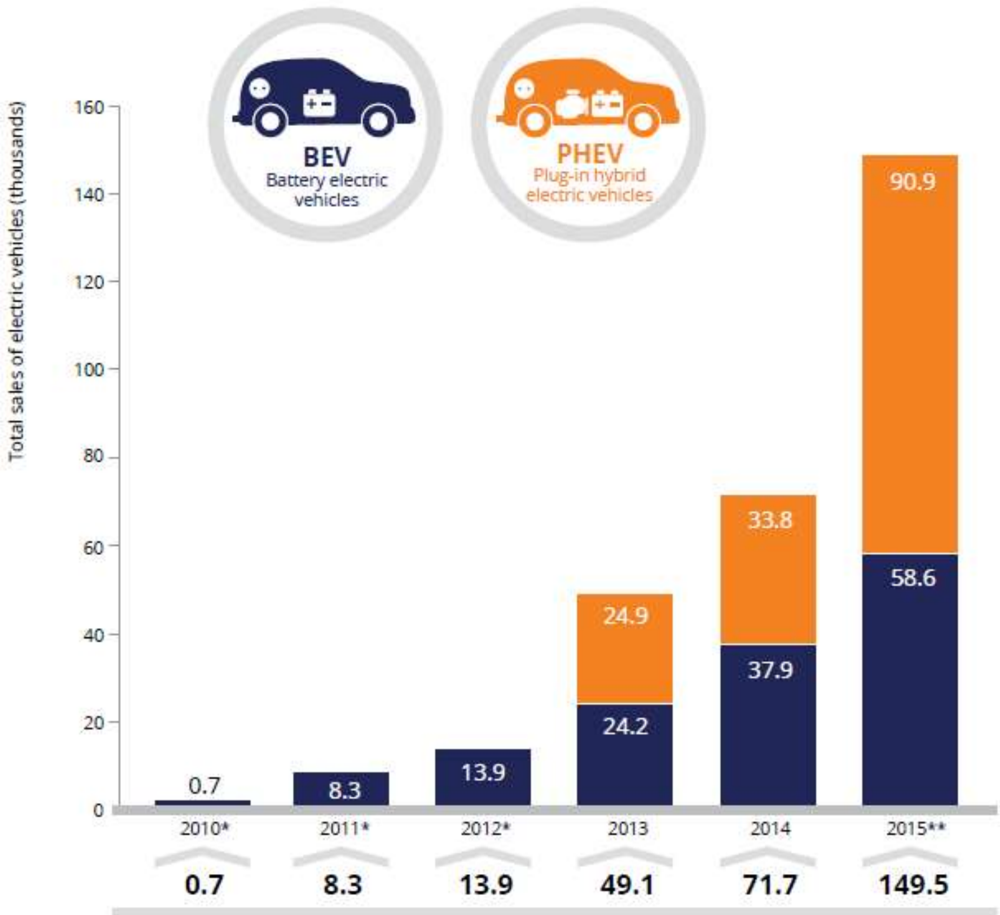

Figure 1-1 Total sales of electric vehicles in the EU-28, Source: EEA 2016

Note: * In 2010, 2011 and 2012, only statistics for BEVs are available. ** The data for 2015 are provisional.

Electric vehicles still make up only a small fraction ***of all new vehicles sold in the EU, just 1,2 % in 2015***. In certain countries, however, the relative proportion of PHEVs and BEVs among new vehicles is much higher. For example, it is approximately 10 % in the Netherlands. In all, ***approximately 0,15 % of all passenger cars on European roads are electric***. Outside the EU, a clear frontrunner in terms of high sales is Norway, where 22,5 % of all new cars sold in 2015 were electric. Almost 34.000 new electric vehicles were sold, of which 77 % were BEVs (EAFO, 2016).

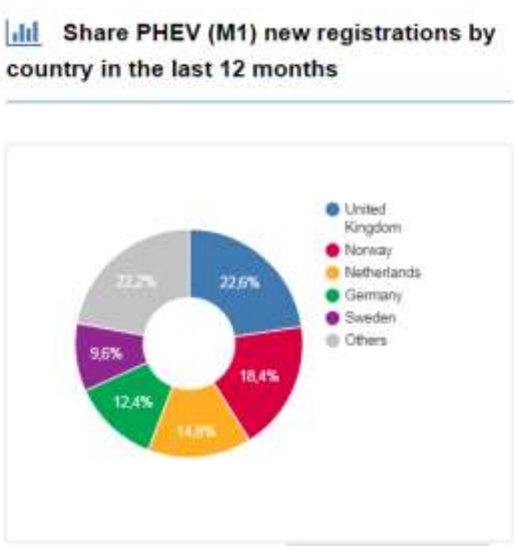

Figure 1-2 Share PHEV (M1) new registrations by country in the last 12 months

Figure 1-3 Share BEV (M1) new registrations by country in the last 12 months

Table 1-1 Overview of the best selling electric vehicles in EU

Rate	Mark	Model	2016	Share PEV market	2015	Share PEV market	2014	2013	2012	2011
1	Renault	Zoe	21 337	10,20%	18566	9,90%	11029	8833	68	0
2	Nissan	Leaf	18 557	8,90%	15345	8,10%	14681	10894	5383	1740
3	Tesla	Model S	12 353	5,90%	16643	8,80%	9550	3975	0	0
4	BMW	i3	9 726	4,60%	6216	3,30%	5458	998	0	0
5	Volkswagen	e-Golf	6 666	3,20%	11170	5,90%	2931	0	48	0
6	Kia	Soul EV	4 433	2,10%	5812	3,10%	598	0	0	0
7	Tesla	Model X	3 688	1,80%	0	0,00%	0	0	0	0
8	Mercedes	B250e	3 504	1,70%	2795	1,50%	185	0	0	0
9	Volkswagen	e-Up!	2 565	1,20%	2976	1,60%	5838	940	0	0
10	Peugeot	iOn	1 893	0,90%	1477	0,80%	577	695	3125	1849

Other	-	-	6 536	3,10%	6762	3,60%	6431	6681	9813	7440

Source: EAFO, 2017

Table 1-2 Driving range and parameters of bestsellers in passenger e-cars

Rate	Mark	Model	Price*	Battery (kWh)	Range (km)	Power (kW)
1	Renault	Zoe	24 000,00 €	41	402	
2	Nissan	Leaf	27 000,00 €	30	249	80
3	Tesla	S	70 000,00 €	60	399	310
4	BMW	i3	33 800,00 €	33	314	125
5	Volkswagen	e-Golf	34 400,00 €	35	300	85
6	Kia	Soul EV	31 400,00 €	27	200	81
7	Tesla	Model X	87 000,00 €	75	417	
8	Mercedes	B250e	37 800,00 €	28		132
9	Volkswagen	e-Up!	22 200,00 €	19	160	40
10	Peugeot	iOn	26 600,00 €	16	150	47

Source: Autoexpress Get the data

Notes: *Prices set by E.ON for Czech market

1.4 History of pedelecs development[3] and pedelecs EU market

History of pedelecs development

There is a surprisingly long history behind the ***invention of the electric powered bicycle***. Dating back to ***into the mid-1890's***, there have been patents and prototypes developed both in the USA and Europe. People have attempted to motorize personal transport throughout the ages and the bicycle seemed like a perfect platform even back then.

The key objective for most of the designs was to supplement the power needed to keep the bikes moving through all types of terrain or to carry larger/heavier loads. This assist model

3 https://electricbikeassociation.org/about/history/

has varied in power and capacity but always included pedaling as an integral part of the propulsion process. It is this integration that has clearly separated electric bicycles from mopeds and motorcycles.

Electric-powered bicycles come in a wide variety of styles and capacities and their versatility has proven indispensable throughout Asia and Europe. In the congested streets of many of the world's capitals, commuters have relied on bicycles as their primary means of personal transport for more than 100 years. In many parts of Asia, for the general population, bicycles were the only mean of personal transport available. To this day, even with the rise of the middle class, there are ***more than 34 million electric-powered bicycles produced in China every year***.

As technology improved, the electric motors gained important sensors and controls that allowed the drive system to "feel" the need for powered support, thus providing the added boost to the rider. Now known as both torque and speed sensors, these measurement methods didn't actually become commonplace until the ***late 1990's*** when a ***Japanese engineer Takada Yutky*** filed for the patent. The general idea of this technology was ***to add power only when needed***, allowing the bike's power source to last longer and go further on a single charge.

Another important milestone in the development of electric bikes has been ***the rechargeable battery***, while the dominant platform for Asian bikes still remains the large lead-acid battery, the type found in your car. Later developments experimented with NiCd and now ***Lithium-ion battery packs***. Today, when cost dictates, toxic lead acid continues to be the primary power source in Asia and India. In Europe, North and South America, as well as countries like Australia, technology has migrated to the advanced lithium battery chemistries and charging solutions. These battery packs have become ***more powerful, safer, smaller and offer a longer lifespan***.

From a forward-looking perspective, the advancement of lithium rechargeable technology will only continue to improve both in performance and cycle life. Much of the motivation for this is coming from the growing demand for electric cars, buses, and trucks.

In 2001 the term "Pedelec", referring to pedal-assisted, and/or a power-assisted bicycle was commonly used to refer to e-bikes. The most common variations being either front or rear wheel hub motors or the mid-drive motor that replaces the traditional bottom bracket, are used right through today. Some motors are designed as direct drives while others use a combination of gears to supply the necessary level of torque and power to drive the bicycle forward.

Since 1998, the pedal-assist electric bike has grown rapidly. Besides the reported 120 million electric bikes being used in China by 2010, a total of 700.000 electric bikes were sold in Europe in that year alone.

Currently one identified barrier which can act as potential limiting factor for bigger market success of pedelecs is the electric bicycle weight. The weight of e-bike (pedelec) is much higher (20-25 kg) than the conventional bike (15 kg) because of battery and engine. This can cause difficult handling e.g. by taking it into public transport or getting over any bigger obstacle. This can discourage some potential customers from bying and usage a pedelec mainly in urban areas. Decreasing the pedelec weight down to 15-16 kg of a standard bicycle may be the biggest technical and economic challenge for the pedelec widespread. However, the research has moved already ahead in this area as the following paragraphs regarding pedelecs developed by Volta or BMW indicate.

Volta - a new lightweight electric bicycle on the horizon

Volta offers an interesting addition to the family of electric bicycles, which at first sight does not look like an electric bicycle. There is no big battery on the frame as it is elegantly hidden inside the frame.

Developers promise an approximate 65 km mileage per charge, which represents an average race compared to other electric vehicles on the market.

Bicycles, unlike their competitors, can boast other smart features such as automatic integrated lights that are activated in the dark. There is also a brake light, which makes it easier for you to see your cars at night.

Volta can be paired with a smartphone, and in case of theft, you can easily find the bike via the built-in GPS signal. You can lock your bike too, and if someone manipulates it, you get a notification on your smartphone.

You also have an opportunity to choose a chain type. Either you can choose a classic metal chain that is tighter or a belt that offers cleaner and easier maintenance.

The engine itself is elegantly hidden in the wheel. Like most electric bicycles, the Volta also offers 4 driving modes – the fast Power Mode, the Eco Mode, which offers the longest mileage (65 km), Smart, offering something between optimum performance and long battery life, and a Bike Mode that simply shuts off the engine. A great advantage is also the low weight, which is approximately 15.8 kg. Most modern electric bicycles weigh about 20kg.

To keep it up, the authors have even created a fitness app that tracks your cycling, burned calories, and even the locations you've been driving. The current price of this e-bikes (spring 2017) is 1,499 USD. It is rather a piece suitable for moving around the city, rather than some challenging cycling.

BMW i Pedelec - small dimension city bike

Features: It can be folded. It can be stored in the trunk of the BMW i3 electric car. It has a weight of 20 kg. Powered by an electric motor that develops a torque of 20nm and a power of 250W. The wheels have an 18 inch diameter. Hydraulic brakes on the front and rear. Three-speed selector. 42V LiMn batteries. 25-40 km autonomy. Charge time for the battery is 1.5 - 4 hours. It can also be charged from the car's battery.

The European bicycle industry

21.000.000 bicycles and EPACs (Electric Power-Assisted Cycles) are sold annually across Europe, out of which 13.000.000 are produced in EU: the European Bicycle Industry generates directly and indirectly more than 70.000 jobs in the Union market over 600 SMEs. On average, European citizens own more bicycles than any other means of transport. Via their national associations, all major players on the European bicycle market are represented within CONEBI (Confederation of the European Bicycle Industry; its members are the national Bicycle Industry Associations in 15 different countries: Austria, Belgium, Bulgaria, Germany, Great Britain, Finland, France, Hungary, Italy, The Netherlands, Poland, Portugal, Spain, Sweden and Turkey).

The bicycle is:

- the most environmentally friendly, energy efficient and sustainable means of mobility;
- the cheapest means of mobility (no ownership- motorway or registration taxes, no insurances, no driving license or parking costs and no high service maintenance costs);
- the most healthy and social means of mobility;
- the most time-saving and silent mode in urban areas;
- the most accessible mode of transport;
- simply the best mobility mode in urban areas.

E-Mobility revolution in the next 10 years should be a "bottom-up" process, focusing first on EPACs (Electric Power-Assisted Cycles) which already developed well in the past decade. Next should be the more powerful two-wheelers such as e-bikes, e-mopeds and e-scooters and only much later (10 to 20 years from now) attention should go to electric cars. In fact, the technology of aluminum alloys and carbon composites, as well as the ever lighter and more powerful batteries that we have been developing in the EPAC industry in the last decade, will undeniably be a source of inspiration for the e-moped and even for the e-cars industry.

Regarding contribution to the European Union's ambitious goals, the EU bicycle & EPAC industry have a very important role to play, not only in Europe's ambition to seriously cut C02 emissions, but also in policies such as public health, environment (energy efficiency, noise pollution, etc.), transport, and many more.

E-bikes market in EU

Between 2006 and 2014, there was a steady grow of electric bikes sales in the EU. It is estimated that around 1 325 000 e-bikes were sold in the EU in 2014, almost 14 times as many as in 2006. Around half of the e-bikes sold in Europe are imported, and of these, almost 80 % originate from China (BikeEurope, 2015).

Strong growth has occurred in several countries over recent years, driven by wider availability and somewhat falling prices. Still, e-bikes are on average more expensive than comparable conventional bicycles. France recorded 2014's biggest increase in e-bike sales:

77 500 electric bicycles were sold, 37 % more than the previous year. Germany, however, has the largest e-bike market in Europe, with total sales of 480 000 in 2014. Other countries reporting strong growth in the numbers of e-bikes include the Netherlands — currently the EU's second -biggest e-bike market — Austria, Belgium, Switzerland and the United Kingdom.

Table 1-3 European Bicycle and EPAC sales (EU 28) (1,000 units) 2006 - 2015

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Bicycle sale (x 1,000)	21 033	21 344	20 206	19 582	20 461	20 039	19 719	19 780	20 340	20 751
EPAC sales (x 1,000)	98	173	279	422	588	716	854	907	1 139	1 357
EPAC share on BICYCE sale (%)	0,47%	0,81%	1,38%	2,16%	2,87%	3,57%	4,33%	4,59%	5,60%	6,54%

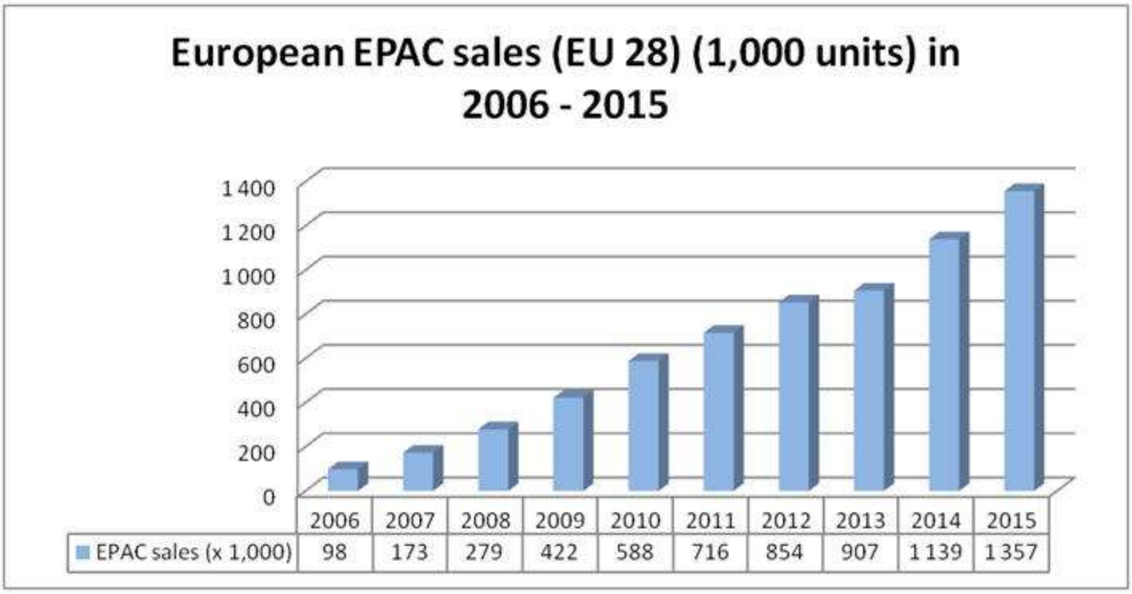

Figure 1-4 European EPACs sales (EU 28) in 2006 - 2015

Source: EUROPEAN BICYCLE MARKET , 2016 edition, Industry & Market Profile, (2015 statistics), Confederation of the European Bicycle Industry

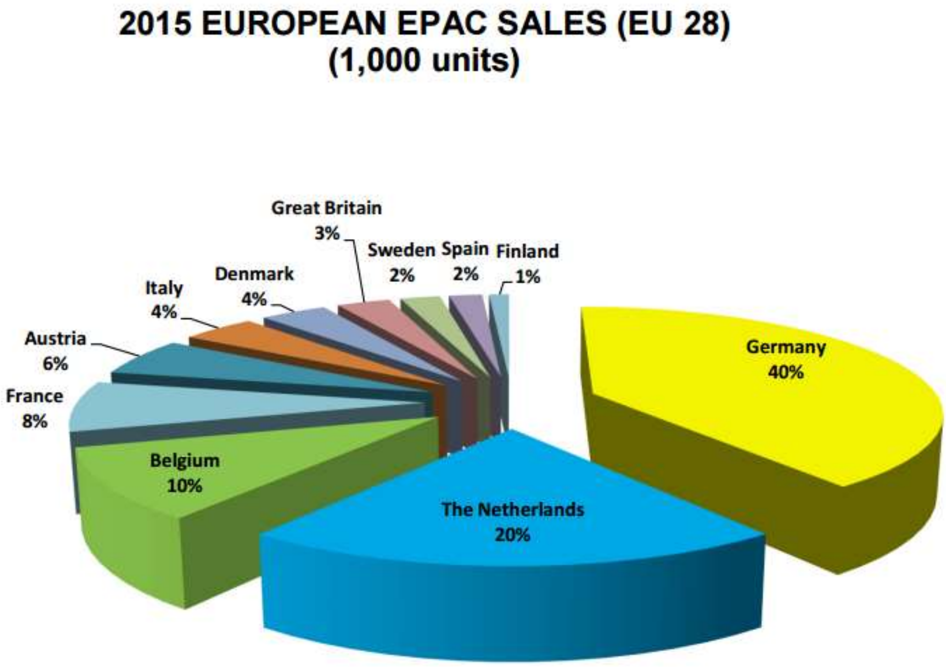

Figure 1-5 Share of EU countries on EPAC sales in 2015

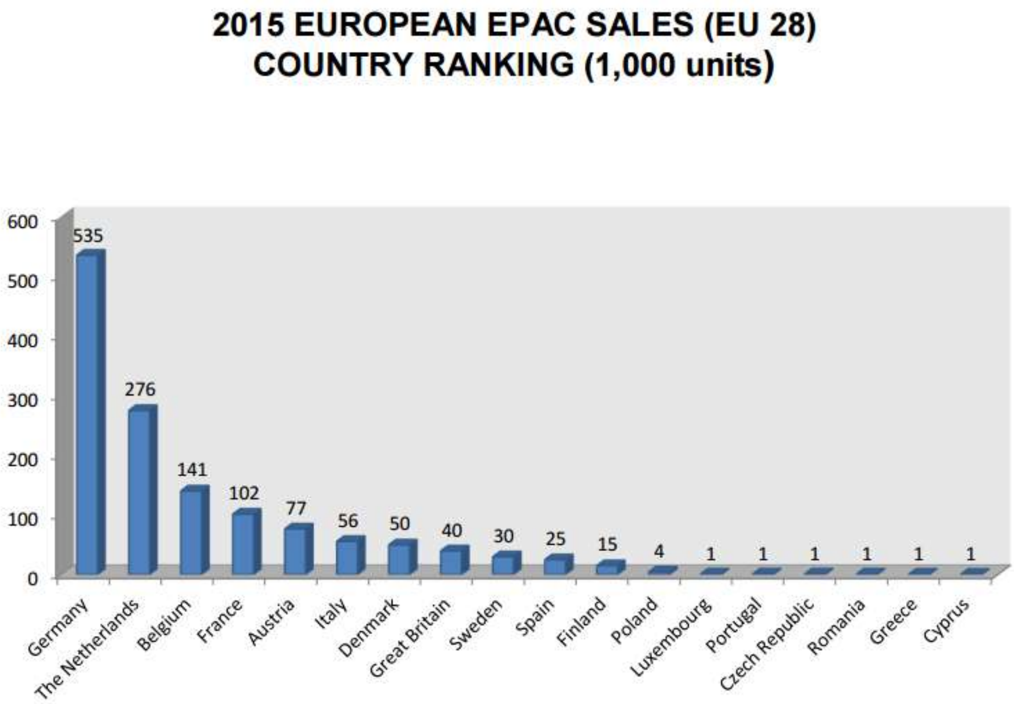

Figure 1-6 2015 European EPAC sales (EU28) country ranking

1.5 Overview of PEV market and fleet in eGUTS countries

Just as the Central and the South-East Europe fall behind the West Europe in the number of built-in charging stations and the complexity of their networks, so it is in the number of EVs.

The market share of PEVs (in number of new registrations (sale)) in DTP region (eGUTS countries), with the exception of Austria, is far below 1% and is counted in tens, max. hundreds of vehicles sold per year. Only Austria with PEV market share around 1,8% significantly exceeds this range.

It can be said that the electric mobility in this region is indeed at the very beginning. To some extent, this can be related to the performance of the economy, and thus to the GDP and the purchase power of the country's population but also due to low e-mobility awareness of population.

A crucial point for greater e-mobility deployment in the eGUTS (resp. DTP region) countries could be a well-chosen fiscal support mechanism and subsidies for e-vehicles purchase at national level. However, the subsidy mechanism should be systematic and long-term to provide a degree of confidence and stability. Short-term and uncoordinated subsidies are also reflected in the fluctuations of PEV market share of some EGUTS countries in single years. In the years of subsidies availability the sales of PEVs and their share on newly registered cars are higher than in years before or after (e.g. fluctuation in the case of Slovakia due to short-term subsidies introduced in 2017, and on the other hand some kind of stability in Austria and Slovenia due to continual subsidies for EV purchase).

Table 1-4 PEV Fleet in EU-28 and eGUTS countries (updated June 2017)

Fuel Source	BEV					PHEV		PEV	
Vehicle Category	L Motorbikes	L6+L7 Quadri-cycles	M1 Passenger cars	N1 (Light Commercial Vehicles	M2 + M3 Buses	M1 Passenger cars	M2 + M3 Buses	M1 Passenger cars	M2 + M3 Buses
Country									

2	EU 28	14 617	20 506	249 098	50 607	1 158	302 800	536	551 898	1 694
3	Austria	1 681	694	11 860	1 618	164	2 994		14 854	164
4	Croatia	199	100	179	61	9	86		265	9
5	Czech Republic	1 495		931	202	18	451		1 382	18
6	Hungary			523	98	33	232		755	
7	Romania		23	165	15	6	203		368	6
8	Slovakia			341	23	9	227		568	
9	Slovenia	33	65	483	70		237		720	

Source: EAFO (June 2017), accessed on 11.12.2017

Table 1-5 Overview of some basic national indicators and e-mobiliy characteristics of eGUTS countries

	Population	Gross Domestic Product Capita (in EUR)	Passenger cars	Moto-risation rate (cars per 1000 inhabit.)	PEV total (2017)	Share of PEV on fleet of passenger cars	PEV (M1) market share (2017)	Number of publicly accessible charging positions (2017)	High power charging positions publicly accessible (2017)
EU 28	510 464 684	36 000,00	235 441 444	461	570 952	0,24%	1,18%	104 519	11 350
Austria	8 662 588	50 659,00	4 641 000	536	15 749	0,34%	1,81%	3 008	416

Croatia	4 284 889	9 844,00	1 499 802	350	269	0,02%	0,04%	234	32
Czech Republic	10 535 000	18 997,00	4 729 000	449	1 618	0,03%	0,20%	474	85
Hungary	9 835 000	13 214,00	3 041 000	309	887	0,03%	0,41%	213	50
Romania	19 822 000	10 054,00	4 696 000	237	399	0,01%	0,17%	108	13
Slovakia	5 426 000	18 389,00	2 373 744	437	639	0,03%	0,35%	442	95
Slovenia	2 065 000	23 952,00	1 064 000	515	788	0,07%	0,55%	483	135

Source: EAFO (June 2017), accessed on 11.12.2017

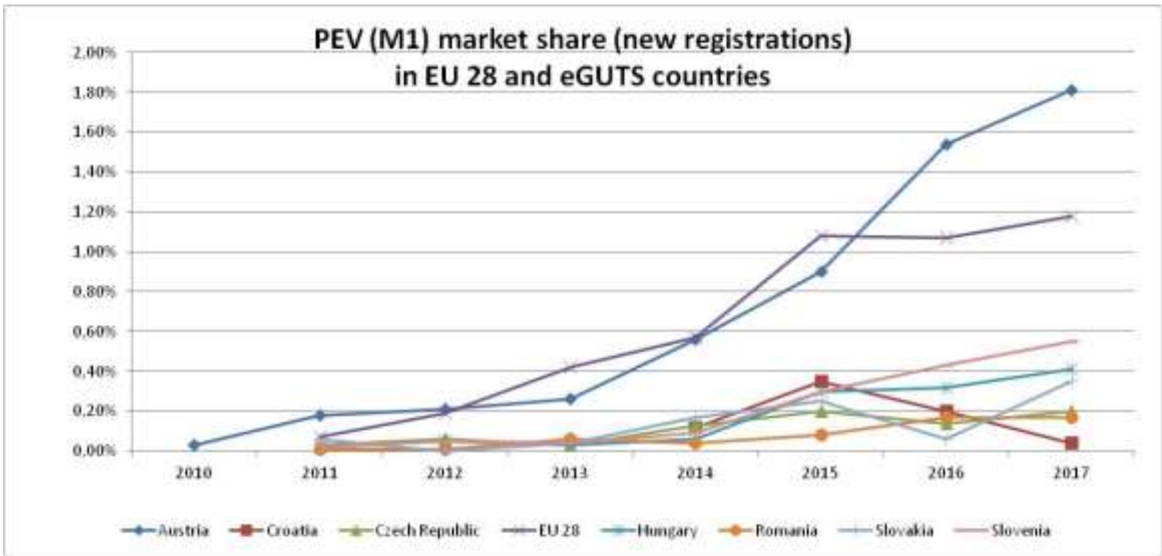

Figure 1-7 2015 PEV (M1) market share in EU 28 and eGUTS countries

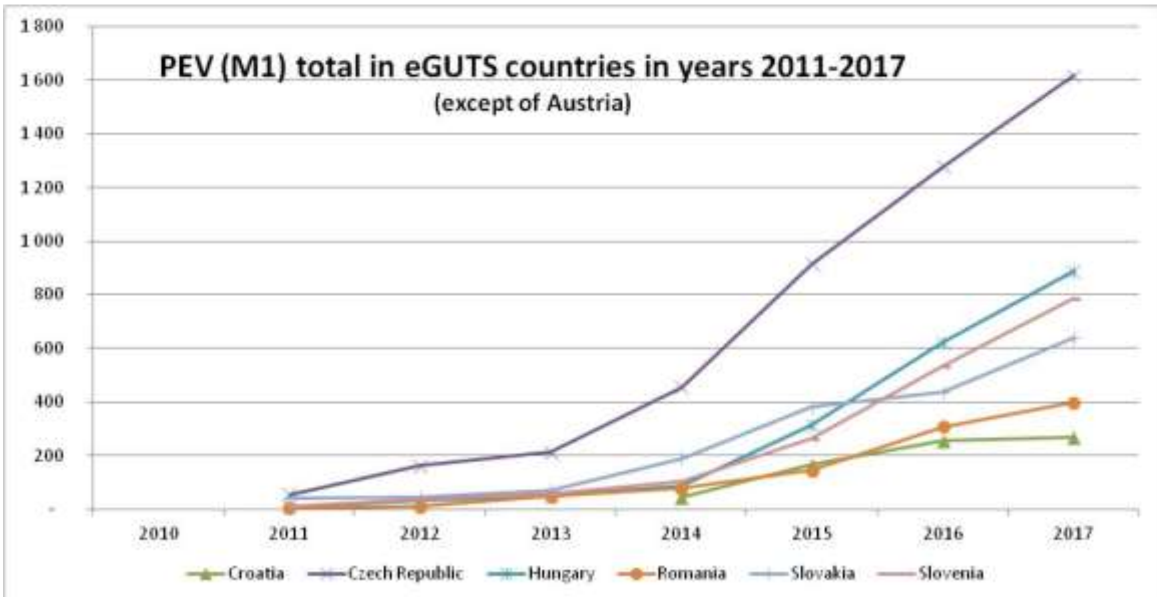

Figure 1-8 2015 PEV (M1) total in EGUTS countries between years 2011-2017

9.1 Country specific information

9.1.1 Austria

Current state of development of pedelecs and e-cars in Austria/Burgenland

In January 2013, the European Commission presented a proposal for a Directive to ensure the development of infrastructure for alternative fuels and the establishment of uniform technical specifications for the relevant infrastructures in the European Union. The Directive applies to electricity, hydrogen and natural gas for road transport and shipping. This proposal culminated in Directive 2014/94 / EU on the construction of infrastructure for alternative fuels on 28 October 2014.

There are no quantitative requirements for the construction of the charging infrastructure for electric vehicles by 2020. Rather, targets are being defined for the development of an infrastructure for alternative fuels and the promotion of the market in national strategies. No additional costs will be incurred by the public authorities. Instead, the implementation of the directive is to be carried out through regulatory measures and incentives in close co-ordination with key stakeholders.

In Austria, some of these requirements have already been met. At the national level, Austria's energy strategy (2010) supports the promotion of new drive systems (such as electric mobility) in order to reduce emissions in the transport sector and to achieve employment policy effects.[4]

By the end of the fourth quarter, 3,826 electric cars and 1,237 plug-in hybrid vehicles were approved in 2016. Thus, the result of 2015 (2,787 electric vehicles) could now be increased by 2,981 vehicles (+ 81.84%).

The following table shows the increase proportion to overall new registrations of cars from 2009 to 2016 in Austria.

Table 1-6 Overall new registrations of cars and share of e-cars in Austria in 2009 - 2016

YEAR	NEW REGISTRATIONS	SHARE OF ELECTRIC CARS
2009	319.403	0,34 %
2010	328.560	0,41 %
2011	356.145	0,55 %
2012	336.010	0,77 %
2013	319.035	1,01 %
2014	303.318	1,20 %
2015	308.555	1,68 %
2016	329.604	2,59 %

4 https://www.wien.gv.at/stadtentwicklung/studien/pdf/b008435.pdf

Source[5]

From the electric models based on Statistic of the Austria the mark Tesla is now the most popular vehicle with an increase in sales with over 100%. (see the following figure of the most popular marks in Austria 2016)

In the years 2015 and 2016 most of Tesla's battery-powered vehicles were approved in the manufacturer's comparison. The 492 BEVs account for around 30% of all 1,677 newly registered BEVs. Tesla increased the number of registrations by 261 percent compared to the previous year 2014 (previous year 136 new registrations) and increased it further in 2016 with 102,6 percent. Renault, still number one in 2015, followed with 279 vehicles and a share of 16.6 percent (previous year: 30.4 percent). In the third place, last year's second BMW with 228 BEVs and a market share of 13.6 per cent (previous year: 23.1 per cent). In addition, in 2015, for example, Kia gained significant market shares (9.8 percent). In contrast, the now adjusted Think brand has fallen out of the statistics. The entire BEV market in Austria (100% of the new registrations) was split in 2015 to twelve vehicle brands.

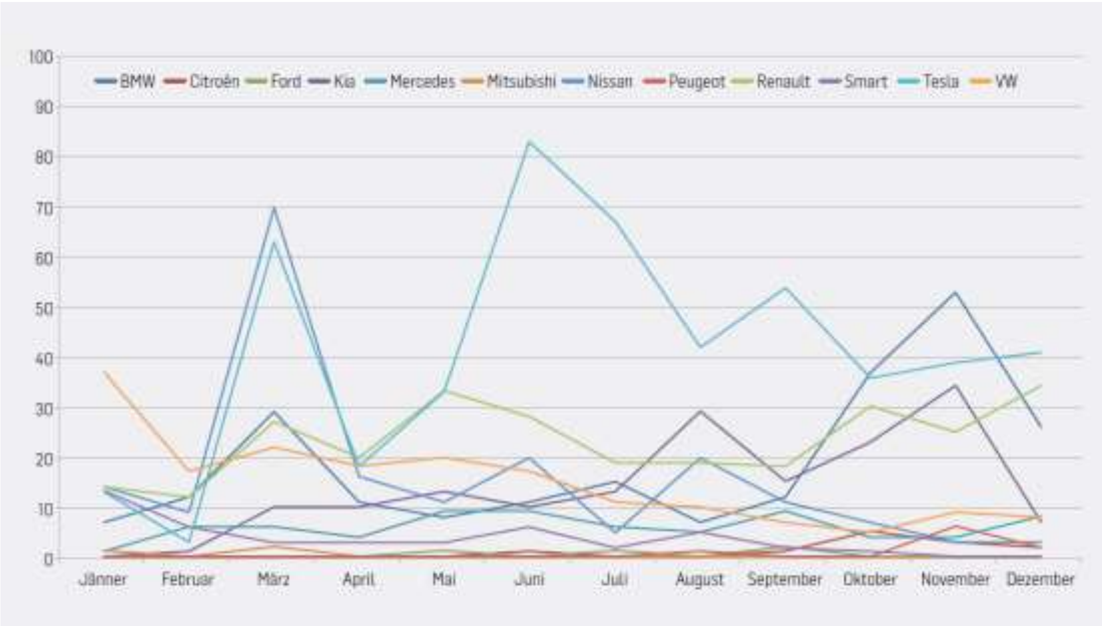

Figure 1-9 The entire BEV market in Austria in 2015

Source[6]

E-Bikes and pedelecs also increased in Austria constantly from 2010 till 2016. Based on the below figure, 6 802 e-bikes/pedelecs were sold in 2016.

Table 1-7 Sale of e-bikes and pedelecs in Austria between years 2010 - 2016

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5 http://www.austrian-mobile-power.at/amp/AMP_Factsheets/Austrian_Mobile_Power_Factsheet_09_Entwicklung_Elektromobilitaet_OEsterreich.pdf

6 https://www.bmvit.gv.at/verkehr/elektromobilitaet/downloads/emobil_monitoring_2015.pdf

YEAR	2010	2011	2012	2013	2014	2015	2016
E-bikes, Pedelecs	3.034	3.772	4.565	4.835	5.116	5.324	6.802

Source: Statistik Austria (own figure)

The most widely used vehicle with electric motor remains the electric bicycle in 2015, in most cases with pedal support (pedelec). According to this, around 50,000 pedelecs were sold in Austria in 2014. This corresponds to a share of 12.5 percent of the total of 400,000 bicycles sold. This percentage is even higher for the Austrian manufacturer KTM.[7] In 2015 the company sold 230,000 bicycles worldwide, 22 percent or 50,000 of which were e-bikes.[6]

Since May 2015, KTM has been offering the Freeride E-SM a road version of the E-SX and E-XC electric free-ride models introduced last year.

Another example is the BICAR[8]. This was developed by an interdisciplinary research team of the Zurich University of Applied Sciences (ZHAW) and presented in May 2015. This is an electrically driven vehicle with three wheels intended for use on the last mile. The BICAR project is not just a vehicle concept but serves as an open research platform where interested people can develop, test and practice new ideas and concepts for a more sustainable urban mobility.

Figure 1-10 BICAR[9]

9.1.2 Croatia

Market of EV in Croatia

[7] http://www.ktm-bikes.at
8 https://blog.zhaw.ch/bicar/
9 https://www.bmvit.gv.at/verkehr/elektromobilitaet/downloads/emobil_monitoring_2015.pdf

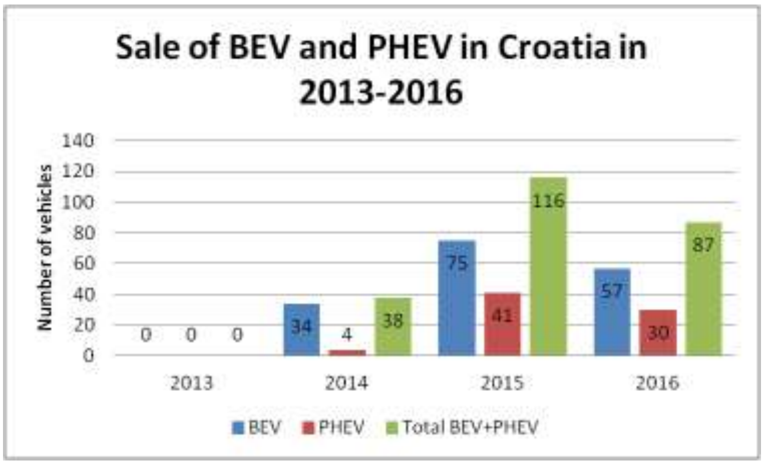


Figure 1-11 Sale of BEV and PHEV in Croatia in years 2013-2016

Source: EAFO[10]

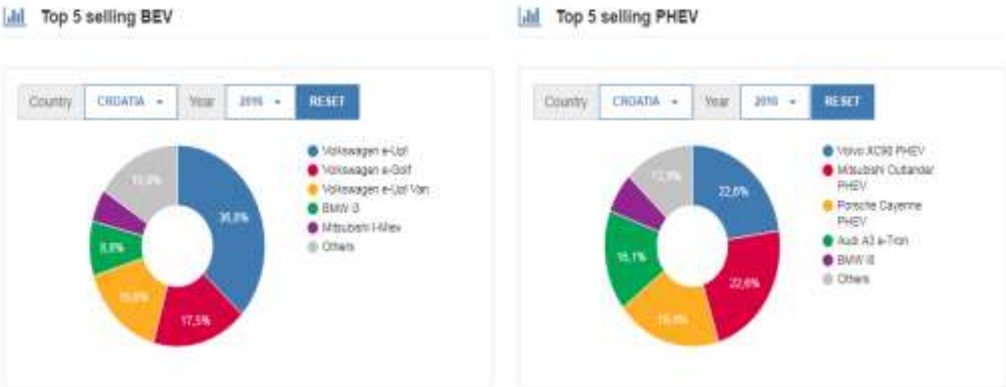


Figure 1-12 Top 5 selling BEV and PHEV in Croatia in 2016

Source: EAFO[11]

Even though Croatia is not known as a country with a developed car industry, there are few start-ups and established companies that started to develop pilot electric vehicles that are used mostly as technology carriers but also as attempts to start a serial production. ***There are two companies in Croatia, DOK-ING and RIMAC automobili that have developed electric cars that can go into a full serial production.***

One of the first companies in Croatia that started to develop electric vehicles was the Zagreb based company, DOK-ING. It is a 100% privately owned Croatian company, established in the late 1991 and registered for the production of robotized and special purposes systems and equipment. During the early period DOK-ING was actively engaged in demining activities and has gathered vast experience in different types of landmine clearance, on all types of terrain in the Republic of Croatia, as well as in the surrounding countries. This experience was the basis for designing and manufacturing the first remotely controlled demining systems,

10 *http://www.eafo.eu/content/croatia*
11 *http://www.eafo.eu/content/croatia*

constructed exclusively for humanitarian demining. Based upon that, DOK-ING designed and manufactured the first Croatian urban electric car, DOK–ING Loox.

Figure 1-13 Dok-Ing Loox

This small sized vehicle uses the latest battery and power train technology that is available. The vehicle has a 33 kWh Lithium-Iron-Phosphate (LiFePO4) battery pack, which is sufficient for a range of 220 km at the average consumption of 14 kWh/100 km. The power train features a 120 HP AC motor. The basic price of the vehicle is around 50.000,00 €. The company is known for a number of conversions to electric vehicles and the development of the vehicle for municipal services, called TomTom which is currently being prepared for the market.

The RIMAC Automobili company was established in 2009 and has developed the Concept One vehicle. The vehicle itself is an extremely expensive technology carrier, where the built in technology, made by RIMAC Automobili is offered to companies that already have a serial production of cars. As an example, RIMAC has established cooperation with the Koenigsegg car manufacturer and Aston Martin, where RIMAC Automobili is developing battery packs for their cars.

Figure 1-14 Rimac Concept_one

Among others, the company Electa Sol is producing small and affordable vehicles that are being manufactured mostly in China, and imported to Croatia where the final assembly is taking place.

Figure 1-15 Electa Sol Nevo

Regarding ***Pedelecs/eBikes***, the most important manufacturer in Croatia is the company DUCATI komponenti, a subsidiary of DUCATI energia Italia located in Ludbreg, Croatia. The company is known for the production of the "Copenhagen wheel", an innovative concept of a built-in power train and battery pack system that can be mounted on every conventional bicycle. The wheel is assembled in the facilities of the Ducati plant in Ludbreg, Croatia.

Figure 1-16 Copenhagen wheel elements

Taking into consideration the European rate of adopting electric vehicles, Croatia has been at the lower end of the scale. There are numerous reasons for that, but obviously the lower purchasing power, longer than in the rest of the European Union lasting crisis, lack of charging facilities and the overall small size of the market have contributed to this.

Even though the number of registered electric vehicles in Croatia has risen from 7 in 2007 to 224 in 2016, electric vehicles present a very small, minor part of the overall number of cars in Croatia. The average rate of increase of newly registered electric vehicles is currently about 60%. If the rate continues to hold, this would mean that by approximately 3000 electric vehicles would be present in Croatia by 2020.

9.1.3 Czech Republic

Technology development

The development of electric vehicles in modern era came at the turn of the 1960s and 1970s, when a small city personal vehicle EMA-1 and a van EMA-2 were designed and produced. More intensive development came in the 1990s. In 1990 on the basis of Škoda Favorit, Škoda Plzeň produced a prototype of an electric vehicle "ShortCut", which was designed for serial production. The production started in the company Škoda Elcar Ejpovice in 1992. In the end the vehicle had just slightly modified original bodywork of škoda Favorit model. Later, a modification on the basis of a model Pick Up was produced. The production was designed for Switzerland and other countries in Western Europe. Several vehicles were purchased by Česká Pošta a.s. The electric vehicles from Ejpovice were marked as Škoda ELTRA 151L and 151 Pick-UP. The production in Ejpovice continued with a model Škoda (later Tatra) BETA, with a partially laminated bodywork. The production ended in 1997. In 1994, TES s.r.o. produced a modified Škody Favorit vehicle called PROTOEL 2, which was used for testing accumulators.

In 2009-2011 a vehicle VUT SUPERBEL II (CVIS VUT, FEKT VUT, EVC Group s.r.o., TÜV SÜD Czech s.r.o., TILI) was being developed. The electric vehicle was a conversion of a non-homologated sedan of Škoda Superb (from the initial series) which is homologated under its own make VUT (Brno University of Technology). In the period of 2009-2012 an electric roadster Kaipan VoltAge (VŠB Technical University Ostrava, Isotra company) was being developed. Production of a new model Kaipan E is currently in preparation. In 2010, a civic association Future Age organized a competition, which was participated by 10 teams, for the most interesting prototype of an electric vehicle. The winner was Electric Hot rod EHR10 (Machinery Engineering Faculty, University of West Bohemia, Pilsen). Other participants included a Pick-up of Solarex company, roadster Kaipan, and others.

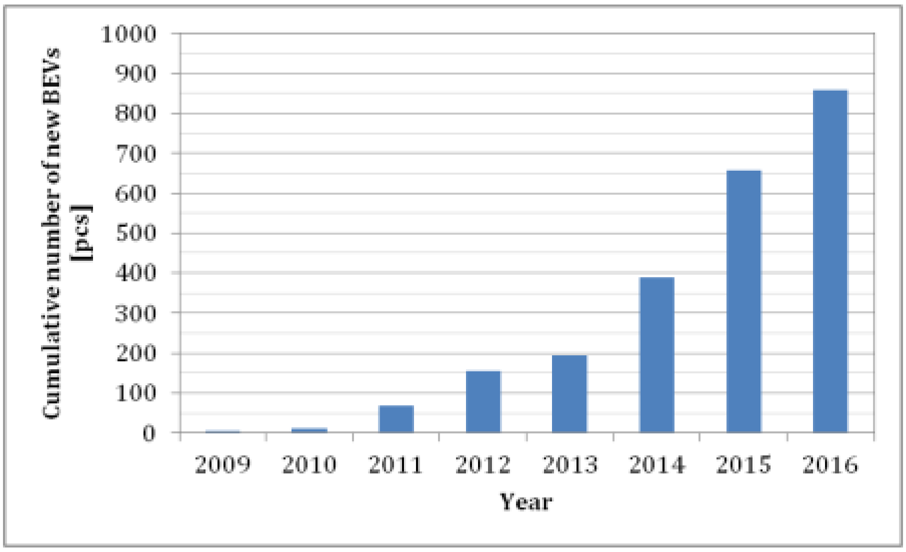
In 2011, the biggest Czech producer of personal vehicles (Škoda Auto) produced a 10-piece initial series Octavia Green E Line in order to gain practical experience with electric drives in real traffic. In 2017, the company introduced a concept Škoda Vision E, indicating a future form of serial produced electric vehicles. EVC GROUP s.r.o. is another company focused on the development and professional conversions of electric drives. Large-scale conversions focus on vehicle categories M1, N1 and M3, N3 that are used for passenger transport or as freight vans.

Development and production of pedelecs is experiencing significantly higher attention. There are several producers in the Czech Republic – BPS Bicycle, Bike Fun Int., 4EVER, Bohemia Bike, AGOGS, and others. They are already in serial production. Products of these companies are present in most of the EU markets.

Market development

There are neither official nor unofficial sales statistics for bicycles. Therefore, it is difficult to monitor spreading of pedelecs. The surveys are usually performed at the level of stakeholders questioning, or based on their expert estimates. In 2014, the sales of pedelecs were estimated to reach approx. 20,000 bikes. According to the Association of Specialized Bike Sellers in the Czech Republic, sport models made nearly 40 % of sold pedelecs. (ČTK, 2014[12]) In addition, an increase in sales of folding bikes, particularly thanks to multimodal transport, was noticed. The users travel a part of their journey by car, bus, or train and then they ride a bike, which they carry as a portable package. Similar volume of sales was estimated for the year 2015 as well. In 2016, more detailed research was performed. Between 10/2015 and 9/2016 190,000 bicycles were imported to the Czech Republic and 353,000 bicycles were exported. The share of pedelecs in the import reached 17.5 % (approx. 40,000 bikes), and more than 12 % in the export (approx. 48,000 bikes). Some of the imported pedelecs were re-exported and some of the produced pedelecs were sold in the domestic market. Total sales in the Czech market in 2016 were estimated to reach 40,000 pedelecs. The most popular category was a city bicycle with a lowered frame. Recently, increasing interest in pedelecs with speeds of up to 45 km/h has appeared. However, the sale of these models is not allowed in the Czech Republic (Ditrich, 2016[13]).

In contrast to bicycles, the statistical data for personal vehicles are very detailed. According to the statistics of the Car Importers Association, which are based on the data from the Central Vehicle Register (within the Ministry of Transport), the number of sold battery electric vehicles (BEV) has been growing since 2009. The exceptions were the years 2013 and 2016 when the sales of BEVs decreased, although the decrease was compensated by higher sales of HEVs. The cumulative increase in the number of new BEVs registrations is shown In Graph 1. In comparison, the total number of registered electric vehicles (including L category) reached 2,100 vehicles on 1 January 2015. (a study of the Ministry of the Environment). The trend in the total number of BEVs is shown in Graph 2.



12 ČTK. (2014). Šéf ekolo.cz: Češi si letos koupí až 20.000 elektrokol [Online]. In Blesk.cz. Praha: Czech News Center. Retrieved from http://www.blesk.cz/clanek/zpravy-live-ekonomika/242617/sef-ekolo-cz-cesi-si-letos-koupi-az-20-000-elektrokol.html
13 Ditrich, J. (2016). Český trh s elektrokoly v roce 2016 [Online]. In EBIKE.CZ. Praha. Retrieved from http://www.ebike.cz/cesky-trh-s-elektrokoly-v-roce-2016/

Figure 1-17 Increase in number of new BEV registrations

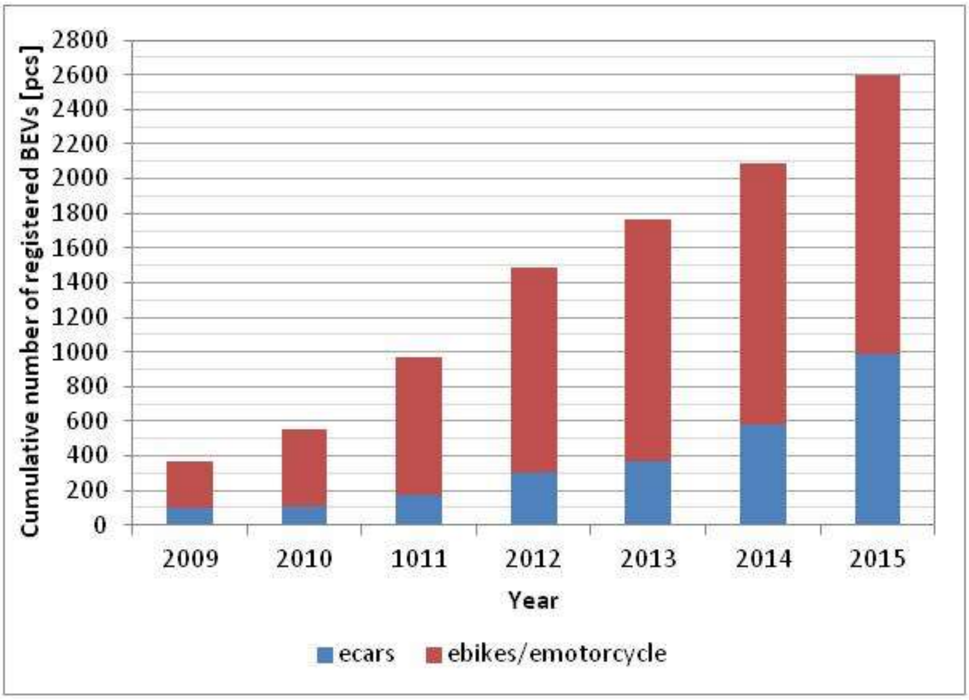


Figure 1-18 Increase in total number of registered BEVs

In its basic scenario, the National action plan Clean Mobility expects (excluding eMobility development support) the total number of e-cars to reach 2,200 by 2020 and 8,900 vehicles by 2025.

9.1.4 Hungary

Unfortunately the personal use of e-vehicles in Hungary is still in its infancy. Numerous models are available and quite a few types of pedelecs are also manufactured in Hungary, although mainly for export (125-140 thousand pedelecs made per year by Accell Hunlad Kft, Neuzer Kft, Gepida/Olimpia Kft, Csepel Zrt.), only 600-800 pedelecs are sold domestically. This is due to the currently high price of these vehicles.

The situation of electric cars is similar. Currently there are approximately 700 “environmentally friendly” vehicles, i.e. a combination of PEV’s and PHEV’s, on Hungarian roads. An optimistic estimate is that by 2023 this number will be exponentially higher, around 52,000.

9.1.5 Romania

Nearly 700 electric and hybrid cars were sold in Romania in the first nine months of 2016, up 108.1% over the same period in the previous year, when their number was 333 units.

According to statistics, from January to September 2016, compared to the same period of the previous year, the hybrid car segment sales increased by 88.7%, while in the case of electric cars the increase is 129,4% (data from the Association of Car Manufacturers and Importers).

In the top of the most traded 100% electric cars, from January to September, BMW ranks first and is followed by Volkswagen, Mercedes-Benz and Volvo. At the same time, most hybrid cars sold in Romania in the first 9 months are Toyota, Lexus and Land Rover. In 2016 495 new electric and hybrid cars were sold, the number more than doubled (110%) in comparison to 2014, when 236 units were sold.

in 2017 Electric cars sales in Romania increased by 24% in the first 7 months of the year, but they remain at a low level compared to other European countries, despite Rabla Plus government program, which offers a subvention of 10,000 EUR. The best-selling model remains BMW i3. Electric cars are still not very popular in Romania because of the high discourse between purchasing power and price.

Pedelecs/ e-bikes

The Romanian electric bicycle market has just started to develop, last year selling around 2,000 units, but the production of these vehicles marks one of the highest values at the level of the European Union, according to data provided by the European Confederation of Bicycle Industry (CONEBI). In 2016, 60,000 electric bicycles were produced in Romania, or 5% of all European Union production. Romania is the 6th biggest producer of e-bikes in EU (see graphic below).

2016 EUROPEAN EPAC PRODUCTION[6] (EU 28)
COUNTRY SHARE (1,000 units)

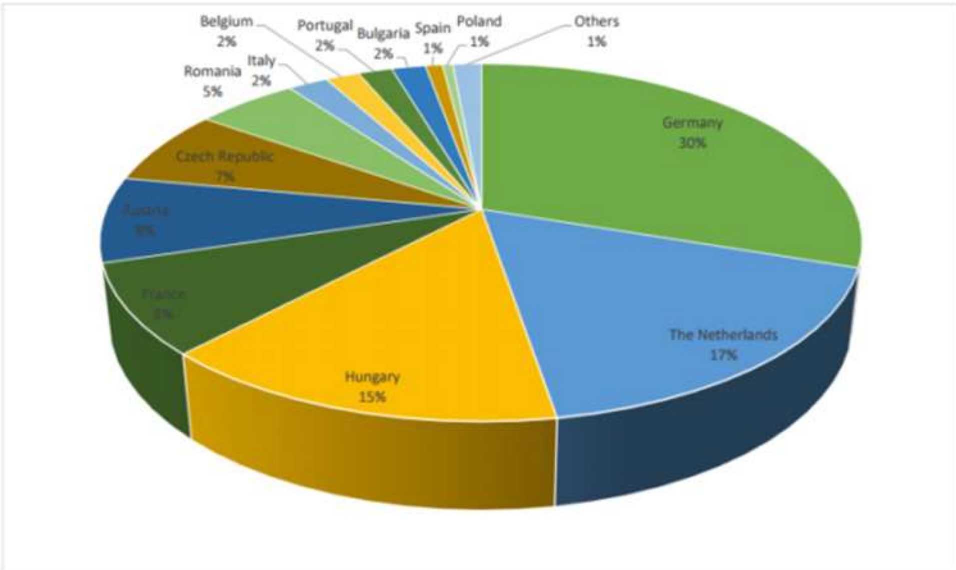


Figure 1-19 European EPAC production (EU 28), Country share, 2016

The biggest e-bikes producer in Romania is Eurosport, a company located in West Region of Romania (city of Deva). The production is primarily intended for the German market.

Most of the owners purchased the e-bike for commuting or for recreational purposes as they can travel longer distances without much effort. Folding e-bikes are especially sought as they can be easily stored in a car trunk, transported in the elevator and stored in any home.

E-bikes market is growing in Romania, as the demand for quality of life increase and the purchasing power is increased, the demand for e-bikes will also increase.

9.1.6 Slovakia

E-cars – market development

Electromobility in the Slovak Republic has a growing tendency both from the point of view of the number of registered electromobiles as well as from the point of view of the existing recharging infrastructure. However, in spite of the relatively low absolute numbers of registered electromobiles, in 2011-2015, the growth in the number of electromobiles and plug-in hybrids is obvious, what indicates the future development in the context of the global trend. *Nonetheless, the applied methodology of motor vehicle record-keeping cannot clearly identify the category of plug-in hybrids so the data for the above-stated category will have to be derived based on international statistics and forecasts for the Slovak market which indicate that the proportion of distribution of electric vehicles between BEVs and PHEVs will be 60 : 40.*

The table below documents the increase in the number of electromobiles, particularly the numbers of newly-registered electromobiles in the SR in 2015.

Table 1-8 Fleet in M1 an N1 categories for 2011 - 2015

	2011	2012	2013	2014	2015
Fleet	2,019,417	2,045,599	2,105,510	2,179,802	2,373,744
BEV (60%)	25	28	46	119	223
PHEV (40%)	17	18	30	79	147
PEV total	**42**	**46**	**76**	**198**	**370**
Increase (%)	-	+12%	+64%	+159%	+87%

Source: Automotive Industry Association of SR, 2016

Scenarios of development of electromobility in Slovakia

Growth scenarios defined for Slovak conditions may be perceived as a range in which the country may move in the following period, depending on the extent of its active approach and expended resources as well as on external elements which will have an effect on the speed of growth of the electromobiles market. The technical and standard scenarios are based on expert forecasts which have been approved by the Slovak Government in "*Electromobility Development Strategy in the Slovak Republic and its Impact on the National Economy of the Slovak Republic*". Since the described National Strategy contained only baseline expectations of the number of electromobiles for 2020 for both scenarios, the forecasts were modelled in line with the current trends for the period until 2030. The above-stated considerations are based on the expected harmonization of promotion of infrastructure construction development and stimulation of the alternative fuel vehicles market.

The scenarios were drafted by the Working Group on Electromobility of the Ministry of Economy in SR on the basis of assumptions regarding the development of battery prices, prices for EV, crude oil price and supplies, public perception, business environment, consumer behaviour and public infrastructure and data on the number of new HEV and PEV for 2013 in SR.

Standard scenario thinks with a slight interest in e-mobility industry development in Slovakia and is a picture of conservative development in the world markets (especially the development of oil prices, battery prices and electric cars, development of demand on electric cars in Western Europe).

Technological scenario considers with optimistic development on world markets in line with the relevant forecasts. He also thinks with a proactive approach of Slovakia, which the electromobility sees as an opportunity and systematically takes action to become a leader in electromobility in the region of Central Europe.

Table 1-9 PEV share in new registered vehicles

	2020	*2025*	*2030*
Standard scenario	***5.35%***	***9.43%***	***16.63%***
Technological scenario	***11.36%***	***19.14%***	***30.83%***

Source: SEVA; 2016

Table 1-10 Estimated numbers of electric vehicles (BEV+PHEV) in the SR

Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2025**	**2030**
Number of PEV	500	1,200	2,500	5,500	10,000	20,000	35,000

Source: AIA SR; 2016

Pedelecs (e-bikes) – market development

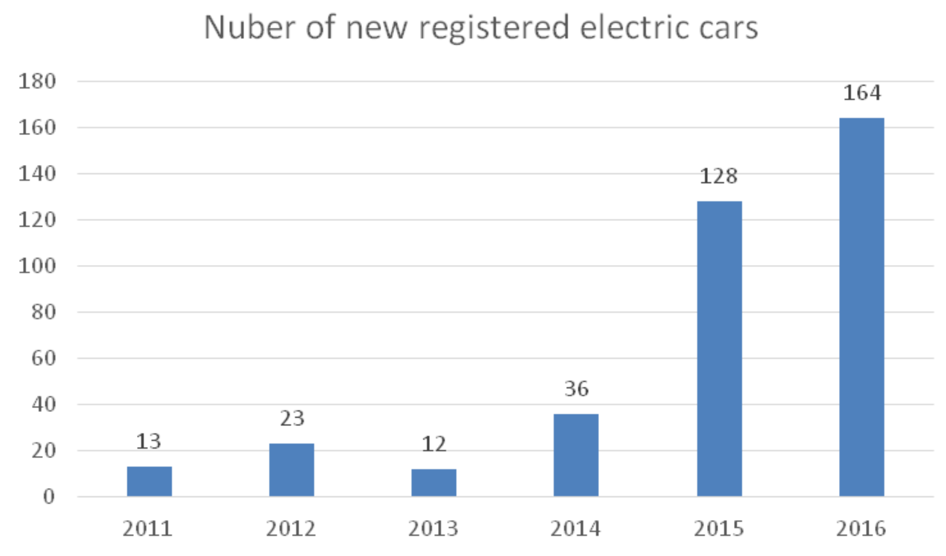
There are four major bicycle manufacturers and dealers in Slovakia having in their offer also e-bikes (urban or mountain e-bikes), KELLYS, CTM, DEMA and KENZEL. Except of them almost every conventional bike seller/distributor in Slovakia has already in its offer some mark/type of pedelcs or e-bikes, which are becoming more and more popular.

KELLYS[14] is probably the best-known Slovak bicycle manufacturer. Today the company annually produces about 95,000 bicycles. More than 80% of them will end outside Slovakia. Overall, Kellys exports its bicycles to more than 30 countries. The prices of KELLYS`s e-bikes start at 2,200 eur. ***CTM Bikes Company***[15] has produced its first bicycles in 1999. Annually, it produces about 55,000 bicycles. From foreign markets it focuses mainly on V4 and Austria. Since its inception, the company has grown rapidly and has been able to overtake older competitors as well. ***In 2016, the first electric bike was added to its collection***. The price for its current e-bike model Metric is 1,900 eur. ***Dema***[16] is the first and oldest Slovak bicycle mark. In production, it depends on the constant development and modernization of its bicycles. Annually they produce about 40,000 bikes. More than half of this is exported across the border. DEMA has received several awards for its bikes, including the Bicycle of the Year Award and three Slovak Superbrands Awards. The future can certainly be seen in electric bicycles. It has ***developed its own electric motor and frame with an integrated battery***. The prices of DEMA`s e-bikes are in the range 1,000 – 1,700 eur. ***Kenzel***[17] has about 70 employees who produced around 30,000 bicycles each year. They are exporting them all over Europe. All production goes in Slovakia, only raw frames are imported in Kenzel. Greater emphasis is being put on electric bikes in future.

9.1.7 Slovenia

State of development of e-cars

In Slovenia electric cars are still in minority, compared to classic internal combustion type of cars. Yet as we can see from the following graph, each year there are more new registrations of electric cars. Altogether there are 376 registered electric cars driving on Slovenian roads.



14 https://www.kellysbike.com/
15 http://www.ctm.sk/
16 https://www.dema.bike/
17 http://www.kenzel.sk/

Figure 1-20 Number of new registered e-cars in Slovenia in 2011-2016

Source[18]

Worth mentioning is »DeMS – Društvo Emobilnost Slovenija[19]« (the Emobility Society of Slovenia), who care very much for unbiased information exchange among users of e-vehicles and help potential users in purchasing or retrofiting an e-vehicle with hands-on-experience.

In an effort to enable smoother launching e-mobility in Slovenia, a compherensive public consultancy document on E-mobility[20], which describes the interplay of different energy stakeholders in Emobility, was published in 2017 as "Smernice za razvoj elektromobilnosti v Sloveniji" [21] (in translation: "Guidelines for development of Emobility in Slovenia") by the Energy Agency in the Slovenian energy market.

There are two electric car renting systems present in Slovenia. ***Avant car***[22] is an older and already recognized provider of car renting services. Their key business areas are short- and long-term leases, car fleet management and vehicle rentals with drivers. The company is particularly active on the field of electric mobility, since they have a large car fleet of electric vehicles. They offer different brands and types of electric cars, from the smallest Smart Electric Drive to the luxurious Tesla S. They also offer an electric delivery van Nissan eNV200. They constantly upgrade their fleet of electric vehicles with new models. Besides car renting, they also offer a mobile app Charge juice, for finding, reserving and activating a charging station. They also sell their own solution of a fast charging station.

In July 2016 another car renting system called ***Avant2go***[23] was started in Slovenia. This is actually the first car sharing system in Slovenia. At the moment they are present in Ljubljana and Murska Sobota. They promote themselves as the first 100% electric car sharing system in Slovenia with a big car fleet of 50 electric cars. They offer three different brands of electric cars. Namely BMW i3, Renault ZOE and Smart Electric Drive. Car sharing differs from rent-a-car in terms that car sharing is intended only for short-term leasing. Renting is self-service at different predetermined locations. The price of rental depends on the chosen car and is composed of the rental period and mileage.

State of development of e-bikes

18 http://www2.drobtinice.si/app/gw.dll/portal?req=regListInput
19 http://www.dems.si/
20 https://www.agen-rs.si/posvetovanja/-/asset_publisher/M2GdU2jRtCxV/content/zbrani-odgovori-udelezencev-javnega-posvetovanja?inheritRedirect=false&redirect=https%3A%2F%2Fwww.agen-rs.si%2Fposvetovanja%3Fp_p_id%3D101_INSTANCE_M2GdU2jRtCxV%26p_p_lifecycle%3D0%26p_p_state%3Dnormal%26p_p_mode%3Dview%26p_p_col_id%3Dcolumn-1%26p_p_col_count%3D1
21*https://www.agen-rs.si/documents/10926/20705/Smernice-za-razvoj-elektromobilnosti-v-Sloveniji/5e9d3029-f691-4a11-8952-2f07c7066a85*
22 http://www.avantcar.si/sl/
23 http://www.avant2go.com/

The number of e-bikes is growing in Slovenia. There are already some companies that offer e-bikes for rent, sell conversion kits and most of sellers of regular bikes also offer modern electric bikes for sale.

In the next paragraphs some of the e-bike renting companies are be described.

The vision of **Bikeways**[24] is that the bike becomes a key connecting element of a sustainable approach of eco-tourism in order to visit cities, cultural attractions and return to nature. This goal is feasible through the establishment of an international network of bike rentals and service centers along the bike routes in the territory of Slovenia and in other European countries. Renting points already exist in Slovenia, Croatia, Italy, France and Spain. Not only do they offer different types e-bikes (road bikes, fat bikes, mountain bikes…), they also offer descriptions of the various bike paths and provide information about stopping points which are e-bike friendly.

In April 2017 the **first e-bike sharing point**[25] was opened in Slovenia. The owner of this sharing point is the company Oven, a subsidiary of Elektro Maribor d.d., which deals with renewable energy sources. E-bike sharing point is located in Maribor. At the moment they offer 3 bikes for rent, but they plan to develop their business with offering more e-bikes and locate more sharing points across the city of Maribor.

In April 2016 an automated bike rental system **JeseNICE Bikes**[26] started operating. They offer fifteen ordinary bikes and six e-bikes for rent. They charge a 10 € registration fee, which is valid for one year and by registering bike rental is free.

Figure 1-21 Automated bike rental system JeseNICE Bikes in Slovenia

FlyKly[27] is a Slovenian company and a very successful project on Kickstarter that is really worth to mention. They raised 701.239 $ on Kickstarter with help of 2.358 backers. They

24 http://www.bikeways.eu/
25 https://mariborinfo.com/novica/lokalno/foto-maribor-z-novo-bike-sharing-postajo-kmalu-ze-druga/133910
26 http://www.jesenice.si/cps/item/15450-kolesa-si-je-ze-mogoce-izposoditi
27 *https://www.kickstarter.com/projects/flykly/flykly-smart-wheel ; http://www.flykly.com/en/*

invented the Smart Wheel. Smart Wheel is designed in a way that makes installation as easy as possible. The motor and all the other components are packed inside a robust case. There are no wires or other gadgets to install. You simply remove your rear wheel, replace it with the Smart Wheel, which comes in many different standardized sizes. Top speed of the Smart Wheel is 25 km/h for 50 km range. The Smart Wheel weighs only 4 kg. The Smart Wheel is pedal assist and you can monitor and control it with the FlyKly smart phone app. This app has also many other interesting features like remote locking of the bike, tracking the bike if it gets stolen and the app also studies your cycling habits and suggests the most time efficient, the safest or the most attractive routes.

9.1.8 Montenegro

No legislatives are in force or defined concerning the development, production or use of electrical vehicles powered by batteries or pedals. The terms of technical requirements and conditions which must be fulfilled concerning a vehicle, are enforced under UN ECE regulations.

The development and production of electrical vehicles powered by batteries as a source of energy or pedals does not exist in Montenegro, and use of electric vehicles in Montenegro is unsufficient. A few hybrid vehicles are used for taxi service for passenger transportation and touristic vehicles and electric vehicles with pedals are used in the coastal touristic area of Montenegro.

9.1.9 Serbia

About 200 hybrid cars are in use in Serbia and only about 30 are electric cars. There is no adequate charging infrastructure. There are 3 public chargers in Belgrade and one at the border crossing with Macedonia. 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.

The price of an electric car on the Serbian market is very high. Cars with this price are inaccessible to citizens.

At present, electric cars cannot be registered in Serbia. They can only be registered temporarily.

The development and use of electric cars in Serbia is in the initial phase. It mostly ends with prototype development.

In 2010, in “Zastava” company in Kragujevac, a prototype of a passenger electric vehicle was produced on the FIAT Punto car platform. It was the first temporary registered electric car in Serbia, however serial production was not realized.

This pilot initiative was continued by the Automobile and Motorcycle Association of Serbia (AMSS)- Vehicle institute. The classic FIAT Punto was converted into an electric model. This conversion costs about 15.000 €. Electric Punto can run for 150 km with one battery charge. Charging of the battery takes 6 hours. There is also the possibility of a partial charge with which a shorter distance can be passed. This car is adapted so that it can be recharged to any conventional connection supply.

Figure 1-22 Converted FIAT Punto into e-car, “Zastava” company in Kragujevac

It is estimated that this model has a 3.000 days driving cycle. Final vehicle testing and licensing procedures are under way.

In the first decade of the 21st century, “Globus auto” developed two prototype electric cars. Due to lack of funds, further development has been stopped.

The „Eko Srbija”company started the assembly of „aksisos” model of the electric car from the imported components. At present, chassis, engines, batteries, bodywork are imported from China, and the assembly is done in Belgrade.

Figure 1-23 Small city e-car model “Aksios”, “Eko Serbija” company, Belgrade

"Aksios" is a model of a small city car whose price does not exceed 10,000 €. With one battery charge, the range is 140 km and the maximum speed is 60 km / h. This model is charged at an ordinary 220 V outlet and the maximum charging time for the battery is about 8 h. It takes only 2 hours to charge 60 percent of the battery capacity.

It is planned to start production of electric motors and bodywork in Serbia and in the long run with other components of the car.

Pedelecs

There is a large offer of pedelecs manufacturers from the EU and China on the market. The sale is very limited, on a symbolic level.

E-cars

Three models of electric cars are available on the Serbian market:

- BMW i3 - price 36.990 € (battery 33 kWh, Vmax = 150 km/h)
- VW e-Up - price cca 30.600 € (battery 18,7 kWh, Vmax = 130 km/h)
- VW e-Golf - price based on customer specification (battery 35,8 kWh, Vmax = 150 km/h)

10 Review and a brief description of existing projects and studies

10.1 EU projects and studies

I-CVUE Project[28]

I-CVUE aims to reduce CO2-emissions in urban environments by ***increasing the number of EV's in large fleets in urban areas.***

The project will achieve this by mentoring large urban based pan-European fleet operators, offering them free EVusage analysis and mentoring and creating a framework that authorities can use to set up tailored fleet incentive programs to increase the uptake of EVs according to the specific socio-economic conditions of the city, or region.

The project will achieve actual EV uptake in large urban fleets by analysing their composition and actual vehicle usage and combining this with whole life cost analysis. This will enable us to make concrete recommendations for some or all of the vehicles to be converted to EV and for these recommendations to be implemented and evaluated within the scope of the project with the goal of putting 1000 additional EVs into fleets during the lifetime of the project.

The model for mentoring is based on the successful implementation of models in the UK and Austria. The mentoring core of the project will be enhanced throughout the project based on the relevant local incentives of participating fleets. The diversity of the fleets selected to take part in the project from strategic sectors such as rental and leasing, logistics, and corporate fleets, will ensure that the project results will be highly replicable and broadly applicable to a wide range of fleets across Europe.I-CVUE will facilitate the transfer of best practice principles and incentives between different Member States in Europe through the development of an incentive framework to support EV uptake. The results of the mentoring and analysis of the pan-European fleets taking part in the project will feed into the incentive framework and tool to be used by policymakers and fleets.

For more information please check the I-CVUE website.

Car2go - Amsterdam's innovative electric car-sharing scheme (Netherlands)[29]

Like many other European cites Amsterdam is supporting electric mobility with its ‘Amsterdam Electric’ programme. Since November 2011 the city has a smart non station based electric car sharing scheme, 'car2go', which complements existing transport systems by providing a service for short distance trips.

To drive car2go electric, one must register with the service through the website. The membership card issued then allows members to unlock and drive away any of the fleet by simply holding the card in front of the card reader which is behind the front windscreen on the driver’s side.

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28 *http://icvue.eu/*

29 *http://www.eltis.org/discover/case-studies/car2go-amsterdams-innovative-electric-car-sharing-scheme-netherlands*

Unlike most car sharing programs, car2go is not station-based. The concept is simple: no need for a subscription or vehicle reservation; users can access vehicles where they want and then drive off; parking is possible anywhere in Amsterdam, i.e. there are special free of charge parking spaces for members, and users can park at six Q-Park garages completely free of charge; there's no need to take the car back to a fixed depot. If the battery performance display drops below 20%, users have to end their journey at a charging station in the home area (Amsterdam city centre); the nearest charging point can be selected on the touch screen navigation on-board.

Users pay only for the actual number of minutes of car usage. The fee is €0.29 per driving minute and €0,09 per "stop over" minute (including: costs for servicing, cleaning, repairs, energy, insurance, road tax, navigation system and parking at dedicated parking spaces). Users can find the nearest available car (or charging point) through the website or on an application (for iOS and Android systems) designed for smartphones and tablets. The app is available in Dutch amongst other languages.

E-Mobility Works project[30]

Regarding e-mobility, the municipality's role is to set regulations and standards, encourage interoperability and to provide incentives. The private sector's role is to bring the new technology to the market and enforce mass production and thereby reduce costs. Emobility Works will therefore encourage municipalities to create new partnerships with the private sector, such as energy companies and vehicle manufacturers. Stakeholders will then altogether set up and implement a local Action Plan integrating the use of renewable energy in e-vehicles and charging stations. In total, project partners developed and finalized 30 e-mobility action plans together with the participating municipalities and consulted more than 170 businesses. By doing so, the acquisition of more than 400 e-vehicles and more than 120 charging stations in European municipalities was triggered.

e-MOTICON[31]

The project "e-Mobility Transnational strategy for an Interoperable Community and Networking in the Alpine Space" is actually an ongoing similar project to eGUTS, only focused on a different macro region. Its partnership aims to support Public Administrations in ensuring homogeneous development of electric mobility.

The project acts on the problems of low and inhomogeneous deployment of electric mobility (e-mobility) that characterises Alpine Space (AS). The count of electric charging stations (E-CS) varies from 15 to 235 E-CS per M inhabitants whereas electric vehicles'(EV) number varies from 70 to 470 per M inhabitants. One reason for the inadequate diffusion is low interoperability of E-CS often due to the limited integration of planning instruments used by Public Administrations (PA) and their lack of knowledge in technological innovation and business modelling.

30 http://emobilityworks.com/the-project.html
31 http://www.alpine-space.eu/projects/e-moticon/en/about

After the analysis of policies, business models and technological solutions, e-MOTICON will deliver a White book on innovative E-CS planning to respect e-mobility requirements in Alpine Space transnational strategy and Regional Action Plans. It will provide a toolset to anticipate E-CS network requirements and test it in 3 joint pilot actions. A transnational community will involve Public Administrations and representatives of the e-mobility industrial sector, research centres, regional agencies, end users and public transport agencies to improve Public Administrations' capacity on E-CS planning, cooperation, increase knowledge and enhance consensus.

Project Go Pedelec [32]

The slogan "Go Pedelec!" is the name of the EU-funded project, carried out by four municipalities, three non-profit organizations and three private companies. The common goal of these ten partners from Austria, the Czech Republic, Germany, Hungary, Italy and the Netherlands is to increase awareness of pedelecs among citizens and political decision-makers. The Go Pedelec! Handbook[33] is the main output of the Go Pedelec! project. It informs you about many things on pedelecs which you will not have known even though you might have already intensively dealt with the topic - be it as a final customer or as a municipal decision maker.

PRO-E-BIKE[34]

Project promotes clean and energy efficient vehicles, electric bicycles and electric scooters (common name "E – bikes"), for delivery of goods and passenger transport among private and public bodies such as delivery companies, public administration and citizens in European urban areas as an alternative to "conventionally fossil fuelled" vehicles.

The project actions are directed towards E-bike market uptake and promotion of policies that stimulate the usage of E-bikes in urban transport. Therefore, PRO-E-BIKE aims for a change in behaviour of target groups in urban areas manifested in their decision to replace their conventionally fuelled vehicles with E- bikes. Pilots among target groups will not only help the project to achieve its objectives, but as well, enable the demonstration of measurable effects in terms of CO2 emission reduction and energy savings by inclusion of E-bikes in urban transport.

Overall, by the actions predicted by PRO-E-BIKE we hope to shift urban delivery transport from fossil fuel delivery vehicles toward E-bike vehicles, and in that way not only to reduce noise and pollution in urban areas, but as well to reduce congestion, save energy and to create new market opportunities for local economy.

The variety of electric vehicles in the marketplace has grown over the past few years, resulting in a vast number of new available and affordable pedelec, e-bike, e-scooter and e-car models. As a consequence, the increased e-vehicles choice is also driving the financial

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32 http://www.gopedelec.eu
33 http://www.gopedelec.eu/handbookEN.html
34 http://www.pro-e-bike.org/project/

services sector to offer more flexible leasing services. In addition to the car dealer activities, private businesses may set-up innovative applications, such as offering e-transport services in hotels and leisure facilities or installing charging points at offices.

Ebike rental service in Stuttgart[35]

Since 2007, the German Railway Company Deutsche Bahn AG (DB) has been offering the public bike rental system "call a bike" in several German cities. Users have to be registered once by phone or via the website as members of the call a bike community. There are different forms of call a bike in Germany: Some cities like Cologne or Berlin provide a free system, that means that the users can catch the bike or deliver the bike at any place in the city. Stuttgart decided to establish a station-bound system ("call a bike fix") with 60 stations in the city where the bikes have to be rented or delivered. The 450 bicycles could be rented by mobile phone only.

In 2009, the German Government made a call for innovative bike rental systems. DB and Stuttgart decided to participate and developed together a new system with bikes and pedelecs. The partners finally won a grant of 3 Million Euro of the German government. The overall aims were a new mixed offer of pedelecs and bicycles at all stations, a charging infrastructure, an easy handling and the integration in public transport.

In November 2011, the e-call a bike system in Stuttgart was launched. There are 44 stations with currently 60 pedelecs (from January 2012 on 100) and 450 bicycles. Every station has a new designed terminal with a touch screen and slots for the DB customer card and ec/credit cards. The pedelec is the same vehicle as the conventional bike plus motor and battery. In order to avoid destruction by vandalism, there are no buttons or displays, only a small LED which shows if the battery is charged or not by a green or red light. The motor is from BionX, it starts automatically when the pedelec is being moved. The drivers can choose between 3 gears. Despite the weight of more than 20 kg, the handling of the bike is easy, especially the brakes are excellent.

35 *http://ebikeee.com/2011/12/27/ebike-rental-service-in-stuttgart/*

Figure 10-1 E-call a bike system in Stuttgart

The installation of the charging facility was a huge effort, as all stations needed to be provided with a standard power connection. The solution was a subterranean serial bus with connection to charging devices. The cable which is used to lock the pedelec to the station has an integrated plug, so if the pedelec is locked, its battery will be charged. If the plug is connected correctly, a green or red light on the top of the locker columns shows the actual charging status of the battery. A pedelec with less than 20% of energy level is blocked for rental until it is charged again to an acceptable level.

For better service at the stations, DB has developed a terminal which is being used in Berlin and Hamburg. It is possible to rent a bicycle or to bring it back, using the menu on the touch screen of the terminal. In Stuttgart there are different terminals due to cooperation with energy supplier EnBW in the field of electro-scooters. EnBW is promoting electromobility in the Stuttgart region, and therefore it carried out a one-year-test with 700 “elmoto”-scooters with participation of citizens, companies and local authorities. The test has ended in August 2011. Users have driven more than 1 million kilometres. Based on this experience, EnBW decided to cofinance the terminals provided that they are modified in order to serve as charging facilities for e-bikes. The result is a flat terminal column with a “blue side” for EnBW with two sockets for the charging plugs of e-bikes, and a “red side” for DB with the touch screen for the bike rental. So there are 90 charging sockets for e-bikes in Stuttgart, which is the basis for a good supply of the users of e-bikes and scooters all over the city. The energy is “green energy” from renewable sources.

Figure 10-2 Terminal column of E-call a bike system of DB

While the normal Call a bike bicycles can be used for free in the first 30 minutes, the use of e-Call a bike pedelecs costs 12 cent per minute (daily rate 22,50 Euro). Another alternative is to pay a yearly flat rate of 54 Euro. In this tariff the first 30 minutes are free of charge. For frequent public transport users of DB and the regional transport consortium (VVS), who posses a yearly ticket, there is a discount.

ELTIS[36] and EPOMM[37]

Beside the above mentioned concrete EU projects dealing with the aspects of pedelecs or e-cars in transport systems of urban areas, worthy to mention are surely two wide-european platforms, i.e. ELTIS and EPOMM. Both of them provide expert as well as laic public with the precious and various information and data on themes and topics in the area of sustainable urban mobility, including e-mobility.

10.2 National studies and projects

10.2.1 Austria

Analytical case study Title: Marketing project “Pedelec rental system at local car dealers” [38]

Since 2009 various marketing measures aiming at spreading the use of Pedelecs have been carried out in the Municipality of Weiz. The percentage of bike use in Weiz is approximately 6 % of all ways driven. By launching different campaigns for the using of Pedelecs this percentage should be increased. One of these campaigns was to install a rental-system for

36 http://www.eltis.org/
37 http://www.epomm.eu/index.php
38 *http://www.eltis.org/sites/eltis/files/case-studies/documents/atn_casestudy_weiz_pedelec_rental_system_final_7.pdf*

Pedelecs at local car dealers in Weiz. Car drivers who have their cars serviced – a car service usually takes up to two hours – should be given the opportunity to rent a Pedelec and make a test drive in the city during the time their car is being serviced.

The Pedelec rental system at local car dealers should motivate a new target group that is to say car drivers for using the Pedelecs or normal bikes in the City of Weiz. Thus the shift of the mode of transport towards non-motorised traffic should be accelerated.

The key objectives of the project were as follows:

- Car drivers who have their cars serviced are offered to use a Pedelec instead of being offered a substitute car.
- When the car drivers agree with using a Pedelec they get vouchers for different shops in Weiz as a reward for trying out this new mode of transport. They can go for a ride into the City of Weiz and can cash their vouchers at coffee houses or in different shops.

CEMOBIL[39]

The E-mobility project CEMOBIL was launched by the City of Klagenfurt on Lake Wörthersee in September 2010. The project demonstrated that E-mobility does indeed work in European cities such as Klagenfurt on Lake Wörthersee and that effective and sustainable improvement in environmental quality in cities is achievable without imposing undue restraints on individual mobility.

At the same time it was demonstrated that a valuable contribution is being made towards climate protection and towards meeting the Kyoto target by ensuring that the electricity required to power E-vehicles comes entirely from renewable sources of energy.

All in all, 69 electric vehicles (35 passenger cars, 10 micro cars, 2 utility vehicles, 10 E-bikes, 10 scooters, 1 E-bus and 1 solar boat to run on the Lenkanal Canal) were purchased and tested. At the same time, the necessary infrastructure was developed. Fifty charging stations were erected in Klagenfurt and its surroundings by the project partner, the Land of Carinthia. Another 50 charging stations are to be provided through private initiatives (e.g. residential building cooperatives, shopping centres, etc.). In addition, a self-sufficient PV charging station was built. The E-vehicles were made available for testing to private persons, public institutions, driving schools and taxi companies.

More Austrian emobility project flagships under „Klima Fond[40]" such as: EMPORA 1 & 2; Crossing Borders ; VECEPT; eMPROVE; eMORAIL; SMILE – simply mobile; SEAMLESS; CMO; EMILIA; LEEFF; E-LOG-BioFleet; RE²B.

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39 http://www.cemobil.at/

40 *https://www.klimafonds.gv.at/assets/Uploads/Broschren/Leuchttrme-der-E-Mobilitt/2016ElectricMobilityFlagshipProjectsEN.pdf*

10.2.2 Croatia

The popularisation of electric vehicles in Croatia has been closely connected with the accession of Croatia to the European Union and the availability of funds that were opened to the end users. The users in this case were mostly local communities - Cities, Counties and the State. The reason for that was that during the late 2000s and beginning of the 2010s electric vehicles were simply unavailable to the general public due to their price. In 2012, the total number of electric vehicles in Croatia was 13, in 2013 there were 24 electric vehicles, in 2014 the total number of vehicles was 74.

A great deal of electric vehicles purchased in 2014 and 2015 was funded by the project of the national Fund for energy efficiency and environmental protection (FZOEU) called "Vozimo ekonomično" ("Lets drive economically").

Figure 10-3 2014 »Vozimo ekonomično« leaflet

Through this project, the FZOEU has encouraged the usage of energy efficient vehicles in Croatia, among them, it co-funded the purchase of full electric, hybrid, plug in hybrid vehicles and electric motorcycles and scooters. The end users of the project were Croatian citizens and companies, which could apply for the fund after they purchased one of the mentioned vehicles.

The co-financing rate for the end users was as following;

- ***a)*** Full electric vehicles 70.000,00 HRK (9.333,33 €)
- ***b)*** Plug in hybrids and electric vehicles with range extenders 50.000,00 HRK (6.666,67€)
- ***c)*** Hybrid vehicles 30.000,00 HRK (4.000,00 €)
- ***d)*** Electric motorcycles and scooters, from 7.500,00 HRK (1000€) till 30.000,00 € (4.000,00 €)

Citizens could buy up to one vehicle and the one of the conditions set by the FZOEU was that they had to keep the vehicle in their ownership minimally one year. Companies could buy up to 5 vehicles and 700.000,00 HRK (93.333,33 €). The condition set by the FZOEU for companies was that they could not sell the vehicles for three years. Most of the companies that used these funds were taxi companies that purchased mostly hybrid vehicles.

In total, there were two calls, in 2014 and 2015 In 2014 the budget was 11,2 mil. HRK (1,5 mil. €) and in total 340 vehicles were co-financed; 313 hybrid vehicles, 24 electric vehicles and 3 plug in hybrids. In 2015 the budget was 18,5 mil. HRK (2,5 mil. €) and in total 506 vehicles were bought; 314 hybrids, 179 full electric vehicles and 13 plug in hybrids.

Figure 10-4 Mitsubishi i-MieV, the most sold electric vehicle in Croatia in 2014

As a direct result of this project, the number of electric vehicles rose from 13 in 2012 to 224 in 2016, and hybrid vehicles from 354 in 2012 to 1843 in 2016. Also, drastic increase of electric vehicles bought from 2014 to 2015 was due to the fact that many car producers offered their electric vehicles on the Croatian market and made the first step in the market penetration of electric vehicles in Croatia. The project was suspended in 2016.

Also, the FZOEU had, during 2015 in the scope of same project "Vozimo ekonomično" another call for the purchase of other means of electrically powered transport and the appropriate infrastructure, namely the purchase of electric bicycles with the maximum power output of 0,25 kW. Most of the users were local authorities that have mostly established bike sharing system with electric bicycles. The users could purchase from 5 to 15 eBikes with a co-financing rate ranging from 40% to 80%, depending on the level of development of the local authority that was the end user.

As a result of the call, many cities in Croatia have established their first public bike systems with electric bikes. One of the examples is the system that was set up in the City of Čakovec, called "ŠTROMČEK". It is a public bike system within total 20 e-bikes, fully available to the general public. Total value of the project was 1 mil. Kn (133.000,00 €) with the co-financing rate of 40%. Other similar project that were co-financed by this call were the "Učka e bike" project and similar.

Figure 10-5 Štromček eBike public system in Čakovec, Croatia

Beside the FZOEU funds, a number of Croatian municipalities purchased ebikes through different sources. The public bicycle system in Pula, called "Bičikleta" was developed in the scope of the FP7 project "Movesmart", project "Pro-e-bike" promoted the introduction of electric bikes as a delivery tool in old city centres in Croatia, where the City of Zadar joined the project as a pilot City. City of Koprivnica conducted a large scale FP7 project in promoting electric vehicles called "Civitas Dyn@mo". This was one of the first projects that systematically approached electromobility development in Croatia. The project included the establishment of a network of fast charging stations that are used by a fleet of 5 full electric vehicles, two electric buses that are used in the public transport operations of the City of Koprivnica and an ebike system that is an integrated part of the public transport system in Koprivnica.

Another best practice example was the ***project of the Croatia post***, where in total ***180 ebikes substituted old and obsolete scooters*** that the Post was using for everyday deliveries. Total value of the project was 3,738.825,00 HRK (appr. 498.000,00 €). The purchase of the ebikes was also co-financed by the FZOEU by 49%. The results of this project were used in the PRO-E-BIKE project as a part of the evaluation process.

Figure 10-6 Training for eBike driving, Pro-e-bike

10.2.3 Czech Republic

Systemic user support of eMobility (Technological Agency of the Czech Republic, 2016-2017)

The aim of the project is to identify barriers and the development potential of eMobility in the Czech Republic, to estimate demand for electric vehicles and willingness to pay for characteristics of electric vehicles based on the research of companies and personal vehicle drivers' preferences, to design tools which effectively support the development of eMobility and stimulate demand for electric vehicles for the state administration, to design measures to overcome barriers for the existing and potential users of electric vehicles in the Czech Republic, to create a professional map of charging stations, to develop an ICT application for electric vehicle users, and to prepare materials for the update of the National Action Plan Clean Mobility and the transposition of 2014/94/EU.

EMobility for urban services (Ministry of Finance, 2011-2012)

The main goal is the transfer of know-how and best practice in the field of the electric vehicle use in the community domain in the Czech Republic, support of these advanced transport technologies, including independent commercial consultancy for their implementation, and the initiation of an example for the behaviour of people in individual transport. The project was supported from the Swiss-Czech Cooperation Programme.

Apart from the above mentioned research projects, there is another group of projects, particularly projects of distribution companies (energy distributors), which are focused on the improvement of the infrastructure, collection of operation data and practical experience in different application areas, e.g. rescue service, police, authorities, etc.

10.2.4 Hungary

Since e-mobility is still a relatively new topic in Hungary, previous projects in this field are sporadic, although promising. Projects and studies relating to the use of pedelecs (or any other LEV's) usually do not cover electric cars, and vice versa.

Regarding the use of pedelecs, a larger scope, i.e. transnational project that pioneered in Hungary was the "Go Pedelec!" project implemented within the frameworks of the Intelligent Energy Europe programme between years 2009-2012. The project's participating partners were from the Netherlands, Austria, the Czech Republic, Italy and Germany. The Hungarian partner was Miskolc Holding Zrt., the trustee company of the City of Miskolc. Miscolc Holding plays a key role in town planning, strategic enterprise development, exploiting synergies and economy development activities. In case of economy development activity strengthening innovation potential is a crucial goal.

During implementation of the project they organised a roadshow to introduce and popularize the use of pedelecs in Hungary in three Hungarian cities (Budapest [BringaExpo = a cycling fair], Balatonfüred [Bikefest], Miskolc [International Europe-Bartók Operafestival]).

The Go Pedelc! detailed Handbook is also available in Hungarian language, although it reflects mainly on the international situation. It is available on the project's website: http://www.gopedelec.eu

The succession of the project is found at www.gopedelec.hu, which is coordinated by the Szélessáv Alapítvány (Broadband Foundation). They are currently working on writing concise studies/recommendations for the dissemination of this form of transportation. They have forwarded their reccomendations to the responsible parties at the Ministry of National Development: **[Possible incentives for the national expansion of electro-mobility – comments by the Szélessáv Közhasznú Alapítvány [Broadband Foundation]]** “A pedelec elterjedésének lehetséges ösztönzői a hazai elektromobilitás terén Szélessáv Közhasznú Alapítvány észrevételei”[41]. This explores not only incentives, but describes the positive aspects of using pedelcs, goals to be achieved, barriers to overcome, possible measures to be taken, and **[*Recommendations for bicycle-friendly municipalities regarding the spread of pedelecs*]** “Ajánlás kerékpárosbarát települések számára a pedelec kerékpárok térnyerésével kapcsolatban”.[42] This study starts from the basics, introducing and clarifying the difference between pedelecs and other two-wheeled LEV's (e-bikes and S-pedelcs), takes a look at national and international trends, different legislation problems, and a few ideas regarding popularization and infrastructure development.

Local/sub-regional tourism projects have also incorporated pedelecs into their implementation.

In 2014 the Göcsej-Hegyhát LEADER Association in cooperation with two other local associations implemented the "Energia két keréken – mobilitás témaút kialakítása Zala megyében" **[*Energy on two wheels – development of thematic mobility route in Zala County*]** tourism route project which connects 13 villages’ tourist attractions[43]. 12 pedelecs were acquired and are available for rent in the two ending villages (Nagypáli and Szalafő) of the route. An e-car (Smart for two) was also purchased and can be rented and charged in Zalaegerszeg at the headquarters of project partner Zala Megyei Fejlesztési Közhasznú Nonprofit (Zala County Development Nonprofit).

Another thematic route “Zöld Kerékpár – Ős-Dráva” was developed in the Ős-Dráva area in 2015. (http://greenebike.hu/osdrava/) It connects 5 villages in Baranya County with 5 charging stations and offers 70 pedelecs for rent. The project was developed by Public Bike System Hungary (http://publicbikesystem.eu/our-projects/) a company which also operates an urban public bike sharing scheme “Kaposvár Tekergő” in the city of Kaposvár.

To our knowledge, preceding the Hungarian Government's current (2016-2017) incentive programme for the purchase of e-cars, independent projects have not been implemented in this field. Few studies are available. One of the studies – “Merre tart az elektromos autók

41 *http://www.gopedelec.hu/download/Osztonzok/Pedelec_osztonzok_Szelessav.pdf*
42 *http://ketosz.hu/sites/default/files/PedelecAjanlas.pdf*
43 http://e-mobil.omega-csoport.hu/e-mobilitas/

piaca" (summary available in English, "Electric cars: A market outlook"[44] – was written by PwC in 2014, which builds on a previous study of theirs published in 2012. (Full Hungarian language study available online[45]). It gives an overview of the international use of electric cars and challenges faced, a prediction regarding the spread of electric cars in Hungary (52,000 by the year 2023, but this a cumulate of PEV and PHEV's), the effects that the spread of electric cars may have on the electricity network, as well as positive environmental and economic effects.

Another study was written based on a lecture given at an energy strategy conference in 2014:"Az elektromos járművek elterjedésének energiapiaci hatásai" ["Effects of the spread of electric vehicles on the energy market"].[46]

10.2.5 Romania

THE EVENT PROJECT (Electric Vehicles in Urban Europe)

The Urban Electricity Network (URBACT) has provided a platform for 9 cities in Europe which allows them to learn more about each other and how to solve problems in order to ensure sustainable mobility. The following issues were addressed as important elements for ensuring the penetration of the electric cars market: a) the existence of business models; b) acquisition; C) infrastructure; D) Raising awareness. The following partner cities collaborated on the project EVUE: Beja, Frankfurt, Katowice, Lisbon, London, Madrid, Oslo, Stockholm and Suceava.

ROBG-1 E-bike Net

The project deals with establishing a network of electrical bicycles for people to use in the cross-border area of 32 towns of Romania and Bolgaria. Tourists will be able to rent an electric bicycle for a minimum of three hours for just one euro and explore the two banks of the Danube. 240 bicycles will be purchased, of which half will be leased from Bulgaria and the other half from Romania. Electric bikes will be distributed in 16 cities in Romania and 16 cities in Bolgaria on the Danube.

Additinally 35 charging stations in both countries will be installed, allowing charging of 5 e-bikes at the same time. Charging will take about four or five hours, and bicycle users will pay for the electricity consumed.

10.2.6 Slovakia

Slovakia is a relatively mountainous country, so it is understandable that the development of e-mobility in the area of cycling is mainly focused on sport (leisure) cycling. Several activities, initiatives and projects have just begun with the support in the field of cycling-tourism in

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44 http://www.pwc.com/hu/hu/kiadvanyok/assets/pdf/e-car_eng.pdf
45 https://www.pwc.com/hu/hu/kiadvanyok/assets/pdf/merre_tart_az_elektromos_autok_piaca-e-car_2014.pdf
46 http://unipub.lib.uni-corvinus.hu/1904/1/Felsmann_20141111.pdf

connection with e-bicycles. No remarkable projects were implemented in the area of urban transport.

E-BIKE project in Central Slovakia[47] is one of the unique projects in e-mobility. This project is a Slovak novelty and aims to increase interest in tourism around Banská Bystrica and make the cycling routes of Central Slovakia more attractive by connecting important towns, monuments and selected accommodation facilities, as well as by technical equipment of information points, where there will be bicycle chargers, service tools and rental of e-bikes and bicycles. Since the summer 2011 is in operation the first charging and service station for electric bicycles in Slovakia, which is located in the Mountain Hotel "Kráľova Studňa" (1300 m.n.m) in the mountain range of Veľká Fatra. There is possible: to charge Bosch CX / Performance / Active, Bosch Classic, BionX 48V; to charge at the same time 5 e-bikes; charging is free. This unique project is the result of the cooperation of the RIDE.sk (e-bikes vendor), the Mountain Hotel Kráľova Studňa (accommodation provider) and the Regional Tourism Organisation Central Slovakia.

Figure 10-7 Bicycle charger on the Mountain Hotel Kráľova studňa in Slovakia

Ebajkconnect[48]

The community of cyclists is growing, and it is the duty of the electromobility promoters to build the background in the form of charging stations on their favorite cyclopaths. The presence of points on familiar routes is important for the sense of certainty of all who use their electric bicycles with assistance of electric motors to the maximum.

Ebajk connect is a network of charging points for electric bicycles with additional services (if possible with the refreshment / buffet). The charging point is usually built by an attraction e-bike salesman, who cares about the comfort of his customers and feels like an additional service related to the sale of electric bicycles.

"Ebajk - The world of electric bicycles", a commercial-service centre with an electric bicycle rental is one of the first activists that the network is building as a joint initiative with the civic association of e-DNA and other partners. The service is provided free of charge.

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47 *https://ride.sk/spustili-sme-nabijaciu-stanicu-na-kralovej-studni/*
48 *http://www.ebajkconnect.sk/*

Currently there are cca 15 charging points for e-bikes located predominately in the mountain range of Malé Karpaty and in Podunajská nížina lowlands. On the ebajk connect charging points are available for charging the original Bosch and Yamaha chargers from the supplier of “Ebajk - Svet elektrobicyklov”. E-bikers also have all the necessary facts and information about the charging point service via ebajkconnect.sk. It also includes a map with GPS points of charging stations, instructions, videos and photographs. With an increase in the number of additional charging points, a mobile app will be available.

Figure 10-8 Network of e-bikes chargers in Slovakia close to the eGUTS pilot city Senec

Company e-vehicle fleet in Slovenské elektrárne (ENEL) is the biggest in Slovakia. [49]

Slovenské elektrárne (electricity production company), subsidiary of the group Enel, (SE) has the largest corporate electric vehicle fleet in Slovakia. After they purchased 5 new 100% electric Nissan Leaf in February 2015 and put them into operation for particular power plants and employees, in total, the fleet of Slovenské elektrárne expanded to 15 electric vehicles of different brands. The company's ambition is to increase the number of electromobiles in its fleet by the end of the year 2015 to double.

The introduction of electric cars into the day-to-day operation of the corporation has confirmed their technical and economic advantage. The geographical location and distances between particular power plants of the Sovenské elektrárne provide an ideal opportunity to fully utilize the driving range of e-cars at one charging. For this reason, Slovenské elektrárne presented to its employees so called “Enel's car rental” which uses electric vehicles to transport employees between single power plants in Slovakia.

Additionally, already in October 2014, Slovak power plants made available to the general public free of charge six charging stations, located at the administrative and operational

49 *24/02/2015; https://www.seas.sk/clanok/flotila-elektromobilov-slovenskych-elektrarni-rastie/158*

facilities of the power plants in Bratislava, Nováky, Jaslovské Bohunice, Mochovce and Trenčín. The stations are connected to a control centre that monitors and collects information about electricity consumption, as well as the number of charges or the need for service intervention. The charging stations use state-of-the-art technology that is a patent of the Enel group and allows full charge of the battery within two hours.

Today, thanks to the portfolio of water, photovoltaic, nuclear power plants and co-incineration of biomass, power plants of Slovenské elektrárne generate more than 90% of electricity without producing harmful CO2 greenhouse gases.

10.2.7 Slovenia

Alterenergy[50] (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.

MOBINCITY[51]**.** 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.

KULeBIKE[52] is a project that unites **Slovenian** local tourist service providers from many different municipalities. Its goal is to offer new opportunities of spending vacation and leisure time by introducing more than 100 kilometres of new bicycle paths and an environment friendlier way of transportation. An important aspect of the project is also to make e-mobility more popular and to improve its outreach.

PREKOPITI project was implemented in the north east region of Slovenia. Its aim was to connect 20 suppliers of tourism products and services in the area of the project partner municipalities and establish 5 e-points with the possibility of free rent of e-bikes and a at least 120 km long e-bicycle path, thus improving the tourist infrastructure in rural areas. Another aim was to encourage the use of e-bikes of at least 750 users**.**

50 http://www.alter-energy.eu/
51 http://www.smartgrids.si/index.php/sl/*projekti*
52 http://www.kulebike.si/domov

10.2.8 Montenegro

No national studies were cerried out in Montenegro, nor any other projects for construction, production or use of electrical vehicles which are powered by electricity or pedals.

10.2.9 Serbia

The transport development planning is not regulated by the existing legal framework at either national or local level, but indirectly.

No studies have been conducted in the Republic of Serbia on the topic of e-vehicles involvement into public and personal transport in urban areas.

Strategic planning of traffic development, based on SMART goals, defines the following indicators:

- Efficiency of traffic,
- Safety in traffic,
- Economics,
- Accessibility,
- Environmental Protection.

In strategic documents, taking into account the environmental protection, strategic objectives of sustainable development put emphasis on e-mobility.

The available strategic documents are:

- at the national level: ”Strategy for development of railway, road, water, air and intermodal transport in the Republic of Serbia by 2015”
- at the local level: ”Strategy for the development of traffic in the city of Kragujevac 2012-2021”

11 Advantages and disadvantages of pedelecs and e-cars

11.1 In general main advantages and disadvantages of pedelecs and e-cars

Advantages of EVs

EVs have a *low degree of pollution* compared to fuel vehicles. The production of electricity as charging source of EVs can generate pollution, but the use of electricity at EVs does not pollute. In essence, the way from electric power to wheels is the following: Battery – Electric Power Convertor - Transmission - Wheels.

The efficiency of electric motors. Looking at the whole, electric motors can have an efficiency of about 90% compared to thermal engines powered by gasoline, petrol or gas with efficiency around 40%. This superior efficiency of the electric motors compared to the thermal ones is due to the fact that most of the components used to store, produce and distribute the energy used to power electric vehicles are much more efficient. An EV with electric motors can have an acceleration that is between the same values as the fastest cars or even racing cars. This can happen because the electric motor can produce the maximum torque from moment 0 compared to the thermal one.

Due to the fact that EVs have fewer moving parts compared to a vehicle with thermal engine its *maintenance is easier and cheaper*. Indeed, EVs being relatively new in the consumer market, EV services where they might be repaired and maintained are few compared with those where vehicles with thermal engines are repaired and maintained. This will change due to the need for such services for EVs which will be more and more.

EVs safety in case of road accidents. Due to the fact that in the case of electric cars the variant in which each wheel has its own electric motor is preferable, the mass of the vehicle is evenly distributed. In the case of thermal engine vehicles, the area where the engine is located is the heaviest, and for some types of impact, the material damage and human life loss is higher. Because the propulsion system is distributed in several areas of the vehicle, this leads to a different behavior of the car in the event of an accident. At the same time, the danger of fire due to ignition of fuel or pipes located in high temperature areas is much lower or non-existent, although on the other hand, batteries can catch fire in case of short-cuts.

Disadvantages of EVs

EVs autonomy. This is significantly improved with new technologies that allow more power to be stored in the car's battery. Top electric cars have a range of about 430 km with fully charged batteries. It seems a bit odd, but there are cars (and not few) which, due to the high fuel consumption or the small tanks, can make about as much kilometers with a full tank. At the same time, the autonomy will not increase in proportion to the number of accumulators found in the car. The biggest impact on the car autonomy is in general the weight of the vehicle, and with the increase of accumulators, the mass of the machine will also increase.

Power Supply. The charging time depends a lot on how much electricity can be delivered to the vehicle. There are "high-power" systems that operate at high voltages and deliver in about 45 minutes enough energy to travel over 250 km. There are also cases when full battery charging can take up to 8 hours, when the EV is charged from home by a 220 V / 110V power grid. Although that should not be much of a problem since many EV users will charge at home overnight.

Infrastructure for power supply. Thanks to the technology that is relatively new on the consumer market, the infrastructure cannot keep up with the technological advance in the car manufacturing industry. In Europe, in western countries, charging stations for electric cars began to appear in highway car parks, but if you leave the highway you will find other stations with difficulty.

Battery lifetime. Depending on the battery charging/discharging mode, lifetime may vary from 5-6 years to 13-15 years.

Control of electric motors. Although precision electric motors are clearly superior to thermal or hydraulic control systems, this performance comes at a low cost.

E-cars vs. e-bikes

By 2050, the UN expects the global urban population to be 6.3 billion – the same size as the world's entire population in 2004. An ever-expanding suburban landscape will sprawl beyond the outskirts of these mega cities.

European Union studies on the future of cities have suggested that the continent will witness a steady increase in the growth of built-up suburban areas referred to as SMESTO (small-to-medium-sized towns). In other words, we need to become more open-minded about urban transport.

In simple terms, those who wish to avoid congestion will take the bicycles. Alternatively, commuters with a longer distance to travel will have the option of riding a new generation of electric bicycle capable of 45 km/h. It's no surprise that sales of these high-speed pedelecs have already overtaken conventional electric bicycles in some parts of Europe.

When it comes to urban transport and a contest between electric cars and electric bikes, there is little contest. It was said before, but electric bicycles continue to be the best application of electric motor technology. And while battery performance continue to improve, for the time being, if you want powered personal transport that's clean, quiet and safe, bag your yourself an electric bicycle.

Advantages of e-bikes (pedelecs)[53]	**Disadvantages of e-bikes (pedelecs)**

53 ECF, ELECTROMOBILITY FOR ALL, Financial incentives for e-cycling, 2016

(vs. conventional bikes and e-cars)	(vs. conventional bikes and e-cars)
• **E-bikes allow for longer distances to be cycled with the same level of effort compared to conventional bikes. (*A study of the German Federal Environmental Agency shows that in an urban context, conventional bikes are faster than cars for distances of up to 5 km. With e-bikes, this radius is enlarged to 10 km, and even for longer distances of up to 20 km the time difference with the car (electric or fuel-driven) is marginal.)*** • **E-bikes make it easier to overcome natural obstacles to cycling, like hills or headwinds.** • **E-bikes and electric cargobikes make it possible to transport heavier goods than conventional bikes and cargobikes. This is an advantage for private individuals, for example when they do their shopping by bike, but also for companies relying on fast urban logistics solutions.** • **Electrically assisted bikes open up cycling for groups that have not cycled previously because of their physical condition (the elderly, handicapped people) or because of a lack of perceived convenience, for example commuters who do not want to transpire during their ride to work.** • **Speed pedelecs can compete on travel time with cars for even longer distances than low-powered pedelecs. With a top speed of 45 km/h, they can now replace up to 90% of car journeys.** • **Not limited by charging infrastructure (vs. to e-cars), battery can be taken away in most cases (except of pedelecs having the battery embedded in its**	• E-bikes are still considerably more expensive than conventional bikes • Higher demands on safe parking infrastructure both in public and private space (due to the higher price of bikes) • Exposure to adverse weather conditions such as rain, wind, i.e. reduced comfort (in compare to e-car) • Limited driving speed of pedelecs (up to 25 km/h), what enable their usage on bicycle lanes contrary to speed-bikes (S-bikes), which can go up to 45 km/h, but therefore they can't be used on bicycle lanes. • Safety and infrastructure adaptation of existing road infrastructure for bikes, e.g. bike lanes (which is important due to the higher speed that can be reached in case of “speed pedelecs”, ev. e-mopeds/e-scooters). • Life span of batteries (ecology and sustainability of their production). • The weight of e-bike (pedelec) is much higher (25 kg) than the conventional bike (15 kg) because of battery and engine – difficult handling e.g. by taking it into public transport or getting over bigger obstacle

frame) and recharged with the use of a standard mains outlet. • **Allowed entry to urban centres and usage of existing bicycle infrastructure (i.e. bike lanes)** • **The better acceleration of e-bike will help to get out of traffic lights faster and the possibility to get away from dangerous situation on the road quicker**	
Advantages of e-cars **(vs. conventional cars and e-bikes)**	**Disadvantages of e-cars** (vs. conventional cars and e-bikes)
• **E-vehicles have higher energy efficiency than ICE.** • **The electric motor is characterized by its simplicity of construction and thus also by simpler maintenance / repairs resulting into lower operation cost.** • **Electromobiles feature is a simple trigger and control.** • **Very good acceleration.** • **The use of electric vehicles has zero direct exhaust emissions and almost no noise and dust.** • **(E-)car can transport more people/goods at once.** • **(E-)car provides protection against adverse weather conditions (more comfort).**	• Higher purchase price (still high costs of batteries) • Slow return of investment • Currently almost no (limited) service for repairs and maintenance • Long time to recharge • Short driving range • Limited parking capacity, lengthy searching for parking place, particularly in large cities • E-cars (similar to ICE) do not solve the problems with congestions and land-taken in urban areas (parking, new roads) in contrast to e-bikes (pedelecs) • Fewer recharging stations (insufficiently developed charging station network) • Public slow chargers in our cities (e.g. in block of flats) is desperately lacking • Life span of batteries (ecology and sustainability of their production)

11.2 SWOT analyse for e-mobility sector globally (e-cars/pedelecs)

One of the main obstacles which obstruct the increasing of electrical mobility is that *full business models need to be further developed*. As with any new industry, the ability to identify and achieve revenue streams is necessary to provide a development fund. Since electrical vehicles (EVs) have higher initial costs than vehicles with internal combustion (ICs) and require support for the charging infrastructure, additional costs may be important.

Through *proper use of the procurement process*, local authorities can support EVs by taking over the direct purchase of these vehicles in their own fleet or imposing this condition on their suppliers. This increases EVs visibility and demonstrates their viability in a number of important areas.

Regarding the infrastructure, it can be stated that with the growth of urbanity and density, the assumption that people might not have to travel home is very unlikely. If city authorities want to reduce emissions of exhaust pipes and to improve the environment, the infrastructure must allow this. It can be achieved through *policies* such as those *that require the development charging facilities for EVs* or the installation of street charging stations. However, at this initial stage of electrical mobility, most cities have adopted the installation of public facilities.

Even if people recognize the negative impact of vehicle’s emission on the environment, only a few admit what can be done to remedy and diminish them. Even if EVs offers a viable solution, the general awareness of them is quite limited. A general problem faced by cities is that while walking, cycling and public transport fulfill many needs, there will always be occasions or activities that can only be met using private cars. By redefining mobility to include electric vehicles, progress can be made, but cities have to assume and ensure they are not just a niche market but instead they are a viable alternative.

Obstacles identified on the market regarding EVs are related to different aspects, ranging from technology, to the reluctance of society to change factors, such as: a) Technological constraints (e.g. range of vehicles, loading time, and insufficient public charging network); b) Limited vehicle types; c) Large investment costs; e) False expectations; e) Lack/insufficiency incentives; f) Lack of information, misinformation and wrong information (total cost of ownership, lack of trust, etc.)

Interested parties in solving the issue of introducing EVs into the market, and into developing strategies for doing so, are: EVs manufacturers, energy providers, charging stations providers, transport operators and users.

Strengths	Weaknesses
• **E-vehicles have higher energy efficiency than ICE.** • **No dependence on crude oil.** • **Reduced green-house-gas emissions** • **Less air-pollution and noise from**	• High initial investments in the e-vehicle (low residual value of vehicle). • Currently insufficient (public/private) infrastructure for e-vehicles recharging. • Still small user comfort from the point of

transport at places with dense traffic. • **Availability of electricity and its relatively favourable price compared to conventional fuels (lower energy cost per km)** • **The electric motor is characterized by its simplicity of construction and thus also by simpler maintenance/repairs resulting into lower operation/maintenance costs.** • **Pedelecs allow for longer distances to be cycled with the same level of effort (already optimal for suburban commuting with distances over 5 km), easier to overcome natural obstacles like hills or headwinds, enable to transport heavier goods than conventional bikes and cargobikes (e-(cargo)-bikes), are option for solving problems with congestions and land-taken in limited urban spaces.**	view of the need for frequent recharging (low battery capacity, limited driving range). • (Non)-harmonized standards and norms (resp. very early stage of this process). • High costs of battery rent or new battery purchase (resp. not possibility to rent a battery). • Not acceptance of more (various) access cards at charging stations (roaming for electric vehicle charging, i.e. how charging of electric vehicle batteries and its payment can be made at different locations in the grid is not solved) • Non-environmentally-friendly production of batteries and their not sufficient life-span (battery life cycle). • E-cars (similar to ICE) do not solve the problems with congestions and land-taken in urban areas (parking, new roads) in contrast to e-bikes (pedelecs) • (Low) density of servicing network, particularly regarding independent repair shops network • Usage of pedelecs depending on the weather conditions • The weight of e-bike (pedelec) is much higher (20-25 kg) than the conventional bike (15 kg) because of battery and engine – difficult handling e.g. by taking it into public transport or getting over bigger obstacle (potential barrier for interconnecting more pedelecs with PT)
Opportunities	**Threats**
• **Strong EU interest in e-mobility topic and its incorporation into various policies and directives** • **The interest of all major automobile companies in the development and subsequent serial production of their**	• Drop in the purchase power of the population and of companies. • Delayed drops in prices of inputs as a result of a slow introduction of economies of scale with mass production. • Excessive demand for electricity and

own e-vehicles (strong pressure from the private / manufacturing sector), similarly to the producers of (e) bicycles. • **Innovation impulse for car manufacturers and their suppliers.** • **Creation of new innovative business models and services (battery/e-vehicles renting schemes, car-sharing, bike-sharing, cargo-bikes services, operative leasing...)** • **Use of e-vehicles in smart grids.** • **Existence of various incentives for e-mobility support (purchase subsidies, easement of taxation, prior/free parking, free charging at some charging stations...)** • **Opportunity for use of locally produced electricity mainly from renewable energy sources** • **Lower electricity prices compared to conventional fuels** • **Limiting operation of conventional vehicles in urban areas (e.g. introduction of low-emission-zones in town centres)** • **E-mobility sector will generate new qualified job opportunities and space for innovations**	inability to provide sufficient amount of electricity from renewable sources. • Oil price dropping / rising electricity prices and the reluctance of people to change from ICE to e-vehicles • Non-environmentally-friendly battery production, their "short" lifespan and consequently their disposal • Non-sufficiently developed cycle route network in some countries/regions/cities, lower culture of cycling and lower respect to cyclists from car-driver`s side (question of safety). • Negative publicity in media • Incompatibility of charging systems (many different charging plugs/sockets), incompatibility of access and paying for e-vehicles charging

11.3 Main solutions/measures for overcoming barriers in pedelecs deployment

E-bikes are still considerably more expensive than conventional bikes. While they have known a large uptake in several countries (Germany, the Netherlands, Belgium), their market development is still in the take-off phase in others. ***Purchase subsidy schemes could help*** to bridge this price gap. ECF has suggested an approach adapted to market conditions:

- In markets with low sales figures, a purchase ***subsidy of 500€*** (around 10% of the current purchase subsidies of electric cars in many European countries) could help to bridge the price gap to conventional bikes and facilitate market uptake of electric bikes (including low-powered as well as speed pedelecs), which in its turn have a high potential to achieve modal shift from car trips to cycling.

- In more mature markets, ***more targeted subsidy schemes e.g. for speed pedelecs and electric cargobikes*** due to their higher price or for ***charging infrastructure in small businesses*** can be an option. ***Subsidies for electric bikes*** could also be given ***as a reward for cancelling a car's registration.***

Besides these targeted purchase subsidies, which are at the centre of this report, other, ***more general, funding schemes*** can ***also contribute to the promotion of electric cycling***:

- When drawing up ***national electromobility strategies*** according to the EU's Alternative Fuel Directive2, ***due attention and adequate financial support should be given to L-type vehicles***. ***Speedpedelecs and electric cargobikes*** fall into this category. This includes charging infrastructure, but above all infrastructure for safe parking (which is important due to the higher value of these vehicles compared to conventional bikes) and adapted road infrastructure (which is important due to the higher speed that can be reached). While low-powered pedelecs do not fall under the scope of the directive, they would also benefit from these measures.
- ***Research funding for electromobility***, be it at the European (Horizon 2020 and its successor programme) or the national level, should move from focusing only on developing new forms of cars to an approach that ***looks at the mobility system as a whole, and includes electric cycling as an innovative form of transport*** and an integral part of the smart cities of the future.

11.4 Main solutions/measures for overcoming barriers in e-cars deployment

Automotive technology fields

The psychological barriers preventing the spread of electric vehicles remain the same as before, namely the short driving range and the high cost of the batteries. ***The performance and cost of the rechargeable batteries will be crucial to the success of electric mobility.*** Enhancement of the battery technology is mainly concerned with energy density, safety during use, deep-cycle resistance and service life. R&D in this area is heading in several different directions, e.g. how to combine batteries with high-performance capacitors or how to develop batteries with fuel cell range extenders. Within this context, ***life cycle analyses are another important element***, i. e. the process of considering the total ecological and economic costs of the battery from the availability of the raw materials right through to recycling. The integration of energy storage systems into the vehicle is also imposing new requirements in terms of the bodywork. By using new lightweight materials such as carbon fibre reinforced plastics, it is possible to keep the total weight of the vehicle to a minimum, thereby extending the range.

11.5 Safety of e-vehicles (pedelecs)

Battery`s safety

E-Bikes, electric two wheelers and their components must all be manufactured to unified, high quality standards, so as to guarantee the highest possible level of safety. In contrast to the batteries of electric cars, those on e-bikes are accessible externally, and most of them are removable. This gives rise to specific safety requirements to better protect the user.

Recently the new European standard EN 50604-1[54] was published by the European Committee for Electrotechnical Standardization. It defines a unified, Europe-wide safety standard for lithium-ion batteries used in e-bikes and Light Electric Vehicles (LEVs).

This new regulation improves the safety of e-bikes (also named pedelecs) and other LEVs like electric motorbikes and scooters, and it provides a robust legal framework.

These associations urged for the standardization of e-bike batteries as they must be protected against overcharging, deep discharging, short circuits, extreme temperatures and vibrations. The charger and battery pack must match, and chargers must only be able to charge the batteries for which they are designed. So chargers and batteries which belong together must be able to identify each other unambiguously.

E-bikes take faster, shorter, more frequent trips

The Sweden's Chalmers University of Technology made interesting study[55] regarding e-bike riders compared to conventional bike-riders. According to the study, the average speeds of the e-bike riders were, as expected, higher (by about four kilometers per hour). They made shorter, more frequent trips than those in the previous study, "in accordance with previous research suggesting that electric bicycle users travel more" as well as traveling faster.

E-bikes run into hairy situations more often

For e-cyclists, speed was highly associated with crashes and near-crashes—more so than the number of kilometers ridden or riding time. E-bike riders experienced more critical events, and they got into trouble at a higher rate, per kilometer (every 16.7 km, versus every 24.5 km).

The most common catalysts of critical events for e-cyclists were conflicts with pedestrians and other cyclists (49 percent of critical events), and motorized vehicles (29 percent). Fairly similar proportions were found in the earlier study with regular bike riders (45 percent and 33 percent, respectively).

The number of times e-bikes came into conflict with cars, per kilometer, was 30 percent higher than with regular bikes. This might have something to do with drivers making false assumptions about the electrified two-wheelers. Since e-bikes resemble traditional bikes, drivers may underestimate their speed. Plus, e-bikes might be entering into collision paths with cars more often as a result of their speed.

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54 http://www.bike-eu.com/laws-regulations/nieuws/2016/11/eu-standard-for-e-bike-batteries-published-1012808
55 https://www.citylab.com/transportation/2016/08/e-bike-safety-speed/494936/

Authors of the study suggest that e-bikes become more visually conspicuous, "possibly to a point where they can be perceived as different from traditional bicycles." That might help drivers, pedestrians, and other cyclists better anticipate their behavior in traffic. Improved lighting on the bikes themselves might also help cyclists increase their range of visibility and therefore the amount of time they have to react to road conditions ahead.

This research does still support others that have found differences in e-cyclist behavior and the mechanics of e-bikes themselves can produce greater likelihoods of involvement in crashes. And it's a no-brainer that faster speeds create more opportunity for dangerous encounters.

So as e-bikes become a more familiar sight in cities around the world, special safety measures might be in order.

But even if they call for extra precautions, e-bikes still carry promise as a potential breakthrough in energy-efficient transportation.

11.6 Inclusion of pedelecs and e-cars in public transport systems

The deployment of electric vehicles in the network will require the provision of the supporting infrastructure and systems, and their integration in the full mobility system in a wide scale. Rail public transport that uses electric energy provides sustainable mobility solutions as well and will growingly be an alternative to private vehicles in the future. Given the limitations of the electric vehicle, its intelligent integration into the existing urban transport infrastructure is essential. Intelligent ICT solutions enabling proper traffic management, managing the change between different modes of electric transport or giving travel advice will optimize the efficiency of the transport system, make it conveniently useable, and thus acceptable for the public. This contribution therefore will cover all relevant modes of possibly electric transport: individual motorized transport (cars, powered two wheelers), public transport (suburban rail systems, urban rail systems, buses, trolleybuses etc.), vehicles for urban delivery and logistics other vehicles, in particular public fleets of vehicles.

In many cities / regions of the DTP, there are already at the present the public transport systems based on the electricity usage, i.e. metro, trolleybuses, trams or light rail. Therefore, the necessary infrastructure as well as the distribution of the electricity network are present, which could also be used in the future for the charging of other private/public e-vehicles, like pedelecs, e-cars/taxis or e-light-utility-vehicles. This issue, which is relevant to the eGUTS project, is nowadays also addressed by the international project ELIPTIC, funded by the CIVITAS program.

The ELIPTIC[56] project focuses on the use of existing electric public transport systems (including light rail, metro, tram and trolleybus sub-stations) for the electrification of multimodal mobility approaches in the urban and sub-urban context. By integrating existing

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56 http://www.eliptic-project.eu/

electric public transport infrastructure for multi-purpose use, it demonstrates that the further take-up of electric vehicles can be done in a cost-efficient way.

One of its three main pillars addresses „multi-purpose use of electric public transport infrastructure“. Within this pillar ELIPTIC project aims to define how the existing electric public transport infrastructure (trolleybus, metro and tram sub-stations) could be used as charging infrastructure for other non e-bus electric vehicles (pedelecs, e-cars/ taxis, e-vans and e-utility trucks). For safe integration of electric vehicles into existing infrastructure or energy network, different approaches are being developed, which taking into account the vehicle type. Key Enabling Technologies (KETs) are being tested in relevant environments, for instance a sub-station of the future for multi-purpose infrastructure use.

Another „way of inclusion“ of e-vehicles in the public transport system is to create a cooperative system in a mobile device to integrate public transportation real time information in an EV (i.e. „data integration“). Electric Vehicles (EVs) are being introduced in the market, but batteries reduced energy storage capacity and the lack of a high density charging infrastructure limit their autonomy range. In order to overcome this limitation, one research study[57] from Portugal proposes developing a new solution enabling drivers to drive longer distances. This will be achieved by integrating some components of the cooperative transport infrastructure (charging system, public transport system and the vehicle), and by increasing driving autonomy through energy consumption reduction obtained with the improvement of driving efficiency. The research work shows how to create a cooperative system in a mobile device to integrate public transportation real time information in an EV. Integration of EVs with public transport system allows extension of driving autonomy beyond the storing capacity of vehicle’s batteries. Supplying information on availability, schedule and price of public transport allows the driver to plan the journey using EV and public transportation in a complementary way, using functions as car parking booking (and charging) and ticket buying. This information is integrated in a mobile device providing the driver with a collaborative holistic approach of different public transportation infrastructure sources, that can be combined with real traffic information, parking places and charging slots and current driver position, to support the driver decision making process.

Some interesting topic is the integration of e-carsharing system in existing public transport systems. This was the subject of two research projects recently realised in Germany, particularly in Berlin. While the project BeMobility 1.0 focused on the integration of the electric carsharing system e-Flinkster (the electric carsharing of Deutsche Bahn) in the conventional station-based Flinkster fleet and its linkage with Berlins´s public transport

57 João C. Ferreira, V. Monteiro, João L. Afonso, “Cooperative Transportation System for Electric Vehicles,” Annual Seminar on Automation, Industrial Electronics and Instrumentation 2012 - SAAEI'12, pp.452-457, Guimarães, Portugal, Jul. 2012, ISBN: 978-972-98603-5-5.

system, the subsequent project BeMobility 2.0[58] (2012-2014) concentrated on the optimization and extension of e-Flinkster and the installation of the new electric flexible carsharing offer Multicity Carsharing in the city of Berlin. In contrast to station-based offers with fixed parking spaces, return of vehicle to the station where it was rented and booking in advance, flexible carsharing has no fixed stations. The cars are distributed within a designated business area of a city offering spontaneous booking and instant access- pay as you go, one-way and open-end-trips. Multicity Carsharing was the first flexible carsharing in Berlin with EVs introduced by Citroën in cooperation with Deutsche Bahn. The offer was launched in August 2012, starting out with 100 vehicles. Another 250 vehicles were added in April 2013, meaning that the entire fleet consists of 350 EVs at present. Multicity Carsharing provides instant access, open-end and one-waytrips. The cars can be parked within the defined business area which mainly covers the Berlin S-Bahn circle including the city center of Berlin with an area of about 88 km² (Berlin 892 km²) where about 1 million of the 3,5 million citizens of Berlin live (as of 2012). The fleet consists of the car model Citroën C-Zero a purpose designed electric car.

The project has focused on the following three research questions: • Do EVs go with flexible carsharing? • Does flexible e-carsharing substitute journeys made with public transport? • Is flexible e-carsharing so attractive that it would be as possible main means of transportation?

Even though the results suggest that a majority of trips would have been made with public transport if carsharing would not have been available, the respondents stated that these trips were made in situations when the use of public transport was not an adequate and attractive alternative. This usually happened in the case of disruptions, bad connections, or unsufficient timetable intervals. Altogether, flexible e-carsharing is no competition for public transport, but rather complements the system and compensates for its weaknesses. Furthermore, the average use frequency of an e-carsharing user is too low so that a competition with public transport can be excluded. Rather, flexible ecarsharing is an additional component for an attractive city-friendly integrated mobility.

Is The research project BeMobility 2.0 showed that flexible carsharing works very well with EVs from the users´ perspective. The often criticized limited range of EVs is not a barrier for non-users and users of flexible carsharing as average trips lengths are no longer than 6 km. Rather than focusing on the limited range of flexible e-carsharing the service itself should be improved. For example, the number of vehicles, the size of the business area and the price affect the estimation and also the use of carsharing services significantly.

The results of the surveys suggest that flexible e-carsharing substitutes trips involving different modes of transport. Mostly public transport is concerned, however, due to the low

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58 FREE-FLOATING E-CARSHARING: INTEGRATION IN PUBLIC TRANSPORT WITHOUT RANGE PROBLEMS Josephine Steiner, Sandra Wappelhorst, Andreas Graff, InnoZ – Innovation Centre for Mobility and Societal Change, Germany use frequency this is not a threat for public transport. Quite the contrary, public transport gains attractiveness, since flexible carsharing is a promising complement.

11.7 Country specific information

11.7.1 Austria

Key barriers for use of pedelecs and e-cars & Assessment of community readiness for their usage

Charging station - An important point for potential users of electric vehicles and pedelecs is the parking or loading option at home and at work. The availability and infrastructure has to be given for the optimal usage of electric vehicles and pedelecs. Therefore, the mobility and charging behaviour has an influence on the infrastructure requirements and the use of pedelecs and e-vehicles.

Price/Investment costs – The average price of a new e-car is actually around 30,000 €. That could change over time as more sales mean greater economies of scale and lower per-unit manufacturing costs.

Pedelecs costs are naturally significantly lower but need investments into infrastructure and public buildings (parks) to be used optimally.

Limited range – Fossil energy 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 fewer miles 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.

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.

Lack of charging stations - One of the moves that made petroleum-based automobiles popular was the building of fuel stations all over the country. Suddenly drivers could refuel and avoid getting stranded. There isn't a broadly-available equivalent that will necessarily work with all electric cars. People driving any electric car need to be able to plug in wherever they are.

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).

Knowledge - The knowledge of the customer that there are sufficient and free charging stations available in the surrounding area and long distances at any time, and the charging process does not take much longer than conventional fuelling operations, will significantly support the spread of e-mobility. 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.

The following disadvantages, threats or barriers for e-mobility and pedelecs can be listed:

- "Competition" to public transport infrastructure has to be avoided. There should rather be highlighted various synergies and correlation between public transport and e-mobility.
- High price of vehicles, especially of the battery systems is still fact. Funding possibilities and/or tax privileges should be established or continued.
- There is still a small range in comparison to vehicles with combustion engines. Larger soaring capacity should be made available.
- At present (2017) the oil price is comparable low and a switch to an e-vehicle shows no economic benefit. CO2 tax or similar actions to promote the change into e-mobility is recommended.
- The recharging cycles of batteries are limited and the capacity of them lowers during life time which release uncertainty. Additional research and higher quality (or lower price) for batteries is recommended.
- There is lack of charging stations and uncertainty concerning of full charging service in the future.
- Efforts to reach behaviour change is necessary: the use of e-mobility mostly requires a change of behaviour of costumers (less driving speed, energy saving oriented driving, higher planning for refilling the battery)
- Inconsistent subsidies which are changing from region to region and from time period to time period generate uncertainty and should be overcome by stable laws and/or funding options.
- Uncertainty by long distance driving whether charging station will be available and in function should be overcome by the implementation of stable service for long distance drivers with e-mobiles.

Main solutions/measures for overcoming barriers in Austria

While strategies, ideas, objectives and numerous projects on the use of alternative fuels in transport are available across Austria, a clear discrepancy between the sensible incentives and their perceived implementation was apparent. A large proportion of the participants thought the following measures would be useful, however, they were hardly implemented in Austria:

- Pitches or empty piping, which were required to be equipped with loading infrastructure, for simple retrofitting in residential buildings or commercial fleets
- Public procurement of alternative driven vehicles
- Use of electric vehicles in city logistics, taxis or car sharing
- Definition and marking of particularly clean vehicles – will be topics in the future development nationally and regionally in Austria
- The implementation of the necessary infrastructure according to the needs for e-mobility is proposed.

SWOT analysis for pedelecs and e-cars establishment

Strengths	Weaknesses
• alternative "green" mobility • CO2 reduction • independece of oil, if charging possibilities are given • possibility of fuelling at home • less "sweaty" with pedelecs - lower mental resistance to use a bike • pedelecs enable to reach further distances than ordinary bikes	• lack of charging infrastructure - range limitations (e-vehicles) • high investment costs • need of pedelecs infrastructure (roadways) in urban areas • battery lifecycle • pedelecs can be perceived as slow
Opportunities	**Threats**
• unlimited ressources (if energy is produced from renewable energy) • clean environment • pedelecs can replace car useage in some circumstances if cargo space is given	• used charging energy will be produced from fossil resources • lack of public accaptance, knowlege and charging stations • low oil price • no parking space for pedelecs at work or public places

11.7.2 Croatia

Besides the lower purchasing power, late accession of Croatia to the European Union there are other reasons why Croatia is lacking in the usage of electric vehicles. These are some of the barriers that are recognized as essential for the larger implementation of electric vehicles;

Poor market opportunities for electric vehicles in Croatia.

Since Croatia is a rather small country, many European producers have decided not to offer their electric vehicles in Croatia, because their introduction would require large costs in servicing and maintenance facilities, and training of employees. This has decreased the market competition, resulting in much higher prices than in other markets of Western Europe.

Lack of charging infrastructure outside large urban areas

While the charging infrastructure in urban areas has increased dramatically in last three years, there is a problem of availability of fast charging stations on highways that connect large cities in Croatia. Therefore, the problem occurs when large distance trips have to be undertaken, for example a trip between Zagreb and the South of Croatia is not possible on the highway A1 because there are no charging facilities on that road, which is the main artery of the Croatian highway system.

Poorly developed system of cycling lanes in Croatian cities.

In order to increase the number of users of Pedelecs/eBikes basic cycling infrastructure has to be developed. Although Pedelecs/eBikes can develop rather high maximum speeds, they are obliged to use cycling lines. Because of this speed factor, safety is also an issue that has to be taken into account and this could only be guaranteed by a good cycling infrastructure.

Figure 11-1 Uneven dispersion of charging stations in Croatia

Preference of the general public for electric vehicles (e-cars and Pedelecs/eBikes) in Croatia was closely connected with the movement of fossil fuel prices that occurred in the last ten years. This is very specific for the middle-income countries like Croatia, where transport, that is mostly based on private car usage, due to the lack of appropriate public transport services, represents a large part of the budget of the average Croatian household. The interest and the approval of electric vehicles were at the highest just before the prices of fossil fuels started to decline because of the economic crisis. Namely, due to the high economic development rate in the rest of the World before the crises, fossil fuel prices reached their maximum levels and declined in the crisis period because of the lower demand.

Because of this, the electromobility topic was steadily declining in the last couple of years. Also, the offer of new electric vehicles from various manufacturers did not increase the readiness of the general public to purchase new electric vehicles because the prices of the vehicles did not decline as expected.

Incentives, like the before mentioned project “Vozimo ekonomično” of the FZOEU can help in popularising electric vehicles, but in order to do so, it has to be consistent and predictable until the point where it interferes in the market of electric vehicles in a way that it enables a market competition which will lower the prices of the vehicles.

Electric cars SWOT analysis

STRENGHTS	WEAKNESES
• political approval of electric vehicles, • developed road transport and infrastructure	• high prices of electric cars, • limited range of electric vehicles,
OPPORTUNITIES	**THREATS**
• lack of presence of conventional carmakers' products, • usage of energy produced locally/nationally • lower electricity prices compared to conventional fuels	• lower prices of fossil fuels, • insufficient electricity grid for the charging infrastructure

Pedelecs/eBikes swot analysis

STRENGHTS	WEAKNESES
• optimal for urban rural commuting (distances over 6 km), • cheap to implement, • can be used in conventional public bike systems, with the usage of RES and smaller battery storage systems can be off grid	• the usage depends on the weather conditions.
OPPORTUNITIES	**THREATS**
• lack of available public transport system in many Croatian cities and municipalities,	• lack of funding for cycling infrastructure, • low safety record due to higher speeds of the bikes and the **overall lower cycling culture of the cyclists**

11.7.3 Czech Republic

Main advantages and disadvantages of pedelecs and e-cars

The analysis of advantages and disadvantages for using e-cars and pedelecs is conducted particularly from the viewpoint of their use in urban traffic. Since each type of vehicle has its own main, or specific, area of usage, we cannot determine, based on the conducted analysis, whether some of the compared vehicle types are more suitable for urban traffic. It particularly depends on the needs and preferences of users. The analysis results are summarized in the following Tables.

Pedelecs advantages	E-cars advantages
• not limited by charging infrastructure, • battery can be taken away in most cases and charged with the use of a standard mains outlet, • allowed entry to urban centres, • allowed in marked paths in protected reserves, national parks, mountains, etc., • are allowed to use designed traffic lanes	• can transport more people/goods, • driving comfort, • protection against adverse weather conditions, • exempt from road tax,
Pedelecs disadvantages	**E-cars disadvantages**
• reduced comfort, • no protection against weather conditions, • limited travel speed,	• limited entry to urban centres (entries to town centres in the Czech Republic are usually time limited, vehicle drives are not considered), • limited parking capacity, lengthy searching for parking place, particularly in large cities (generally applicable for all motor vehicles)

Key barriers for use of pedelecs and e-cars and main solution/measures for their overcoming

Public charging infrastructure is one of the key barriers for using e-cars in the Czech Republic. Its development is uncoordinated and the infrastructure is randomly deployed in terms of territorial coverage. The charging stations are mainly installed in shopping centres, parking houses, hotel premises, authorities, petrol stations, etc. They are generally located in places where drivers can partially charge the battery during a break before another trip. In contrast, the public charging infrastructure is virtually non-existent in residential areas and in suburbs, where the concentration of people and vehicles is the greatest. According to the data of the Czech Statistical Office, 55 % of households (i.e. 2,257,978 in absolute numbers) are living in blocks of flats. In case a house has no land where access and parking of vehicles is possible, then there are no conditions for the installation of the private charging infrastructure. This concerns the vast majority of cases. Pedelecs are often stored in common basement or underground storage rooms of the houses. Those rooms may be equipped with mains outlets. However, in case more pedelecs are stored or the outlet has no gauge, there may be a problem with the charging a fee for consumed electricity. This may lead to a situation that their charging is not allowed in common rooms of blocks of flats.

Another key barrier from EV user viewpoint is ***a range of types of standardised outlets and access cards***. There is sometimes a problem with obtaining the card, e.g. if EV user is not a customer of a given distributor, and with their acceptance in charging stations of other networks (networks of different energy distributors may not accept all cards). Internet mapping applications usually contain information on available outlets, but the information on accepted access cards and payment methods is not typically provided. In addition, there is a missing information source concerning the existing networks of the charging infrastructure, existing types of cards and their usability, which would provide complex information in a single site. This barrier is not only a local feature, a similar situation occurs across the whole EU.

Acquisition price of new vehicles. According to the data of the Czech Statistical Office, 33.82 % households use personal vehicles for the distance of up to 5,000 km and 32.46 % households use personal vehicles for 5,000-10,000 km per year (*Spotřeba*, 2017[59]). Despite the decrease in battery prices, the acquisition price of new vehicles still exceeds the savings on the operation costs along the vehicles life span. The measures to overcome the barrier may include support for vehicle acquisition, or new financial tools for the purchase of complete vehicles, or for the purchase of vehicles and accumulators separately, e.g. in a form of operative leasing, battery rental, etc.

Vehicle servicing. Regarding the low share of EVs, we can expect longer waiting times for potential repairs of electric drives and delivery of spare parts. Electric vehicle mechanic must be qualified in accordance with Decree No. 50/1978 Coll. on professional qualification in electrical engineering. At the moment there are very few such qualified mechanics in repair shops. This leads to limited offer of suitable service shops. This fact was confirmed by a study of TÜV SÜD performed in Germany (Švihel, 2010[60]).

SWOT analysis for pedelecs and e-cars establishment

Strengths	Weaknesses
• **availability of electricity,** • **relatively favourable price of electricity,** • **separate tariff for EVs,** • **active public clubs and public associations,** • **development and production of**	• number and deployment of public charging stations, • various types of access cards, • acquisition price and offer of vehicles, • (low)density of servicing network, particularly regarding independent

59 Spotřeba paliv a energií v domácnostech [Online]. (2017). Praha, Czech Republic: Český statistický úřad.

60 Švihel, P. (2010). Autoservisy podceňují elektromobily. Mechanici o nich neví dost informací [Online]. In Lidovky. Praha: Mafra. Retrieved from http://byznys.lidovky.cz/autoservisy-podcenuji-elektromobily-mechanici-o-nich-nevi-dost-informaci-15l-/auto.aspx?c=A100423_105118_ln-auto-aktuality_glu

vehicles/components, • available non-cash payments for electric energy, • offer of pedelecs and conversions, • vehicles are exempt from road tax,	repair shops network
Opportunities	**Threats**
• advantages in operation, • battery rent, • acceptance of more access cards at charging stations, • phone application for access and paying for charging EV, • limiting operation of conventional vehicles in urban areas, • public support, awareness, promotion	• growth in electricity prices/reduced price of fuels for ICE, • stagnation of vehicle prices, • negative medialization

11.7.4 Hungary

The most prominent common barrier in Hungary regarding the use of pedelecs and e-cars is their currently high price. Pedelecs are also often confused with e-bikes and their larger power output, which in turn qualifies them as mopeds, which in turn require driver's permits. Community readiness is also hindered by the misconception that the use of pedal electric cycles is un-sporty, while people who drive cars usually do not think to consider pedelecs as a comfortable substitution for their cars. One possible solution for this, proposed by the Szélessáv Alapítvány is for automobile service stations to acquire pedelcs and offer them to drivers in lieu of "replacement cars" while their own vehicle is under repair, e.g. for the 1-2 hours a seasonal oil change takes, this way car drivers would have an opportunity to gain personal experience with the comfortable use of pedelecs.

Regarding the use of electric cars, apart from the main deterrent being the high price, the main concern is the lack of a suitable charging station network. Currently in Hungary there are approximately 160 charging stations present, all within cities, and mainly in the Budapest metropolitan area. It is not possible to make long distance trips within the country.

The fortunate news is that the Hungarian Government is taking steps to facilitate the installation of further charging stations. Namely, it has allocated a budget for a funding scheme that municipalities with a minimum population of 15,000 could apply for in 2016. The optimistic estimate is that the allocated budget can cover up to 1000 new charging points.

Another direct incentive funding scheme (2016-2017) is for co-funding (up to 21%) for the purchase of electric cars (only PEV's).

11.7.5 Romania

Key barriers for the use of pedelecs and e-cars in Romania:

- ***Lack of clear legislation framework for the e-vehicles*** - a new legislation initiative regarding the way of functioning for electric vehicles is prepared in the Parliament. The legislative proposal will establish the regulatory framework and measures for the installment of alternative fuel infrastructure, in order to minimize oil dependence and mitigate the impact of transport on the environment.

- ***Lack of infrastructure*** - the authorities have created a financing scheme to create 6000 EV charging stations by 2020, even though there are about 120 1 charging stations in all the country. The program was conceived as a multiannual, with an indicative target of 6000 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.

- ***High price of new e-vehicles*** - The Rabla Plus Program, is a program special designed for granting the procurement of Electric Vehicles or hybrid cars. The program was granting about 1,000 EUR for hybrid cars procurement and up to 4,500 EUR for electric vehicles until 2016, when the Ministry of Environment, Waters and Forests doubled the amount for grants (2,000 EUR for hybrid, up to 10,000 EUR for EV).

- ***Lack of awareness of citizens*** - Even though there are emerging programs for easier access to wide public, the media isn't promoting enough the concepts of e-vehicle, so the trust of citizens is not built.

- ***Poorly developed system of cycling lanes*** – even though some cities are more bike-friendly (Timisoara, Cluj-Napoca) and some organisations that promote cycling have emerged, Romania is not yet a bike-friendly country in terms of infrastructure. In this respect, many citizens don't feel safe enough of using bikes/e-bikes/pedelecs.

SWOT analysis for electric vehicles establishment

Strengths	Weaknesses
• **Environmentally friendly.** • **Low maintenance costs** • **Almost 0 CO_2 emissions.** • **Incentives for purchase of e-cars from the Romanian Government.** • **Cheaper use on long term than normal vehicles**	• High purchase price • Limited range and long recharging time. • High cost of batteries • Battery lifetime • Lack of clear legislation
Opportunities	**Threats**
• **Financial grants from the Romanian Government.** • **New jobs for infrastructure development** • **Free parking in some cities**	• Lack of e-charging infrastructure • **Excess of different providers of charging services with incompatible systems.** • Battery durability. • Lack of funds for development of needed

• **Development of public-private partnerships for infrastructure**	infrastructure

11.7.6 Slovakia

The current situation and the opportunity for development of electromobility sector in Slovakia is documented by the SWOT analysis below[61]:

Strengths	Weaknesses
• **Strong position of the automotive industry in the national economy and developed network of suppliers for car manufacturers.** • **Strong position of electric engineering in the national economy.** • **Availability of experts in technical fields, including IT.** • **Relatively low staff costs compared to key markets for electromobility.** • **A functioning platform and expert dialogue focused on development of electromobility in the SR.** • **Suitable energy mix.** • **High popularity of cycling, mainly leisure-time mountain cycling (because of Peter Sagan)**	• **Low R&D expenditures.** • **Undeveloped research base of the automotive industry in the SR.** • Lagging behind neighbouring countries. The neighbouring countries, particularly Austria and the Czech Republic, started to systematically support electromobility several years before. • Harmonization of standards and norms. • Currently insufficient infrastructure for the recharging of electromobiles. • **Lower sensitivity of societies to adoption of green or "innovative" solutions.** • Still small user comfort from the point of view of the need for frequent recharging. • High costs for end consumers in terms of initial investments in the vehicle. • **Regarding usage of pedelecs, low developed cycling infrastructure (cycle routes network) in SK-cities**
Opportunities	**Threats**
• **Lower dependence on crude oil.** • **Reduced green-house-gas emissions and less air-pollution at places with dense traffic.**	• Decrease in the GDP growth rate. • Drop in the purchase power of the population and of companies. • Inefficiently expended investments in electromobility development.

61 Strategy on development of electric mobility in the Slovak Republic and its influence on the national economy of the Slovak Republic, approved by the SR Government resolution No. 504/2015 on 9 September 2015

• **Reduced noise emissions from transport at places with dense traffic.** • **Generation of new qualified jobs.** • **Development of research base in certain areas related to electromobility.** • **Innovation impulse for car manufacturers and their suppliers.** • **Creation of new innovative business models and services.** • **Use of electromobiles in smart grids.**	• Delayed drops in prices of inputs as a result of a slow introduction of economies of scale with mass production. • Lagging behind competitor countries; unsuccessful stimulation of investments and employment.

11.7.7 Slovenia

SWOT analysis - e-cars

Strengths	**Weaknesses**
• **Low maintenance costs** • **Environmentally friendly.** • **Good energy efficiency.** • **Almost 0 CO_2 emissions.** • **Quiet. Great driving experience.** • **Incentives for purchase of e-cars from the Slovenian Eco Fund.** • **Electricity is cheaper than fuel. Low energy cost per km.**	• High purchase price compared to conventional cars. • Limited range and long recharging time. • Environmental unfriendly production and battery. • High cost of battery rent or new battery.
Opportunities	**Threats**
• **Financial incentives from the Slovenian Eco Fund.** • **Possible free charging on some charging stations.** • **No road fund in Slovenia.** • **Car renting and sharing business opportunities.** • **Possible free parking spots or reserved parking spots for e-cars in most urban centers.** • **Protected areas will be more accessible - development of tourism.**	• Lack of public charging stations. • Excess of different providers of charging services with incompatible systems. • Many different charging plugs. • Battery durability. • Uncertain resale value. • Higher energy consumption and possible higher electric energy prices.

SWOT analysis - pedelecs

Strengths	Weaknesses
• **Almost no additional maintenance cost compared to conventional bike** • **Environmentally friendly.** • **Good energy efficiency.** • **0 direct CO2 emissions.** • **Usability.** • **Personal exercise.** • **Battery can be removed easily and charged indoors (in most cases).** • **Wall outlet is enough for charging – no need for charging station infrastructure.**	• Long battery charge time. • Battery cycle life. • **Bike is heavier due to motor and battery.** • Indirect environmental emissions. • High prices of e-bikes and conversion kits. •
Opportunities	**Threats**
• **Financial incentives from the Slovenian Eco Fund.** • **Possible free charging.** • **Business opportunities – bike sharing.** • **Less cars in the cities.** • **Good alternative for short distance travels.** • **Development of cycling infrastructure.** • **New innovations.**	• Use of e-bikes as a mean of transport in bad weather. • Unsafe in traffic if there is no specific cycling path. • Can be stolen more easily than electric car.

11.7.8 Montenegro

There are great advantages in the use of electrical vehicles powered by batteries or pedals, especially within urban, rural and coastal areas. If the use of the aforementioned vehicles is applied to a satisfactory level, the levels of harmful gases in the air would be significantly reduced, affirming the self-claimed title by the republic of Montenegro as an Ecological State. Use of aforementioned vehicles would also contribute to reduction of traffic problems and jams, which are very much present in the urbanized areas, considering the very common issue of narrow roads and lack of parking spaces.

11.7.9 Serbia

The key barriers for implementing concept of pedelecs and e-cars into urban transport system:

- lack of a clear legal framework;
- high purchase price of the pedelecs and e-cars
- expensive charging infrastructure; high initial price;
- lack of a systemic approach to subsidizing the infrastructure and vehicles;
- lack of unique vehicle and battery quality standards;

- replacement of the batteries is very expensive; the batteries lose their full potential after a certain number of charging/recharging;
- insufficiently developed citizens' awareness of the advantages of e transport;
- insufficient number of pilot projects;
- lack of media campaign - media approval of the implementation of such a concept; the price of the needed infrastructure is very high and this can have a negative media response

12 Plans and incentives for further development

Electromobility commitments are large - from increasing energy diversification by reducing dependence on oil, environmental protection, long-term stimulation of the economy and the development of new technologies and the whole sectors.

In its path, however, there are substantial technological, social and economic barriers. The price of electric cars and batteries is still high, too long recharging times and insufficient infrastructure. Governments of several countries have already applied various forms of State aid in the form of subsidies for the purchase of electric vehicles, various tax concessions and cancellation of different fees.

The following tables show and shortly describe various incentives for e-cars deployment available in eGUTS countries.

Table 12-1 Availability of various incentives for e-cars deployment in eGUTS countries

Incentive/Country	Austria	Croatia	Czech Republic	Hungary	Romania	Slovakia	Slovenia
Purchase Subsidies	x				x	x	x
Registration Tax Benefits	x	x	x	x	x	x	x
Ownership Tax Benefits	x		x	x	x		x
Company Tax Benefits	x			x			
VAT Benefits	x						
Other Financial Benefits							
Local Incentives	x			x		x	x
Infrastructure Incentives					x		

Source: EAFO, 05/2017

Table 12-2 Detailed description of various incentives/benefits for e-cars in eGUTS countries[62]

62 EAFO, 05/2017, http://www.eafo.eu/incentives-legislation

Incentive category	Description
AUSTRIA	
Purchase Subsidies	Private customers: - 4.000 Euro per BEV (2.500 from the federal government; 1.500 additional rebate by the industry) - 1.500 Euro per PHEV (750 by the federal government; 750 additional rebate by industry) - 2 additional conditions: Purchase price not over 50.000 Euro incl. VAT & minimum electrical range of 40 kilometers (for PHEVs) Businesses, municipalities - 3.000 Euro per BEV (1.500 from the federal government; 1.500 additional rebate by the industry) - 1.500 Euro per PHEV (750 by the federal government; 750 additional rebate by industry) - No additional conditions Additional funding (private businesses) for L1 + L3 category, co-financed by the 2wheelers-industry (375 Euro each – total 750 Euro) Additional funding for other vehicle categories, buses, LDV, HDV for businesses (up to 60.000 Euro)
Registration Tax Benefits	Registration tax (Normverbrauchsabgabe): All cars below 90g/km are tax-free
Ownership Tax Benefits	BEVs are 100% tax-exempt from all relevant federal taxes, except VAT: - Circulation tax (motorbezogene Versicherungssteuer): The tax is calculated on the basis of the engine’s horsepower. PHEV's have to pay only for the ICE part.
Company Tax Benefits	The in-kind benefits for the private usage of company cars is taxed with 0% (formerly 18%). PHEV's remain at 18%. Cars > 130 g/km were raised to 24% (the treshold comes down 3 g/km every year until 2020).
VAT Benefits	Company BEV's are exempt from VAT (eligible for pre-tax deduction).
Local Incentives	- Free Parking: Several bigger cities have already exemptions from parking charges in place The Austrian automobile club ÖAMTC publishes the incentives granted by local authorities on its website (www.oeamtc.at/elektrofahrzeuge).
CROATIA	

Registration Tax Benefits	Tax reduction / exemption - CO_2 based tax
CZECH REPUBLIC	
Registration Tax Benefits	No purchase tax
Ownership Tax Benefits	Electric, hybrid and other alternative fuel vehicles are exempt from the road tax (this tax applies to cars used for business purposes only).
HUNGARY	
Registration Tax Benefits	Electric vehicles are exempt from the registration tax.
Ownership Tax Benefits	Electric vehicles are exempt from the annual circulation tax.
Company Tax Benefits	0% Company Car Tax
Local Incentives	Free Parking: - Parking benefits - Free parking while charging Low / Zero Emission Zones - Traffic allowance during smog alert
ROMANIA	
Purchase Subsidies	- 4.450 Eur (20.000 RON) for the electric car (100%) - 1.100 Eur (5.000 RON) for the hybrid car
Registration Tax Benefits	Electric and hybrid vehicles are exempt from the registration tax.
Ownership Tax Benefits	Tax reduction - CO_2 based tax
Infrastructure Incentives	A refund of maximum 2.500 eur for Stations < 22kW and 30.000 eur for Stations > 22kW You can apply by 15 oct 2016 and eligible are cities over 50 000 citizens.
SLOVAKIA	
Purchase Subsidies	5000€ BEV, 3000€ PHEV, available until the end of 2017

Registration Tax Benefits	BEV pays the lowest (33€) rate of tax on motor vehicle .
Local Incentives	Parking discounts on selected cities
SLOVENIA	
Purchase Subsidies	- 7.500 EUR for the BEV M1 - 4.500 EUR for the BEV N1 and L7e - 4.500 EUR for the PCEV M1 and N1 and for the vehicles with the range extender - 3.000 EUR for the BEV L6e Subsidies are available for persons and companies. More information can be found on this link.
Registration Tax Benefits	BEV's pay the lowest (0,5%) rate of tax on motor vehicle. More information on this link.
Ownership Tax Benefits	Exemption from the payment of annual fees for the use of roads for BEV. More information can be found here.
Local Incentives	- Free parking spots for EVs. - Free parking while charging (in Ljubljana the parking/charging time may be limited to 3 hours).

12.1 Country specific information

12.1.1 Austria

Plans and incentives for further development- Austria/Burgenland

On January 1, 2016, a new company car tax came into effect, which places electric vehicles massively preferential or largely tax free compared to other driven vehicles. As well as on the employer's side, it remains to be seen how much this changed the fiscal framework on new registrations in the passenger car sector. Due to the fiscal focus on purely electric vehicles, it is expected that the 2015 trend in the direction of fossil driven vehicles will weaken again. Overall, however, the number of registrations should continue to rise, probably with a higher dynamic than that in 2015. In an international comparison it is still not clear whether it will be possible to reduce the gap to the leading group (Great Britain, the Netherlands, Sweden) leading from Norway.[63]

63 *https://www.bmvit.gv.at/verkehr/elektromobilitaet/downloads/emobil_monitoring_2015.pdf*

A big topic in e-cars development is car sharing in Austria. The sharing of vehicles brings important environmental benefits and helps to solve existing parking problems in large cities. In cities where the possession of their own vehicle is not absolutely necessary, systems are created which place the common autonomy in the foreground. In Austria, however, small communities and initiatives that increase mobility for their own citizens with a shared car are also becoming more important in the future. In addition to car sharing for private individuals, more and more models are also available for companies that allow car sharing as a complement to their own fleet. In order to make car sharing more interesting for other user groups, Opel offers "Car Unity", for example, a car-sharing platform, which allows vehicle owners to share their own e-vehicle with others.[64] In order to establish e-car sharing also in regional and small-town structures, the project "consciously e-mobile" was initiated, which is based on the project "e-commuter in Lower Austria". Municipalities support the establishment of e-car sharing. The Austrian company Caruso Car-Sharing has so far supported numerous private groups, municipalities and companies with individual peer-to-peer car-sharing projects. In Vorarlberg, Caruso now also offers a classic car-sharing offer. The first vehicles (Renault Zoe) are already available in the communities Bregenz, Hard, Dornbirn, Feldkirch and Bludenz. The goal is to be able to offer car sharing throughout the state. More and more individual initiatives of Austrian cities and municipalities are to be observed. Since summer 2015, for example, two electric cars have been available in Tulln for sharing. For an annual fee of 300 euros the use of a vehicle of 70 hours is included as well as the insurance, maintenance and acquisition costs as well as the charging current In the municipality Gaubitsch active in the e-mobility since 2012 the third Car -sharing vehicle.[65]

Event the ***use of electric bicycles can have a significant effect on the proportion of bicycles in the daily movement.*** In the course of the concrete study, the test group was shifting away from public transport as well as from the car to the use of the e-bikes.[66]

The overall transition to a decarbonisation of transport combined with the reduction of further air pollutants is dependent on governmental incentives. There are efforts worldwide to reduce traffic hazards. The initiatives are, however, very different and the discussion of effective measures to promote clean and environmentally friendly vehicles is still an ongoing process in Austria. Political measures are essential for the spread of electro mobility: the most comprehensive incentives are set in Norway, the Netherlands and California. The result: In these countries, there are about ten times more electric vehicles than on the international average or in Austria. Best practice measures become visible: stricter emission legislation, research funding and national strategies are necessary, but they are not enough to boost the vehicle market sufficiently. In addition, it is important to focus on purchasing incentives, the availability of charging infrastructure, and, above all, a well-coordinated package of measures at national, regional and local levels. [66]

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64 *http://www.opel.at/opel-erleben/ueber-opel/opel-news/2015/06/opel-carunity.html*
65 *https://www.bmvit.gv.at/verkehr/elektromobilitaet/downloads/emobil_monitoring_2015.pdf*
66 *https://www.bmvit.gv.at/verkehr/elektromobilitaet/downloads/emobil_monitoring_2015.pdf*

The Austrian Ministry of Transport, Innovation and Technology, the Federal Ministry for Science, Research and the Economy, the Federal Ministry for Agriculture, Forestry, the Environment and Water Management, who had already published the electro mobility plan for implementation in 2012, are jointly implemented by the Federal Ministry of Transport, Innovation and Technology.[67]

While strategies, ideas, objectives and numerous projects on the use of alternative fuels in transport are available across Austria, a clear discrepancy between the sensible incentives and their perceived implementation was apparent. A large proportion of the participants thought the following measures would be useful, however they were hardly implemented in Austria: Pitches or empty piping, which were required to be equipped with loading infrastructure, for simple retrofitting in residential buildings or commercial fleets; Public procurement of alternative driven vehicles; Use of electric vehicles in city logistics, taxis or car sharing; Definition and marking of particularly clean vehicles – will be topics in the future development nationally and regionally in Austria.

12.1.2 Croatia

Electric vehicles (e-cars and pedelecs) overall are a relatively new term in Croatian legal system. At the moment, there are no laws or other legal documents that would regulate electric vehicles and their use. Following the accession of the Republic of Croatia a number of European directives and strategies had to be adopted and developed. Many of the strategies that are developed or currently being developed are the precondition for the use of European funds that are available after the accession.

Even though there are a number of strategies developed, that would mention electric vehicles, just a few explicitly have electric vehicles as an integral part. These strategies are the following;

1. Transport development strategy of the Republic of Croatia
2. Sustainable development strategy of the Republic of Croatia
3. Low carbon development strategy of the Republic of Croatia

The Transport development strategy of the Republic of Croatia (2014-2020) is a document that was adopted in 2014. As such, it is giving guidelines for the set-up of the Croatian transport system until 2030. Among other, the need for the usage of more efficient and environmentally friendly vehicles is mentioned in the Objective 6. of the strategy "Improvement of the Transport System Organisational and Operational setup to ensure the efficiency and sustainability of the system". This objective has several goals, and those that mention electric vehicles are the following;

Goal 6e "Reduction/mitigation of the environmental impact" aims at avoiding, reducing or mitigating the environmental impacts of transport related activities. In particular, the

[67] *https://www.bmvit.gv.at/verkehr/elektromobilitaet/index.html*

Strategy aims at the reduction of transport-related GHG emissions (transport sector is one of the main sources) and atmospheric pollution. This will be achieved by a set of interventions both on mobility habits (modal shift to public transport, environmental friendly and soft modes such as pedestrians and bicycles) and improvement in vehicles technologies (more efficient and cleaner).

Goal 6f “Improvement of the energy efficiency” aims at improving energy efficient mobility habits. To achieve this objective, the strategy promotes a more efficient usage of the transport network, in particular shifting users to public transport and soft modes. It also promotes the use of modern, more efficient and cleaner vehicles that use alternative fuels and use energy recovery technologies.

The second strategy that mentions the use of electric vehicles is the **“Sustainable development strategy of the Republic of Croatia”** that was adopted in 2009. An important part of the Strategy is developing the transport infrastructure based on principles of sustainable development. Concrete goals that are set in this strategy, that are connected with the encouragement of the use of electric vehicles are as follows;

- Goal 1. To encourage the usage of clean fuels and technologies and the transition on energy efficient forms of transport.
- Goal 3. To enhance collective transport means, improve the quality of sustainable transport means and increase the use of cycling and pedestrian lines.
- Goal 5. Encourage the efficient use of personnel vehicles (efficient fuels, efficient was of driving).
- Goal 10. To increase the overall safety and the investments in the infrastructure for pedestrians and cyclists.

The third strategy that is probably the most relevant for the use of electric vehicles in Croatia is the ***“Low carbon development strategy of the Republic of Croatia”*** that is still in development. The draft documents of the strategy indicate that this document is the most comprehensive in terms of defining the use of electric vehicles. The strategy is being developed by the Ministry of Environment and Energy.

As a part of the process, the Ministry and the team of external experts have developed the White book for the development of the Low carbon development strategy that will serve as the base for the strategy. In the scope of this White book the scenario that was used for all calculations of CO2 reductions regarding transport is the following;

- Increase of the share of electric cars to 2% of total cars in Croatia till 2030 i.e. 70,000 vehicles and 25% share in 2030 i.e. 498,000 vehicles.
- Increase of the share of hybrid and plug-in hybrid vehicles up to 40% share (20% hybrid and 20% plug in hybrid) till 2050
- Increase of the usage of electric energy in public transport buses to 6% by 2050.

Interestingly, promotion of cycling and the development of cycling infrastructure has a relatively small part in the Strategy even though it can have a large impact on the reduction of CO2 emission in everyday transport.

The conclusions from the white book will be translated to the final version of the strategy in line with a complete set of measures how to achieve those goals.

Most of the incentives for the usage of electric vehicles in Croatia will derive from the "Operational programme for competition and cohesion" for the programme period 2014. – 2020.

12.1.3 Czech Republic

National Action Plan Clean Mobility (NAP CM)

NAP CM is based on Directive 2014/94/EU of the European Parliament and the Council of 22 October 2014 on the deployment of alternative fuels infrastructure. The document approved by the government on 20 November 2015 specifies the requirements for the construction of charging stations in the time period of 2020-2030 in compliance with this directive. The material contains a number of other measures that should be gradually implemented so that the number of e-cars and alternative fuel vehicles could be increased and the corresponding infrastructure could be built. NAP CM expects that the state administration will have at least one quarter of vehicles with alternative drives (not only electric vehicles) by 2020. The tool to assure the requirement is met should be a government regulation which specifies binding tender conditions for public contracts for vehicle acquisition.

National programme Environment – Awareness in the Field of Clean Mobility

Incentive programme. The support concerns complex projects leading to higher awareness of the issues of urban mobility and their potential solutions, which will contribute to improve air quality and quality of life in urban areas. The aim is to reach a positive change in the population behaviour through higher awareness of advantages of alternative technologies in transport, advantages of public transport, advantages of alternative possibilities of transport, advantages of non-motorised traffic, and potential measures for air quality improvement in urban areas. The programme is being implemented in 16 statutory towns in the time period of 2016-2017.

National programme Environment – Support of Alternative Transport Modes

Incentive programme whose aim is to reduce negative impacts of transport on the health of population and the environment, i.e. in particular reduced emissions from transport and reduced noise, through supported use of vehicles with alternative drives. The receivers of the incentives are public administration units (municipalities and regions) and city administration units of the capital Prague, allowance organizations of public administration units, public organizations, societies and subsidiary associations established by municipalities or regions, incorporated companies with at least 50 % ownership by municipalities and regions, limited liability companies with at least 50 % ownership by municipalities and regions. The subject matter of the support is an acquisition of new or newly converted vehicles with alternative power trains. Regarding EVs, acquisitions of vehicles are supported for the categories of L1e, L2e, L3e, L4e, L5e, L6e, L7e, M1, N1, M2, and M3 up to 7.5 tonnes. PHEVs acquisitions are also supported, but just categories M1 and N1 (up to 2.5 tonnes). The support comes in the form of a strictly set funds for individual vehicle categories.

Operation programme enterprise and innovation – Low-carbon technologies (activity – EMobility)

The incentive programme for the acquisition of vehicles with alternative powertrains and filling or charging stations for company vehicle fleets. The supported vehicle categories are L7e, M1, M2 and M3 up to 7.5t, and N1 up to 3.5t. Acquisitions of higher middle class vehicles, luxury vehicles, off-road vehicles, and sport vehicles are not supported. The eligible expenses include the acquisition of vehicle (percentage of price, e.g. 30 % for L7e category, 45 % for other categories), production of a business plan, construction of charging stations (includes acquisition of machines and equipment, buildings necessary for the installation of the technology, utility networks, preparation of project documentation)

12.1.4 Hungary

Currently the Hungarian Government has started implementation of national directives and legislation that are in line with the 2014/94/EU Directive on deployment of alternative fuels infrastructure.

In 2015 the Ministry for National Development adopted the Jedlik Ányos Plan, the official e-mobility concept of the Hungarian Government, which was approved in July 2015 with the government decision [No. 1487/2015. (VII. 21.) It covers the development of system of incentives (financial and non financial); adequate regulatory environment; expansion of charging infrastructure; Research, Development and Innovation; electrified community transport; pilot projects (e.g.: building and automotive test track in Zalaegerszeg; integration of community transport: buses, smart city solutions, e-taxis, car-sharing etc.).

The general Jedlik Ányos Plan is supplemented by the Jedlik Ányos Action Plan which includes ideas for concrete measures that can be taken. The developed incentive scheme has direct and indirect elements.

Direct incentives are: no registration fees for electric cars; zero company car tax; VAT on electricity of charging can be reclaimed by companies; allowance for night time charging; support for the purchase of electric vehicles (PEV's); establishment of charging infrastructure***. Indirect incentives*** proposed by the Jedlik Ányos Action Plan are: 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.

To promote the professional discussion of e-mobility stakeholders, the Jedlik Ányos Cluster was founded. The Cluster was established in 2014 primarily as a consultative and advisory platform for the government. It is involved in shaping the necessary development policies, exploring the economic, social and environmental potential of electric mobility and recommending actions for politicians and business. Currently the Cluster has over forty members and cooperating partners: among them – just to mention a few – there are car and bus manufacturers (Nissan, Porsche, Renault, MABI Bus), energy utility companies (E.ON, MVM Hungarian Power Company, ELMÜ), IT-companies (Qualysoft), international consulting firms (KPMG, PwC) automotive suppliers, mobility solution suppliers, the Hungarian Academy of Sciences, the Budapest University of Technology, research institutions, transport companies and several municipalities.

Regarding the use of pedelecs, there are currently ***no central legislation plans***, but various strategies/action plans have been developed by professional organisations. One such plan was developed by the Szélessáv Alapítvány (Broadband Foundation) and forwarded to the responsible parties at the Ministry of National Development. [Possible incentives for the national expansion of electro-mobility – comments by the Szélessáv Közhasznú Alapítvány [Broadband Foundation]] "A pedelec elterjedésének lehetséges ösztönzői a hazai elektromobilitás terén Szélessáv Közhasznú Alapítvány észrevételei" [68] This document explores not only incentives, but describes the positive aspects of using pedelcs, goals to be achieved, barriers to be overcome, possible measures to be taken.

They also wrote a summary about introductory and popularization opportunities of pedelecs[69], which includes ideas such as providing pedelcs as replacement vehicles for drivers waiting at the mechanic's for their car's service; introducing pedelcs at traditional bicycle shops and service shops, offering test rides; introducing pedelecs in the corporate world as a form of business commuting; providing municipalities with test pedelecs that citizens could rent free of charge for individual test runs to gain personal experience; inclusion in public health schemes. The summary includes suggestions for potential partners, financing, sustainability, barriers and advantages.

12.1.5 Romania

The "Green Charging infrastructure program"

The Ministry of Environment, Waters and Forests has launched a financing program that supports the acquisition of EV charging stations.

The Environmental authorities have decided to promote the use of electric vehicles, even though at this point the EV aren't so popular in Romania, mainly because of lack of charging infrastructure. In this respect, the authorities have created a financing scheme to create 6000 EV charging stations by 2020, even though there are about 1201 charging stations in all the country.

The program was conceived as a multiannual, with an indicative target of 6000 charging stations installed by 2020. The "Green Charging infrastructure program" is aimed at local administrations of urban areas with more than 50,000 inhabitants, public institutions and economical actors of these urban areas.

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68 http://www.gopedelec.hu/download/Osztonzok/Pedelec_osztonzok_Szelessav.pdf
69 http://www.gopedelec.hu/download/Osztonzok/Pedelec_megismertetesi_lehetosegek.pdf

The Rabla Plus Program

The Rabla Plus Program, is a program specially designed for granting the procurement of Electric Vehicles or hybrid cars. The program was granting about 1,000 EUR for hybrid cars procurement and up to 4,500 EUR for electric vehicles until 2016, when the Ministry of Environment, Waters and Forests doubled the amount for grants (2,000 EUR for hybrid, up to 10,000 EUR for EV).

As Romania is still in process of developing the electric mobility, the national policies are yet to appear. Still, there are some initiatives worth mentioning:

- National Organism for Standardisation of Romania

Standardisation for Smart Cities: In this context, the applicable standards for the design, construction and performance of equipment and components integrated into smart grids and smart buildings or homes are distinguished. The concept of smart cities / networks requires a permanent concern for research and innovation. In close connection with the latter, the attention of the technical standardization committees is focused on developing and reviewing standards that ensure real-time interoperability of systems for efficiency

Services for urban communities (ex: power supply, water and food, health, secure communications networks at all levels, etc.). Romania is aligned to EU Standards EN 61851 (SR EN 61851) concerning Electric vehicles conductive charging system and to M/468 EN concerning the charging of electric vehicles 2.

- The Ministry of Transport

In 2003, Order no .211/2003 concerning cars homologations defined for the first time the use of electric and hybrid vehicles and technical requirements.

- updating the existing format of car registering by generating a new category: hybrid/electric;
- Legislation introduction of a new category regarding vehicle consumption: "electric energy".

12.1.6 Slovakia

According to the SEVA (Slovak Electric Vehicle Association), the support of e-mobility in the Slovak Republic is currently inadequate and non-systemic from the side of Slovak government. Except of elaborating and adopting two strategy documents on national level (The Strategy on development of electric mobility in the Slovak Republic and its influence on the national economy of the Slovak Republic and the National Political Framework for the Development of the Alternative Fuels Market), as the result of transposition of the European Parliament and Council Directive 2014/94 / EU on the deployment of alternative fuel infrastructure, at the present, there is only one direct specific mechanism to tackle e-mobility in SR, and it is the purchase incentive for a new BEV or PHEV buy. However, this incentive is limited in time (is valid only up to the end of 2017), respectively in volume (up to 5,2 mil.Eur).

Thus, development of e-mobility in Slovakia currently depends and mostly is dragged forward by the activity of private companies (Greenway operator, Voltia, Ride s.r.o....)and energy producers and distributors (ZSE, VSE, Slovenské elektrárne etc.), who are either active in building-up charging stations or offering various concept for leasing or renting e-cars mainly for business purposes.

CONTRIBUTION 5 000 € FOR BEV AND 3 000 € FOR PHEV

There is nowadays only one direct incentive supporting e-mobility in SR and it is the contribution of 5000 eur for BEV and 3000 eur for PHEV. It is the initiative of the Automotive Industry Association (ZAP) of the Slovak Republic and the Slovak Government. A subsidy project to support electromobility was launched on 11 November 2016 and will run until the end of 2017 or until funds have been exhausted. An amount of € 5.2 million was earmarked to support the development of electromobility, with € 5 million coming from the Recycling Fund and € 200,000 from ZAP funds.

The basic condition for obtaining the subsidy is that it is a new, yet unregistered car sold in Slovakia in the plug-in version, i.e. with a battery rechargeable by electricity from a socket. Interested parties just ask for a subsidy at the vendor. The new pure electric drive is supported by a contribution of € 5,000, and in a hybrid combination with an additional combustion engine, the new owner will receive a € 3000 grant.

A citizen, a business entity, as well as cities and municipalities can ask for a contribution (subsidy). Supported e-vehicles are the M1 category, passenger cars and N1 - small trucks up to a total weight of 3.5 tons. However, the entire amount of the contribution will not be paid by motorists directly when the vehicle is bought. In support of EUR 5,000 for BEV, the owner of the new electric car will, after joining the terms of the contribution and registration of the vehicle, immediately acquire 2,000 euros. The second 1,500 euros will be received next month after the first registration year in Slovakia and the remaining 1,500 euros next month after the second registration year in Slovakia. The aim of this procedure is to prevent the speculative export of electromobiles across borders. The condition is also to register a vehicle in Slovakia at the latest by the end of 2017 for a period of at least two years.

According to the current data of the ZAP[70], 76 motorists expressed their interest for subsidy in the first six weeks. For BEV expressed interest 63, thirteen candidates reserved subsidy for plug-in hybrids (PHEV). In December 2016, ZAP SR registered 32 additional grant applications. The most popular mark between electric vehicles is the Nissan followed by KIA.

In addition, the manufacturer / retailer NISSAN SK provided a reduction of EUR 2000 for each newly purchased Nissan Leaf or Nissan e-NV200 during the period 1.1.2016 to 31.3.2017.

Business Lease - Operative Leasing

The Slovak leasing company "Business Lease" has begun to engage strongly in electromobility two years ago. Thanks to its know-how and experience, it is even now the only company in Slovakia that Tesla has chosen as a partner who can provide Tesla's

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70 http://www.energie-portal.sk/Dokument/o-dotaciu-na-elektromobily-ahybridy-poziadalo-uz-76-ludi-najvacsi-zaujem-je-o-nissan-103444.aspx prestigious electric cars with the Tesla Experience service package. Just recently, Business Lease introduced a luxury SUV Tesla X already available for operative leasing.

The company records the growing interest in electric vehicles. Companies are becoming increasingly aware that operating leases allow them to use an electric vehicle without a high entry investment. The total monthly cost of using an electric car can be set by a company comparable to the total cost of the combustion engine vehicles. With optimized charging solutions, operating costs are lower than those of the combustion engine. The leasing company takes the risk of developing the residual value and the costs of maintenance and servicing of the vehicle. The company then only uses the vehicle's use time, ie the difference between the acquisition cost and the residual value.

Business Lease recently launched the Kia e-Soul, Nissan Leaf, VW e-Up and e-Golf campaign, where, ***in addition to the operative leasing of electric cars it provides access to the charging infrastructure, respectively it secures the charging station for the company.*** Companies can also benefit from a state subsidy of 5,000 euros for electric cars and 3,000 euros for hybrids, which will reduce the cost of operating the electric vehicle even under operative leasing.

12.1.7 Slovenia

Incentives for the development of e-mobility in Slovenia are founded through the Slovenian environmental public found – Eco Found[71]. 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 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 converting 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 converted electric vehicle without CO2 emissions in the category M1;

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71 https://www.ekosklad.si/fizicne-osebe/nameni/prikazi/actionID=141

- 4.500 € for a new or a converted 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 converted 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.

Public call for ***loans for environmental investments 55PO16 (citizens) and 56PO16 (legal entities).*** The subject 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 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.
- 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 €.

12.1.8 Montenegro

Montenegro has neither any defined strategy at local nor at national level for the use of electrical vehicles for public transportation, and the existing national legislation barely considers the field of production and use of electric vehicles. 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 legislation in the field of vehicles, and also proposing the ratification of decrees on offering incentives for construction, production and/ or use of electric vehicles e.g. Pedelecs.

12.1.9 Serbia

Implementation of this project in Serbia, creating a Local Action Plan for the city of Kragujevac, promoting the concept of e-mobility and sharing experiences will create preconditions for the wider application of the concept of Electric, Electronic and Green Urban Transport Systems in Serbia.

13 Conclusion

The main global factors of electromobility development include:

- **CO2 emission regulation**;
- **enhancement of air quality, particularly in cities**;
- **safety of supplies**: Dependence on crude oil supplies, particularly from politically unstable regions, represents one of the most significant geopolitical challenges and the reduction of such dependence is one of the main EU objectives. Any risks of limitation of supplies, or of abrupt price fluctuations, are perceived as a major threat. Use of electricity, which, in addition, will be produced locally in an increasing extent, helps decrease such exposure.

The following influences, which also support the electromobility development trend, need to be added to such factors.

- **Customer approach:** There is also a change in customer perception. Not only surveys but also real observations show that in the last few years the population has been increasingly more interested in solutions and products with a lower impact on environment, not only as a result of growing prices or regulatory limitations but also thanks to an active approach of people who are increasingly more willing to pay more for a cleaner solution. A socially more responsible approach is also seen in companies which operate major fleets.
- **Readiness of suppliers:** Technological development gradually helps achieve an acceptable driving range of electromobiles which, moreover, may be efficiently prolonged using fast charging. The price of vehicles with electric drive is gradually falling and their offer is being extended. All major car manufacturers are basically active in the area of electromobility and they are ready to respond to a growing demand.

Regarding the eGUTS (resp. DTP region) countries, perhaps with the exception of Austria, it can be said that the electromobility in this region is indeed at the very beginning. This concerns the area of strategic and legislative documents as well as the charging infrastructure and the share of e-cars and pedelecs on the market as well as various support mechanisms and the public's inclination to change in favor of e-mobility. To some extent, this is definitely related to the performance of the economy, and thus to the GDP and the purchase power of the country's population.

The main identified barriers to the purchase of an e-vehicle are still its high purchase price compared to conventional ICE vehicles (not only in the DTP region) and the inadequate network of charging stations, whether public or private chargers, respectively of those located in places of mass housing, given that a large part of the population is located in the block-of-flats where there is at present a problem with parking and not the placement of charging infrastructure (e.g. case of the Czech Republic, Slovak Republic).

A very important incentive for greater e-mobility growth in the eGUTS (resp. DTP region) countries is definitely well-chosen fiscal support mechanisms at national level. The proof of this fact is Norway, as a country with the largest portfolio of different direct or indirect mechanisms for implementing e-mobility and the result of these incentives (22.5 % of all new cars sold in 2015 were electric). Important are direct subsidies for the purchase of vehicles by public and private persons (not only e-cars, but also passenger vehicles of category L or pedelecs) or various easement of taxation and charges. It is important to introduce e-cars to the public body`s vehicle fleet or to large private companies, which can be both a good promotion of e-mobility (with the possibility of practical testing) and, consequently, a motivating factor for private individuals to purchase the vehicles. Through *proper use of the "green" procurement process*, local authorities can support EVs by taking over the direct purchase of these vehicles in their own fleet or imposing this condition on their suppliers. This increases EVs visibility and demonstrates their viability in a number of important areas.

All this must go hand in hand with the support of innovative business models capable of generating revenues, necessary also for provision of a development fund (e.g. tailor-made rental of e-cars (e-vans) for business purposes; operative leasing; support and introduction of e-car sharing and e-bike sharing systems in the urban areas etc.).

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