i-RESEV NEWSLETTER

ISSUE No. 2 - August 2013

INTRODUCTION

i-RESEV PROJECT

i-RESEV is an acronym for the research project entitled **"ICT-aided integration of Electric Vehicles into the Energy Systems with a high share of Renewable Energy Sources"**. This three-year project started in January 2012, and it has been supported by the Croatian Science Foundation. The main information about the project can be found on the web site http://powerlab.fsb.hr/iresev and the 1st Issue of Newsletter posted therein.

CONTENT OF THIS NEWSLETTER ISSUE

This newsletter issue describes the main projects developments since September 2012, when the 1st Issue was published. This includes an outline of main project activities and results, and a related list of recent publications. The project news are also given, with the emphasis on SDEWES Special Session and Summer School, which are organised by the project team on the project topic. Finally, we keep running the general section dedicated to energy policies and directives, and a popular section including information on upcoming events, web portals, and project calls.

PROJECT NEWS

1st PROJECT WORKSHOP

The project team organised the first project workshop entitled **"Towards Integration of Electric Vehicles into the Energy Systems with a High Share of Renewable Energy Sources"**, which was held at the University of Zagreb-FMENA on December 7, 2012. The main aim of the workshop was to disseminate the project results obtained in the 1st research year period to domestic community involved or interested in electric vehicle and energy system R&D activities. The introductory overview of project results, given by the project leader, Prof. Deur, and the sub-coordinator of energy planning activities, Dr. Goran Krajačić, was followed by detailed presentations given by young researchers. Also, a round table on e-Mobility was held, including presentations by several entities from Croatian companies and organisation (e.g. *HEP Opskrba* and *Energy Institute Hrvoje Požar*). The workshop program can be found on the i-RESEV website (in Croatian only). The workshop participants were able to download all workshop presentations after the event.

PROJECT ADVISORY BOARD MEETING

The second regular meeting of the Project Advisory Board (PAB) was held at the University of Zagreb-FMENA on January 17th, 2013, when the new PAB member, the Croatian Energy Regulatory Agency (HERA), was welcome. The project team and the PAB members discussed the mutual interactions and cooperation through the first project year period, significance of the obtained research results, and opportunities of continuing cooperation through 2013 with emphasis on knowledge transfer, data support to the project team, and possibilities for joint participation in EU projects.

Afterwards, several bilateral meetings have been organised, where the project team presented the relevant research results to the PAB members (e.g. AVL-AST and Konzum) and where the data support was being planned out (e.g. Konzum).

ICT-aided integration of Electric Vehicles into the Energy Systems with a high share of Renewable Energy Sources

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INVOLVEMENT IN COST ACTION

At the end of 2012, Prof. Deur has joined four-year COST (European Cooperation in Science and Technology) Action TU1105 entitled "NVH Analysis Techniques for Design and Optimization of Hybrid and Electric Vehicles", as a member of the Management Committee.

PERSONAL ACHIEVEMENTS

The project sub-coordinator for Energy Planning activities, Goran Krajačić, defended his Ph. D. Thesis "The Role of Energy Storage in Planning of 100% Renewable Energy Systems". Some of the results that involve electric vehicles have already been published in our previous newsletter and the whole thesis can be downloaded here.

In February 2013, Dr. Goran Krajačić was elected by the Ministry of Science, Education and Sports as one of the top 20 young researchers in Croatia. Accordingly, he has been awarded by the position of an Assistant Professor at the FMENA's Department of Energy, Power Engineering and Environment at FSB.

2013 SDEWES SPECIAL SESSION

As a part of the UNESCO-sponsored 2013 International SDEWES Conference to be held in Dubrovnik in September 2013, the i-RESEV team is organising a Special Session on the topic of **Integrated Energy and Electric Vehicle Transport Systems**. The session will include 14 papers that will be group in two sub-sessions related to (i) electric vehicles and fleets and (ii) integration of electric vehicles into energy systems. The invited session program will soon be available on the i-RESEV web page. Those interested in attending the special session and conference can consult the conference registration site.

i-RESEV 2013 International Summer School

The i-RESEV team is also organising an International Summer School on the topic of Electric vehicle-Grid Integration, as a side event of the 2013 SDEWES conference. The summer school is targeted to early stage researchers and professionals who are interested in gaining the knowledge and competence in different types of electric vehicles and their integration into modern energy systems. The main objective is to provide an educational platform and a forum for disseminating and discussing recent R&D efforts in the propulsive area of integration of electrified transport into future greener energy systems.

The summer school will be organized in two parts: the course itself and an optional participation at the SDEWES conference including the aforementioned special session. The course will include lectures and practical examples of computer-aided modelling, design, and optimisation of electric vehicles and related smart grid systems. The students who complete the whole program will be awarded by ECTS credits.

The Summer School Programme is as follows.

- 17/09/2013

  Electric and Hybrid-electric Vehicles: Configurations, Modelling, Optimisation, and Control
  Prof. Francis Assadian, Cranfield University, UK
  Prof. Josko Deur, University of Zagreb, Croatia
- 18/09/2013

  Synthesis of Naturalistic Driving Cycles and Modelling of Electric Vehicle Fleets
  Dr. Tae-Kyung Lee, Ford Motor Company, USA
  Rashid A. Waraich, ETH Zurich, Switzerland
- 19/09/2013

  Integration of Electric Vehicles into Grid Systems and Smart Charging
  Dr. Filipe J. Soares, Prof. Joao A. Peças Lopes, Porto University, Portugal
  Rashid A. Waraich, ETH Zurich, Switzerland
- 20/09/2013

  Energy System Planning including Vehicle-to-Grid Aspects
  Prof. David Connolly, Aalborg University, Denmark
  Prof. Neven Duic and Dr. Goran Krajacic, University of Zagreb, Croatia
- 21/09/2013

  Energy Storage Systems
  Prof. Ingo Stadler, Cologne University of Applied Science, Germany
  Dr. David Dallinger, Fraunhofer Institute, Germany
- 22/09/2013

  Round Table
  Student presentations
  City Tour

The full programme including the registration details is announced on the i-RESEV webpage.

OVERVIEW OF RESEARCH RESULTS

This section gives an overview of recent project activities and results related to EV control system optimisation and design, characterisation of vehicle fleets, and planning of EV-grid integration.

OPTIMISATION OF EREV CONTROL VARIABLES

The 1st Newsletter Issue and the related publications have described the structure and power flow of the considered Extended Range Electric Vehicle (EREV) known as Chevrolet Volt. The below figure shows the functional scheme of EREV transmission, which includes an internal combustion engine (ICE), two electric machines (M/G1 and M/G2), a planetary gear

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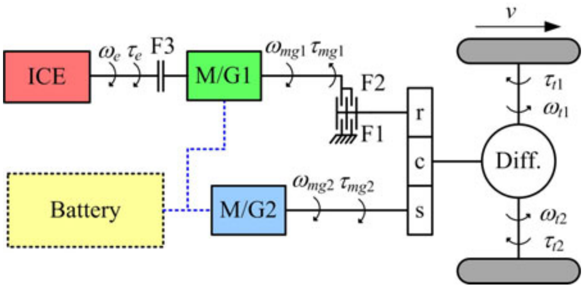
used as a power split device, friction clutches (F1-F3) that are responsible for switching operating modes (see the table below), and an electrochemical battery.



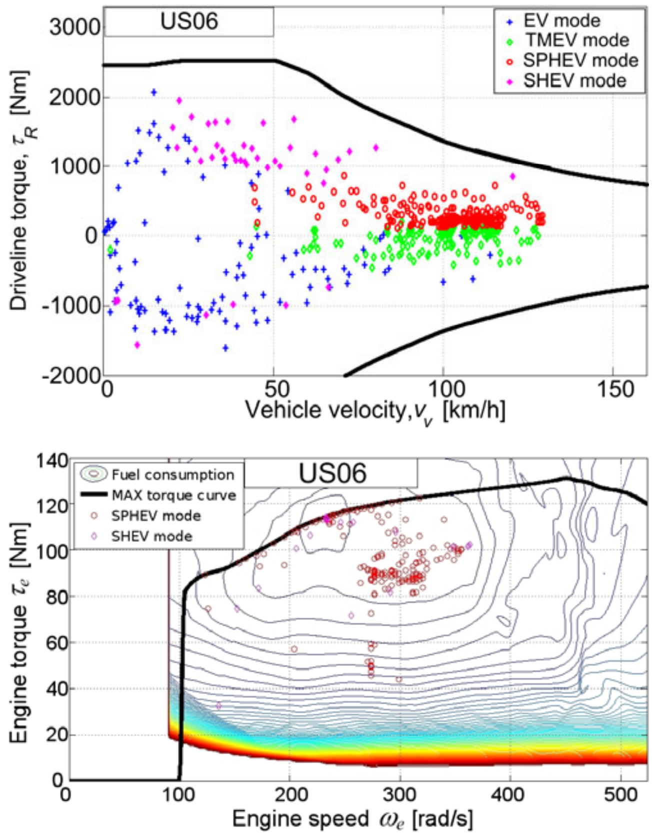
Schematic of EREV powertrain

EREV Modes of operation		F1	F2	F3
Charge Depleting (CD) Modes	Electric Vehicle operation (EV)	1	0	0
	Two Motor Electric Vehicle operation (TMEV)	0	1	0
Additional Charge Sustaining (CS) Modes	Series-Parallel Hybrid Electric Vehicle operation (SPHEV)	0	1	1
	Series Hybrid Electric Vehicle operation (SHEV)	1	0	1
Battery Charging in park position		0	0	1
Idle/Park		0	0	0

The optimisation problem is to find optimal open-loop time responses of the transmission machines torque and speed control variables and the control mode variable, which minimise the fuel and/or electric energy consumption, while satisfying battery state of charge (SoC) constraints and physical limits of the transmission variables. This optimisation has been carried out by using the dynamic programming (DP) algorithm that provides the global optimum solution, which has then been used as a benchmark for assessment of the realistic (closed-loop) control strategy described in the next subsection.

The figure below shows the CS mode optimisation results for the US06 driving cycle. The optimisation results plotted in the powertrain output map (the upper plot) clearly indicate distinct areas of optimal vehicle operating points for the four major driving modes in the CS regime. For low-mid vehicle velocities and high traction torque (abrupt accelerations/decelerations) the vehicle mostly operates in the EV mode. For high velocities and still high traction torques (i.e. for the high traction power), the transmission switches to the SHEV operating mode, in order to reduce high electricity consumption from the battery to satisfy the charge sustainability condition. The power split modes (TMEV and SPHEV) have their operating points mostly located in the area of mid-high velocities and low-mid torques, where the TMEV mode operating points are shifted deeper in the low-torque region. In this area, the TMEV mode has better efficiency than the EV mode, and the SPHEV mode is more efficient than the SHEV mode.

The engine map-related optimisation results (the lower plot) indicate that the majority of engine operating points are located inside or near the area of highest engine efficiency, which are nearby or slightly below maximum engine torque curve.



CS-mode optimisation results for Supplemental FTP Driving Schedule (US06)

EREV CONTROL STRATEGY

The EREV control strategy consists of low-level and high-level subsystems, as shown in the plot (a) of the block diagram illustrations given on the next page. The low-level closed-loop control subsystem is responsible for bringing the powertrain components into desired operating points requested from the high-level controller. The high-level control strategy operates in two basic regimes, CD and CS, depending on the battery SoC value. When the SoC value is above the

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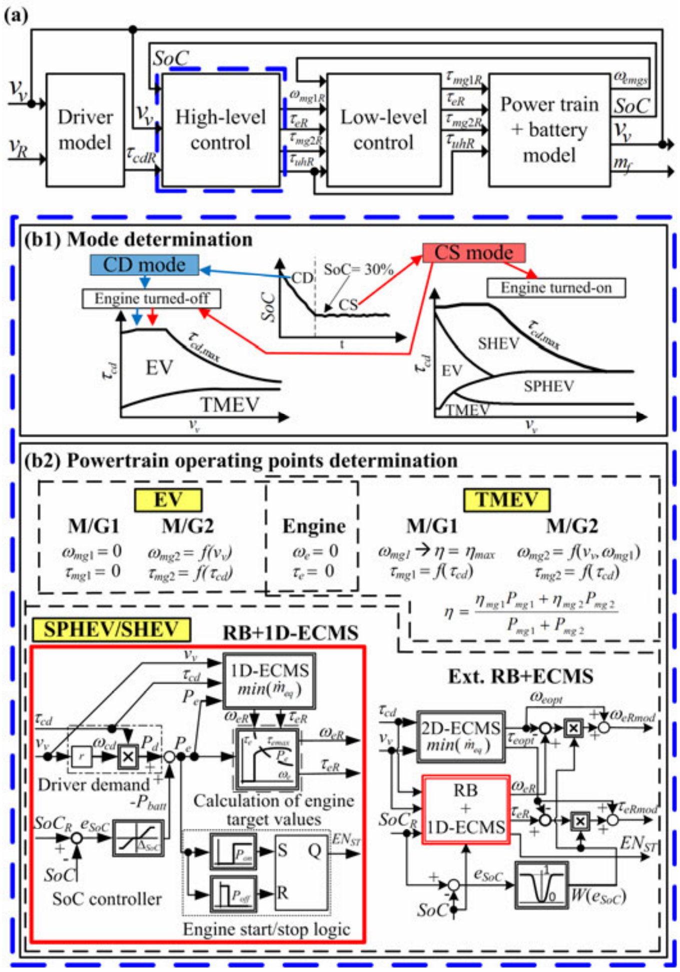
battery-low threshold (30% herein), vehicle is in the CD operating regime (only electric modes are enabled), and after the SoC value reaches 30%, the vehicle switches to the CS operating regime (both electric and hybrid modes are enabled) in order to sustain the battery SoC. The high-level control subsystem consists of two parts: (i) determination of optimal operating mode based on off-line efficiency analyses; and (ii) finding (optimal) powertrain operating points for the chosen operating mode and the given vehicle velocity, driver torque demand and physical constraints.

The DP optimisation results from previous subsection have been used to determine driving cycle-independent distinct boundaries between SHEV and EV modes, and SPHEV and TMEV modes. These boundaries are combined with the basic, torque-limit EV-TMEV and SHEV-SPHEV boundaries, as illustrated in plot (b1). Such obtained mode boundaries are extended with variable-width hystereses, in order to improve the drivability quality while keeping a favourable powertrain energy efficiency.

Depending on the chosen operating mode, determination of optimal powertrain operating points can be divided into several groups, as shown in plot (b2). In the case of EV and TMEV modes, the powertrain operating points are simply set with the aim to satisfy the driver torque demand, and also to maximise the overall powertrain efficiency for the more flexible TMEV mode. In the case of SPHEV and SHEV modes, 1D and 2D instantaneous optimisation (based on the Equivalent Consumption Minimisation Strategy approach, ECMS) is smoothly combined with rule based (RB) and battery SoC controllers. The 1D-ECMS search is carried out over the constant (demanded) engine power curve to reflect the driver and SoC controller power demand, while the more accurate 2D-ECMS search is conducted over an off-line determined mid-high torque area of the engine map. The RB controller includes a simple engine on/off switching logic, and the SoC controller is aimed at providing the sustainability condition.



Functional block diagram of overall control strategy (a) and details of high-level (supervisory) control strategy design (b1) and structure (b2).

The below plots show characteristic control strategy verification results in comparison with the DP global optimum benchmark. The comparative time responses indicate that the real control strategy approaches the DP optimal behaviour, with a reduced number of engine on/off switching events for a favourable drivability. At the same time, the fuel consumption is close to the global (DP) optimum, particularly if the final control strategy combining the RB+1D-ECMS and 2D-ECMS algorithms is used.

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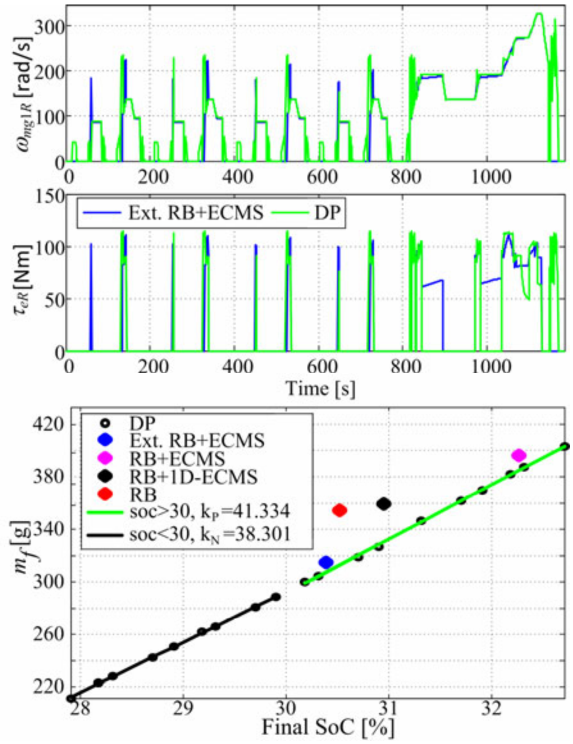
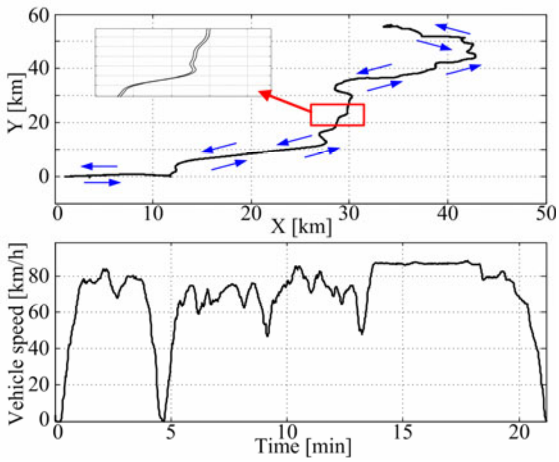


Control strategy verification results with respect to DP global optimum results (New European Driving Cycle, NEDC; CS mode).

ANALYSIS OF FLEET DRIVING CYCLE DATA

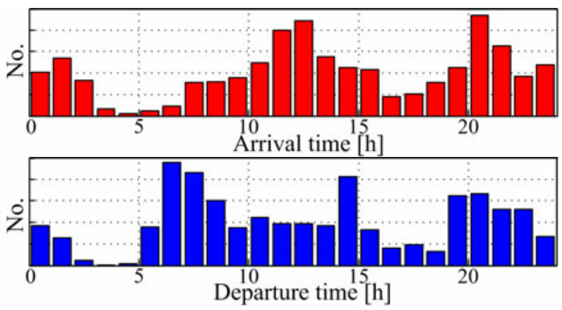
For the purpose of ongoing project studies aimed at investigating possibilities and advantages of replacing conventional vehicles with electric ones, the project team has established cooperation with one of the PAB partners, the leading Croatian retailer Konzum d.d., to acquire realistic driving cycle data related to an isolated vehicle fleet system. The data have been recorded for a representative fleet sample of ten delivery vehicles equipped with GPS/GPRS system, and three-month period of continuous 24 hour operation. The main recorded signals include the vehicle velocity, absolute vehicle position, and cumulative fuel consumption, and the sampling time is 1 sec.

The recorded large set of data has been processed for the purpose of various statistical analyses. These analyses are mostly related to vehicle arrival/departure/resting time features for the main distribution centre and different sales centres, because they correspond to vehicle charging availability if a hypothetical electrified fleet is considered. Some of the initial statistical analysis results are given and discussed below.



Examples of recorded vehicle trajectory during intercity mission and vehicle velocity time profile.

The next plot shows the vehicles arrival and departure time distributions for the distribution centre, which demonstrates the 24h fleet activity. In addition, these distributions can indirectly indicate an average vehicles resting durations in different periods of the day (the time shifts between the peak departure and arrival times).



Arrival and departure time distribution for distribution centre.

The vehicles resting time distribution (next plot) can be directly used to analyse the vehicle charging opportunities. For instance, most of the resting durations for the particular fleet and the distribution centre are less than 2 hours (mostly around 50-60 minutes), and in this case fast charging could be applied. Another significant peak of resting time distribution is around 6 hours, which is related to the night/early morning period. In this case more efficient, slow vehicle charging would be more appropriate.

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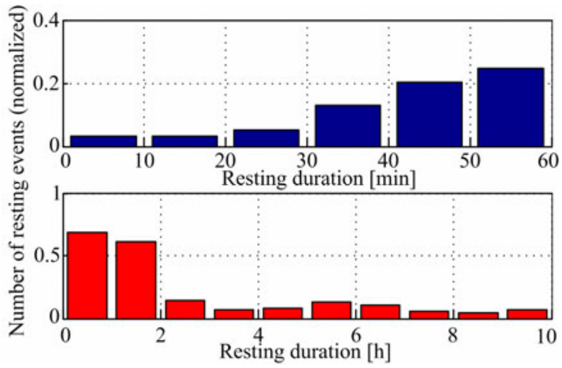
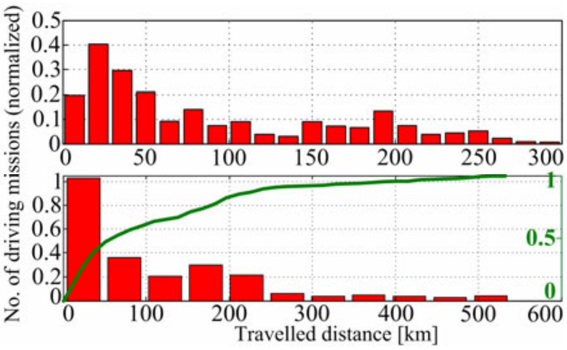


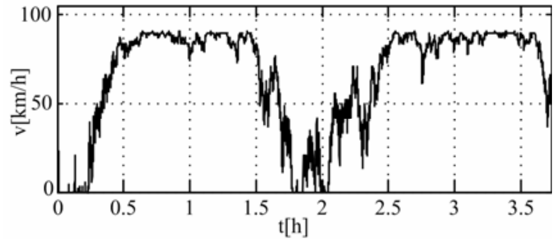
Resting time distribution for distribution centre.

The travelled distance distribution (during one driving mission from and to the distribution centre) is another important feature of the fleet, because it can indicate the type of convenient electric vehicle and sizing of its components. As shown on the next illustration, the most of travelled distances (around 60%) for the given fleet are within 100 km range. These missions could be covered with purely electric delivery vehicles. Other 40% of missions could be covered with range extender or (plug-in) hybrid electric vehicles.



Travelled distance distribution.

A large set of recorded driving cycles can be replaced with several characteristic synthetic cycles, which can further be used for design and verification of electric vehicle configuration and control strategies, and various other fleet-related applications. The below plot shows a synthetic driving cycle, which corresponds to a data subset related to a mixed highway/city driving. More precise synthesis, which takes into account the vehicle acceleration (in addition to the velocity) and includes a systematic procedure of driving cycles validation/selection is subject of ongoing work.



Example of synthetic driving cycle obtained for partly highway and partly city driving.

THE IMPACT OF TRANSPORT ELECTRIFICATION ON THE POWER CURVE AND INTEGRATION OF RENEWABLE ENERGY SOURCES INTO POWER SYSTEMS OF DUBROVNIK REGION

The aim of this work has been to predict future increase of installed power capacity necessary to meet consumer needs, using the known power consumption and consumption predictions by 2050 including the one from a hypothetical EV fleet. Dubrovnik area has a considerable potential for renewable energy sources (RES) and plans to construct new facilities for use of hydropower, wind power and solar radiation, which has been taken into account when planning production for future scenarios. Hourly distribution curves of electricity production from RES, total electricity demand and electricity demand for charging the EV fleet, which were previously calculated in Excel, have represented the input data for the EnergyPLAN model. Calculations were made for various future scenarios.

To run the calculations in EnergyPLAN by 2050, it was necessary to insert capacity input data of each power plant and their hourly production distribution curves for a given year. The hourly distribution curve of Dubrovnik hydropower plant electricity production was taken from 2010, while the hydropower production capacity dedicated to an expanded city region was increased from 70 MW in 2020 up to 100 MW in 2050. The hourly distribution curve of the wind production is derived from the measurement data of wind speeds from 2010, and the capacity of wind turbines was assumed to be boosted from 32 MW in 2020 to 320 MW in 2050. The hourly distribution curve of the solar production is derived from the measurement data of solar radiation from 2010, with the projected capacity of up to 36 MW in 2050.

The hourly distribution curve of electricity demand for the Dubrovnik region was obtained from measurements of the substation Komolac for the year 2010. Electricity demand by 2050 was modelled after an existing study done for Croatia and was predicted to reach the value of 474 GWh. Based on the number of personal vehicles on the territory of the Dubrovnik region in 2010 and a study done for Croatia in which the EV penetration by 2050 was envisaged, EV penetration in the Dubrovnik region (in terms of energy required for charging) was estimated to 0.4 GWh/y for

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2020, 21.9 GWh/y for 2030 and 51.4 GWh/y for 2050. According to the data on driving cycles and traffic load, as well as projected characteristics of EV batteries and the number of EV available to charge, the distribution of hourly electricity demand curves for each scenario was pre-calculated in Excel.

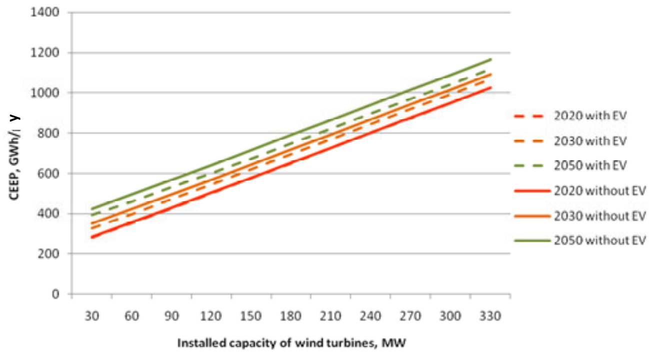
Four models of EV charging were considered:

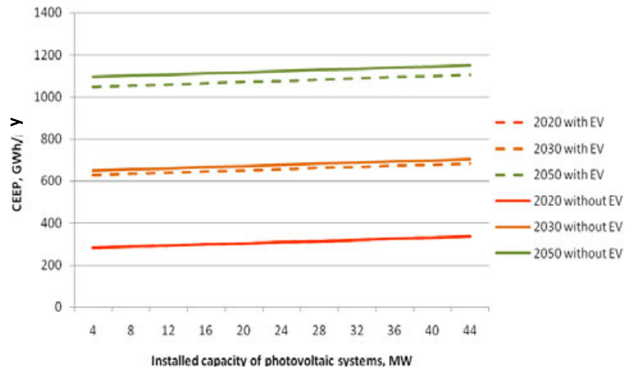
1. Dump charge
2. Flexible demand
3. Smart charge
4. Smart charge including V2G.

Dump charge model is based on the habits and needs of the driver, i.e. vehicles are charged at the time when parked. Flexible demand, due to EV charging, ensures that vehicles are charged during the low electricity demand (night hours), which reduces peak loads while also taking into account charging opportunity during a high production of electricity from RES. Smart charge model ensures that the battery of each vehicle is fully charged before switching off from the grid. Generally, the battery is full in the case when there is potential excess of RES production represented in EnergyPLAN model as Critical Excess of Electricity Production (CEEP). Smart charge model including vehicle-to-grid (V2G) operation allows charging V2G vehicles at the time of available CEEP and utilizes the vehicle battery capacity as storage for bidirectional power flow grid connection. That is, the V2G vehicles, along with being charged, can supply energy into the grid as a possible replacement for the power plant production. The batteries of the V2G fleet are modelled in a simplified way, as a single, "aggregated" battery for the entire fleet.

According to calculation for 2020, the Flexible demand and Smart charge models have the same effect on the increase in peak demand of 21 kWh, because in each case there was the same percentage or amount of charged energy in the form of dump charge. Both models generate the CEEP in the amount of 289 GWh/year (i.e. this is the extra amount of RES energy that must be rejected). Smart charge control is generally considered more favourable than Flexible demand one, because it satisfies the needs of both grid and driver. In scenario for 2030, Flexible demand control increases the CEEP by 0.41 GWh/year and the peak demand by 12.4 MW when compared with more effective Smart charge control. For the year 2050 the model of smart charge with V2G, with lower electricity price from 9 pm to 7 am (P1), is compared with the model of flexible demand, which gives improvement in reducing CEEP by 4.7 GWh/year, but increases the peak demand by 13.9 MW. The reason is that in the model, which includes smart charging together with V2G operation, additional regulation was introduced in order to meet the minimum cost, and the model, apart from the requirements of the driver and the grid, adjusts to the lower electricity price in order to achieve a minimum charge cost.

The following diagrams illustrate the increase of the CEEP in the case of increased penetration of RES in the energy system. These results indicate that the power system, which includes the EV fleet (controlled through the smart charge model), produces less CEEP than the conventional system.





Comparison of CEEP in scenarios with and without EVs included (smart charge model).

APPLICATION OF THE FOUR STEP MODEL IN ANALYSIS OF PERSONAL VEHICLES TRIPS: THE CASE OF CITY OF ZAGREB

The purpose of this research work has been to examine the transportation system of the City of Zagreb, with a focus on personal vehicle trips, and to obtain the power load curve for future analyses of the impact of transport electrification. The investigation is based on travel demand forecasting, also referred to as the four step model (FSM). The FSM is used for the forecasting of future demand and performance of a transportation system, and it was originally developed for the estimation of infrastructure projects. In this case study, the four step model is used to estimate the hourly load curve of transport for the City of Zagreb via the predictions of hourly distribution of kilometers driven and hourly distribution of parked cars.

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As explained by (McNally, 2007), the four components of the FSM are:

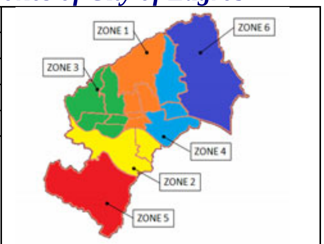
- trip generation,
- trip distribution,
- mode choice and
- route choice

The FSM in this case study was executed using MS Excel.

The first step is to divide the area of Zagreb into Traffic Analysis Zones (TAZs) - see the illustration below. The zones are geographic areas dividing the analyzed region, which represent the origins and destinations of travel activity within it. As it is not possible to represent every household, place of employment, and similar, as a separate origin and destination, these entities are first aggregated into zones and then further simplified into a single node called a centroid.

Traffic Analysis Zones of City of Zagreb

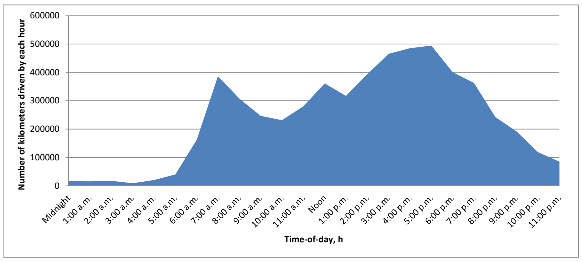
Zone 1	Zagreb Centre
Zone 2	Novi Zagreb
Zone 3	Zagreb West
Zone 4	Zagreb East
Zone 5	Brezovica
Zone 6	Sesvete



Trip generation was computed based on gathered data and model specifications. The total number of households per zone and the number of employees were obtained from the Croatian Bureau of Statistics. The available data is from 2001. The coefficients and rates for all equations were derived from a variety of models for urban area studies and represent a consensus of these models for different sizes of urban areas (Martin and McGuckin, 1998). In trip distribution, trip productions are distributed to match the trip attraction distribution and to reflect underlying travel impedance, thus yielding the trip tables of person-trip demands. The trip purposes in this model were classified into Home Based Work trips, Home Based Others trips and Non-Home Based trips. Trip generation consists of two sub-models, trip production and trip attraction models, which are described in the matrices that are defined as production to attraction (P-A) matrix and origin-destination (O-D) matrix. The O-D format tables, which present a number of daily person trips by purpose, where factored to reflect vehicle occupancy and time-of-day. In mode choice, trip tables are essentially factored to reflect relative proportions of trips by alternative modes. Finally, in route choice, modal trip tables are assigned to mode-specific networks.

HBW	ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 5	ZONE 6
ZONE 1	47,397	18,077	38,721	20,781	6,411	1,011
ZONE 2	18,077	19,587	23,301	16,971	3,239	1,227
ZONE 3	38,721	27,548	75,927	31,869	10,183	2,039
ZONE 4	20,781	16,971	31,869	28,735	6,865	951
ZONE 5	6,411	3,239	10,183	5,726	2,487	245
ZONE 6	1,011	1,227	2,039	951	245	96
HBO	ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 5	ZONE 6
ZONE 1	184,162	25,299	81,470	29,153	10,007	1,030
ZONE 2	25,299	37,063	13,094	9,098	4,615	20,872
ZONE 3	81,470	23,248	29,850	16,814	362,855	5,874
ZONE 4	29,153	9,098	16,814	414,156	27,389	3,542
ZONE 5	10,007	4,615	362,855	27,181	5,467	182
ZONE 6	1,030	20,872	5,874	3,542	182	192
NHB	ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 5	ZONE 6
ZONE 1	74,856	13,482	40,033	13,148	3,748	490
ZONE 2	5,102	55,997	13,794	148,402	671	893
ZONE 3	20,437	18,609	120,589	16,555	4,422	1,053
ZONE 4	8,595	14,965	21,199	60,900	5,010	443
ZONE 5	5,733	1,352	13,250	11,724	6,564	228
ZONE 6	585	2,819	2,463	809	178	237

O-D matrices of Home-Based-Work (HBW), Home-Based-Office (HBO) and Non-Home-Based (NHB) values of person-trips.



Number of kilometres driven on the road in per-hour resolution during the one day in Zagreb

The results presented on the above plot show that there are two significant peaks, one at 7 am when people start to go to work and another around 5 pm when they usually get back home. There is also a small peak at 1 pm which can be associated to some mid-day migrations. The seasonal change in driving patterns have not been included in this analysis.

The below curve shows the number of parked vehicles in Zagreb in every hour of the day. It can be used to approximate an hour load curve on the power system for the charging of electric vehicles in the city and to roughly compute the number of vehicles that are in traffic. The data show that the lowest number of parked vehicles is around 7 am and 5 pm when most vehicles are on the road.

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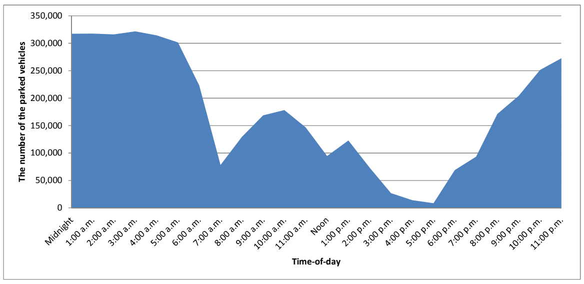
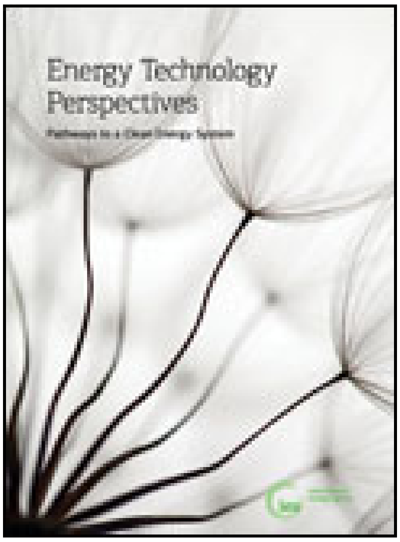


The number of vehicles parked in per-hour resolution during the one day in Zagreb

ENERGY POLICY



Energy Technology Perspectives 2012 - Pathways to a Clean Energy System (ETP2012 - ISBN 978-92-64-17488-7) is the International Energy Agency's most ambitious publication on new developments in energy technology. It demonstrates how technologies – from electric vehicles (EVs) to smart grids – can make a decisive difference in achieving the objective of limiting the global temperature rise to 2°C until 2050 and enhancing energy security. Here we will only present the most interesting findings and results related to EVs.

As the current transport sector relies heavily on oil (more than 93% of the energy used) and deployment of electric vehicles has already started with rates of 40000 sold vehicles from major producers in 2011, there is still a big gap to fill and it is envisaged that it is necessary to invest from several hundred billions of USD to a few trillion USD until 2050 in these advanced technologies.

It is interesting to look at the integration of Hybrid Electric Vehicles (HEV) into transport system, which became available in global markets as early as in 1997. Although boasted of improved efficiency and good customer perception, according to ETP2012, HEVs reached only 1% of the world's sales share until 2010. So if HEVs as new technology needed 13 years to go from market introduction to significant market share, then introducing of battery-electric vehicles (BEVs) and Plug-in HEVs (PHEVs) could also be very challenging task. Hopefully many countries and car manufacturers expressed their interest in a fast introduction of BEVs and PHEVs, and many of them are setting targets and strategies for sales in the 2015 to 2020 time frame. This can indicate that this breakthrough technology can have stepper market or S curve and can go from market newcomer to market mainstay in a shorter period of time than the HEV technology. This fast development and market introduction have been seen with two-wheelers that are the most popular mode of transportation in Asia. According to ETP2012, with an emergence of electric mopeds, scooters and e-bikes the total stock of electric 2-wheelers has reached more than 120 million in China alone showing that a new type of powertrain can succeeded in becoming dominant in a short time frame of one decade. But, the same technology in another market e.g. Europe has not reached cost parity with their conventional, gasoline counterparts.

IEA suggests that to reach a 2020 target of over 20 million BEVs and PHEVs on the road, these vehicles must be supported with price incentives in a cost-sustainable fashion (such as via CO2-based vehicle taxation, etc). At the same time, co-ordination of recharging infrastructure growth must be led by national, regional and municipal governments, with targets corresponding to desired growth of the BEV/PHEV stock. Thus, one of the main conclusions is that governments and policy makers should support urban and regional development of infrastructure for electric vehicle recharging, and should provide coherent policy framework including price incentives to promote electric and plug-in electric hybrid vehicles. Moreover a stable and coherent policy framework until 2020 can build industry and consumer confidence.

IEA calculations show that BEVs and PHEVs could achieve global CO_2 savings of 1.7 Gt in 2050 (or 4.1% of required yearly reductions to stay at 2°C of increase in global temperature), while the cumulative CO_2 savings in the period from 2010 to 2050 would be 33.3 Gt with the investment in technology of 13.1 trillion USD.

To achieve these numbers IEA recommends the following priority actions that should be taken until 2020:

- Set up adequate incentives for PHEV/BEV purchase and production in line with strategic targets and in parallel insure co-ordination of recharging infrastructure development in urban areas.

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- Start low- and medium-volume production, with design optimisations to 2015, then rapidly increasing numbers of models offered and average production volumes. It is necessary to reduce battery and other costs to reach the target levels.
- Make plugs and charging systems compatible across major regions, including basic “smart metering” systems for home and public recharging stations. Develop protocols for fast recharging.

There are also a number of policy recommendations from IEA:

- Make policy support a priority, especially in two areas: ensure EVs become cost-competitive through market-supportive feebates and other financial instruments; and provide adequate recharging infrastructure to support both home charging and construction of public fast-charging facilities.
- Put the consumer first by improving understanding of consumer needs and desires, as well as consumer willingness to change vehicle purchase and travel behaviour.
- Implement information campaigns to assuage range and fuel economy anxiety.
- “Measure performance using the IEA roadmap’s set of proposed metrics and targets for key attributes like driving range (enough to cover at least 95% of all trip lengths) and battery requirements (battery costs below USD 300/kWh), to ensure that EVs achieve their potential.”
- Continue research, development and demonstration in order to reduce battery costs and ensure adequate materials supply.
- Conduct research on smart grids and the vehicle-grid interface as well. In total, public investment in EV technology innovation needs to increase five to tenfold over the next 5 to 10 years.

PUBLICATIONS

The above and related research results have been published in the below journal and conference papers. At least one more journal paper and a couple of conference papers will be submitted in this research year.

Journals:

1. Pukšec, T., Krajačić, G., Lulić, Z., Mathiesen, B. V., Duić, N., "Forecasting long-term energy demand of Croatian transport sector", Energy, Vol. 57, pp. 169-176
2. Škugor, B., Deur, J., Cipek, M., Pavković, D., "Design of a Power-split HEV Control System Containing Rule-based Controller and Equivalent Consumption Minimisation Strategy", Proceedings of the Institution of Mechanical Engineers, Part D, Journal of Automobile Engineering, (in review).

Conferences:

1. Škugor, B., Deur, J., "Instantaneous Optimization-based Energy Management Control Strategy for Extended Range Electric Vehicle", SAE paper #2013-01-1460, SAE World Congress, Detroit, MI, 2013.
2. Cipek, M., Čorić, M., Škugor, B., Kasać, J., Deur, J., "Dynamic Programming-based Optimization of Control Variables of an Extended Range Electric Vehicle", SAE paper #2013-01-1481, SAE World Congress, Detroit, MI, 2013.
3. Šare, A., Krajačić, G., Pukšec, T., Duić, N., "The Impact of Electrification in the Transport Sector on the Power Curve, and the Integration of Renewable Energy Sources in to the Power Systems of the Dubrovnik Region", 8th SDEWES Conference, Dubrovnik, Croatia, 2013.
4. Gašparović, G., Krajačić, G., Šare, A., Duić, N., "Advanced modelling of an electric vehicle module in the H2RES energy planning software", 8th SDEWES Conference, Dubrovnik, Croatia, 2013.
5. Novosel, T., Pukšec, T., Krajačić, G., Duić, N., "The impact of electric vehicles and driving cycles on hourly electrical load curves: a case study for Croatia", 8th SDEWES Conference, Dubrovnik, Croatia, 2013.
6. Perković, L., Ban, M., Krajačić, G., Duić, N., "Receding horizon model predictive control for smart management of microgrids under day-ahead electricity market", SDEWES 2013. 8th SDEWES Conference, Dubrovnik, Croatia, 2013.
7. Škugor, B., Deur, J., "The vehicle fleet data collection, processing, analysis, and naturalistic driving cycles synthesis", 8th SDEWES Conference, Dubrovnik, Croatia, 2013.
8. Škugor, B., Ranogajec, V., Deur, J., "On Smoothing HEV/EREV Supervisory Control Action Using an Extended ECMS Approach", The International Electric Vehicle Symposium & Exhibition (EVS27), Barcelona, Spain, 2013.

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ONGOING EU PROJECTS

The below EU projects deal with various aspects of EV-grid integration.

1. eCo - FEV, Efficient Cooperative infrastructure for Fully Electric Vehicles, Coordinator: Dr. Massimiliano Lenardi
2. e-DASH, Electricity Demand and Supply Harmonization for EVs, Coordinator: Antonio Paradell
3. EMERALD, Energy ManagEment and RechArging for efficient eLectric car Driving, Coordinator: Marco Boero
4. FastInCharge, Innovative Fast Inductive Charging solution for electric vehicles, Coordinator: David Mignan
5. IoE, Internet of Energy for Electric Mobility, Coordinator: Dr. Ovidiu Vermesan
6. OPTIMORE, Optimised Modular Range Extender for every day customer usage, Coordinator: Dr. Theodor Sams
7. PowerUp, Specification, Implementation, Field Trial, and Standardisation of the Vehicle-2-Grid Interface, Coordinator: Andras Kovacs
8. SmartV2G,Smart Vehicle to Grid Interface, Coordinator: Andreas Varesi

UPCOMING EVENTS, WEB PORTALS AND PROJECT CALLS

8th SDEWES CONFERENCE, Dubrovnik, Sep 2013

The 8th UNESCO-sponsored Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES Conference, www.dubrovnik2013.sdewes.org) will be held in Dubrovnik in September, 22-27, 2013 in organisation of the University of Zagreb-FMENA.

Over 400 participants from 60 countries are expected to attend the conference. The invited speakers are Prof. X. Zhang, Prof. B. V. Mathiesen, Prof. Q. Wang, Prof. L. Ribbe, Prof. J. Yan, Prof. H. Schnitzer and Prof. D. Gvozdenac. Apart from regular sessions, the conference will include two panels including the one on *Smart Grids or Smart Systems*, and 10 special sessions dealing with the actual topics of sustainable development.

One of the special session is organised by the i-RESEV project team, as described in News section above.

The conference registration is still open - please visit:

http://www.dubrovnik2013.sdewes.org/registration

i-RESEV 2013 International Summer School

As a side event of the SDEWES Conference, the i-RESEV team organises the summer school on the project topic - please see News section above and the Summer School Programme. Participation of 20-30 Ph.D. students, engineers and researchers from European universities and automotive OEMs and suppliers is expected.

The summer school registration is open until September 10, 2013 - please visit:

http://powerlab.fsb.hr/iresev/?pg=29

2nd i-RESEV WORKSOP

The i-RESEV team will organise 2nd Project Workshop at the Faculty of Mechanical Engineering and Naval Architecture, I. Lucica 5, Zagreb, in December, 2013. The main goal of the workshop is to promote the results and project achievements of the first research year. Workshop will bring together various stakeholders coming from domestic industry, academia and government, which are interested in further promotion of electric vehicles and renewable energy sources.

The workshop is anticipated to be organized in three main sections:

1) **Plenary lectures** of the project leader and the sub-coordinator of energy system planning activities, which will outline the main project outcomes in the 1st and 2nd research years and the plans for the 3rd research year
2) **Panel discussion** on the importance of EV-grid integration and the corresponding role of ICT technologies, including **external keynote presentations**
3) **Individual presentations** of the team members, concerning the results of the above-described ongoing project activities, and including demonstration of developed software tools, as appropriate.

The exact date and the final schedule of the workshop will be announced by email and web in due course.

Please contact us in the next 60 days if you would like to present your R&D initiatives, activities, and results in the field.

2ND MEETING OF PROJECT ADVISORY BOARD

In January 2014, the representatives of the project team and the PAB member companies will hold their second plenary meeting to discuss the project results and mutual interactions during the 2nd research year,

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and outline the plans for cooperation in the final, 3rd research year.

CONFERENCES

The following forthcoming conferences are closely related to the topic of i-RESEV project.

- The 8th Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES 2013), 22-27 September, 2013, Dubrovnik, Croatia
  http://www.dubrovnik2013.sdewes.org/
- The 16th International IEEE Conference on Intelligent Transportation Systems (ITSC 2013), 6-9 October, 2013, Hague, Netherlands
  http://ieee-itsc13.org/
- The 22nd The Aachen Colloquium on Automobile and Engine Technology, 7-9 October, 2013, Aachen, Germany
  http://www.aachener-kolloquium.de/
- The 9th IEEE Vehicle Power and Propulsion Conference (VPPC 2013), October 15-18, 2013, Beijing, China
  http://www.vppc.org/
- The European Utility Week, 15-17 October, 2013, Amsterdam, Netherlands
  http://www.european-utility-week.com/
- The 27th World Electric Vehicle Symposium and Exhibition (EVS27), 17-20 November, 2013, Barcelona, Spain
  http://www.evs27.org/
- The 5th Innovative Smart Grid Technologies Conference (ISGT 2014), 19-22 February, 2014, Washington, DC, USA
  http://ieee-isgt.org/
- Society of Automotive Engineers' International World congress (SAE 2014), 8-10 April, 2014, Detroit, Michigan, USA
  http://www.sae.org/congress/cfp/index.htm
- The 2014 IEEE Intelligent Vehicles Symposium, 8-11 June, 2014, Ypsilanti, Michigan, USA
  http://www.ieeeiv.net/

WEB PORTALS

There are a number of web portals, magazines and libraries that deal with electrified road transport and its integration into energy systems:

- Society of Automotive Engineers (SAE)'s International Global Technology Library – Electric Vehicle
  http://saegtl.org/ev/
- Vehicle Electrification (SAE)'s Magazine
  http://ev.sae.org/
- Information and Communication Technologies for the Fully Electric Vehicle
  http://cordis.europa.eu/fp7/ict/micro-nanosystems/docs/brochure-ict-for-fev-2nd-edition-2011_en.pdf
  http://www.ict4fev.eu/public/
- European Green Cars Initiative
  http://www.green-cars-initiative.eu/public/
- The IEEE Transportation Electrification Initiative
  http://electricvehicle.ieee.org/
- E-mobilnost
  http://www.e-mobilnost.hr/
- ELTIS The Urban Mobility Portal
  http://www.eltis.org/

DISCLAIMER

The opinions, findings, conclusions and/or recommendations included in this newsletter are of sole responsibility of the project team, and they do not necessarily reflect standpoints of the Croatian Science Foundation.

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