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

Publishable summary: Due to the intermittent nature of renewable energy sources (RES), the related energy systems need to include significant backup in terms of traditional energy sources or a significant electric storage capacity. This increases the cost of electrical energy and the overall energy system and hinders the RES proliferation. The growing presence of electric vehicles (EV) and plug-in hybrid electric vehicles (PHEV) brings a substantial amount of distributed battery storage capacity that is connected to the grid (vehicle-to-grid concept, V2G), thereby opening new opportunities for the RES integration. However, the overall transport and energy system (TES) becomes more complex and it can be optimally managed only by way of a widespread involvement of information and communication technologies (ICT). The main objective of the proposed project is to provide a basis for full integration of EVs into the RES-based energy systems, through extensive use of ICTs in: (i) modelling, simulation, and optimisation processes; (ii) on-line optimal control, estimation, and prediction; (iii) strategic planning; and (iv) supporting services. There are two distinctive research and development (R&D) paths towards realising the goal of predeployment and wider uptake of smart connected electromobility, which will propel future transport and energy systems towards sustainability. The first path is focused on solving the problem on the energy system level (top-down approach) in terms of optimising the use of RES, having in mind benefits and requirements of electrified transport. The second (bottom-up) approach is aimed at optimising the EV energy management control (EMC) system, with the goal to minimise the fuel and electricity consumption for given grid parameters and a-priori unknown driving conditions. Clearly, as these basic individual efforts evolve and the ICTs become more sophisticated, there is a need for a comprehensive approach to planning, design and control of the overall TES, in order to approach the optimal behaviour for given operating parameters. To achieve this goal, the proposed project assembles a multidisciplinary team of automotive control and energy system planning researchers with a significant international experience. The proposed research approach starts with optimal design of EV control strategy. The optimised EV system is simulated for a variety of realistic 24-hour driving cycles. The obtained data are used to develop a probabilistic model of the electric transport system, which is linked to energy system planning models to optimise energy system components and V2G operation. Finally, the overall TES model is used for assessment of various RES-grid-EV configurations.