INNOSOC Case Study

(selected for Zagreb 2016; extended version)

Case Study title:

Innovative Application of Electric Vehicles in Sustainable Energy Systems of the Future

Keywords: Electric Vehicles; Sustainability; Innovation; Energy systems

H2020 challenge addressed by the Case Study: Secure, clean and efficient energy

Introduction to the Case Study

Nowadays, a term *sustainable development* is most often associated with a term *environmental sustainability*, whose goal is to conserve natural resources and to develop alternate sources of electricity while reducing pollution and harm to the environment [1]. In that respect, the undisputed truth is that *changes* are needed in the way people *produce* and *consume* energy. The lucrative amount of money EU offers through the HORIZON 2020 framework [3], as well as the latest Paris agreement on a climate change [2], communicates a clear strategic vision on **what to accomplish** but it provides **no clues on how to do so**.

An *electric vehicle* (EV) is a prime example of energy efficient and low carbon technology [4, 5, 6, 7]. Not only does an EV drive more *smoothly* and more *economically* than its internal combustion engine counterpart, but it also has a dedicated battery which can **store electricity**. In theory, this can be really exciting because the EV battery provides means to use EVs not only for traveling but also for **storing the excess electricity**, which typically happens when the wind turbine produces more electricity than users (e.g., industry and residential) currently need.

It *seems* an EV is a **clear winner** in all areas. In current practice, however, this may **not be the case**. Without serious incentives, **economic benefits** of EVs are still **doubtful**. Even though EVs have so-called **zero tailpipe emissions**, the electricity still largely comes from **fossil fuels**. Potential applications of EVs as energy storage are yet to be explored due to its **costly battery** and the overall **lack of charging infrastructure**. Thus, energy systems of the future need a lot of ICT-based innovation to tackle challenges imposed by EVs.

Five INNOSOC students, supervised by two INNOSOC lecturers, will collaborate on answering how innovative coupling of ICT and EVs can contribute to building sustainable energy systems of the future. These activities will be conducted as a part of the ERASMUS+ blended mobility and will be finalized during the INNOSOC Zagreb 2016 workshop in late April 2016.

How this Case Study is related to the selected H2020 challenge?

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The so-called *Energy Challenge* is aimed at transforming traditional and aging energy systems towards reliable and competitive energy systems. This highly complex problem needs to cope with *increasingly scarce resources*, *growing energy needs* and *climate change*.

EVs are **strongly tied** to the specific objectives and research areas from the HORIZON 2020. In particular, EVs are highly efficient machines which **reduce energy consumption and carbon footprint**. Being **mobile energy sources**, EVs, along with appropriate policies and incentives, promote the inclusion of a **low-cost, low-carbon electricity supply**. Energy entrepreneurs interested in EV business (e.g., charging facilities) will need **robust decision-making** (e.g., pricing policies) as well as **public engagement** (e.g., EV owner charging flexibility) in order to achieve a **market uptake**. That being said, **new knowledge and technologies** are needed in the area of EVs to tackle wicked problems [8] in the energy systems of the future.

How this Case Study is related to the INNOSOC project?

While conventional cars are used primarily for driving, EVs potentially have much more applications and consequently much broader positive impact on people's lives. For example, EVs, apart from being used for commuting to work or shopping mall, can potentially be used as power plants through vehicle-to-home technology [9]. Essentially, EVs act as both producers and consumers (i.e., prosumers) of energy. Indeed, the **innovation aspect** of EVs surpasses technical advancements. Energy entrepreneurs, along with a positive input from policy makers, are able to extend their businesses with charging infrastructures. In order to get there, however, there are years of a dedicated innovation ahead of us.

The Case Study eagerly awaits for participants from different countries and cultures. The **intercultural communication** is needed to discuss what people from different areas think and do about changing energy landscape. A bad reputation for nuclear power in Germany, lucrative incentives for buying an EV in Norway [10] and protests for coal-based power plant in Croatia are only few examples suggesting we are in the process of *emotionalization of energy*.

Finally, today's EVs are *highly sophisticated* machines. It is expected that, in the near future, billions of machines will be connected by the means of ICT, EVs included. In contrast to the traditional energy systems, the energy system of the future will require two-way flows of power and communication between producers and consumers. Smart in-vehicle applications, interaction with a charging infrastructure and many other innovative applications are just small examples which prove that an **ICT aspect** is a cornerstone for EV applications.

Questions that need answers during the Case Study development

- Vehicle taxonomy: what types of vehicles are there (e.g., EV, BEV, ICV, FCV, PHEV, …)? Outline pros and cons (e.g., energy efficiency) for each of them.

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- How do EVs affect three pillars of sustainable development: economy, environment and social community?
- What is the state of the global EV market (w.r.t., sales, battery costs, incentives, popular cars, ...)?
- How does an EV owner use its car (w.r.t., demand (charging), typical traveling patterns, …)?
- What is the state of the EV charging infrastructure (w.r.t., types of chargers, number of chargers in popular countries, …)?
- What is the role of ICT in EVs (e.g., in-car applications, communication with charging infrastructure, …)?
- What my country and culture think and do about changing energy landscape (e.g., incentives for EVs and renewables, what kind of power plants are being used in my country, …)?
- How can we innovate with EVs (e.g., integration with renewables as energy storage system, smart parking lot [7], vehicle-to-home, vehicle-to-grid, electric charging lanes, …)?

References

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Knowledge and skills needed for developing the Case Study

(P: prerequisite; D: desirable, but not necessary)

- to be familiar with newest trends in ICT (P);
- to have interest in Electric Vehicles (D);

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- to care about sustainability (D);
- to be curious and prolific Internet researcher (D);
- to be familiar with Energy Systems (D).

Figures describing this Case Study

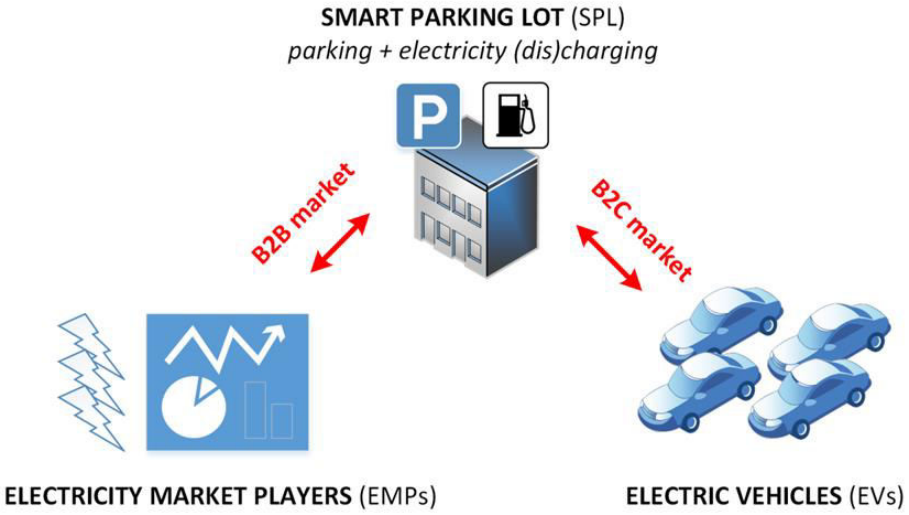

Figure 1. Smart parking lot as an example of innovation with EVs

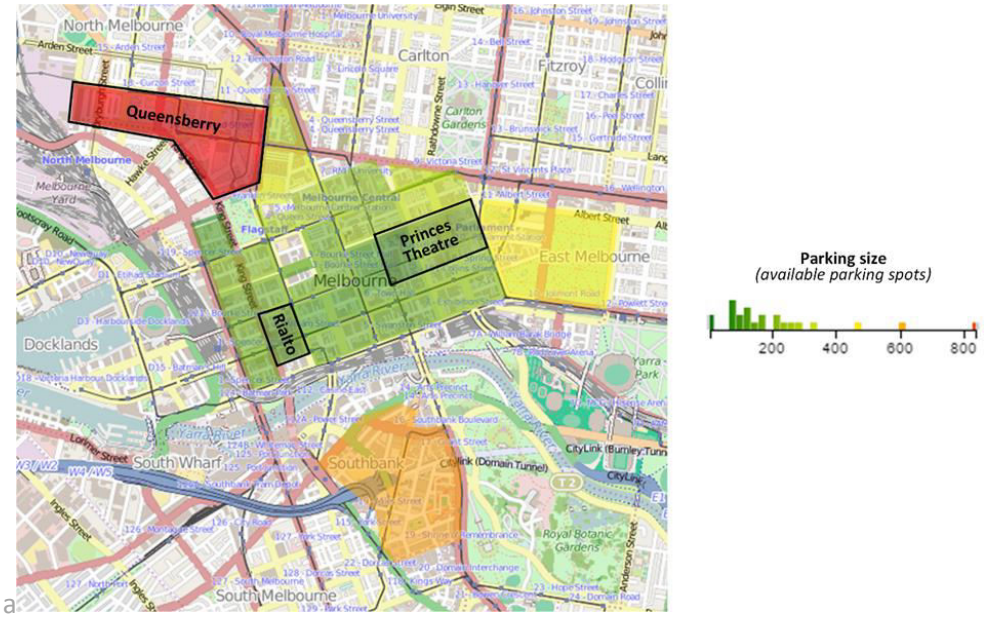

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Figure 2. Parking lot size affects planning of charging infrastructure

Figure 3. Electric vehicle "Concept_One" produced by a Croatian company "Rimac Automobile"

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