i-RESEV NEWSLETTER

ISSUE No. 4 - September 2014

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"**, and supported by the Croatian Science Foundation. The project started in January 2012, and is currently in its final year. The main information about the project can be found on the web site http://powerlab.fsb.hr/iresev and the previous newsletter issues posted therein.

CONTENT OF THIS NEWSLETTER ISSUE

This newsletter issue describes the main project activities since December 2013 when the 3rd Issue was published. This includes an outline of main project results, and a related list of recent publications. The project news section is also given, as well as a popular section including information on upcoming events, web portals, and project calls.

PROJECT NEWS

2ND PROJECT WORKSHOP

The project team organised the second 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 January 24 2014. The main aim of the workshop was to disseminate the project results obtained in the 2nd research year period to the 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 and Slovenian companies and organisation (i.e. *Hrvatski Telekom*; *United Nations Development Programme in Croatia; and ETREL, Slovenia*). 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 third regular meeting of the Project Advisory Board (PAB) was held at the University of Zagreb-FMENA on March 24th, 2014. The project team and the PAB members discussed the mutual interactions and cooperation through the second project year period, significance of the obtained research results, and opportunities of continuing cooperation through 2014 with emphasis on knowledge transfer, data support to the project team, and possibilities for joint participation in EU projects.

BEST PAPER AWARD

The Ph.D. student working exclusively on the i-RESEV project, Branimir Škugor, has won the Best Paper Award at the 9th SDEWES conference for his paper "Dynamic Programming-based Optimisation of Charging an Electric Vehicle Fleet System represented by an Aggregate Battery Model".

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

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i-RESEV TEAM

Luka Perković, the project team member, received his Ph.D. Degree in June 2014. His Ph.D. Thesis was related to advanced turbulence modelling in turbulent combustion processes in order to improve the product design in terms of energy efficiency and formation of pollutants. Luka Perkovic is involved in energy planning activities within the i-RESEV project, particularly in modelling of integration of the new operating strategies of complex systems including RES and storage technologies, through development of new modules and optimisation procedures in the in-house energy planning model H2RES.

APPLICATION TO H2020 CALLS

The i-RESEV team has been active in applying several cooperative projects to the Horizon 2020 Calls from the Transport and Energy domains, with emphasis on Green Vehicles section. The results are expected around the end of the year.

3rd PROJECT WORKSHOP

The 3rd Project Workshop will be held at the University of Zagreb-FMENA in December 2014 or January 2015. The main aim of the workshop is to disseminate the project results obtained in the last research year, as well as to present the overall project achievements and perspectives for continuing activity of the research group in the EV-grid integration field. The workshop will also include a round table preceded by presentations from several companies. More detailed information about the workshop is given in a separate section below, and the workshop call and programme will be given soon on the project web site.

OVERVIEW OF RESEARCH RESULTS

This section gives an overview of recent project activities and results related to characterisation of electric delivery vehicle fleets, optimisation of EV charging, and planning of EV-grid integration. More detailed results are included in our publications listed in a separate section below.

ELECTRIC DELIVERY VEHICLES

Electric vehicles are seen as a good alternative to conventional vehicles in terms of reduced energy consumption and emissions of air pollutants and CO2. The statistical data on European annual road freight transport show that over 90% of the total road freight transport is carried out over short distances, representing urban distributions. Thus, electric vehicles have a good potential to be an adequate replacement to conventional vehicles in urban areas.

The main aim of the below contribution is sizing of a fully electric delivery truck being capable of replacing the existing conventional truck (MAN - TGM 15.240), as well as a comparative analysis of the two trucks in terms of energy cost and CO2 emissions. The considered truck is used by the leading regional retail company Konzum d.d. (the member of PAB) in their freight delivery fleet (see Newsletter No. 2). The delivery truck mission is to load cargo in the distribution centre and to distribute it to one or more sales centres.

The considered conventional vehicle has the loading capacity of 7460 kg and the empty vehicle mass of 7860 kg. The vehicle velocity is limited to 90 km/h. The vehicle is propelled by a diesel engine with the maximum power of 176 kW. The engine is characterized by the specific fuel consumption (g/kWh) and maximum output torque maps shown in upper plot in the figure below. By using the catalogue data for the 12-speed automated manual transmission and driveline gear ratios, the powertrain output torque vs. vehicle velocity map can be obtained (lower plot in the figure below).

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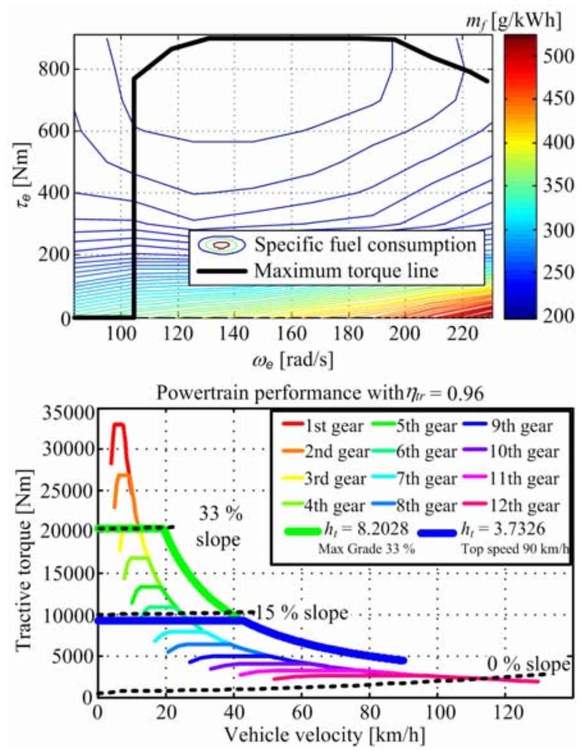
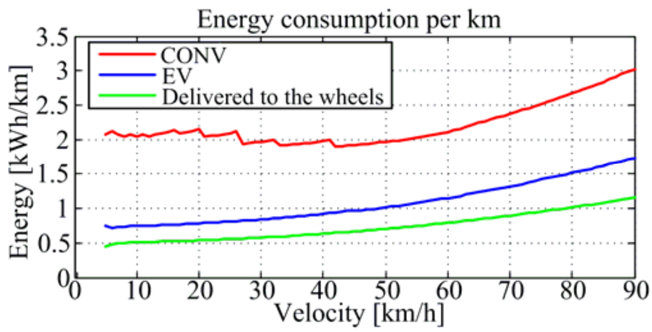


Delivery truck diesel engine maps (upper subplot) and comparative torque limit curves for conventional and electric truck drivetrains (lower subplot).

By using the above maps and known and estimated basic truck parameters (such as mass, tire radius, aerodynamic drag coefficient, and drivetrain efficiency), the truck longitudinal dynamics model has been developed. The model has been validated with respect to recorded fuel consumption for different recorded driving cycles. The validation results have pointed out that the model-predicted fuel consumption differs from the recorded one by less than 10% for a great majority of driving cycles, thus confirming a good modelling accuracy.

In a fully electric vehicle the energy to propel the vehicle is stored in its battery, which has a major influence on the vehicle range. For this simulation study the existing conventional delivery vehicle is virtually converted to a fully electric vehicle with a comparable torque and power performance. However due to the relatively low energy density of batteries the targeted driving range is limited to the city cluster (≈ 70 km). An electric motor with the rated power of 128 kW and the overload capability of 280 kW has been selected in conjunction with a two-speed gearbox (with the gear ratios h_{t1} = 8.203 and h_{t2} = 3.733), in order to satisfy or exceed the required specification including the velocity limit of 90 km/h and the maximum grade of 33% (see the comparative torque limit curves above).

Based on the aforementioned model, the conventional truck fuel consumption for constant vehicle velocity and each transmission gear ratio has been determined. The minimum fuel consumption is then extracted for each velocity, thus resulting in the energy consumption plot (given in kWh/km by the red line in figure below) by considering that 1 L diesel contains 9.970 kWh of energy. The green line relates to the energy delivered to the wheels, while the blue line shows the energy consumption curve for the electric truck assuming the constant total efficiency of 80% for the battery and its charger.



Comparative constant-velocity energy consumption plots for conventional and electric trucks.

Evidently, the electric vehicle is significantly more efficient than its conventional counterpart, particularly at lower velocities. Knowing the fuel and electricity usage, and energy costs defined by local suppliers (Diesel = 1.313 euro/litre; low tariff electric energy EE-LT = 0.06 euro/kWh; high tariff electric energy EE-HT = 0.13 euro/kWh), the costs of energy per 100 km can be calculated. These data, shown in the upper subplot of the next figure, reveal that the energy cost can be around four times lower for the electric vehicle and the low tariff. At the same time, well-to-wheel CO_2 emissions can be obtained based on the assumptions that one litre of diesel fuel produce 3.16 kg CO_2, while the electricity, depending on technology, can emit around 1 kg CO_2/kWh for coal fired power plants, 0.45 kg CO_2/kWh for natural gas power plants and 0.1 kg CO_2/kWh for nuclear energy and renewable sources. The results presented in the lower subplot indicate that the electric vehicle can give significant CO_2 reduction benefits only if the electricity is generated from renewable sources.

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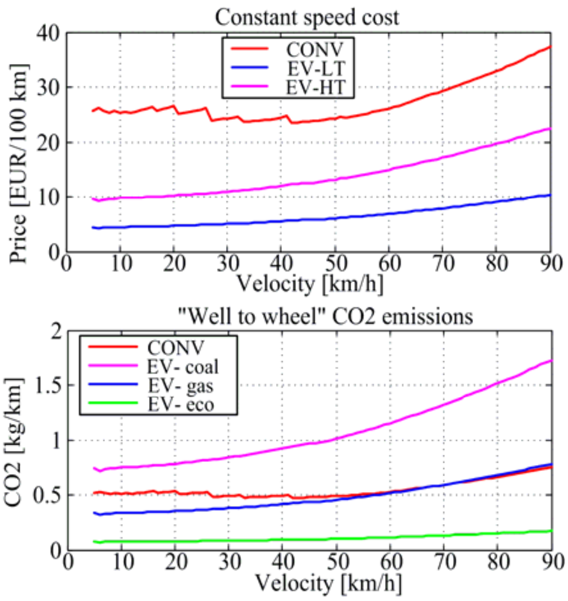
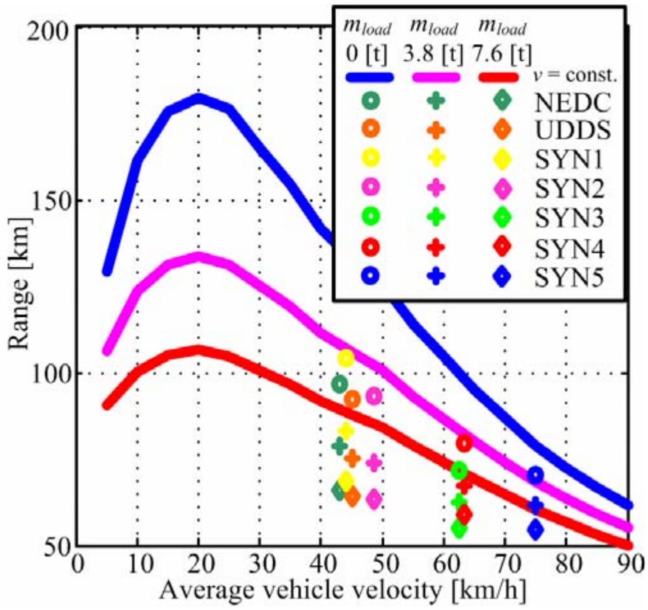


Comparative plots of constant-velocity energy cost and well-to-wheel CO2 emissions for conventional and electric trucks.



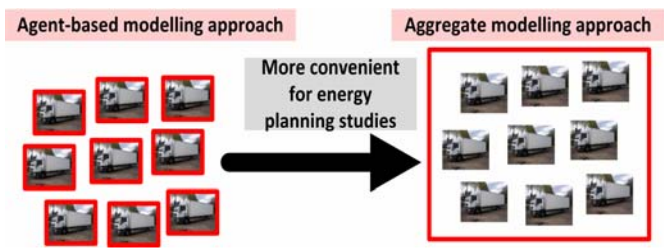
Predicted range of e-truck for constant velocity driving and various certified and synthesized naturalistic driving cycles.

Based on the preliminary constant-velocity analysis and the requirement to satisfy the city cluster range (at least 70km) for the maximum payload, a 114 kWh Li-Ion battery has been selected. The battery mass of 1.2 t approximately replaces the diesel engine, automatic transmission and fuel tank mass. In order to verify the driving range for realistic driving scenarios, a simulation analysis has been conducted for two certified driving cycles (heavy duty NEDC and UDDS), and also for five synthetic driving cycles (SYN1-SYN5) representing five driving clusters ranging from urban to regional clusters (see Newsletter No. 3). The simulation results shown in the figure below show that for the selected battery and the urban and near-urban driving cycles (UDDS, NEDC, SYN4, and SYN5) the electric vehicle range is from 60 to 105 km depending mostly on the cargo load.

A further simulation analysis has been carried out for recorded driving cycles from the urban driving clusters, in order to estimate the energy cost and CO_2 emissions for the real driving scenarios including variable cargo load. When compared to the conventional vehicle, the benefits of electric vehicle include lower well-to-wheel CO_2 emissions if electricity is produced from gas and in particular nuclear+renewable power plants, and up to 5.5 times lower energy price for city driving and the low tariff of electricity price.

MODELLING OF ELECTRIC VEHICLE FLEET AGGREGATE BATTERY

In order to evaluate benefits of replacing conventional vehicles with electric ones from the standpoint of electric vehicle-grid integration, it is crucial to develop accurate and relatively simple models of electric vehicle fleets. An electric vehicle fleet is usually modelled through an aggregate battery modelling approach, which means that the whole set of fleet vehicle batteries is replaced by a single, aggregate battery with a single state variable representing the lumped state of charge (SoC).



Electric vehicle fleet modelling approaches.

Two aggregate battery models, basic and novel, have been considered, as illustrated in the figure below including the corresponding input time distributions. Both models include SoC as a single state variable, and charging power ($P_{c,agg}$) as a single control variable. The basic model is taken from the literature and it includes the following input time distributions: (i) number of vehicles connected to the grid (n_{dc}), (ii) aggregate fleet driving power demand ($P_{dem,agg}$), and

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(iii) aggregate fleet regenerative braking charging power. The charging power upper limit is set to be dependent on the number of vehicles connected to the grid and the maximum charging power of individual battery. This model assumes constant battery capacity available for charging which is found unrealistic since the portion of vehicles within fleet will be driving and thus disconnected from the grid.

Correspondingly, the novel aggregate battery model has been proposed, which improves on the basic modelling approach by accounting for a variable structure of the aggregate battery systems, variable SoC constraints and specific input time-distributions. The novel model assumes the knowledge of the following input time distributions: (i) number of vehicles connected to the grid (n_{dc}), (ii) number of vehicles connecting to ($\Delta n_{in,dc}$) and disconnecting from ($\Delta n_{out,dc}$) the grid, and (iii) average SoC of vehicles connecting to the grid ($SoC_{in,avg}$).

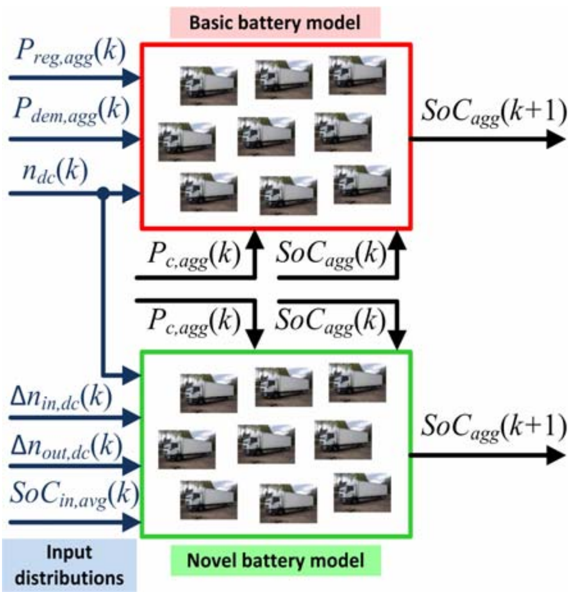
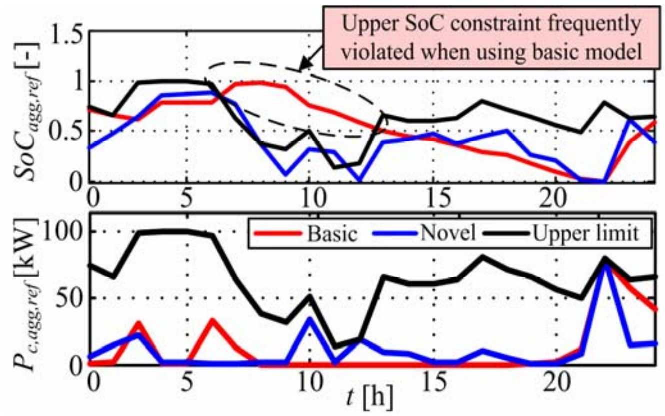


Illustration of basic and novel aggregate battery models including corresponding input distributions, control and state variables.

In the particular case-study related to delivery vehicle fleet of the regional retail company, the input distributions are reconstructed from a large set of driving missions recorded for the representative fleet of 10 delivery vehicles described in the previous subsection. The transport demand-related distributions are obtained through simulation of individual vehicle behaviours over the full set of driving cycles. The data acquisition and related analyses are described in more details in 2nd and 3rd Newsletter Issue.

The optimal charging power input for both aggregate battery models is obtained by using a dynamic programming (DP)-based optimisation algorithm aimed at minimizing the electricity cost. The optimised daily charging power and aggregate battery SoC profiles are shown in the figure below along with realistic SoC and charging power constraints for the case of two-tariff electrical energy cost distribution. It can be observed that, in the case of using the basic model, the upper SoC limit is frequently violated, which is not the case when using the novel model. Also, it can be noted that the battery charging mostly takes place in the early morning and in the late evening periods, when the electricity cost is low.



DP-optimised aggregate battery charging power and SoC daily time profiles.

For the purpose of novel model validation and its comparison with the basic model, a distributed fleet vehicle model has been developed, which captures realistic fleet constraints on the individual vehicle level. Furthermore, a specific algorithm is proposed for distributing the optimised charging power input to charging inputs of individual vehicles.

The level of correlation between the original (optimized) and achieved (through distribution) aggregate SoC and aggregate charging power profiles indicates how well an aggregate model represents the distributed model. The figure shown below indicates that the novel model is consistently superior to the basic one in terms of higher SoC and charging power correlation coefficients K_{SoC} and K_E, respectively. Also, when using the novel model, a more accurate prediction of fleet charging cost (C_{agg}) is observed when compared to the basic model.

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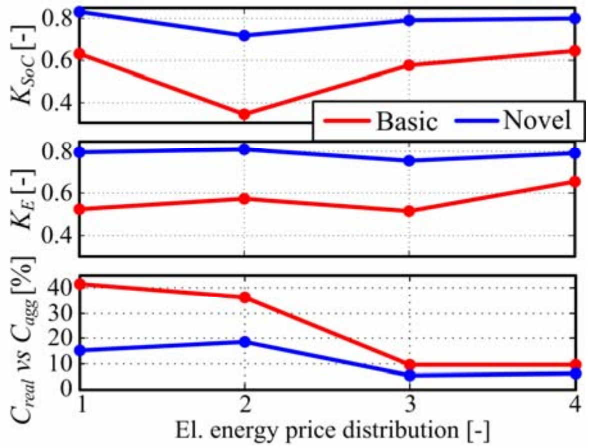

Correlation factors of basic and novel aggregate battery models for different electricity price models.

OPTIMISATION OF ELECTRIC VEHICLE FLEET CHARGING

Energy system optimisation is deemed as a crucial aspect of energy planning studies, because it reveals optimal structure, its parameters, and guidance/control of an analysed energy system. For the purpose of charging studies, a low-order aggregate battery modelling approach of an electric vehicle (EV) fleet should be used in order to provide numerically efficient optimisations of integrated transport-energy systems. The transport-energy system is assumed to include not only the EV fleet, but also renewable energy sources (RES), e.g. photovoltaic panels, and electrical appliances, as illustrated below on an example of the regional retail company's main distribution centre.

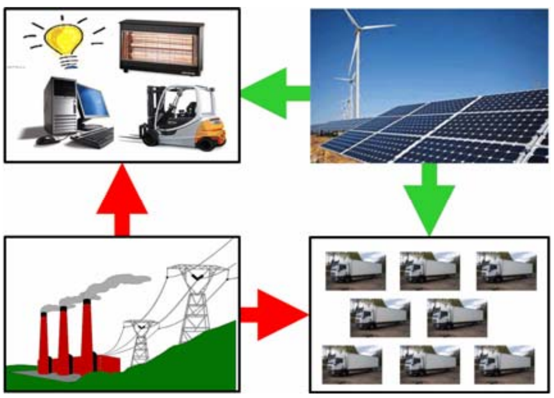

Illustration of power flow in electrified freight transport system.

First, an aggregate battery heuristic charging method taken from the literature is considered, which is focused on minimizing energy excess production from the RES. This charging method is justified in the case when a relatively large RES installation potential is considered, but in general it cannot guarantee optimality of obtained results.

To overcome this problem, the optimal control problem is formulated with the aim to find a time sequence of the aggregate battery charging power, as a single control variable which minimises the cost of charging electric vehicle fleet over a predefined time horizon, while satisfying imposed SoC and charging power constraints. This optimal control problem is solved by using dynamic programming (DP) optimisation algorithm. The main motivation for using the DP method is that it results in globally optimal results. The algorithm is executed in two distinctive phases: (i) backward solution where optimal control variable values, which minimises current cumulative cost function, is found for each discrete value of state variable in each discrete time step (backward in time), and (ii) optimal solution reconstruction starting from the initial condition (forward in time).

In order to quantify benefits of using the DP optimisation algorithm over the heuristic charging approach, the basic model of fleet aggregate battery is used and parameterised for the case of hypothetical delivery EV fleet, as described in the previous subsection. Hypothetical electrical energy production from RES is assumed based on a sun global horizontal irradiance time distribution (taken from Meteonorm 5.1 software for the particular location of the retail company distribution centre).

Two scenarios of RES energy production are analysed, as shown in the figure given below, where the daily time profiles of aggregate SoC and charging power are given for the case of two-tariff electrical energy price distribution.

In the case of no RES energy production excess (1st scenario), the DP optimizer mostly charges the battery in the periods when the price of energy is low (night charging). Consequently, it provides significant savings in terms of electricity prices when compared to the heuristic algorithm, which range from 10% to 40% depending on the electricity price model (see the C_{bat} plots below). Furthermore, the DP algorithm provides that the charge sustaining condition is satisfied (final SoC is equal to the initial SoC), as opposed to the heuristic algorithm which results in a gradual depletion of battery.

In the second scenario, both DP and heuristic algorithms result in charging the battery around solar noon when the excessive energy production from photovoltaic RES exists. This is an expected result having in mind that the heuristic method was designed with the main aim of employing the RES potential.

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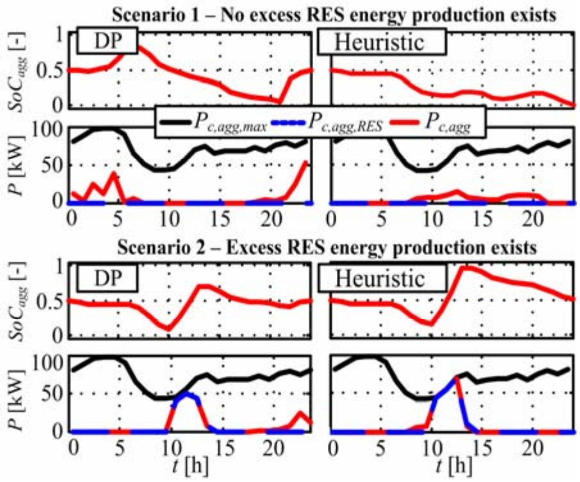
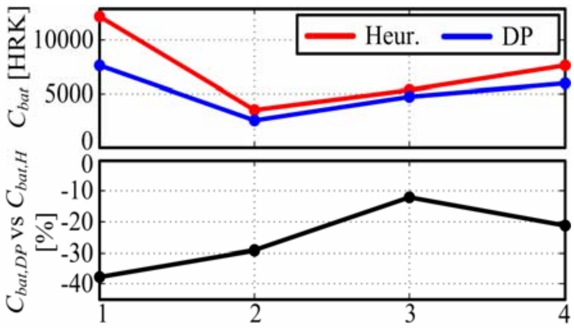


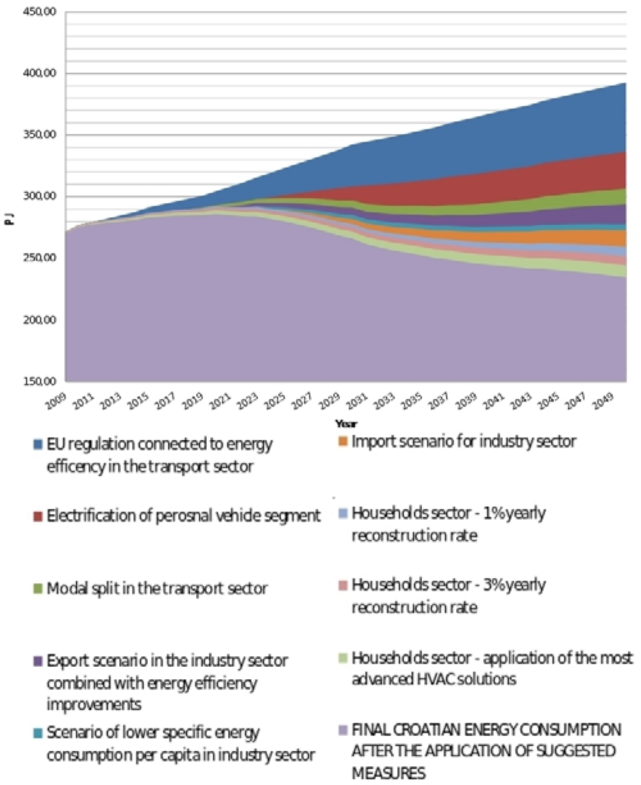
Aggregate battery charging results using DP optimization and heuristic approaches for two RES energy production scenarios.



Comparative DP vs. heuristic algorithm results on aggregate battery charging costs for three months period and four electricity price models.

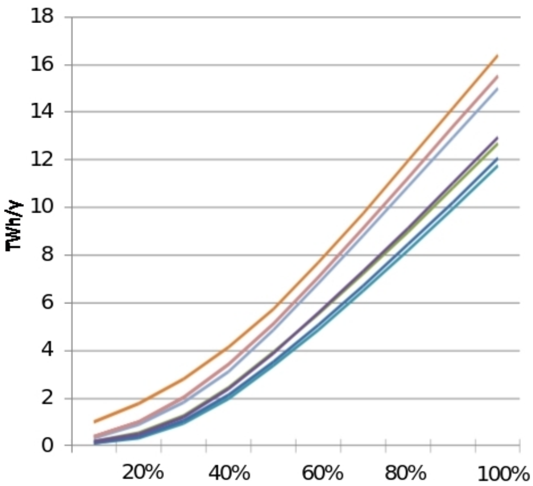
RECENT RESEARCH RESULTS IN THE AREA OF ENERGY DEMAND PLANNING

Energy demand modelling research has been continued in this final project year. Already developed EDT (Energy demand of transport sector) model was implemented and integrated with the NeD (National energy demand) model. This integration was crucial because national supply side modelling could not be possible without an integral national energy demand model (consisting of all six economic sectors). As the main result, one can stress out the energy wedge overview of energy policy actions on a national scale (see below figure). More details on the two models integration can be found in the journal paper by Pukšec et al., cited in the publication section below.



Energy wedges based on energy policy actions.

With the NeD model finally completed, energy planning team could test it as an input data for the energy system modelling (supply side modelling). This was done with Croatia as a case study and the focus was on the possibility of RES integration into the Croatian energy system (below figure). More detailed research results were published in the journal paper by Cerovac et al.



Calculated CEEP (critical excess electricity production) for all scenarios and normal hydrology in 2020.

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PUBLICATIONS

The above and related research results have been recently published in the below journal and conference papers. Previously published papers are referenced in the previous newsletter issues, as well as on the project web site.

Journals:

1. Škugor, B., Cipek, M., Deur, J., "Control Variables Optimization and Feedback Control Strategy Design for the Blended Operating Mode of an Extended Range Electric Vehicle", SAE International Journal of Alternative Powertrains (Paper No. 2014-01-1898), Vol. 3, No. 1, pp. 152-162, 2014.
2. Pukšec, T., Mathiesen, B.V., Novosel, T., Duić, N., "Assessing the impact of energy saving measures on the future energy demand and related GHG (greenhouse gas) emission reduction of Croatia", Energy. (In Press)
3. Cerovac, T., Ćosić, B., Pukšec, T., Duić, N., "Wind energy integration into future energy systems based on conventional plants – The case study of Croatia", Applied Energy. (In Press)
4. Škugor, B., Deur, J., "Delivery Vehicle Fleet Data Collection, Analysis, and Naturalistic Driving Cycle Synthesis", International Journal of Innovation and Sustainable Development. (in review)

Conferences:

5. Deur, J., Škugor, B., Cipek, M., "Integration of electric vehicles into energy and transport systems", 34th Conference on Transportation Systems - Automation in Transportation, Dubrovnik, Croatia, 2014. (invited lecture)
6. Škugor, B., Deur, J., "Dynamic Programming-based Optimization of Electric Vehicle Fleet Charging", International Electric Vehicle Conference, Florence, Italy, 2014.
7. Cipek, M., Škugor, B., Deur, J., "Comparative Analysis of Conventional and Electric Delivery Vehicles Based on Realistic Driving Cycles", European Electric Vehicle Congress, Brussels, 2014.
8. Škugor, B., Deur, J., "A Novel Model of Electric Vehicle Fleet Aggregate Battery for Energy Planning Studies", 9th Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES), Venice-Istanbul, 2014.
9. Škugor, B., Deur, J., "Dynamic Programming-based Optimisation of Charging an Electric Vehicle Fleet System Represented by an Aggregate Battery Model", 9th Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES), Venice-Istanbul, 2014.

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: Massimiliano Lenardi
2. EMERALD, Energy ManagEment and RechArging for efficient eLectric car Driving, Coordinator: Marco Boero
3. FastInCharge, Innovative Fast Inductive Charging solution for electric vehicles, Coordinator: David Mignan
4. COSIVU, Compact, Smart and Reliable Drive Unit for Fully Electric Vehicles, Coordinator: Dag Andersson
5. MOBINCITY, Smart Mobility in Smart City, Coordinator: Zsolt Krémer
6. COTEVOS, Concepts, Capacities and Methods for Testing EV systems and their interOperability within the Smartgrids, Coordinator: Eduardo Zabala
7. ICT4EVEU, ICT Services for Electric Vehicle Enhancing the User Experience, Coordinator: Carlos López

UPCOMING EVENTS, WEB PORTALS AND PROJECT CALLS

3rd i-RESEV WORKSHOP

The 3rd Project Workshop will be held at the Faculty of Mechanical Engineering and Naval Architecture, I. Lučića 5, Zagreb, in December 2014 or January 2015. The main goal of the workshop is to disseminate the results and project achievements of the last research year and throughout the project. The 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 will include the following three main sections:

1) **Plenary lecture** of the project leader and his associates, which will outline the main project outcomes in the 3rd research year and the overall project achievements.
2) **Panel discussion** on e-mobility, including invited lectures by representatives from various companies.
3) **Individual presentations** of the team members, concerning the results of the recent and ongoing project activities, and including demonstration of developed software tools, when appropriate.

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2015 SDEWES CONFERENCES

The 10th Conference on Sustainable Development of Energy, Water and Environment Systems – SDEWES Conference, to be held in Dubrovnik in 2015, is dedicated to improvement and dissemination of knowledge on methods, policies and technologies for increasing the sustainability of development by de-coupling growth from natural resources and replacing them with knowledge based economy, taking into account its economic, environmental and social pillars, as well as methods for assessing and measuring sustainability of development, regarding energy, transport, water, environment and food production systems and their many combinations. Sustainability being also a perfect field for interdisciplinary and multi-cultural evaluation of complex system, the SDEWES Conference has at the beginning of the 21st century become a significant venue for researchers in those areas to meet, and originate, discuss, share, and disseminate new ideas.

HORIZON 2020 CALLS

Horizon 2020 is the biggest EU Research and Innovation programme ever with a budget of 77 billion EUR available for 7 years (2014-2020). It represents a financial instrument aimed to secure Europe's global competitiveness and strengthen the EU's global position in research, innovation and technology.

The most interesting calls in the fields related to the i-RESEV project are grouped in the transport, energy and ICT domains, where the corresponding 2014-2015 Programmes can be found on the following links:

http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/main/h2020-wp1415-transport_en.pdf

http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/main/h2020-wp1415-energy_en.pdf

http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/main/h2020-wp1415-leit-ict_en.pdf

One of the calls, which the i-RESEV team is particularly interested in is from the Green Vehicles (GV) section:

- **GV.8-2015. Electric vehicles' enhanced performance and integration into the transport system and the grid**

CONFERENCES

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

- Vehicle Power and Propulsion Conference (VPPC 2014), 27-30 October, 2014, Coimbra, Portugal
  www.vppc2014.org
- The European Utility Week, 4-6 November, 2014, Amsterdam, Netherlands
  http://www.european-utility-week.com/
- European Electric Vehicle Congress (EEVC 2014), 2-5 December, 2014, Brussels, Belgium
  http://www.eevc.eu
- The 6th Innovative Smart Grid Technologies Conference (ISGT 2015), 17-20 February, 2015, Washington, DC, USA
  http://ieee-isgt.org/
- Society of Automotive Engineers' International World congress (SAE 2015), 21-23 April, 2015, Detroit, Michigan, USA
  http://www.sae.org/congress/
- The 2015 IEEE Transportation Electrification Conference & Expo (ITEC 2015), 14-17 June, 2015, Metro Detroit, Michigan, USA
  http://itec-conf.com/
- The 2015 IEEE Intelligent Vehicles Symposium (IV 2015), 28 June – 1 July, 2015, COEX, Seoul, Korea
  http://www.iv2015.org/
- The 18th International Conference on Intelligent Transportation Systems (IEEE ITSC 2015), 1-4 September, 2015, Canary Islands, Spain
  http://www.ieee.org/conferences_events/conferences/conferencedetails/index.html?Conf_ID=30712
- The 17th European Conference on Power Electronics and Applications (EPE' 2015), 8-10 September, 2015, Geneva, Switzerland
  http://event-epe2015.web.cern.ch/
- The 10th Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES 2015), September, 2015, Dubrovnik, Croatia
  http://www.dubrovnik2015.sdewes.org/

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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://magazine.sae.org/digevsae/

- Information and Communication Technologies for the Fully Electric Vehicle

  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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