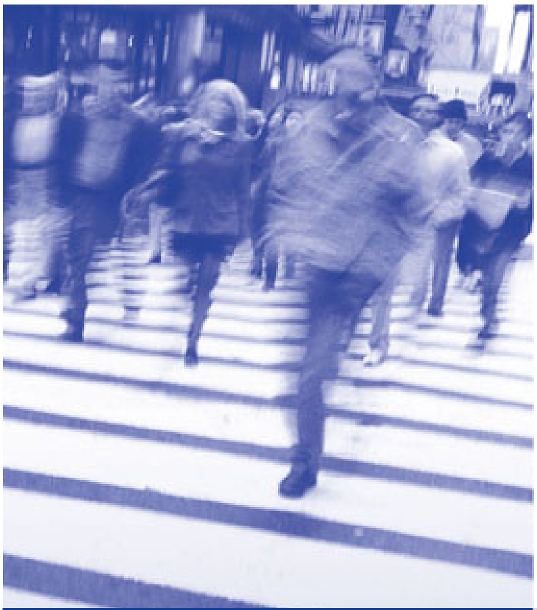

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Sustainable Electro-mobility Plan for Ljubljana

ELAN Deliverable No. 4.15-D1 (Draft SEP document)

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					WP6 Innovative mobility services		WP12 Impact and process evaluation
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ABSTRACT

The first suggestions to use electrical energy for the propulsion of vehicles arose already in the first half of the 19th century, soon after the first electric motor had been invented. Since then electric vehicles (EVs) have often seemed to be on the verge of becoming our standard means of transport. Nevertheless, vehicles using internal combustion engines (ICEV) have dominated over other technical solutions throughout the 20th century.

Virtually all automobile manufacturers have now decided to focus on EVs by producing and selling at least one electric model in the coming year. In urban areas, the number of EV charging stations is increasing rapidly. There is every indication that this time the electromobility (transport by means of EVs) will not remain a dead-end in technological evolution and in mode of transport but will gradually gain equal and eventually even prevailing status among the different modes of transport.

There are many reasons that support the mass market adoption of EVs this time. They can be categorised as environmental, strategic, technical, and economic:

- environmental: without EVs, the goal to substantially reduce greenhouse gas emissions seems unattainable,
- strategic: independence of fossil fuel is possible only with a considerable share of EVs in public and private transport,
- technical: battery and smart grid technologies have successfully passed their initial development phase; electromobility is expected to play a central role in the future technological development in Europe,
- economic: electromobility creates new business opportunities and is therefore expected to play a major part in the economic rebuild of Europe.

Rapid development and introduction of electromobility provokes different “pro and contra” opinions from both lay and professional communities.

Lay opinions are especially affected with the consideration of only particular segments instead of the entire spectrum of electromobility. This results in a belief that only cycling, walking, and public transport should be promoted since cars will always be merely cars, electric or not. Of course the support for these activities is beneficial, but if we stick to them alone, we may literally drown in future emissions from the projected one and a half billion additional vehicles on the world's roads by 2050. In absence of mitigating policy, global transport CO_2 emissions will almost treble by that year. With consideration of expected traffic growth a significant reduction of per-kilometre emissions will be needed only to retain the emissions from cars at current level – this can only be achieved by employing new technologies, with electromobility leading the way.

The professional community is also somewhat troubled when faced with electromobility. It is concerned by its rapid development, which often precedes the standardization of equipment and coordination of information and communication technology, the transfer of power from fossil fuel lobbies to those supporting electric power, the need for new connections, and the constant emergence and evolution of new technologies, making it difficult to pinpoint the correct business process and money flow in certain occasions. The subject of electromobility is a complex one; however, that is exactly why it might present an opportunity to all those who understand it already today.

The »Sustainable Electromobility Plan« (SEP) provides arguments for electromobility, explains the link between EVs and the supporting infrastructure, and puts forward strategic starting points and proposals for the faster adoption of electromobility in the city of Ljubljana.

It has to be pointed out that the measures to promote electromobility are not in contradistinction with the basic goal of MOL transport policy, which is to increase the share of walking, cycling, and use of public transport in the general composition of urban mobility. Adoption of electromobility must therefore adjust to the higher goal of decreasing the use of cars in Ljubljana transport. **All road users should be encouraged to use public transport, walk, or travel by bicycle as much as possible; however, those unable or unwilling to do so should be able to use a passenger car to travel to their destination with minimum negative impact on the environment and public health.** To paraphrase: **the share of passenger car use in transport should be reduced, while the number of eco-friendly (electric) vehicles within this share should be increased at the same time.**

The proposed measures to foster electromobility in the City of Ljubljana are divided into the following categories:

- infrastructure measures,
- subsidisation of EV use,
- traffic organisation measures,
- investment measures,
- promotional and informational activities, and
- measures outside of MOL jurisdiction.

The expected results cannot be clearly defined for every individual measure, since all measures are complementary and should be implemented together to achieve the main objective. There are also numerous independent factors outside of MOL's influence which will affect the accomplishment of the main objective.

The main objective of the measures: **The share of EVs in Ljubljana will be at least twice the share of EVs in the rest of the country in 2020**. The achievement of the targeted objective will be verified by occasional counting of EVs in comparison with total quantity of vehicles entering the city of Ljubljana and by means of national data on purchased and registered vehicles.

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1. DOCUMENT OVERVIEW

The »Sustainable Electromobility Plan« has been prepared within the CIVITAS ELAN project with the cooperation of the Task Force for Electromobility of the Ljubljana Urban Municipality (hereafter: MOL) and Etrel d.o.o.

The original title of the document is taken from the CIVITAS ELAN project assignment. Throughout the document, the English title and abbreviation (SEP or SEP MOL) shall be used.

1.1. Objective of the document

Regardless of the plans and needs of Slovenia and its capital (MOL), EVs will eventually take over the streets and parking lots. The pace of their adoption depends on various factors, especially purchase subsidies for EVs and subsidies for the construction of »smart« public charging infrastructure together with the associated ICT systems. Other factors are the presence of a widespread and efficient network of charging stations, public promotion of electromobility, and adoption of successful projects (best practices) from abroad.

EVs are ideal for city use, which is characterised by lower driving speeds and frequent stops. Besides global reduction in greenhouse gas (GHG) emissions, electromobility also brings important local benefits. The most important ones are the elimination of road noise and the reduction of particulate air pollution. The latter is believed to decrease the life expectancy of an average Ljubljana citizen for more than a year in comparison with a scenario in which air pollution is below the recommended levels of the World Health Organization (WHO).

A passive approach to the adoption of electromobility may cause problems in the form of charging safety issues, power network overloads, decline in the quality of electrical energy, etc. On top of that, any undesirable habits that EV users might acquire if the adoption of EVs remains uncontrolled (e.g. using extension cords to charge their EVs) may cause much bigger problems later on and could prove to be very hard to change afterwards.

With the large-scale adoption of electromobility, it is important that the EVs will be connected to a flexible common information network which will offer information on the location and status of each EV. This will create an ideal environment for shared use of personal transport (e.g. *car sharing* and *car pooling*). An in-depth prior analysis and implementation of results-based measures may greatly reduce the number of vehicles per individual.

These facts require that all efforts must be made to ensure a properly controlled and efficient adoption of electromobility, taking full advantage of emerging new technologies at the same time. SEP is thus a comprehensive starting point and base for all measures which will be implemented by MOL in the areas, connected with electromobility.

It should be pointed out that the objective of SEP is not to replace all of today's vehicles with their electric counterparts. SEP merely presents a framework which will guide the otherwise possibly uncontrolled adoption of EVs in the right direction.

1.2. Contents of the document

The SEP document can be roughly subdivided into three main parts. The first part explains the basic concepts of electromobility and the reasons for its adoption. It is followed by the overview of current electromobility measures in transport policies on different scales. The third part introduces the measures planned to be implemented by MOL to promote and adopt electromobility.

The SEP document is intended for the citizens of Ljubljana and the city administration. With its help they will be able to take an active stance in the development of new forms of mobility.

1.3. Context of the document

The SEP document is linked to the Lisbon and Gothenburg Strategy in both of their main segments: environmental and economic. The document also refers to different initiatives, directives, and programmes which are connected with the two strategies, as follows:

- SET-Plan, which declares EU's commitment to enable a breakthrough of low-carbon technologies and their market competitiveness. One of the main specific goals of the SET-Plan is to achieve a 100% renewable energy production by 2050.
- White Paper 2011 – Roadmap to a Single European Transport Area[3]; one of its goals is a complete elimination of conventional (ICE) vehicles in cities by 2050.
- Directive 2009/33/EC on the promotion of clean and energy-efficient road transport vehicles; the Directive states that in the initial phase of a public procurement in all its segments (item description, technical specifications, contract related conditions and specifications), environmental aspects of the procurement must also be considered by the bodies of self-governing local communities. The proposal for a Regulation determines the environmental requirements and recommendations for ten groups of products and services, including road transport vehicles. The Republic of Slovenia was urged to bring its legislation into line with the Directive by December 4, 2010, but is currently still in violation of this Directive. The Directive also refers to the document »An Energy Policy for Europe«, published on January 10, 2007, which establishes the goal of a 10% share of renewable energy in transport.
- Kyoto Protocol for Europe, with the collective emissions reduction goal of 8% below 1990 levels by 2008-2012,
- Update of the "Climate Change Programme (2000)",
- Directive 2008/50/EC on ambient air quality and a cleaner air for Europe,
- "Clean Air for Europe" programme – CAFE (2005),
- Sustainable development strategy (2001), 6th Environment Action Programme, updated in 2006,
- »Europe's Communication Towards a comprehensive climate change agreement in Copenhagen (MEMO/09/34)", which determines the role of technologies in reducing the CO_2 emissions with the goal of limiting the average rise of temperatures below 2°C relative to the pre-industrial levels,
- Regulation on the so-called »super credits« with the goal to regulate the emissions in new vehicles as a part of the integrated approach of the EC to reduce the emissions of light commercial vehicles (443/2009),
- CARS 21 (Competitive Automotive Regulatory System for the 21st Century); the process aims to make recommendations for the public policy and regulatory framework [COM(2007) 22]. This framework enhances global competitiveness and employment, while sustaining further progress in safety and environmental performance at a price affordable to the consumer,
- Communication from the EC 'Responding to the crisis of the European automotive industry' [COM(2009)104 final], which calls for an intensive approach to the development of »green vehicles«,
- »European Green Cars initiative« as a part of the »European Economic Recovery Plan« [COM(2008) 800]
- Directive 2002/49/EC on the assessment and management of environmental noise

SEP refers to several Slovenian documents, including:

- National Energy Programme
- MOL Municipal Spatial Plan (2010)
- MOL Local Energy Concept (2011)
- Environmental Protection Programme (2008)

[3] Single European Transport Area White Paper 2011 http://ec.europa.eu/transport/strategies/2011_white_paper_en.htm

- Sustainable Development Strategy in Ljubljana (2002)
- Regional Development Programme of the Ljubljana Urban Region 2007-2013 (2007)
- Expert Groundwork for the Strategy of Regional Transport Regulation (2009)
- Expert Groundwork for the Preparation of the Regional Spatial Plan (2009)
- Energy Act (EZ-UPB2; Official Gazette RS, No. 27/2007), which determines the principles of the energy policy, energy market regulation, operation of electric utilities, principles to ensure reliable supply and efficient use of energy, conditions for operation of power plants, regulation on conditions for performing energy activities, regulation on the granting of licences and energy permits, and determines the bodies to perform administrative activities in accordance with the Act. The Act establishes an environment for a safe and reliable supply of energy services to the consumers in accordance with market principles and principles for sustainable development, efficient energy use, economical use of renewable energy sources, and protection of the environment.
- Environmental noise directives:
    - Environmental Protection Act (ZVO-1-UPB1, Official Gazette RS, No. 39/2006)
    - Decree on Limit Values for Environment Noise Indicators (Official Gazette RS, No. 105/2005)
    - Decree on the Assessment and Management of Environmental Noise (Official Gazette RS, No. 121/2004), which determines the measures to reduce environmental noise pollution, in accordance with the Directive 2002/49/EC of the European Parliament and of the Council with the aim to prevent or reduce harmful effects of environmental noise.

1.4. Timeframe

The objective behind the preparation of the SEP document is to adopt the guidelines of the plan in the Ljubljana city council and continue to follow the development of the area. Verification of results, monitoring and evaluation must be conducted on an annual basis, according to some other requirements (i.e. Directives 2009/33/EC and 2002/49/EC). In addition to the acquisition of statistical data required by local and foreign institutions, the objective of monitoring will be to adjust the incentives and limitations, needed for a successful adoption of electromobility.

In the first implementation period, the pilot projects for the promotion of EV use will take place. At the same time, the construction of charging infrastructure will continue, with active participation of the city. This period is projected to last until 2015. The same year marks a predicted breakthrough of some technologies which will significantly improve the autonomy and availability of EVs. Europe has committed to achieve a 10% share of renewable energy in transport. Additional incentives for the development of EVs and their market penetration are planned in the same period. Further limiting of the allowed CO_2 emissions is predicted to additionally increase the number of EVs in transport all the way until 2050 when EVs will replace most of the conventional ICE vehicles.

Throughout this entire period, a close monitoring and coordination of the development will be required. Within the new paradigm, previously unlinked areas of transport and energy production and distribution will become more and more intertwined. The gradual increase of the share of EVs on the roads will require changes also to the national energy strategies and legislation.

1.5. Scope

Due to the nature of the CIVITAS ELAN project, the SEP document in general is intended to be used in the city of Ljubljana. However, since the situation in other Slovenian urban municipalities is similar, most of the SEP results and findings can also be applied elsewhere. In the framework of the CIVITAS ELAN project, a special workshop for the representatives of other Slovenian municipalities is planned. The workshop will present the topic of electromobility, its impact, and the measures which will be implemented in MOL to speed up its adoption. This will enable other Slovenian municipalities to tackle the new challenges of electromobility faster and more effectively.

2. REASONS FOR ADOPTION OF ELECTROMOBILITY

A consistent implementation of electromobility might be the solution for several problems on different levels in the modern society. Economic and environmental factors are the main reasons for switching from widely used internal combustion engines which run on expensive and limited fossil fuels to the alternative electric engine. Based on their scope, the main reasons for the use of EVs can be classified as global and local.

2.1. Global reasons

The reasons for the adoption of electromobility on the global scale are:

- Environmental: the goal of reducing GHG emissions cannot be met without immediate large-scale adoption of EVs;
- Strategic: fossil fuel independence can be achieved only with a higher share of EVs in transport. The limited reserves of fossil fuels, their rising prices, and the concerns over large amounts of oil originating from politically unstable regions present serious issues for the current and future geostrategic position and safety of Europe. EVs do not depend on fossil fuels, since the electricity needed to power them can be produced from other sources, including renewable energy;
- Technical: the new battery and smart grid technologies are past the test phase, which means electromobility can become one of the key elements of Europe's technological development;
- Economic: investments in sustainable innovations can help revive economy in time of its recovery from the global crisis. Electromobility creates new business opportunities and can thus become one of the central points of Europe's economic recovery.

Strategically, EVs are not only a possible solution for the reduction of GHG levels, but can also help tackle the dependence on imported fossil fuels. A staggering 53% of all oil produced today is used for transport[4]. There are approximately one billion cars in the world at the moment and their number is expected to increase two- or three-fold by 2050, posing serious problems to the undisturbed supply of oil. The 2011 EC White Paper on Transport[3] emphasises that oil reserves will decrease in the coming decades and that the supply of oil may become more uncertain. The International Energy Agency (IEA) puts another perspective on the issues of oil reserves and prices and the effect on global climate change – less success of actions to reduce the GHG emissions will directly result in a higher price of oil. In 2010, oil imports in EU amounted to around 210 billion €. If the EU does not reduce its dependence on foreign oil, this can lead to higher inflation, trade deficits, and lower standard of living as a result.

The adoption of electromobility presents an opportunity for the world's energy industry, which will have to keep up with the growing demand. Smart grid technologies will be a key factor in the successful development of the power sector and a step forward from the existing distribution networks. Optimised production of green energy is one of the areas that can prosper in the smart grid environment.

The introduction of new technologies can provide a much needed push to the global economy by creating new jobs and thus encouraging economic growth. The countries that will adopt electromobility sooner will have an important technological edge over those which will lack behind.

2.2. Local reasons

On local level, the electromobility can directly help to improve the quality of life for the citizens. The introduction of EVs will bring an improvement in different areas, such as:

- Harmful emissions: EVs do not produce any fine particles or other emissions, therefore they do not cause respiratory health issues or increase cancer incidence;

[4]Julia King, 2010, John Collier memorial lecture, http://www.icheme.org/johncollierlecture2010

- Noise: EV's are silent compared to vehicles with internal combustion engines. The reduction of urban noise provides better living and working conditions and reduces stress levels, which leads to lower health expenses and increased productivity;
- Soil and water pollution on the account of disposed engine oil is eliminated;
- Lower costs: higher initial prices of EVs are compensated with lower maintenance costs and fuel savings.
- Higher reliability: electric engines are comprised of only a few movable parts and do not need as much liquid substances for maintenance (e.g. engine oil, cooling fluid, transmission fluid, lubricants, etc.). EVs thus require minimum maintenance and are less likely to break down than ICEVs.

Local reasons that support the adoption of electromobility are closely linked with concerns over lower air quality and noise pollution caused by transport in cities and their vicinity. The recent development in car technology has reduced average GHG emissions, but the growing number of vehicles and the increase of mileage per vehicle continue to remain the main factors in local noise and air pollution.

Local reasons for the adoption of electromobility are described in detail in section 4.5, where the Ljubljana municipality measures and the introduction of electromobility in its area are discussed.

2.3. Electromobility and global climate change

2.3.1. Greenhouse gas emissions

Global warming is caused by man-made activities. Unpredictable weather changes and more frequent extreme weather events affect the individual and the society. Studies have shown that without additional incentives the reduction of GHG emissions will be inadequate and the 2050 goal of stabilising the PPM levels will not be met.

The current estimated cost of curbing GHG emissions is approximately 1% of the world's GDP, which amounts to roughly 650$ billion per year[5]. Without an immediate intervention, the annual costs will increase to between 5% and 20% of the world's GDP. This means that investing 1% of the world's GDP now can help save a 5 to 20-times greater amount in the future. Additionally, indirect costs of global climate change (such as the damage to coastal areas with low altitude) should be added into the calculation.

2.3.2. Transport and greenhouse gas emissions

Global climate change is largely caused by the increasing GHG emissions from transport. In 2000, 14% of all GHG emissions were a result of transport related activities.

Road transport emissions account for 76% of transport related emissions. 45% of all transport related emissions are caused by passenger cars and light commercial vehicles (LCVs)[5]. Passenger cars and LCVs therefore account for approximately 60% of all road transport emissions.

Any action to tackle the problem of transport related GHG emissions should address especially the road transport sector and GHG emissions from passenger cars and LCVs, which account for 6,3% of the world's total GHG emissions. The solving of light road transport problems should be a priority because there are already mass-marketed solutions available – EVs, comparable with today's ICE vehicles, especially regarding short distance travels in urban and suburban transport.

The share of transport related GHG emissions in Slovenia is even higher than on the global level. Transport related GHG emissions amount to 27% of the country's total emissions (5.337 million tonnes of CO_2 out of 19.436 million tonnes in total). On top of that, the share of rail and air transportation emissions is merely 0,8% of total transport related emissions[6]. Considering the same global share (60%) of emissions from passenger cars and LCVs in the total amount of road transport related emis-

[5]The King Review of low-carbon cars, October 2007
[6]TGP Archive, Slovenian Environment Agency, April 2009, http://kazalci.arso.gov.si/?data=indicator&ind_id=253

sions, the share of emissions from both of these vehicle categories in the total amount of Slovenia's GHG emissions exceeds 16%.

If the current trends in the use of different energy sources in transport will continue, the oil dependence will slowly decrease due to the use of biofuels and EVs. Still, the amount of renewable energy used in transport will barely exceed the goal of 10% by 2020. However, despite the technological advances in ICEVs, the growing number of vehicles will cause the total CO_2 transport emissions to increase by one third by 2050 (compared to 1990 levels).

A radical reduction in average emissions per kilometre driven will be needed to achieve any considerable reduction of total emissions, especially considering the estimated growth of the number of vehicles and longer average distances travelled. A large portion of new vehicles will come from BRIC (Brazil, Russia, India, and China) and other developing countries. The total number of vehicles in the world is predicted to more than double by 2050. With this in mind, transition to the use of cleanest possible vehicles is absolutely necessary to restrain the future road transport emissions. Later on this might prove to be impossible if no immediate action is taken. This places the adoption of electromobility on top of the measures that can ensure sustainable mobility in the future.

2.3.3. Electric vehicles and greenhouse gas emissions

The facts and requirements stated above are clearly in favour of a large-scale introduction of EVs. The required emissions reduction cannot be met even if using the technologically most advanced ICEVs. The goal can be achieved only with the use of EVs, construction of a smart and balanced EV charging system, and a higher share of renewables in energy production.

In normal operation, EVs generally produce much less GHG emissions than ICEVs and have considerably more efficient engines. With more than 90% of produced energy actually transformed into mechanical energy, the EV's are clearly superior to ICE vehicles with 10 to 35% efficiency (in urban driving cycle, compared to 15 to 40% for diesels). Even considering the losses in the process of electrical energy production for EVs, their efficiency is still far greater than that of ICEVs.

Analyses of energy efficiency for urban driving cycles based on "well-to-wheels" calculations have shown that EVs produce around 30% less GHG emissions than ICEVs even with electricity from the current European energy portfolio. Using electricity from renewable sources increases this percentage to ~70%.

The power sector remains the biggest polluter. Even though electromobility mainly attempts to solve the current transport related problems, it can at the same time help reduce emissions in the power sector by more efficiently using primary energy sources and facilitating advanced renewable energy production options.

The Government of Slovenia[7] states that the total life cycle CO_2 emissions of an EV using electrical energy from the current energy portfolio in Slovenia would amount to 26 tonnes, which is nearly three times less than an average ICEV. Using electricity produced exclusively from renewable sources (hydro, solar, wind, biomass, etc.) would reduce the CO_2 emissions to merely 5 tonnes per 300.000 kilometres, as opposed to 71 tonnes in the case of an average ICEV. The greatest potential to reduce transport related emissions therefore lies in the use of low-carbon and renewable energy sources for the propulsion of EVs.

[7] Plan for infrastructure and system environment measures for the introduction of battery electric vehicles in Slovenia - http://www.svps.gov.si/fileadmin/svps.gov.si/pageuploads/EV/EV.doc.pdf

3. ABOUT ELECTROMOBILITY

3.1. Electric vehicles – the basis of electromobility

Electromobility as a new way of sustainable and eco-friendly mobility is inseparably linked with the use of electric vehicles. Large-scale availability of competitively priced EVs with a sufficient driving range is essential, yet at the same time not sufficient for a successful development of electromobility. A special emphasis should be placed on cleaner energy production, widespread and efficient public infrastructure of charging stations and the use of advanced possibilities, enabled by modern ICT technologies. A synergy of these factors will optimise the future use of passenger cars and the transport sector itself.

3.1.1. Definition and classification of electric vehicles

EVs include cars, motor tricycles or quadricycles, motorcycles, mopeds, and other vehicles which are intended for use on public roads and are equipped with one or more main electric motors used to power the driving wheels and have one or several batteries to store electrical energy. The batteries can be charged by the use of external charging infrastructure or the use of an own source of electrical energy. Based on their powertrain systems, the EVs are classified as:

- battery electric vehicles – BEV (also fully electric vehicles - FEV): the powertrain consists of an electric motor, the batteries are charged with an external energy source and with regenerative braking;
- hybrid vehicles - HEV: the powertrain consists of an electric motor (series-hybrid vehicles) or an electric motor and an internal combustion engine (parallel hybrid vehicles). The batteries are charged by the generator, which is powered by the internal combustion engine or with regenerative braking;
- plug-in hybrid vehicles – PHEV: same as with hybrid vehicles, the difference being that the batteries can also be charged with an external energy source;
- fuel cell electric vehicles: the powertrain consists of an electric motor, the batteries are charged with the energy from fuel cells or with regenerative braking.

The currently available EVs are classified into one of the existing vehicle categories:

- M1: motor vehicles with at least four wheels used for the carriage of passengers with no more than eight seats in addition to driver's seat,
- N1: motor vehicles with at least four wheels used for the carriage of goods having a maximum mass not exceeding 3,5 tonnes,
- N2: motor vehicles with at least four wheels, used for the carriage of goods, having a maximum mass exceeding 3,5 tonnes but not exceeding 12 tonnes,
- L1e and L2e: two-wheeled (L1e) and three-wheeled (L2e) mopeds and bicycles with auxiliary motor (design speed not exceeding 45 km/h and maximum continuous rated power not exceeding 4 kW in the case of an electric motor,
- L3e, L4e and L5e: two-wheeled (L3e) and three-wheeled (with sidecar - L4e or with three symmetrically arranged wheels - L5e) mopeds and motorcycles with design speed not exceeding 45 km/h
- L6e: »light four-wheelers«, mass of empty vehicle not exceeding 350 kg without the mass of batteries, with design speed not exceeding 45 km/h and maximum continuous rated power not exceeding 4 kW in the case of an electric motor,
- L7e: »four-wheelers«, excluding light four-wheelers of L6e category, mass of empty vehicle not exceeding 400 kg (or 550 kg in case of freight vehicle) without the mass of batteries and maximum continuous rated power not exceeding 15 kW in the case of an electric motor,

Despite the fact that EVs can also include golf carts, fork-lifts, wheelchairs, and other vehicles, SEP is focused primarily on vehicles used for personal or freight transport on public roads or other transport areas.

The SEP document also excludes fuel cell vehicles, although they represent one of the classes of EVs. Based on the assumption of further development of advanced energy storage systems (used as EV batteries), sufficient driving autonomy will be achieved at one point. Only exceptionally will there be a need to use fuel cell powered vehicles, where electrical energy is first used to produce hydrogen which is later burned inside the EV to create electrical energy for propulsion, with inevitable energy losses along the way of this process.

3.2. Charging infrastructure

3.2.1. Co-dependence of charging infrastructure and the adoption of EVs

The main topic in past discussions about electromobility used to be solely EVs. However, it has become clear through time that the use of EVs is inseparably linked with the use of appropriate charging infrastructure and the entire power network. The project of electromobility is therefore closely linked to the development of infrastructure.

Investments in transport infrastructure overall have a positive impact on economic growth, create wealth and jobs, and enhance trade, geographical accessibility, and the mobility of people. They have to be planned in a way that maximises positive impact on economic growth and minimises negative impact on the environment.

There is a sceptical objection that the lack of charging infrastructure will prevent the spread of EVs. The counter argument is that even standard home outlets can theoretically be used to provide the most basic charging infrastructure. However, to ensure a safe and optimal introduction of electromobility and EV charging, designated home charging stations are a necessity. These stations can be connected to a common network and control system to enable controlled EV charging. A widespread network of smart public charging station remains a necessary addition.

The availability of charging stations will probably present no obstacle for EVs whish will be charging in commercial parking facilities. On the other hand, EV owners in apartment buildings, especially those with external parking facilities, will be faced with a problem which will have to be tackled with the use of multiple public charging stations, including fast charging stations. The adoption of EVs in the city will differ in different neighbourhoods. Still, the development of charging infrastructure will have to precede the growth of the EV market, since a potential EV user will only buy an EV if there will be enough adequate charging options available.

3.2.2. Charging modes

The IEC 62196 standard »Plugs, socket-outlets, vehicle couplers and vehicle inlets – Conductive charging of electric vehicles«, which is used in Europe, differentiates between several different modes of charging:

- **Mode 1**: charging with an alternating current (AC) using single- or three-phase sockets (similar to domestic sockets), maximum current (3 x) 16 A,
- **Mode 2**: charging with an alternating current (AC) using single- or three-phase sockets (similar to domestic sockets), maximum current (3 x) 32 A,
- **Mode 3**: charging with an alternating current (AC) using single- or three-phase sockets, maximum current 32 A, charging station and the vehicle are connected with a communication wire inside the charging cable, which enables control over charging power,
- **Mode 4**: charging with a direct current (DC) using special sockets, maximum current 400 A, voltage up to 250 V. Charging station and the vehicle are connected with a communication wire , which enables control over charging power,

For charging modes 1 – 3, the rectifier, which converts alternating current of the power supply into direct current, is built into the vehicle. In mode 4, the rectifier is built into the charging station. This, in combination with the considerably higher charging power, makes mode 4 DC charging stations noticeably bigger and more expensive than mode 1 – 3 AC charging stations.

The preferred method of BEV charging for public charging stations will presumably be mode 3 (fast) charging. This method ensures acceptable charging times for EV users and enables the power network operator to control network loads by adjusting charging power according to the requirements of the power distribution network. These adjustments should not affect EV users and their charging times, as long as the total connection time available to charge the EV battery is sufficient. For EVs with lower battery capacities (PHEVs, ...) and for domestic charging needs, mode 1 (slow) charging will mostly be sufficient.

Mode 4 DC charging (rapid charging) is intended for commercial and public charging stations. The functional characteristics of such stations is similar to petrol stations, considering the time to charge (»refuel«) a vehicle is somewhere between 10 and 15 minutes (for a 50% battery charge).

The charging methods can also be classified according to levels (common in USA and Japan):

- Slow – Level 1: single-phase alternating current 15-20 A, voltage 120 V,
- Fast – Level 2: single-phase alternating current up to 32 A, voltage 230 V (corresponds to mode 2 charging),
- Rapid – Level 3: DC charging (corresponds to mode 4 charging).

The sockets and plugs in the charging stations differ according to different charging methods. Most of sockets used today are equipped with communication and data wires, whereas they differ in the number of phases (1 or 3) and the charging current used (AC or DC).

The alternative to charge the depleted battery is to swap it with a fully charged one on designated battery switching stations. The convenience of this option is declining with increasingly better EV driving ranges. The necessary standardisation of batteries and their placement in different EV models poses an additional problem. The high number of extra batteries required for swapping (which stand idle most of the time) is also an environmental concern. Even though this approach is the only one that can come close to the time needed to refuel an ICE vehicle at a petrol station, it is unlikely that it will play a major role in the future.

3.2.3. Charging stations

The basic elements of charging infrastructure are individual charging stations, connected to a wider common charging network. To connect the charging stations into an integrated EV charging system, they must enable the operator of the charging infrastructure to remotely control the charging stations and receive and gather data from each station (for means of control of each socket, billing, maintenance, and network planning), The charging stations must also enable the option of user/vehicle identification and the option for EV users to make a reservation of any station. Charging stations with these characteristics are a key element of any smart charging infrastructure for personal and public EV transport.

The adoption of new technologies is often accompanied with various initial obstacles. A negative »halo effect« may slow the development of new EVs and charging infrastructure. It is therefore important to follow the existing safety standards and take into account all possible risks. EV users and charging infrastructure operators should be properly informed and trained, while at the same time development processes and product certification should be developed further by the manufacturers. In Slovenia, these tasks are already voluntarily organised and performed by the Slovenian Electric Vehicle Association, DEVS[8].

The charging stations must enable maximum level of safety of their use. This includes adequate electrical and mechanical protection and an appropriate spatial placement of the station.

With regards to user safety, the minimum requirements for the charging stations and their equipment are:

- overcurrent, overvoltage and ground fault protection of the power supply,
- electrical protection of each socket,

[8] Slovenian Electric Vehicle Association

- the station should not provide any power until the user connects the vehicle and is successfully identified,
- remote control to stop charging or remove charging station from operation (for operators),
- dust and humidity protection,
- spatial placement which prevents collisions of vehicles with the station and does not interfere with traffic.

Besides complying with these safety requirements, the charging stations must enable the following functionalities:

- single-phase charging (up to 32 A) or three-phase charging (up to 64A) with the option to install different types of sockets,
- simultaneous charging of two or more vehicles in order to minimise the space needed to equip a single parking place with EV charging capabilities,
- the option of direct connection of charging station to the public distribution network, where the charging station act as a connection point to the public grid, i.e. as a separation point between the public and private network,
- control over the state of the charging cable plugged into the socket, charging current, and the operation of protection,
- automatic recommencement of charging in the event of abrupt power outages,
- communication with the Control centre for charging stations,
- the option of SMS and/or RFID user identification,
- direct communication with the built-in energy meter via DLMS or M-bus protocol,
- remote operation control and software updates from the Control centre,
- the option to connect together the entire charging infrastructure in a single area by only having one charging station operating as the communication interface, thus minimising costs and simplifying data transfer.

User identification should be required to use the charging station. This enables a controlled EV charging and prevents unauthorised access to the charging station which might affect user safety. With the help of user identification, the transition to a new billing system can be performed without any major additional interventions to the system.

The charging station should have a modular design, which enables upgrades to the infrastructure without any major added costs in order to keep up with new developments.

The casing of the charging station should be in accordance with the following guidelines:

- clean, modern design, which can be placed into any urban environment,
- practicality of use,
- weather resistance,
- easily accessible to infrastructure maintenance services.

User interface of the station should be intuitive and should provide good usability in all weather conditions. Ergonomic design should be practical for the user and enable quick user identification. The lighting of the station should clearly indicate its availability status.

Design of the interface as a whole should be multi-lingual and should clearly indicate when the charging station is available, if the vehicle is properly connected, and if the charging process is being carried out properly.

3.2.4. EV charging times and charging speed

The time required for a full EV battery charge depends on several factors:

- the current state of battery charge (kWh),
- maximum battery capacity (kWh),
- charging power (kW).

The charging power depends on the power of the charging station (overcurrent protection setting or maximum charging power) and the power of the AC/DC rectifier. Maximum charging power is thus lower or equal to these values. The charging power is also not constant throughout the charging cycle, which means that maximum charging power can be used only until roughly 80-90% of full battery charge (depends on battery type), after which the speed of charging decreases significantly.

Battery capacities differ among various types and classes of EVs. The currently marketed EVs have the following typical battery capacities:

- category L7e, battery EV: typically 9 kWh, range between 3-15 kWh.
- category M1, battery EV: typically 29 kWh, range between 10-72 kWh,
- category M1, plug-in hybrid EV: typically 8 kWh, range between 2-13 kWh,
- category N1, battery EV: typically 23 kWh, range between 10-40 kWh,
- category N1, plug-in hybrid EV: typically 8 kWh, range between 2-13 kWh,
- category N2, battery EV: typically 85 kWh, range between 51-120 kWh.

Based on the type and class of EV, the charging power and rectifier capacity also differ accordingly:

- category L7e, battery EV: typically 3 kW, range between 1-3 kW.
- category M1, battery EV: typically 3 kW, range between 2-9 kW,
- category M1, plug-in hybrid EV: typically 3 kW, range between 3-5 kW,
- category N1, battery EV: typically 3 kW, range between 1-3 kW,
- category N1, plug-in hybrid EV: typically 3 kW,
- category N2, battery EV: typically 10 kW.

Such diversity of battery capacities and maximum charging power makes it almost impossible to give an estimate of the duration of charging for specific EVs. On top of that, the capacities are constantly improved in order to achieve better driving ranges and shorter charging times. A better way to estimate the time needed to charge an EV would be to look at EV energy consumption per kilometre. An average sized passenger car uses 0,15 kWh/km, which means that level 1 single-phase charging (charging power 3 kW) would charge the battery for a 50 km range in 2,5 hours. Subcompact city cars use approximately 0,07 kWh/km, which gives an estimated time of 1,3 hours for a 50 km charge. Other, smaller EVs use even less energy (bikes 0,01 kWh/km, scooters 0,02 kWh/km), but are also usually equipped with less powerful chargers, which results in charging times similar to those for passenger cars.

3.2.5. Charging infrastructure architecture and the charging process

The multi-tier architecture of the charging infrastructure consists of three tiers. The first tier consists of charging stations, distributed throughout the city and available to all users.

The charging stations are controlled by the charging infrastructure operators with the help of Control centres. The stations communicate with their Control centre and constantly send them relevant data. The Control centre represents the second tier. It is used by the operators to ensure an undisturbed operation of their networks in terms of the connection between EVs and public distribution networks (the so-called V2G connection – *Vehicle to Grid*) and monitor the data on current and past chargings.

The third tier is the user information system, which enables the users to access their user data and past charging reports, view their current charging status, view charging stations' locations, make a reservation of an available charging station, and use other functionalities. The user interface also enables the users to contact their charging infrastructure operators and suppliers.

3.2.6. EV charging and end users

For EV users, the purchase of EV presents an entry into the world of electromobility and the first step towards zero-emission driving. However, the most important environmental component of electromobility is the type of energy used. The charging process itself, with all the related services, presents the opportunity to make electromobility truly the cleanest and smartest mode of driving and transportation.

Current trends show that the majority of EV users predominantly use domestic charging to charge their vehicles and perceive public charging options as a necessary addition that enables extended driving ranges when needed. The network of public charging station provides unlimited mobility regardless of the state of battery in the EV at the time when users leave their home. They can charge their vehicle when they least need it: during working hours, while shopping, or while visiting cultural and sport events

At one point in the future, when EV charging infrastructure is well developed and easily accessible, the EV charging process does not interfere with the daily routine of the user. If the user needs to make a longer trip than expected, a fast charging station can be used for a quick last-minute recharge, giving the user enough energy in a matter of minutes. At the end of the working day, the user can charge the EV at home, preferably during night-time, making use of cheaper electricity rates. This way the users can have their EVs fully recharged and ready in the morning while saving money at the same time.

The EV charging process is a part of the integrated interactive service which enables numerous additional functionalities. The users must first register with the chosen service provider. They then receive their own identification card, used to simply initiate EV charging and record charging data. Mobile phones can also be used for the same task. After the registration, users can use all available charging stations and additional services from their own service provider, or use roaming to charge on other providers' charging infrastructure.

The user portal is where the users can control the entire charging process after the visit to the charging station itself. The portal is the so-called front-end, which can be accessed through a web or mobile application. Users can use the portal to control the state of the current charging, view data on past chargings, view a map of charging stations' locations, find a nearest charging station or make a reservation for one.

The user portal enables the users to log in and have an overview of their user data, identification data, charging reports, SMS notifications for completed or interrupted chargings, contracts with the suppliers, and communication with the supplier (new contracts, cancellation of identification cards, reclamations, etc.)

The portal can easily be set up on a national level, connecting several control centres (EV charging service providers) into one system. In this case, the application uses a common user database and enables roaming on all charging stations that are a part of the system.

The described approach towards electromobility can be fully implemented already today with the existing technology and infrastructure. However, the main advantages of this approach lie in the potentials for further development. With the emergence of smart grids, new options for the communication between EVs and the power network are enabled. EV users will soon be able to park their vehicle and connect it to a charging station and the system will automatically recognise the vehicle and link it with the appropriate subscription and bank account. The vehicle and network will be able to communicate in both ways and exchange data on the state of battery and the amount of energy needed. Real-time data on the current and future price of electricity will be available at all times. Based on this information and personal settings, which the users will be able to edit online or with a mobile device, the system will automatically provide the cheapest and cleanest available energy to the vehicle. When the prices of electricity will be high and EV batteries full, users will be able to sell energy back to the system, with profits transferred directly to their bank accounts.

Hand in hand with a larger number of EVs on the roads, the practice of offering free energy in exchange for a visit to the owner's commercial or business facility will become more common. A trip to the shopping mall will be combined with free charging (possibly with green energy), which the owner of the shopping mall will offer to attract more EV costumers.

3.3. *Charging infrastructure planning*

3.3.1. General guidelines

The charging infrastructure will be introduced gradually, with one goal in mind from the very beginning – to develop a reliable and smart charging infrastructure, which will enable safe charging for EV users and a complete overview of the functioning and use of the charging stations for the operators. The current problems in this area stem mostly from the dichotomy between relatively lengthy standardisation procedures and fast technological development, which makes it hard for EV manufacturers, power sector, and policy makers to form and define clear-cut EV strategies. Nevertheless, EV charging standards are gradually being developed for different charging modes and the corresponding sockets.

The strategies for the adoption of electromobility in different businesses, local communities, and countries have two main aspects in common:

- Strategic distribution and promotion of charging stations, which creates an impression of a widespread charging network and can thus minimise initial investments.
- Use of public funds for public welfare: cities, municipalities and the state should invest in the construction of public (possibly also domestic) charging stations; regulators should allow the distribution companies to charge for the costs of infrastructure and perform its installation.

At the same time, the strategies are focused on the development of innovative business models for the management of charging stations. These models include services provided by the owners of the charging stations and energy traders (principles of billing for the use of charging stations and the consumption of energy, advertising, network services to support the power network in terms of smart grids, etc.).

Within the Seventh Framework Programme (FP7), there is currently a multitude of on-going European projects dedicated to the development of EV charging infrastructure. In addition to EU incentives, some of the more prudent European countries have invested considerable amounts in the development of their local EV industry and the accompanying infrastructure. These countries are now actively expanding their economic influence on account of those who have missed the chance to be among the pioneers of electromobility.

In Slovenia, there are several on-going projects and activities in the area of electromobility and infrastructure:

- Slovenian Electric Vehicles Association (DEVS) is a member of AVERE[9] and an active participant in the MERGE project,
- the SMARTV2G project aims to upgrade the software and hardware in smart charging stations for the demonstration needs of the V2G process. There are two Slovenian companies cooperating with several foreign partners in the project: Etrel, which will upgrade its smart charging stations with DSM functionalities, and Elektro Ljubljana, a distribution company which will work on the demonstration part of the project.
- establishment of a Workgroup for EV infrastructure within DEVS, which includes several key stakeholders (Elektro Ljubljana, Elektro Gorenjska, Petrol, ELES, and others) to lay the foundations for the successful construction of EV infrastructure,
- first phase in the use of the EV charging infrastructure Control centre in Elektro Ljubljana,
- establishment of the electromobility section in the framework of the Smartgrids technological platform

3.3.2. Locations of charging stations

According to their location, the charging stations are divided into two main groups – public and private charging stations. Public charging stations are in principle available to everyone and are intended for the general public, however they can still be under private ownership. Private charging stations usually

[9] The European Assiciation for Battery, Hybrid and Fuel Cell Electric Vehicles

have restricted access and are intended for a specific group of users – for example a family in a household or employees in a company.

Private charging stations are mostly intended for longer EV charging periods, which is why they usually enable only slow method of charging. The vehicles can be charged during the working hours (in companies) or during night-time (in households).

Public charging stations can be placed on more diverse locations. Each of these locations has its own specific charging properties:

- parking lots and parking garages: due to mostly long-term parking on these locations, the majority of charging stations will enable slow charging,
- apartment buildings: long-term parking, especially during night-time, will enable the most efficient and cost-effective slow charging,
- shopping malls: short-term parking makes a good case for fast charging stations, which can be offered as an additional service or benefit for the shoppers,
- sport, cultural and recreational facilities: characterised by mid-term parking, it is expected that most of the charging stations will enable slow charging.

3.3.3. Principles for construction of charging network

Construction of a network of charging stations should follow several general principles. Electromobility must be introduced with universal accessibility and equal treatment of all potential users who wish to charge their EV batteries or use any of the additional services. To do this, the following must be ensured:

- free choice of electricity supplier for all electromobility needs;
- unrestricted access to all public charging stations (for means of EV charging only) regardless of the electricity supplier for electromobility or the owner of the public charging station;
- interoperability between different electromobility networks and different EV charging systems.

The initial introduction of electromobility must consider the principle of fair competition of all interested parties for the construction of charging stations on premium and other locations. The local community must ensure a rational and efficient use of public urban space, minimise costs and maximise income, and enable a competitive market where there is a sufficient number of developed suppliers present, ideally ensuring an equal distribution of charging stations from different suppliers in every area.

Construction of the network of charging stations should observe the following general principles:

- universal accessibility of charging stations: they need to be accessible to all citizens and different groups of users (e.g. persons with disabilities, etc.) and conveniently distributed. Ideally, the majority of citizens should be within a maximum radius of a couple 100 m to the nearest public charging station;
- even and economical distribution of charging stations: proper ratio of fast and slow charging stations needs to be established. The fast charging stations will prevail on public locations, while the majority of private charging stations will enable only slow charging;
- safe spatial placement: the charging stations should not present an obstacle in pedestrian and cycling areas. The charging cables can pose a threat and present a tripping hazard for the pedestrians. If the charging station has to be placed in a pedestrian/cycling area, an area with the minimum pedestrian/cyclist frequency should be chosen.
- unified visual appearance of public charging stations, in order to ensure better recognisability;
- the charging stations should be treated as a simple works, which does not require a building permit for its construction. An appropriate number of designated parking places should be constructed in the direct vicinity of each charging station. These parking places must be reserved exclusively for EV owners (similar to parking places for the disabled) and properly marked. City traffic wardens or the police should monitor the parking regime.

3.4. Electromobility and the power system

The management of the grid needs to evolve in response to the growing use of renewable energy (especially from solar and wind farms) and an increasing share of distributed generation (from smaller power plants, connected to the grid without any centralised control or planning). Energy flow in the power network has thus become more unpredictable. Distribution systems experience a completely new energy flow, in the previously unseen direction from low- to high-voltage networks. All these circumstances influence the operation of networks and the planning of their further development with regards to energy flow and load on different network elements.

Unlike larger power plants, dispersed power sources within distributed generation are not included in the centralised management of energy production. Their current energy production is highly variable and unrelated to the needs of the power system as a whole. This is especially true for solar and wind farms, the output of which is entirely dependent on the unpredictable weather conditions. This presents a problem for the power system, which must ensure a balance between the production and consumption of energy at all times. The unreliability of predictions of energy consumption and its constant real-time fluctuation is additionally combined with an unreliable power output on the side of energy production. As a consequence, the power system requires more operating reserve, which in turn leads to a more complex and more expensive operation of the entire system.

The increasingly stern economical and environmental circumstances lower the rate of investments in the power system and do not allow any increase in the system's operational costs. In a nutshell, the solution for the future operation of the power system therefore lies in active management of the distributed generation and energy consumption on the side of energy consumers. Such management requires a new approach to the management of the power system, a strong support in the information system, and appropriate physical equipment at the location of energy consumers (in this case end users and distributed generation). Due to the requirements for advanced supporting information systems and coordinated actions of both the energy infrastructure and its users, the described approach is referred to as »Smart Grid«.

In this context, a large-scale EV charging system can not only help tackle environmental issues, but can benefit the functioning of the power system itself. While charging, EV consumes electrical energy. If the EV is connected to a smart charging station with the option of remote control, the charging can be stopped when the power system faces higher loads and resumed at a later time. This decreases the power consumption within the network, with the same effect on the balance between energy production and consumption as if the operating reserve in a designated power plant had been activated. Such management should of course consider the needs of EV users and only stop the charging when there is enough time available to fully charge the vehicle later on (or to charge it to the desired level, set by the user). This could mostly be done with EVs which are charging at home or during working hours, where the available charging time is considerably longer that the time needed to recharge the battery.

An advanced EV charging management option in the power system is to use its battery as an energy storage device. In this case, the EV does not function merely as an equivalent to reserve power (in the sense of lowering consumption when needed), but can also store excess energy in its battery and return it to the network in times of shortages. In combination with smart grid functionalities, EVs can strongly benefit the increase of energy production from renewable sources (especially wind farms); a larger number of EVs connected to the network can »capture« and store the otherwise lost energy produced by wind farms when their output exceeds the demand of the power system. This energy can be later returned to the network or used for driving needs. Besides enabling a higher share of energy produced by wind farms to be used in the grid, this scenario also supports combinations with photovoltaics and micro-cogeneration. EVs thus indirectly facilitate the use of a higher share of renewable energy in the energy portfolio of energy producers and traders.

Considering the daily energy needs of Slovenia, energy consumption of a single EV seems insignificant. However, if we consider the total number of passenger cars in Slovenia and assume only a 1% share of EVs, their charging capacity presents a significant amount of power which could be used for energy adjustments in the power system. With the use of proper control systems and adequately equipped vehicles, this power can be used to control the consumption according to local (energy flow and overloads in the power distribution network) and national needs (balance between the total output of power plants and total consumption).

The interaction between the EV and the grid is referred to as »Vehicle-to-Grid« (V2G). For an efficient functioning of the V2G process (integrating the EV charging process into control systems of the power system), a physical connection (with a charging cable) and a reliable communication connection are needed. This enables control over the energy flow and the current state of the EV battery.

Even though V2G systems are not yet widely used, questions on the integration of EV charging into the power network and its control systems already arise. A special emphasis is placed on the issue of billing for the services offered by EVs to support the functioning of the power network. The position of electromobility will strengthen together with the solutions it offers for some of the more pressing issues of today (the need to increase the share of renewables in the production of electrical energy, support for the management of the power system, improvement of reliability and quality of energy supply). This will result in an increased support for the adoption of electromobility from countries, local communities, power companies, EV manufacturers, and charging infrastructure manufacturers and service providers. The V2G concept will also help potential EV users make a decision for the new mobility, since EV charging costs will decrease as a result of using EV charging as a support mechanism for the grid.

Slovenian energy policy places a special emphasis on the introduction of electromobility, mostly from the aspect of constructing an operational network of charging stations. The Slovenian Green Paper for National Energy Programme – consultation document for public debate[10] states that: "Electrical energy required to power the estimated total number of vehicles in 2030 would present only 2% of today's total energy consumption in Slovenia, or 6% of the energy consumption in low-voltage networks. The reason for a low share of consumed energy is the high energy efficiency of electric vehicles (especially urban electric vehicles) and the gradual replacement of older vehicles with new ones. The efficiency of these vehicles is up to 7 times greater than the efficiency of vehicles with internal combustion engines."

The Draft Proposal of the National Energy Programme of Republic of Slovenia for the period until 2030 (NEP)[11] refers to the following strategies for the implementation of actions related to the usage of energy in transport:

- promotion of battery electric and fuel cell vehicles;
- construction of charging infrastructure for battery electric vehicles;
- adequate availability of charging infrastructure for transit and inland transport;
- supplementation of spatial regulations with criteria for construction of EV charging infrastructure,
- development of smart grids and ensuring technical conditions for the construction of charging infrastructure for battery electric vehicles.

NEP also introduces measures in the area of use and supply of energy in transport, among which are the improvement of the energy efficiency of vehicles and driving style, adoption of new energy products in transport, construction of EV charging network, and adoption of electric vehicles and other alternative fuel vehicles. These measures should reduce both local and global pollution and the overall strain on the environment. Among the specific goals of the Programme regarding the use of energy in transport are:

- to ensure a 50% share of renewable energy for the charging of battery electric and fuel cell vehicles by 2015 and 100% share of renewable energy by 2020 for all public charging stations;
- to develop energy and charging infrastructure for the efficient use of modern, environmentally friendly vehicles by ensuring 1.000 new public charging stations for battery electric vehicles by 2015 and 3.000 new public charging stations by 2020.

NEP refers to electromobility also in connection with the supply of electrical energy and the operation of the distribution system. The strategic tasks include requirements for network operators to introduce smart metering and billing devices for the consumers of electricity, gas, district heat, and water at the location of the consumer. The electric distribution utilities will have to ensure a simplified and standardised network connection process for new distributed generation plants and EV charging infrastructure.

[10] Ministry of Economic Development and Technology, April 2009, http://www.mg.gov.si/si/zakonodaja_in_dokumenti/energetika/pomembni_dokumenti/ nacionalni_energetski_program_za_obdobje_do_leta_2030/

[11] Ministry of Economic Development and Technology, June 2011, http://www.mg.gov.si/si/zakonodaja_in_dokumenti/energetika/pomembni_dokumenti/ nacionalni_energetski_program_za_obdobje_do_leta_2030/

3.5. Impact of electromobility on end users

3.5.1. Electromobility and end users

The adoption of electromobility in public transport enjoys a high public support, although general acquaintance with electromobility and its background is low[12]. As a part of the project, a public survey was conducted among citizens living alongside the Dunajska-Slovenska-Barjanska road corridor. The results of the survey showed a strong attachment of citizens to passenger cars. Nevertheless, the majority of them showed support for the implementation of measures for a sustainable public transport and other alternatives to cars, as long as the costs of mobility for the users do not rise. The survey also confirmed support for changes in the traffic regime, but with emphasis on soft measures.

The results in general suggest the possibility of a relatively simple transition to a large-scale use of EVs, especially if accompanied by appropriate activities to raise public awareness of the advantages of electromobility. The use of EVs brings improvements not only to the local, national and European environment, but also to all citizens' habits which are knowingly or unknowingly linked to transport.

Passenger cars today are a synonym for the freedom of mobility, but at the cost of polluting the environment and with an important limitation – the dependence on the limited amount of fossil fuel and its centralised distribution. EVs have the ability to solve all of these issues. Besides presenting a clean mode of transport, the EVs enable their owners a high level of independence. Most of the energy needed for the daily use of EVs can be acquired by domestic charging. Charging EVs at home provides a greater independence from fossil fuel distribution network (especially for households who produce their own electricity) and is at the same time simple and practical.

EVs can provide complete energy independence to their owners for shorter periods of time. It is easy to imagine the advantages of EVs in the case of natural disasters and other similar events. Electromobility may also assist the needs of the Civil Protection Service, especially by providing access to energy stored in EV batteries, which can even be used to save human lives in the most extreme cases.

With regards to the most concrete part of electromobility – driving an EV – it can be said that EVs offer an exceptional driving experience. With their smooth acceleration, quiet running engine and considerably lower pollution, they provide responsible pleasure to their owners. EVs particularly excel in urban driving environment. As opposed to ICE vehicles, where braking only causes energy loss in the form of heat, the main advantage for EVs is the ability to store the energy released by braking and reuse it (the so-called regenerative braking). Moreover, EV's do not use any energy when standing still at a traffic light or in a traffic jam, whereas at the same time ICEVs use their fuel with zero efficiency. Another difference is that EVs do not have a transmission box, meaning that a full torque of the vehicle is available at all times.

EVs are also safer to drive. They include all the latest technological and safety solutions on the market. The option to use new communication possibilities (for example between the driver and the vehicle, the vehicle and the infrastructure, or between vehicles) will improve traffic safety and reduce the number of accidents without influencing the existing traffic regimes.

EV ownership is a rational choice also in terms of finances. Even though the purchase price is higher than for an ICEV, EV owners are soon rewarded by the much lower driving costs and lower maintenance costs due to fewer movable mechanical parts which can wear out.

3.5.2. End users' habits and expectations

End users set high demands for EVs and expect them to be comparable with ICEVs in terms of functionality and price at the same time. Virtually all automobile manufacturers are trying to respond to these demands as soon as possible. At the moment, EVs are ideal for shorter journeys, while ICEVs remain better suited for long distance journeys. It is a common expectation for EVs to have as much range as an ICEV with a full tank of gas. Even though that is currently almost impossible to achieve, the limitations of mass-marketed batteries are diminishing with time. EV batteries will soon be able to compete with the currently much greater energy density of fossil fuels. The growing usability of EVs will boost greater demand, leading to economies of scale and a considerable price drop, making EV subsidies obsolete. EVs will thus become price-wise competitive with other vehicles as well. However,

[12] Support for CIVITAS ELAN measures, working material, Uršič et al., 2009

in its initial phase, the adoption of electromobility will benefit greatly from local incentives and government subsidies to overcome the technological challenges.

The use of EVs is closely connected with the charging infrastructure. End users' habits will play a vital role in the development of the charging system. In the framework of the G4V[13] European project an online survey[14] was conducted in eight countries among more than 1900 respondents. The survey used predetermined technical data (120 km EV range, 4 h charging time, 3€ for the price of private charging and 5€ for public charging). The results have shown that 85% of respondents drive less than 100 km a day. Nevertheless, the desired average EV range was 308 km. 70% of respondents were found to have a private parking place. One third of respondents would charge their EVs only at home or at work, another third would also use public charging stations and additional third would be forced to use public charging options due to their driving habits.

Considering the different charging prices (5€ versus 3€), 53% of respondents would charge their EVs exclusively at home or at work. Results have shown an interest in delayed charging (meaning that the EV does not start to charge as soon as it is plugged in, but only charges during night-time between 10 P.M. and 6 A.M. so that the battery is full in the morning at the latest). The delayed charging scheme included incentives in the form of lower charging prices (2€ versus 3€ for immediate charging). In average, the respondents showed great interest in delayed charging (5, 74 on the scale from 1 to 7). The respondents also stated the inability to immediately use the car in the event of an emergency as one of the reasons against delayed charging.

The final findings of the survey emphasised the need to address the concerns about limited mobility on the account of inadequate charging infrastructure before any mass roll-out of EVs. The survey also concluded that the public will favour private charging whenever possible, mostly because of better practicality and safety. In the first phase it is therefore necessary to offer technical solutions for a simplified domestic charging and improve the availability of public charging infrastructure. This will improve the support for charging elsewhere besides home and other private locations.

A clearer picture of the usability of EVs on today's market can be seen by analysing the actual data on the daily transport habits in Slovenia. As a part of its Plan for infrastructure and system environment measures for the introduction of battery electric vehicles in Slovenia[7], the Government published a study which shows that 50% of drivers drive less than 50 km per day, 35% between 50 and 100 km and 10% drive between 100 and 150 km or more. Moreover, the average daily commuting distances of people living in urban areas are even shorter. The EVs currently on the market have a range between 110 and 150 km on a single charge.

Although the majority of drivers do not drive more than 100 km per day, most of them want EVs to have a much greater range. The reason behind that is the need for occasional longer journeys and the need for extra energy in case the charging station is not available. This "range anxiety" will disappear with growing public awareness and the ability for users to find the nearest charging station at any time (for example via smart mobile phones). EV manufacturers need to be aware of the fact that the range of EVs will have to be improved before they can fully replace ICEVs – otherwise they might remain merely an auxiliary vehicle.

The biggest advantage of EVs over ICEVs is the operation and maintenance costs. With the current prices of electricity, the cost of a 100 km drive in an EV is somewhere between 0.5€ and 1.5€. Similar costs were confirmed during the six months test drive period in the United Kingdom, where people spent about 1.5€ per 100 km. Prices of electricity are higher in UK than in Slovenia.

Calculations clearly show that concerns over EVs are exaggerated, which is further proved by real-world use. Pilot projects confirm that EVs meet most of average drivers' demands and are in reality more useful than expectations of people without prior EV driving experiences might indicate.

3.6. Electromobility today and in the future

It is not possible to determine the exact number of battery and hybrid EVs in Europe or in the world. Vehicle classification has not yet been adjusted to accommodate for the mass arrival of EVs, therefore national records do not yet differentiate between EVs and ICEVs, or even between hybrids, battery EVs, and plug-in hybrid EVs.

[13] http://www.g4v.eu/about.html
[14] http://www.ecn.nl/docs/library/report/2011/o11030.pdf

The current number of light EVs is even more unclear, since dealers are not obligated to report the number of (electric) motorcycles and mopeds sold.

The number of charging stations is also hard to estimate. A charging station is classified as a simple works and does not require any special permits to be installed. As with EVs, there is currently no special classification in place which would enable an overview of the number of charging stations on the national levels.

The only data left to estimate the rate of adoption of EVs are the sales figures from car dealers or manufacturers, even though the majority of today's EV are actually converted ICEVs. According to data from JATO Dynamics[15], there were 5222 EVs sold in Europe in the first half of 2011. The figure might not be exactly high, but the growth of the market (1337 EVs sold in 2010) is evident. This growth is a direct result of recent subsidies by the European governments.

The exact number of EVs in Slovenia is unknown due to the lack of special classification of EVs. An educated guess can be made by subtracting vehicles using gasoline, diesel, oil, or natural gas from the total number of vehicles. If all the remaining vehicles are EVs, there should be around 50 EVs in Slovenia. The number of electric bicycles and scooters is unknown.

As for the charging stations, their exact number is also unknown. According to data provided by both existing portals for EV owners[16,17] the approximate number is 35 public charging stations (usually each with two sockets), 15 of which are installed in Ljubljana.

The Green Paper for National Energy Programme refers to other foreign studies and predicts approximately 400.000 hybrid vehicles, 200.000 plug-in hybrids, 100.000 battery vehicles, 100.000 hydrogen hybrids, and 100.000 hydrogen vehicles in Slovenia by 2030.

These estimates are consistent with the Draft National Energy Programme (NEP). The reference (basic) strategy of the draft estimates the share of EVs to increase to 0,1% in 2015, 1,3% in 2020 and 6,8% in 2030. The intensive strategy establishes even higher estimates: 0,3% in 2015, 2,7% in 2020 and 10,2% in 2030. In absolute numbers, the referential NEP strategy anticipates the growth of the number of EVs to 1.000 vehicles in 2015 and 87.700 in 2030, while the intensive strategy estimates the number of EVs to be 3.300 in 2015 and 131.600 in 2030.

[15] JATO: Incentives fail to stimulate European electric vehicle sales
[16] http://polni.si/index.php
[17] http://www.elektro-crpalke.si/

4. ELECTROMOBILITY IN TRANSPORT POLICIES

4.1. European transport policy

EC White paper 2011 Roadmap to a Single European Transport Area refers to transport as fundamental to the economy and society. Mobility is vital for the development of the internal market and for the quality of life of citizens. Transport enables economic growth and job creation and must be sustainable in the light of the new challenges we face.

EU urged for a considerable reduction of the world's GHG emissions to limit the global climate change within 2ºC. To achieve this goal, the calculations of the Commission[18] indicate that at least a 60% reduction of transport related GHG emission by 2050, relative to 1990 levels, is necessary. This equals to a 70% reduction relative to 2008 levels. By 2030, the goal is to reduce transport related GHG emissions by 20% relative to 2008 levels. Considering the increase of transport related emissions in the last two decades, the GHG emissions levels will still be 8% above 1990 levels.

European legislation[19] requires car manufacturers to reduce the average CO_2 emissions of new passenger cars to 130g CO_2/km by 2015, which presents a 19% reduction relative to 2007. The industry is on a good way to achieve this goal, especially considering the fact that the average car emissions for vehicles registered in EU in 2010 were 140g of CO_2/km. However, any further reductions for ICEVs will be more expensive and harder to achieve. The average CO_2 emissions have decreased by 5,1% in 2009, and only 3,7% in 2010. At the same time the total number of vehicles (and emissions) is constantly growing. The next goal is to reduce the average CO_2 emissions for passenger cars to 95g CO_2/km by 2020. These commitments will promote the introduction of the next generation of affordable eco-friendly cars, which will mostly be able to use alternative sources in addition to fossil fuels.

The main challenge will be to tackle the issue of oil dependence without reducing the efficiency of the transport system or the freedom of mobility. In accordance with the flagship initiative "A resource-efficient Europe" determined within the Europe 2020[20] strategy and the new Energy Efficiency Plan[21], the main objective of the European transport policy is to implement a system which will boost economic growth and competitiveness and offer high-quality mobility services with a more efficient use of resources. In practice, this means using less and cleaner energy in transport, make better use of modern infrastructure, and reduce the negative impact of transport on the environment and basic resources, such as water, soil, and ecosystems.

The effect of synergy with other sustainable development goals (such as reducing oil dependence, improving competitiveness of European automotive industry and improving air quality in urban areas) further encourages an even faster development and adoption of clean and energy-efficient cars.

Among other innovation strategies, EC emphasises the need for demonstration projects for electromobility (and other alternative fuels), including charging infrastructure and intelligent transportation systems, especially in urban areas where air pollution poses most problems. The strategies include partnerships for smart mobility and demonstration projects for sustainable urban transport solutions (including presentations of road tax schemes etc.) and actions for an increased replacement rate of older inefficient and polluting vehicles.

Subsidisation of EV purchases remains the most common measure in Europe to promote electromobility. The JATO market report and analysis provides data on subsidies in different European countries, together with the sales figures for the first half of 2011. The title of the report indicates that EV sales are marginal, however in reality their sales figures have increased tenfold compared to the same period one year before. The report's title therefore refers to the correlation between the amount of subsidies and the number of EVs sold. EV sales do not depend on subsidies alone, but on other supporting measures as well (e.g. subsidised price for the use of charging stations and electricity to charge the EVs), the level of development of the charging infrastructure, and the presence of traditional automotive industry (ICEVs) in a certain country (the countries with the lowest share of EVs are Germany, France, Spain, Italy, and Romania).

[18]Communication from the Commission A Roadmap for moving to a competitive low carbon economy in 2050, COM(2011)112.

[19]Regulation (EC) No. 443/2009 of the European parliament and of the Council setting emission performance standards for new passenger cars as part of the community's integrated approach to reduce CO2 emissions from light-duty vehicles.

[20]Communication from the Commission EUROPE 2020 - A strategy for smart, sustainable and inclusive growth, COM(2010) 2020.

[21]Communication from the Commission Energy Efficiency Plan 2011, COM(2011) 109.

4.2. Slovenian transport policy

Resolution on the Transport Policy of the Republic of Slovenia[22] states the following general transport policy goals:

- efficient use of energy and clean environment,
- raising awareness and informing the public on the topic of sustainable mobility,
- ensuring the necessary transport infrastructure for land, air, and sea transport, which will follow the principles of sustainable and coordinated regional development,
- ensuring a reliable, safe, economically competitive, and environmentally friendly passenger and goods transport,

with the promotion of use of more energy efficient and environmentally acceptable vehicles as one of the general measures of the transport policy.

Within this measure, the Government Office of Climate Change of the Republic of Slovenia has presented the current state in the area of electric vehicles to the Government in August 2011 and proposed relevant measures for the promotion of electromobility[23]. The main emphasis in the document has been put on:

- electric vehicles and their potential contribution in solving some of the major challenges of the European Commission, such as climate change, fossil fuel dependence, local air quality, and the storage of energy, produced in smart grids from renewable energy sources,
- clean electric vehicles will be the most suitable for urban use,
- current market trends necessitate an efficient introduction of energy efficient electric vehicles, where Slovenia is no exception.

Besides environmental concerns, the document emphasises the impact of the adoption of electromobility on the Slovenian economy, where the automotive industry with its numerous manufacturers of car parts and a well-developed automotive cluster is one of the most important sectors. The measure for the promotion of electric vehicles and the already realised or projected EV charging infrastructure will undoubtedly have a positive impact on the results and competitiveness of these companies. The Automotive Cluster of Slovenia, some of the more active EV components manufacturing companies, and the offices of some automobile manufacturers have already established a cooperation in drafting the document.

On the basis of this Information, the Government confirmed the Programme for the support of purchases of electric vehicles for 2011-2013 in September 2011. This was followed by two public calls for EV purchase subsidies in October and December 2011[24]. The exact amount of subsidies in each of the two calls depends on vehicle category (see section 3.1.1) and type of investment (purchase of a new vehicle or ICEV to EV conversion). The amounts of subsidies are:

- 5.000 € for the purchase of a new battery electric vehicle of M1 category with zero CO_2 tailpipe emissions and a minimum 100 km battery range;
- 4.000 € for the conversion of an existing ICE vehicle of the M1 category to EV;
- 4.000 € for the purchase of a new plug-in hybrid battery vehicle (with an ICE and a battery), with a minimum 50 km battery range;
- 3.000 € for the purchase of a new battery electric vehicle of N1 category with zero CO_2 tailpipe emissions;
- 3.000 € for the purchase of a new battery electric vehicle of L7e category with zero CO_2 tailpipe emissions and a minimum 40 km battery range;
- 2.000 € for the conversion of an existing ICE vehicle of N1 or L7e category to an electric drive;

[22] Official Gazette RS 58/2006
[23] Information on the latest trends regarding the introduction of battery-powered electric with the plan for infrastructure, system environment, and demonstration project measures
[24] Public call for grants to private individuals for the purchase of battery electric vehicles and Public call for grants to legal entities for the purchase of battery electric vehicles, Official Gazette RS, 79/2011 and 109/2011

- 2.000 € for the purchase of a new battery electric vehicle of L6e category with zero CO_2 tailpipe emissions and a minimum 40 km battery range;
- 1.000 € for the conversion of an existing ICE vehicle of L6e category to EV,

whereas the amount of subsidy shall not exceed 50% of the recognised investment costs and the owner must cover at least 25% of the recognised investment costs.

4.3. Transport policies in other major cities

In order to effectively curb transport emissions and tackle congestion and traffic jams, the implementation of transport policies in urban areas requires a mixed strategy, which should include urban planning, suitable pricing of public transport services, construction and use of infrastructure for non-motorised means of transport, and charging/refuelling infrastructure for »green« vehicles.

The ever-increasing road traffic density in most of the European cities results in congestion problems, reduced traffic flow, and especially in alarming rates of air pollution. Most cities are struggling to keep individual air pollutants below or at least close to their limit values.

The transition towards a cleaner transport in cities is simplified by lower performance requirements for an average urban car and a higher population density. The availability of public transport is generally much better, as well as the convenience of other forms of mobility (walking, cycling). The most negative aspects of traffic in cities are congestion, poor air quality, and noise.

Urban transport is the cause for nearly a quarter of all CO_2 transport emissions. A gradual replacement of »conventional« vehicles (with ICE engines and without a hybrid powertrain) in the urban environment will present a great contribution to the reduction of oil dependence, GHG emissions, and local noise and air pollution. The process will have to be complemented with a development of an adequate infrastructure designated to charge or refuel the new vehicles.

Cities should encourage the use of smaller, lighter and more specialised road passenger vehicles. Large fleets of urban buses, taxis, and delivery vehicles are particularly suited for the introduction of alternative powertrains and fuels. These systems could substantially reduce the CO_2 emissions in cities and at the same time serve as a testing ground for new technologies and opportunity for early market adoption of alternative vehicles. Road tax, congestion charges, and properly directed taxation in general can contribute to the promotion of public transport use and the gradual large-scale introduction of alternative propulsion.

The interface between long distance and last-mile freight transport should be organised more efficiently. The aim is to limit individual deliveries, the most 'inefficient' part of the journey, to the shortest possible route. The use of Intelligent Transport Systems contributes to real-time traffic management, reducing delivery times and congestion for last-mile distribution. This could be performed with low emission urban trucks. The use of electric, hydrogen and hybrid technologies would not only reduce air emissions, but also noise, allowing a greater portion of freight transport within the urban areas to take place at night-time. This would ease the problem of road congestion during morning and afternoon peak hours.

The European Commission promotes the development and use of new and sustainable fuels and powertrains. One of its goals is to halve the use of 'conventionally-fuelled' cars in urban transport by 2030 and phase them out in cities by 2050, and achieve essentially CO2-free city logistics in major urban centres by 2030. One of the strategies to achieve this will be to promote joint public procurement for low emission vehicles in commercial fleets (delivery vehicles, taxis, buses…).

One of the measures to reduce the use of ICEVs is the application of internalisation charges to road vehicles, covering the social costs of congestion, CO2 – if not included in fuel tax – local pollution, noise and accidents. For passenger cars, road charges are increasingly considered as an alternative way to generate revenue and influence traffic and travel behaviour. The Commission will develop guidelines for the application of internalisation charges to all vehicles and for all main externalities. The long-term goal is to apply user charges to all vehicles and on the whole network to reflect at least the maintenance cost of infrastructure, congestion, and air and noise pollution. In parallel, the Commission plans to develop additional market-based measures to further reduce GHG emissions.

4.4. MOL transport policy

Travelling by car is the most common means of transportation in Ljubljana today. The MOL Environmental Protection Programme[25] states that in 2006, there were 611 registered vehicles per 1000 inhabitants in Ljubljana, and 608 vehicles per 1000 inhabitants in the wider Ljubljana urban region.

According to statistical data from 1994, there were slightly less than 97.000 daily commuters coming to Ljubljana and their number has risen to more than 120.000 in 2000. A part of this rise can be contributed to daily trips to the newly built shopping centres.

The region is characterised by an intensive suburbanisation process, which was additionally sped up by the construction of the Ljubljana ring road and the motorway network. In comparison with other European capitals, the traffic situation in Ljubljana is unfavourable. On top of that, both personal and transit freight transport (within trans-European corridors) are constantly on the rise.

The existing Ljubljana transport policy aims for an integrated approach to sustainable transport in the city and includes both citizens and stakeholders. Its goal is to establish principles for a sustainable development of mobility, which will help achieve the balance between social equality, quality of environment, and economic development.

The MOL Transport Policy Plan[26] introduces principles for sustainable urban mobility and aims to upgrade the existing traffic regime with more energy efficient, environmentally friendly, and spatially optimised transport solutions in the city and its wider region.

The main characteristics of the planned sustainable transport system are an integrated and balanced transport network, sustainable hierarchy of urban users of the transport system (with passengers on top, followed by cyclists, public transport, and passenger cars, in that order), rational use of passenger cars, competitive public transport system, improved management of traffic demand, better organisation of road use, efficient management of the transport network, and cost efficiency.

The transport policy aims for a balanced development of Ljubljana, which endeavours to become a city which will enable a high living standard and healthy lifestyle to its citizens. At the same time, it will remain competitive in the world of expensive fossil fuels, attract new businesses and enable their growth, reduce noise and air pollution, operate with a minimum use of non-renewable resources and become a city in which people will be able to reach most of their daily destinations without using a passenger car.

Among its operational goals, the transport policy includes balancing the use of different means of transportation (in essence: more walking, more cycling, more bus rides and less car travel), prioritised development of public transportation, improvement of conditions for walking outside the city centre, exploitation of potentials of cycling, optimisation of passenger car use and optimisation of freight transport. Ljubljana transport policy is thus based on reducing the use of passenger cars for transport (particularly to and from the city centre) and increasing the use of other means of transportation at the same time.

The main and most important goal of the Ljubljana transport policy is to reverse the negative trends in the use of certain means of transportation. However, an average MOL citizen still heavily depends on passenger car use. This is even more true for the daily commuters and transit passengers. Theoretically, large areas of the city could be closed for cars or made less accessible with higher entry fees or taxes, but at the price of less freedom of mobility for citizens. In this scenario, some group of transport system users always benefits at the expense of the others.

Passenger car transport cannot be completely eliminated from the wider urban area without employing drastic measures and limitations, which could ruin the reputation of Ljubljana as a visitor-friendly city. A certain part of population, be it citizens of Ljubljana, daily commuters, students, or tourists and business visitors, will always require the possibility of using a passenger car to get around the city. Therefore an active approach towards introducing necessary improvements within the passenger cars sector is required.

Promotion of walking, cycling, and use of public transportation is the best possible start to reduce the negative impacts of transport on the citizens of Ljubljana. However, since cars will always remain one

[25] MOL Environmental Protection Programme for 2007-2013, http://www.ljubljana.si/si/mol/mestna-uprava/oddelki/varstvo-okolja/

[26] Proposal for the MOL Transport Policy Plan, 30.9.2011, www.ljubljana.si/si/mol/mestna-uprava/oddelki/gospodarske-dejavnosti-promet/

of the means of transportation in Ljubljana, it is vital that the transport policy focuses on the options to reduce their negative impact despite their continued growing use.

4.5. Socio-economic aspects of electromobility in MOL

Even though the global reasons for a wide adoption of electromobility are compelling, its primary positive effect will still first be witnessed on the local level. Electromobility will directly improve the quality of life for the Ljubljana citizens. Large-scale adoption of EVs brings the following benefits:

- reduced environment pollution,
- reduced city noise,
- lower total cost of car ownership,
- better reliability of vehicles.

The tangible lasting benefits of EVs mean that every single EV on the streets of Ljubljana will present a further step towards the solution of local pollution problems. The introduction of electromobility addresses several of the most important issues faced by Ljubljana and other major cities. The common denominator for these issues is their source – transport in the urban area. Pollution rates from individual vehicles may have fallen as a result of advances in ICE technologies, but the rising number of ICEVs and longer average car trips in general raise new concerns about the increasing contribution of transport to local air and noise pollution.

Electromobility tackles the problem at its core. Without a wide adoption of EVs, some of the issues will remain unresolved or even complicate further.

4.5.1. Impact of pollution on health

Air, water, and soil pollution are directly related to health problems, which affect all Ljubljana citizens and their quality of life. There is a direct link between the deteriorating health record of Ljubljana citizens and urban transport. The results of a study[27] conducted in the town of Novo mesto may serve as an illustration. The study explored the topic of detrimental impacts of transport (predominantly consisting of ICEVs) on the health of the population living in the vicinity of main roads. The major health risks which were found to be linked to transport were the following:

- long-term exposure to nitrogen dioxide (NO_2) reduces normal lung capacity and increases symptomatics of bronchitis and asthma. NO_2 also irritates the mucous membrane in the lungs and increases risk of respiratory infections (e.g. influenza, etc.). Chronic or frequent exposure to higher than usual concentrations can increase the prevalence of various acute diseases in children.
- exposure to volatile organic compounds (VOCs) can cause chronic diseases, such as cancer, central nervous system disorder, liver and kidney failure, reproductive system disease, and various embryonic defects;
- exposure to PM10 particulate matter can cause coronary and respiratory diseases or even lung cancer. The fine particles can penetrate deep into the lungs and cause infections or deteriorate the health of people with chronic coronary or respiratory diseases.

All these health risks are also present in Ljubljana, which faces the same pollution problems as other major cities. The MOL Environmental Protection Programme for 2007-2013 reports that transport is the leading source of air pollution in most of Ljubljana's urban area. Transport related pollution is reflected in the form of higher concentrations of nitrous oxides, carbon monoxide, VOCs, and particulates. During periods of warmer weather with direct sunlight, larger amounts of ozone are formed from VOCs and NOs. The specific conditions of ozone formation result in higher concentrations of ozone outside the city (and not in the city centre).

[27] Zdravstvena tveganja za skupnosti ob hitri cesti 3. osi, http://tretjaos.com/img/files/3os-zdravstvenatveganja.pdf

A study[28] on the link between the use of fossil fuels and air quality was conducted in cooperation of CEHAP, IVZ, RS, and ARSO. The study reports that almost every inhabitant of a major European city is occasionally or permanently exposed to polluted air. Approximately 90% of the European urban population is occasionally or permanently exposed to excessive levels of air particulates, ozone, and NO_2 compounds in the air, which presents direct health risks.

Air pollution caused by the use of fossil fuels has several negative impacts on health: it causes asthma and its aggravation, respiratory diseases and their aggravation, increases the prevalence of new cases of respiratory diseases in children, reduces lung capacity in children and adults and causes other pulmonary complications, increases premature mortality rate, causes atherosclerosis and increases the general prevalence of respiratory and coronary diseases.

Air pollution does not only cause aggravation of asthma but can also cause new cases of asthma in children. Each year in Ljubljana, there are on average 272 (12%) cases of asthma recorded for children aged 0 -17 which can be attributed to the exposure to polluted air in the vicinity of main roads (within a 75 m area).

The estimated impacts of air pollution are often even underrated, since they are based on studies which draw their results only from short-term observations. Actual figures may be even higher, since the impact of polluted air on public health is a complex issue with long-term consequences. Studies confirm that the use of fossil fuels and transport are the two most important sources of air pollution in urban areas.

4.5.2. Air pollution

The Government of Slovenia refers to the action taken by the European Commission, which started an analysis of EU countries in 2009 with the goal to determine their compliance with the European standards for air quality and emissions of particulates. The EC directive on ambient air quality and cleaner air for Europe[29] determines that the daily limit values of PM10 concentrations can be exceeded for up to 35 days a year. In 2006, there were 50 days when these limit values were exceeded in Ljubljana. In 2007, there were 48 such days and the record is even worse for 2008. The towns of Zagorje and Trbovlje stand out in Slovenia, mostly due to their heavy industry. The other city that stands out is Ljubljana, where the largest share of pollution can be attributed to road transport.

According to ARSO[30], the data for 2011 (until September) show that the limit daily value of particulates in Ljubljana (50 $\mu g/m^3$) was exceeded between 31 and 37 times, depending on the measurement location. The exceeding of European set limits in Slovenian cities and failure to follow the Directive on air quality may result in actions against Slovenia by the European Commission.

The increasing particulates emissions are linked to the increase in mortality rates and health problems, especially in children population. If the PM10 levels in Ljubljana would be comparable to those in some of the Scandinavian cities, this would result in 300 less deaths every year from respiratory and coronary diseases[31]. If Ljubljana succeeded in lowering its average yearly levels of PM10 to 20 $\mu g/m^3$, an estimated 66,7 lives per 100.000 citizens would be saved. Lowering the levels to 10 $\mu g/m^3$ would result in an estimated 106,8 lives saved per 100.000 citizens.

The 10 $\mu g/m^3$ value of PM10 particles is the recommended average value determined by the WHO, which is supposed not to affect public health considerably. Measurements have shown that the average PM10 value in Ljubljana is 29,4 $\mu g/m^3$, which results in a one year shorter life expectancy for an average Ljubljana citizen (in comparison with the scenario in which PM10 pollution is below the recommended WHO values).

The two major air pollutants besides PM10 emissions are nitrous dioxide (NO_2) and ozone (O_3). MOL Environmental Protection Programme identifies NO_2 as an important indicator of transport related pollution in Ljubljana. In 2006, road corridors were on the top of the most polluted areas, with an average yearly concentration of NO_2 reaching as high as 80 $\mu g/m^3$ in certain areas (the limit value for yearly NO_2 concentration in 2006 was legally determined to be 48 $\mu g/m^3$). City topography also considerably affects air quality in the vicinity of roads. The level of pollution depends on the average wind inten-

[28] Fossil fuels, air quality – CEHAP, IVZ RS, ARSO (Ljubljana, June 15, 2010, Center Evropa)
[29] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:152:0001:0044:SL:PDF
[30] http://kazalci.arso.gov.si/?data=indicator&ind_id=388
[31] Air quality – health, CEHAP, IVZ RS, ARSO working group (Ljubljana, June 15, 2010, Center Evropa)

sity (influx of fresh air) in individual areas. The traffic from the Slovenska road corridor pollutes also pedestrian zones on Čopova and Cankarjeva street. Measurements up to 50 m from roads have recorded exceeding concentrations of NO_2. Hourly limit concentration is exceeded occasionally, while yearly limit concentration (40 µg/m^3) is exceeded regularly.

Transport is the source of 60% of nitrous oxides and 28% of hydrocarbons. The combination of these two compounds is the key to the formation of ozone. Chronic exposure to ozone can cause chronic pulmonary disease and can lead to pulmonary necrosis and fibrosis, complications in the respiratory system, infections, and other health issues. Transport is also the main source of benzene, a carcinogenic compound found mostly in the vicinity of main roads. If every Ljubljana citizen would be exposed to average benzene concentration of 3 µg/m^3 for a prolonged period of time, Ljubljana could expect to face 4-7 new cases of leukaemia each year on the account of benzene pollution.

4.5.3. Noise

Noise pollution affects a growing number of people, especially in urban areas. MOL Environmental Protection Programme defines noise as an unwanted, disturbing, possibly harmful sound, which may be perceived differently by different people. Fluctuation of noise is greater in urban areas where it can change already at small distances and time intervals. This creates scattered areas of intense noise which cannot be simply contained in one single area.

About one fifth of the Ljubljana population (50.000 people) lives in areas heavily polluted by noise. In recent years, transport is the greatest source of noise pollution, especially in direct vicinity of main roads and railways.

Very high levels of noise pollution (over 65 decibels) in the city centre are a direct consequence of the high traffic density, with lots of traffic jams and stop-and-go driving. Numerous service activities located in the centre are also one of the causes for heavier noise pollution.

EVs are especially well suited for quiet urban stop-and-go driving, since they are practically silent. Urban traffic is specific since it usually moves slower and is denser. This means that most of the noise is the result of the running of the conventional engines and not air resistance. EVs can eliminate this issue entirely and help reduce noise levels on urban roads.

Heavy noise pollution has also been recorded in prominent tourist areas of the city, affecting hotels, tourist sights, landmarks, etc. By reducing urban noise levels, Ljubljana would promote its reputation as one of the most popular tourist destination in this part of Europe.

4.5.4. Impact of pollution on vegetation

Studies have confirmed a correlation between road transport based on ICEVs and the pollution of areas in the vicinity of roads with heavy metals, such as lead and cadmium. Besides certain heavy industry sectors, the usage of fossil fuels is one of the main sources of lead and cadmium contamination. The two metals accumulate in roadside vegetation and can enter the human diet through ruminants, causing digestion anomalies. The highest levels of pollution with heavy metals were recorded in in the vicinity of main roads. It is highly recommended not to carry out any pasture in these areas or grow crops and vegetables.

Other pollutants that are considered most harmful for roadside vegetation are SO_2, NO, NO_2, O_3, fluorides, and fine particles. Transport emissions are a major source of nitrous oxides and fine particles.

One of the studies conducted in the United Kingdom [32] confirmed that nitrogen originating from transport emissions causes observable changes in roadside vegetation within a 100-200 m roadside area.

Additional soil pollution is caused by motor oils and other improperly disposed fluids from ICEVs. EVs eliminate this issue, since they require a minimum amount of lubricants and oils and do not need as many maintenance fluids (e.g. motor oil, coolant, transmission fluid, etc.) as ICEVs.

[32] Angnold PG. 1997. The impact of road upon adjacent heathland vegetation: effects on plant species composition. *J.Appl. Ecol.* 34:409–17

The immediate effects of pollution on vegetation might be visible or invisible. Visible damage is usually caused by short-term exposure to pollution, while long-term exposure to pollution additionally causes invisible damage.

The visible damage is manifested in the form of leaf discolouration. This kind of damage lowers the market value of the visually delicate crops, such as lettuce, spinach, or tobacco. The damage can also lead to smaller yields and can present a risk for pathogenic elements to enter the plants.

Invisible damage is a result of the effect of pollutants on biochemical and physiological processes in plants. This can in turn lead to slower growth, decreasing yields, or can even change the nutritional value of the crops (for example protein content).

In major world cities, the problems with food distribution lead to the emergence of urban agriculture projects. The existing food production industry is linked with high transportation costs. On average, a product travels 2.400 km[33] and uses 8.44 l of fossil fuel per 100 kg of weight[34] before it is delivered to the store. The use of energy for the transportation of food can be reduced if the food is produced in urban areas or their direct vicinity. However, in the current situation this is unrealistic due to high levels of pollution in urban centres, mostly on the account of traffic with ICEVs.

The optimisation of food production and transportation can reduce the strain on the delivery zones and reduce the pollution resulting from transporting massive amounts of food into urban areas. Considering the fact that more than 50% of world population lives in urban areas, electromobility could be crucial to the introduction of urban agriculture projects. Producing healthy food close to the consumers can finally become reality.

The conditions for the production of food would drastically improve if the ubiquitous use of ICEVs were limited or eliminated altogether. Higher number of EVs in Ljubljana and proper land use management can lead to larger areas of land being suitable for low-intensity agriculture needs. The citizens of Ljubljana could discover new possibilities for roadside land areas no longer polluted by ICEVs. Urban agriculture in Ljubljana would bring people closer to the nature and ensure a higher level of self-sufficiency. These activities would also set an example for the younger generation, enabling them a closer connection with nature and presenting the importance of environmental protection. With the help of electromobility and a sustainable transport policy, it is possible to achieve a previously unimaginable synergy of urban agriculture and transport.

4.5.5. Higher land values

The effects of electromobility are even more far-reaching. The reduction of noise and particulates pollution results in higher values of land and properties. New land use possibilities appear for the currently most polluted areas once the main polluter is eliminated, for example the option to grow healthy local food which is hard to imagine today.

Lower air and noise pollution that can be achieved with the adoption of electromobility will directly result in higher value of urban land and properties in those areas, which are currently most affected by traffic, namely in areas close to main roads and highways.

4.5.6. Other positive effects of electromobility

There are some other positive trends which can benefit from the adoption of electromobility, and negative trends which can be tackled more efficiently:

Electromobility is linked with other sustainable mobility measures in MOL

Pedestrians, recreation enthusiasts, cyclists, and users of public transportation will undoubtedly support a large-scale adoption of electromobility. These groups cause minimum pollution but are unfortunately most exposed to its effects due to their lower travel speeds through the polluted urban areas.

One of the measures to promote sustainable mobility is to increase the share of journeys on foot or by bicycle. The Strategy exposes the problem of areas reserved for pedestrians and cyclists being occu-

[33] http://www.leopold.iastate.edu/pubs/staff/files/food_travel072103.pdf
[34] http://www.washingtonpost.com/wp-dyn/content/article/2008/03/07/AR2008030702520.html

pied by commercial vehicles during morning deliveries. The highest frequency of light commercial vehicles (almost 40% of non-passenger vehicles) was recorded between 6:00 and 9:30 A.M., when most of the citizens leave home to go to school or work. Use of electric delivery vehicles could thus reduce pollution levels where and when they most affect the population.

Electromobility and user satisfaction for EV owners

Regardless of the high purchase price of EVs, the total costs of EV ownership are lower than for ICEVs. The higher initial price is compensated with savings on fuel and considerably lower maintenance costs due to better reliability of EVs compared to ICEVs.

Electromobility and its effect on cultural landmarks

A large number of the most important landmarks and some of the most beautiful historic buildings in Ljubljana are located close to the city centre, in areas with the highest traffic density. Emissions from transport based on ICEVs cause deterioration of these landmarks and negatively affect the image of Ljubljana as a clean and tourist friendly city. The consequent requirement for more frequent renovation and maintenance interventions also presents a considerable cost for the city's budget. Less traffic in the city centre accompanied with the introduction of cleaner vehicles can thus have a positive effect on the cultural landmarks in Ljubljana.

4.6. Adoption of electromobility in MOL

4.6.1. Current state

There are currently at least 15 public EV charging stations in Ljubljana, each of which enables two vehicles to charge simultaneously.

Two charging stations in the Ljubljana area were installed by the Petrol energy company, which plans to add another 4 charging stations in 2012. Further development will depend on market demands.

The Elektro Ljubljana distribution company is an owner of six[35] charging stations in Ljubljana and plans an intensive expansion of its network in 2012.

The number of battery and plug-in hybrid EVs in Ljubljana cannot be precisely determined, since there are no official records with statistical data on EVs as a special category. We can conclude that around three quarters out of the estimated 50 EVs in Slovenia are in Ljubljana.

MOL uses two Kavalir electric vehicles, intended for the transport of citizens in pedestrian areas. The Snaga public company owns 5 electric trucks and one electric road sweeping vehicle.

Pošta Slovenije, the national postal company, uses one electric light commercial vehicle and 20 electric bicycles in Ljubljana. Their plan is to expand this fleet with electric mopeds and increase the number of electric delivery vehicles and electric bicycles.

No statistical data can be found for electric bicycles, scooters, and mopeds; these vehicles do not require registration, their dealers are also not obligated to report any specific sales figures.

4.6.2. The role of MOL

One of the key MOL objectives is to ensure better quality of life for its citizens and set an example to other Slovenian cities and the entire country. However, air and noise pollution as a result of transport activities are increasing with each passing year. These might be local problems, but they are not without global consequences for the Europe and the world: climate change and global warming, increasing number of public health risks and problems, logistic bottlenecks, etc.

To tackle the problems that arise from the wide use of passenger cars, MOL transport policy will implement measures focusing especially on traffic and parking regimes. Traffic congestion (both in stationary and moving traffic) is the most important negative impact resulting from the prevalence of pas-

[35] www.elektro-crpalke.si

senger car transport in Ljubljana, though by far not the only one. Car use will always be a part of transport in Ljubljana. It would be rational to direct some of the attention to reducing the negative impacts of those cars that will remain in Ljubljana despite the on-going intensive transition towards other modes of mobility.

The promotion of cleaner electric vehicles and their use as a replacement for ICEVs perhaps does not solve the most urgent problems of urban transport, but the benefits of their adoption in the form of lower noise pollution and less harmful emissions are big enough to speak strongly in their favour. A large-scale introduction of EVs presents a possible solution to preserve passenger car transport in the city. EVs make it possible to maintain the freedom of personal mobility while at the same time reducing the negative impacts on health and the environment. The aim of the city's policy should not be to eliminate passenger car transport entirely, but to make it cleaner, more sustainable, and thus more acceptable.

The coming EV technologies undoubtedly have a potential to change and improve the passenger car transport and integrate it into the overall system of sustainable transport. Adoption of electromobility can bridge the gap between sustainability and freedom of mobility, since it can easily coexist with other sustainable modes of mobility (such as cycling and walking) due to its clean and quiet nature.

It has to be pointed out that the measures to promote electromobility should not contradict the basic goal of MOL transport policy, which is to increase the share of walking, cycling, and use of public transport in the general composition of urban mobility. Adoption of electromobility must therefore adjust to the higher goal of decreasing the use of cars in Ljubljana transport. **All road users should be encouraged to use public transport, walk, or travel by bicycle as much as possible; however, those unable or unwilling to do so should be able to use a passenger car to travel to their destination with minimum negative impact on the environment and public health.** To paraphrase: **the share of passenger car use in transport should be reduced, while the number of eco-friendly (electric) vehicles within this share should be increased at the same time.**

5. MEASURES TO PROMOTE ELECTROMOBILITY

The proposed measures are divided into the following categories:

- infrastructure measures,
- subsidisation of EV use,
- traffic organisation measures,
- investment measures,
- promotional and informational activities, and
- measures outside of MOL jurisdiction.

The main objective of the measures: The share of EVs in Ljubljana will be at least twice the share of EVs in the rest of the country in 2020.

The expected results cannot be clearly defined for every measure, since all measures are complementary and should be implemented together to achieve the main objective. There are also numerous independent factors outside of MOL's influence which will affect the accomplishment of the main objective.

5.1. Infrastructure measures

The Local Energy Concept of the City of Ljubljana[36] introduces two planned measures regarding the construction of charging stations:

- UI-11-Construction of five charging facilities which will provide a self-sufficient service for the entire MOL EV fleet with the implementation period of 2012-2020 and earmarked funds of 125.000 € for vehicles and 70.000 € for the construction of charging facilities,
- UII-20-Installation of EV charging stations with the implementation period 2011-2020 and earmarked funds of 2.000.000 € (of which 50% will be provided by MOL and the other 50% by private investors). The measure is identified as a priority measure. The detailed description of the measure defines the role of MOL as follows: »Within the framework of the municipal spatial plan, MOL will prepare the expert groundwork which will serve as the basis to define the areas to be equipped with EV charging infrastructure. The expert groundwork will analyse the possibility of installing charging stations in the existing stationary traffic areas and determine potential new areas. These amendments will also be considered in the preparation and amendment of programme for arrangement of building land (public utility charge).«

Infrastructure measures within the MOL SEP will define in detail and in some fields upgrade the measures proposed in the Local Energy Concept.

5.1.1. MEASURE 1: Drafting the charging infrastructure development plan

In the process of drafting the charging infrastructure development plan, MOL will determine the starting points for the design of the charging network with regards to the principles, outlined in section 3.3.3 (Principles of charging network construction). The plan will contain:

- definition of methods for determination the adequate density of charging station in the MOL area, which will be based on the needs of users (according to the number of EV users and the distance between individual charging stations) and the current state and projected development of the distribution network,
- determination of process and actions needed to include the charging infrastructure development plans in spatial and implementation acts,

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[36] Lokalni energetski koncept Mestne občine Ljubljana – Predlog, November 2011: http://www.ljubljana.si/si/mol/mestna-uprava/oddelki/varstvo-okolja/

- definition of methods for determination the microlocations for installation of charging stations, where the principles of rationality, efficient use of urban space, safe spatial placement, and minimum interventions into the current traffic regime will have to be followed,
- determination of modes for charging station installation on MOL areas (parking facilities owned by MOL): it is expected that MOL will not install and manage the charging stations on its own, but rather grant concessions to public-private partnerships or use other means to control the growth of the network, dictate technical and formal characteristics of charging stations, influence the efficiency of network's operation and maintenance, and enjoy the added economic benefits at the same time,
- basic technical and formal characteristics of charging stations, which will have to ensure safe operation, adjustment to the needs of the users, and recognisability of the urban electromobility brand while following the accepted aesthetic criteria,
- the modalities to ensure fair competition for the construction of the charging network by minimising costs and maximising income and enabling equal participation of providers of charging station construction services and EV charging services in the MOL area,
- the principles implemented to ensure free access for all EV users to all public charging station regardless of who manages the charging station or provides energy for its use,
- definition of methods for monitoring the implementation of the development plan and its modification according to the most current circumstances.

The development plans for private and public areas should be separated in the drafting of the plan.

The plan will be drafted in several stages, beginning with identification of priority fields of activity.

Measure duration or deadline:

- 1. stage: Identification of priority areas: by August 2012,
- 2. stage: Drafting the plan for priority areas: by end of 2012,
- 3. stage: Drafting the final plan: by end of 2013.

The plan will cover the period between 2012-2020.

Organisation or department responsible for implementation: Office for Development Projects and Investments, Department for Commercial Activities and Traffic, Department for Environmental Protection, Department for Spatial Management, JP LPT.

Indicators, methods, and frequency of monitoring of implementation: after the drafting of the final plan, the plan will be assessed on an annual basis and revised if needed.

Costs: the plan will be drafted by the MOL departments. In the first drafting stage the eventual need to include external parties will be assessed.

Source of funding: MOL.

5.1.2. MEASURE 2: Installation of charging stations in new parking facilities owned by MOL

Charging infrastructure can most easily and efficiently be installed within new facilities, which can be adjusted to the specific requirements for the placement and connection of charging stations already during the project phase. MOL will determine the percentage of parking places with the EV charging option in all new constructions. These requirements will be included in the tender documentation for the construction of new parking facilities.

In the first stage, 2% of parking places in new parking facilities will be required to enable EV charging. At the same time, at least 15% of parking places (and the supporting energy infrastructure) will be required to enable later installation of additional charging stations.

The percentage will be increased in the future, based on the development of the EV market and the analysis of the availability of the existing charging stations.

Measure duration or deadline:
- general technical requirements for charging stations and the process of their incorporation in the tender documentation for the construction of parking facilities and concession contracts: by the end of 2012,
- parking places will be equipped with charging stations in accordance with the plan for the construction of new parking facilities.

The requirements to equip parking places with EV charging infrastructure will remain in place until 2020. After 2020, the rationality of increasing the percentage of parking places equipped with EV charging infrastructure will be assessed, based on the development of the EV market and the availability of existing charging stations.

Organisation or department responsible for implementation: Office for Development Projects and Investments, Department for Commercial Activities and Traffic, JP LPT.

Indicators, methods, and frequency of monitoring of implementation: for each parking facility, the implementation of the measure will be assessed in the tender documentation phase, in the project documentation phase, and in the construction phase.

Costs: the earmarked funds for the construction of charging stations by 2020 are 2.000.000 € (for MEASURE 2 and MEASURE 3). The dynamics and rate of the disbursement of funds will depend on the dynamics of parking facilities construction and the selected business model for the installation of charging stations in MOL areas (as defined in MEASURE 1).

Source of funding: MOL (50%), private investors (50%).

5.1.3. MEASURE 3: Installation of charging stations in existing parking facilities owned by MOL

MOL will gradually equip the existing parking facilities with EV charging infrastructure, with the goal of:

- 2% of parking places enabling EV charging by 2015,
- 4% of parking places enabling EV charging by 2020.

Further dynamics of equipping parking places with EV charging infrastructure will depend on the development of the EV market and the availability of existing charging stations.

Parking facilities include parking lots, parking garages, and »blue zones« for short-term parking. The percentage of parking facilities with the EV charging option is established as a ratio between all parking places equipped with charging station and total number of all parking places on all types of parking facilities.

The actual allocation of charging stations will depend on the projected density of charging stations in individual MOL areas (as defined in MEASURE 1) and on the existing energy infrastructure.

Measure duration or deadline:
- general technical requirements for charging stations and the process of their incorporation in the tender documentation for the construction of parking facilities and concession contracts: by the end of 2012,
- equipping the parking facilities with charging stations: 1% of parking places by the end of 2012, 2% of parking places by the end of 2015, 3% of parking places by the end of 2017 and 4% of parking places by the end of 2020.

The proposed requirements to equip parking places with EV charging infrastructure will remain in place until 2020. After 2020, the rationality of increasing the percentage of parking places equipped with EV charging infrastructure will be assessed based on the development of the EV market and the availability of existing charging stations.

Organisation or department responsible for implementation: Office for Development Projects and Investments, Department for Commercial Activities and Traffic, JP LPT.

Indicators, methods, and frequency of monitoring of implementation: indicator for the implementation of the measure will be the ratio between the total number of parking places in the MOL area and the number of parking places equipped with EV charging infrastructure. The implementation of the measure will be assessed on a semi-annual basis.

Costs: the earmarked funds for the construction of the charging network by 2020 are 2.000.000 € (within MEASURE 2 and MEASURE 3). Disbursement of funds will depend on the selected business model for the installation of charging stations in the MOL area (as defined in MEASURE 1).

Source of funding: MOL (50%), private investors (50%).

5.1.4. MEASURE 4: Construction of new parking facilities in the MOL area

MOL Spatial Arrangement Plan – guidelines for execution[37] requires that every parking facility with at least 100 parking places includes at least one parking place equipped with a device that enables EV charging. According to the expected development of electromobility, MOL will revise the Act to include the following requirements:

- at least 1 parking place enabling EV charging in every parking facility with 10 – 20 parking places,
- at least 2 parking places enabling EV charging in every parking facility with 21 – 30 parking places,
- at least 10% of parking places enabling EV charging in every parking facility with more than 30 parking places.

Measure duration or deadline:
- drafting of the proposal for revision of the MOL Spatial Arrangement Plan: by the end of 2012,
- start of measure implementation: 2014.

The requirements to equip parking places with EV charging infrastructure will remain in place until 2020. After 2020, the rationality of increasing the percentage of parking places equipped with EV charging infrastructure will be assessed based on the development of the EV market and the availability of existing charging stations.

Organisation or department responsible for implementation: Department for Spatial Management.

Indicators, methods, and frequency of monitoring of implementation: the objective of the measure is the revision of the MOL Spatial Arrangement Plan The implementation will be assessed in mid-2012 (drafting of the proposal for the revision of the Act) and at the end of 2013 (adopted revision of the Act). The implementation of the Act will be verified according to the provisions that regulate this area.

Costs: the proposal for the revision of the Act will be drafted by the MOL departments.

Source of funding: /

5.2. Subsidisation of the use of EVs

Subsidisation of the use of EVs refers to measures which do not include any infrastructure investments but nevertheless require certain funds for their implementation. Unlike the one-time nature of subsidies for the installation of charging stations, these on-going incentives are designed to continually promote a wider use of EVs among the population.

[37] Official Gazette RS 78/2010, Article 38, item (10)

5.2.1. MEASURE 5: Parking fees

The MOL transport policy plan states that the improvement of stationary traffic conditions can be achieved with an appropriate parking fee policy, following the principles: closer = more expensive, short-term = cheaper (or long-term = more expensive). In a similar manner, the choice of the vehicle to enter, drive around, and park in the city can be influenced, following the principle cleaner = cheaper.

MOL will introduce a special parking regime in the parking garages under its ownership with a reduced parking fee for battery and hybrid EVs. Other parking garage owners will be eligible to receive subsidies for the evidenced parking of EVs in their facilities.

The reduction of parking fees should not be disproportionate in order not to redirect potential public transport users back to cars, although electric. Reduced parking fees should promote the use of cleanest possible vehicles for those who were determined to use a passenger car and park in Ljubljana in the first place.

The parking fees will be reduced as follows:

- 50% in the first two years of measure implementation,
- 25% from third to seventh year of measure implementation,
- 10% in eighth and subsequent years of measure implementation.

Measure duration or deadline:

- determining the practicality of measure implementation by MOL and other parking garage owners: by mid-2012,
- determining exact parameters (duration, reduction percentage) of the measure: by the end of 2012,
- start of measure implementation: early 2013.

Organisation or department responsible for implementation: JP LPT.

Indicators, methods, and frequency of monitoring of implementation: in accordance with the time schedule; the amount of the subsidy and the number of subsidised parkings will be determined on a semi-annual basis.

Costs: direct costs will depend on the technical execution of the measure (identification of EV users in the process of parking fee billing).

Source of funding: MOL.

5.2.2. MEASURE 6: Congestion charge in the city

When dealing with congestion charge, the two main negative effects of passenger car use need to be taken into account: cars cause congestion in both stationary and moving traffic, and emit noise and harmful pollutants. This is the reason that charging a fee to enter the city or some of its areas is called a congestion charge and/or environmental charge.

Many European cities use congestion charges to limit the access of road vehicles to certain urban areas. The introduction of such charges is currently not a part of the MOL Transport Policy Plan. Nevertheless it would be reasonable to commit to reduced charges for EVs in the event the congestion charge will be introduced in the future.

In city centres, traffic issues (congestion) present a greater challenge than environmental issues; whereas on the outskirts, the traffic issues as such are less explicit. If environmental or congestion charges were introduced in Ljubljana, it would be reasonable to implement considerable subsidies for EVs on the outskirts and lower subsidies closer to the city centre (since EVs do not cause any pollution, but may still cause congestion). Subsidising EVs in this manner may influence the behaviour of those who wish to enter the city – they may use an EV to access the city outskirts (e.g. Park+Ride car parks) and continue their journey with public transportation, by foot, or with a rented bicycle.

Measure duration or deadline: cannot be determined since the implementation is linked to the potential introduction of a congestion/environmental charge.

5.2.3. MEASURE 7: Taxi services

Taxi services are a part of the public transport, which greatly helps to solve transport issues in the city. In its essence their effect is the same as that of short-term car-sharing – several passengers use a single vehicle to travel the city instead of each using their own car. On average, taxi drivers drive the longest daily distances in the city and are thus responsible for the most pollution. This is why it would be welcomed to promote the use of EVs for taxi services.

Measures regarding taxi services can be realised in the form of subsidies for the purchase of EVs or reduced annual fees (concessions) for their operation.

Subsidisation of EV purchases is already regulated on the national level**Error! Bookmark not defined.**. It is questionable if additional MOL incentives would spark any extra interest for the purchase of EVs. To achieve the same effect it would probably be more effective to provide additional fast charging stations for taxi services, which would enable to charge the EV battery in around half an hour (see section 3.2.2). There is also the issue of ensuring that the vehicles which would be purchased with the help of MOL subsidies would later actually be used in the MOL area or that they would not merely be resold for a profit, undermining the aim of the subsidy.

Subsidisation of annual concession fees therefore seems to be the more rational way of promoting the use of EVs in taxi services. This ensures that the vehicle for which the subsidy was given is actually used for taxi services and is used in the (wider) MOL area.

The concession fees for taxi service operation are determined on the national level by the Chamber of Commerce. MOL will propose a reduction of concession fees for battery electric taxi vehicles as follows:

- by 50% in 2013-2014,
- by 25% in 2015-2019,
- by 10% after 2019.

Measure duration or deadline:
- drafting of the subsidisation proposal to the Chamber of Commerce: by the end of 2012,
- start of measure implementation: in 2013 (if the proposal is accepted).

Organisation or department responsible for implementation: Department for Commercial Activities and Traffic.

Indicators, methods, and frequency of monitoring of implementation: implementation will be assessed in mid-2012 (drafting of the proposal).

Costs: the proposal will be drafted by the MOL departments.

Additional measure, related to taxi services: if MOL decides to establish its own taxi service, it should commit to include eco-friendly vehicles in its fleet (battery and hybrid electric vehicles, CNG vehicles).

5.3. Traffic organisation measures

Traffic organisation measures provide incentives for EV ownership and at the same time enable a visual promotion of electromobility with minimum added investments or costs for MOL.

Traffic organisation measures strongly influence the traffic regime and basic aims of MOL regarding its transport policy. The implementation of these measures will therefore need to be constantly monitored and adjusted according to the actual number of EVs on Ljubljana's roads. With the growth of the number of EVs, some of these incentives will have to be abolished to ensure normal traffic flow in the city.

To monitor and control the implementation of the measure and prevent any abuse by ICEV drivers, it would be reasonable to introduce special vehicle plates, vignettes, car stickers, or other visual markers to easily distinguish EVs from ICEVs. EV owners could acquire these markers upon vehicle registration (MEASURE 16).

City traffic wardens will control the implementation of the new traffic and parking regime. In the framework of traffic organisation measures, city traffic warden service staff will have to be trained to meet the requirements of these new tasks.

5.3.1. MEASURE 8: Delivery in the city centre

On account of their minimum noise, EVs could potentially perform deliveries in the city centre even during night hours. However, since the loading and unloading of goods itself is still a source of considerable noise, this measure is not appropriate. Nevertheless, using EVs for delivery (regardless of the time of access to the city centre) results in lower air pollution as the main benefit.

MOL will reduce the price of permits for electric delivery vehicles in the city centre:

- by 50% in 2013-2014,
- by 25% in 2015-2019,
- by 10% after 2019.

The measure refers to the plan to rationalise the delivery of goods by using freight consolidation depots on the outskirts and centralised freight transport to the city centre (see MEASURE 10).

Measure duration or deadline: start in 2013.

Organisation or department responsible for implementation: Department for Commercial Activities and Traffic.

Indicators, methods, and frequency of monitoring of implementation: the impact of the measure (share of EVs in freight transport) is assessed on an annual basis.

Costs: the measure is implemented by the MOL departments. All associated costs are indirect (lower income for MOL on the account of delivery permits price reduction).

5.4. Investment measures

5.4.1. MEASURE 9: MOL public procurements

Directive 2009/33/EC on the promotion of clean and energy-efficient road transport vehicles states that in all segments of a public procurement of vehicles (scope of delivery, technical specifications, contractual conditions and specifications), the environmental aspects must be considered.

In its procurement of vehicles, MOL will follow at least the minimum criteria stated in the Directive. In addition it will use even stricter environmental criteria where possible and where not in contradiction with the usability of vehicles.

These stricter criteria might not always lead to the selection of EVs on the account of ICEVs, but will nevertheless lead to the use of cleaner vehicles in the MOL fleet.

MOL will also include the environmental criteria in the tender documentation for other procurements and services, besides procurement of vehicles.

Measure duration or deadline:

- examining the possibilities for the implementation of stricter environmental criteria with the quantification of individual items in the selection criteria: mid-2012,
- incorporating the criteria into the tender documentation for the procurement of vehicles and other equipment or services: from the beginning of 2013.

The measure is implemented continuously.

Organisation or department responsible for implementation: Office of Public Purchasing and organisations founded by MOL.

Indicators, methods, and frequency of monitoring of implementation: every two years, MOL will assess the existing criteria and make a revision if needed, based on the technological development of mass-marketed EVs.

Costs: the measure is implemented by the MOL departments.

5.4.2. MEASURE 10: Introduction of EVs into the MOL fleet

MOL will speed up the introduction of EVs into its own fleet, starting mostly with specialised vehicles (as has already been done in the Snaga public company), service vehicles with predominantly short journeys (city traffic wardens, courier services, maintenance services of the VO-KA and Energetika public companies), and vehicles used in the city centre and on pedestrian zones.

Despite the decision to purchase methane-powered buses, MOL will continue to follow the technical development of electric buses and conduct comparative analyses between different types of eco-friendly vehicles which can be used in public transport.

MOL will study the possibility and rationality of introducing EVs for a free (or cheap) transport in the main cemetery Žale. This kind of service was already offered in 2011 around the November 1 holiday with Kavalir electric vehicles. For a normal daily use of EVs on the cemetery (when there are less visitors), the vehicles should be accordingly smaller.

In the event of freight transport rationalisation with the use of freight consolidation depots on the outskirts of Ljubljana, it would be reasonable to use EVs for freight transport to the city centre. They are very well suited for short urban trips with lower speeds and numerous stops, which characterise delivery in the city centre.

Measure duration or deadline:

- drafting the plan for the introduction of EVs into MOL and JHL fleets: by the end of 2012.

The measure is implemented continuously.

Organisation or department responsible for implementation: Department for Commercial Activities and Traffic (drafting the plan), Office of Public Purchasing, JHL (purchase of EVs).

Indicators, methods, and frequency of monitoring of implementation: every two years, MOL will assess the plan for the introduction of EVs into the MOL and JHL fleets and make a revision if needed, based on the technological development of mass-marketed EVs.

Costs: the plan for the introduction of EVs into the MOL and JHL fleets will be drafted by the MOL departments.

Source of funding: the purchase of vehicles will be performed in accordance with the MOL and JHL investment plans.

5.5. Promotional and informational activities

5.5.1. MEASURE 11: Obtaining information on the needs of the citizens

For a successful planning and implementation of measures it is vital to obtain information from the general public on the acceptance of electomobility and planned measures in the MOL area:

- obtaining information on the acquaintance of citizens with the topic of electromobility,

- obtaining information on the support of citizens for the planned or implemented measures to promote electromobility in MOL,
- obtaining information on the needs and interests of the general public regarding electromobility, especially the issues of EV charging, the locations and equipment of charging stations, billing methods, notifications about upcoming events and new developments in the area of electromobility, and other additional measures which may be needed to improve user satisfaction.

MOL will conduct regular online, postal, and/or field surveys to achieve these aims. The surveys will include the general public as well as special interest groups, such as EV users, residents of the city centre, etc. Additional information will be obtained from the media, organised workshops, and other promotional activities. The results of the surveys will be used by MOL as an important feedback for the already implemented measures and to determine new measures.

Before the implementation of the first measures, MOL will issue a promotional leaflet about electromobility with an attached questionnaire (MEASURE 12). This way, MOL will be able to obtain basic information on the general acquaintance with electromobility and the needs and interests of the general public regarding the use of EVs and the adoption of electromobility in the MOL area.

Similar surveys will be conducted regularly until the end of the implementation period for the measures to promote electromobility.

Meanwhile, MOL will systematically gather information connected to the implementation and planning of particular measures.

Measure duration or deadline: the measure is implemented continuously until 2020:
- preparing the leaflet with the questionnaire: in autumn 2012,
- regularly gathering citizens' feedback about electromobility and MOL measures: every two years,
- gathering information regarding the planning and implementation of particular measures: based on the dynamics of implementation for other measures.

Organisation or department responsible for implementation: Department for Commercial Activities and Traffic.

Indicators, methods, and frequency of monitoring of implementation: indicator for the implementation of the measure is the number of conducted surveys.

Costs: the measure is implemented by the MOL departments.

Source of funding: MOL.

5.5.2. MEASURE 12: Promotion of electromobility and public awareness

Raising public awareness of the advantages of EV use can have a central role in the promotion and development of electromobility, at least in its initial stages. Ljubljana must use its status as the capital city and a leading pioneer in the systematic approach towards electromobility to promote its development throughout the country.

A successful collaboration between MOL and Eurobasket 2013 organising committee could set an example for the promotion of electromobility. By using EVs as a part of the integrated approach towards efficient green logistics, Ljubljana could present the possibility of sustainable organisation of such big events to all the European athletes, reporters, and visitors.

It is important to establish user-friendly demonstration projects to display the real-world use of new technologies in transport at the very beginning of any promotional activities.

The demonstration projects will provide important input to compile a knowledge base, which will shed a light on the possibility of a large-scale adoption of EVs. This will also provide grounds for answering any public questions and doubts about the adoption of EVs. For the demonstration projects to succeed, it is necessary to correctly define the niche market and target user groups. The demonstration projects must have clearly defined goals, independent result verification, and a wide dissemination of final results.

The demonstration projects should not include only EVs from commercial or public transportation fleets, but also private owners of EVs and EV dealerships.

The demonstration projects have to present the following information:

- functionality, reliability, and suitability of everyday use of EVs,
- positive impact of EVs on the quality of life, compared to the impact of ICEVs,
- availability and efficiency of EV charging infrastructure,
- economic impact of EVs, by comparing the purchase price and total cost of ownership (maintenance, fuel costs, etc.) for EVs and ICEVs,
- achievements and future plans of MOL regarding the promotion and adoption of electromobility.

Promotional activities will include the following:

- distribution of promotional and educational leaflets,
- presentation of the most important information about electromobility, FAQ, etc., on the MOL website,
- organisation of workshops on the topic of electromobility, combined with EV test drives. The charging infrastructure operators can be included in the organisation of the events. EVs from JHL and MOL fleet can be used for test drive purposes,
- appeal by MOL to all EV dealerships to enable free test drives for the citizens of Ljubljana,
- awarding certificates and rewards to companies which will actively take part in the adoption of electromobility (e.g. introduction of EVs in commercial fleets, installing public charging stations on private locations, installing above-standard charging stations according to MEASURE 4, ...). This can be done in the framework of general promotional activities in the area of transport (such as mobility plans in companies) or in the area of the use of eco-friendly vehicles (hybrid vehicles, CNG-powered vehicles, biodiesel powered vehicles, ...).

As a part of its informational and promotional activities, MOL will establish an information office for electromobility, where citizens and companies will be able to acquire all information on electromobility, installation of public and private charging stations, and use of EV charging infrastructure in one place.

The information on locations of charging stations and on mode of their usage (free access, access with identification card, procedure to obtain the identification card, payment) will be accessible also in the existing Tourist Information Offices within the frame of MOB-i-LNICE (Mobility Shops) programme.

As a part of informing the public, comprehensive information about the locations and availability of charging stations in the MOL area will be available at all times. EV users will be able to access this information through web portals or with the help of LCD displays on the site of the parking facility (similar to those which already show available parking places). The exact way of how this information will be displayed will be determined in the drafting of the plan for the development of charging infrastructure (MEASURE 1).

Measure duration or deadline: the measure is implemented continuously until 2020.

- establishing the MOL electromobility information office: mid-2012,
- drafting the plan for the implementation of promotional activities: end of 2012,
- implementation of promotional activities; starts when the plan is completed, ends when all MOL measures for the promotion of electromobility are implemented,
- appeal to EV dealerships to enable free test drives: end of 2012,
- establishing the system to inform EV users on the locations and availability of charging stations in the MOL area: based on the dynamics of the construction of charging infrastructure (MEASURE 2 in MEASURE 3).

Organisation or department responsible for implementation:

- establishment of the MOL electromobility information office: Department for Commercial Activities and Traffic,

- training for Tourist Information Offices staff: izobraževanje za osebje TIC: Javni zavod Turizem Ljubljana,
- drafting the plan for the implementation of promotional activities: Department for Commercial Activities and Traffic, Mayor's Cabinet – Section for Public Relations,
- implementation of promotional activities: Department for Commercial Activities and Traffic, Mayor's Cabinet – Section for Public Relations,
- appeal to EV dealerships to enable free test drives: Department for Commercial Activities and Traffic,
- system for the informing of users on the locations of charging stations in the MOL area and their availability: JP LPT.

Indicators, methods, and frequency of monitoring of implementation:
- MOL electromobility information office: the number of questions raised by the public (monitoring and report on a semi-annual basis), in the event of little interest, additional promotion of the information office and its tasks will be required,
- drafting the plan for the implementation of promotional activities: the drafting process is assessed in mid-2012,
- implementation of promotional activities: in accordance with the plan, the implementation ends after the implementation of all other MOL measures for the promotion of electromobility,
- system for the informing of users on the locations of charging stations in the MOL area and their availability: in accordance with the dynamics of the construction of the charging infrastructure (MEASURE 2 and MEASURE 3).

Costs:
- establishment of the MOL electromobility information office: two-day training for two members of the staff (app. 2.500 €), 4-hours training for the Tourist Information Centres staff (2 trainings; 1000 €),
- drafting the plan for the implementation of promotional activities: the plan is drafted by the MOL departments,
- implementation of promotional activities: based on the plan for the implementation of promotional activities,
- appeal to EV dealerships to enable free test drives: the appeal is prepared and disseminated by the MOL departments,
- system for the informing of users on the locations of charging stations in the MOL area and their availability: costs are covered with the funds from MEASURE 2 and MEASURE 3.

Source of funding: MOL.

5.5.3. MEASURE 13: Ljubljana electromobility brand

MOL will make its approach to electromobility more recognisable by designing a brand for the Ljubljana electromobility. Whoever will encounter MOL's efforts and activities for the promotion and adoption of electromobility will be able to instantly recognise the unified visual and design solutions intended to display the deliberateness behind MOL's approach.

Visual design solutions will be used for all of MOL's activities regarding electromobility, especially for the design of informational and promotional materials and websites, design of charging infrastructure elements (charging stations, status displays), and the design of EVs' appearance (especially for the JHL fleet).

Measure duration or deadline: the public procurement call for the design of visual identity of the Ljubljana electromobility will be issued by the end of 2012, the design will be completed by mid-2013. The measure is implemented continuously until 2020.

Organisation or department responsible for implementation: Department for Commercial Activities and Traffic, Department for Spatial Management, Office of Public Purchasing.

Indicators, methods, and frequency of monitoring of implementation:
- design of the visual identity of the Ljubljana electromobility: assessment of the preparation process for the public call for design of the visual identity of the Ljubljana electromobility in mid-2012, publishment of the call at the end of 2012.

Costs: costs will be covered with funds from MEASURE 2, MEASURE 3, and MEASURE 12.

Source of funding: MOL (in the framework of other measures).

5.5.4. MEASURE 14: Use of separate driving lanes

Use of separate driving lanes today is reserved for city buses and taxies. The proposal for EV drivers to be allowed to use separate lanes is in contradiction with the main objectives of the MOL transport policy (promotion of public transport use – city buses and taxies). Personal EVs are not a part of public transport, therefore allowing them to use separate lanes would encourage people to use passenger cars (although EVs) instead of public transport. This goes against the policy to improve traffic conditions in the city.

However, use of separate lanes can be employed for promotional purposes. MOL will grant permits for the use of separate lanes to those EV drivers who will offer some space on their vehicles for promotional purposes.

The smaller number of EVs in the beginning will not influence traffic conditions considerably. Later on however, as the number of EVs grows, separate lines will either have to be once again restricted for EVs or the number of permits for driving on separate lanes will have to be limited appropriately.

Measure duration or deadline:
- design of the visual appearance of promotional car stickers to be used on EVs: mid-2012,
- start of measure implementation: 2013.

The measure is implemented continuously until 2020.

Organisation or department responsible for implementation: Department for Commercial Activities and Traffic.

Indicators, methods, and frequency of monitoring of implementation: the number of EV drivers participating in promotional activities will depend on their interest. The trend will be assessed on a semi-annual basis. MOL departments will annually assess whether the number of granted permits to use separate lanes should be limited or not.

Costs: design and production of promotional car stickers.

Source of funding: MOL.

5.6. Measures outside of MOL jurisdiction

These measures are linked to the regulation and administrative procedures which are determined or implemented outside of MOL jurisdiction. However, it should be in MOL's interest that procedures outside of its jurisdiction too are implemented in accordance with its interests. The drive of the largest local community can, in combination with pressure from other interest groups, crucially contribute to the accomplishment of MOL's objectives regarding the adoption of electromobility.

5.6.1. MEASURE 15: Technical regulation

In the process of constructing the charging infrastructure, MOL can influence the technical configuration of public charging stations (within measures in section 5.1), but cannot directly influence the configuration of domestic charging stations. Nevertheless, safety and reliability of the latter should also be in MOL's interest, since citizens' health can be directly affected by their use.

Uncontrolled and technically unregulated installation and use of domestic charging stations can result in electric shocks, fires, and malfunctions of home power networks. End users – including MOL citizens – might get seriously injured or even die as a result of these unfortunate events. To tackle this issue, MOL will encourage the competent bodies to standardise the installation process and control the use of domestic charging stations. Besides activities on the national level, MOL will cooperate especially with the local distribution company (Elektro Ljubljana) to ensure the implementation of this measure.

Measure duration or deadline: implementation by April 2012, duration until the adoption of relevant acts by the legislative authority or competent national bodies.

Organisation or department responsible for implementation: Department for Commercial Activities and Traffic, Office for Legal Affairs.

Costs: the proposal is drafted, submitted, and monitored by the MOL departments.

5.6.2. MEASURE 16: Organising national vehicle register and ensuring EV recognisability

To monitor the implementation of measures for the adoption of electromobility, MOL will require data on the number of EVs registered in its area. The current official vehicle register does not differentiate between conventional vehicles and EVs. MOL will strive for the creation of a unified EV register, which will enable a complete overview of the current state of electromobility in Ljubljana. MOL will address the Ministry of Infrastructure and Spatial Planning with a proposal to regulate the area of official vehicle registers in a manner which will enable MOL to monitor the effects of its measures to promote electromobility.

EVs should be easily recognisable for the purpose of monitoring the effect of the measures and for potential sanctioning of offenders. Battery electric vehicles (BEVs) can easily be identified by their lack of tailpipe. The other EV category, plug-in hybrid vehicles (PHEVs), are however identical to ICEVs in this aspect. To easily distinguish between all types of EVs and conventional vehicles, it would be practical to introduce special vehicle plates, vignettes, car stickers, or other visual markers which the EV owners could acquire upon registration of the vehicle. This would also simplify control and monitoring of the measures to promote electromobility.

MOL will address the competent body for the registration of vehicles with the proposal to regulate EV identification in a manner which will enable MOL to monitor the effect of its measures for the promotion of electromobility and sanction potential abuse. In the event the area will not be adequately regulated one year after the submission of the proposal, MOL will implement its own EV identification process.

Measure duration or deadline: both proposals will be drafted immediately after the adoption of the Strategy for the development of electromobility. The measure (EV register and EV identification) will be implemented continuously until the end of the implementation period.

Organisation or department responsible for implementation: Department for Commercial Activities and Traffic, Office for Legal Affairs.

Costs: the proposals are drafted, submitted, and monitored by the MOL departments.

6. ABBREVIATIONS

AC	alternating current
ARSO	Slovenian Environmental Agency
BEV	battery electric vehicle
DC	direct current
EC	European Commission
EV	electric vehicle
GHG	greenhouse gas
HEV	hybrid electric vehicle
ICE	internal combustion engine
ICEV	internal combustion engine vehicle
ICT	information-communication technology
JHL	Javni Holding Ljubljana, d.o.o. (Public Holding Ljubljana)
JP LPT	Javno podjetje Ljubljanska parkirišča in tržnice d.o.o. (Public Company Ljubljana Parking and Markets)
LPP	Javno podjetje Ljubljanski potniški promet d.o.o. (Public Company Ljubljana Public Transport)
MOL	Municipality of Ljubljana (used also for Ljubljana City Administration)
NEP	National Energy Programme
PHEV	plug-in hybrid electric vehicles
PM	particulate matter
RFID	radio frequency identification
SEP	Sustainable Electromobility Plan
V2G	Vehicle-to-Grid (interaction of EV with public charging and energy infrastructure)
VOC	volatile organic compound
WHO	World Health Organization