

E-MOD

Electric MObility Development in Italy:
a multidisciplinary evaluation





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Description

The project addresses the topic of electric mobility following a multidisciplinary approach, in order to answer the most common concerns, to analyse strength and weaknesses and to assess further need of improvements.

First of all, the current status of Electric Vehicle (EV) availability on the market and of the recharging infrastructures are analysed, both worldwide and in some specific countries. The environmental aspects of Electric Mobility (EM) are analysed with a comprehensive approach. Direct atmospheric emissions are compared to those of traditional vehicles, and the same for internal and external noise emissions. The exposure to electromagnetic field inside the vehicle is also assessed, as well as the release of heat during standard driving cycles. This step of the project is conducted



in cooperation with Stazione Sperimentale dei Combustibili (SSC), where two electric vehicles and an internal combustion one were tested during two days on a dynamometer test bench. A Life Cycle Assessment (LCA) is then performed, with special emphasis on the sensitivity of the results to the type of energy used for recharging in order to check whether the emission savings during the use phase are able to compensate the higher impacts of the batteries production phase. The energy aspects are mainly addressed by analysing the possible role of EVs (when plugged and not in use) as energy storage devices integrated to the smart grid.

The economic aspects are addressed by suggesting possible business models in order to promote a quicker development of electric mobility in Italy. This is addressed by looking both at the sale of EVs and the development of the recharging infrastructure.

Finally, some social aspects are addressed, in order to analyse the further barriers that prevent users to opt for EV mobility and the influence of hot issue on the social network

The following case studies are critically analysed.

- The strategy of E-mobility promotion adopted in Norway, USA and China. Heavy subsidies for EV (not only in economic terms) have sky-rocketed their sale, rising some concerns on other categories (i.e. the use of priority lanes restricted to buses and taxis)
- Electric Mobility Industry Companies such as Tesla Motors, FastNed and BYD.

Group Picture - Attending eCarTech 2015, Munich

Tasks and skills

Awaz Alfadil: took care of the social aspects part, developing the EV & Dieselgate platform and analysing Cluster Analysis results.

Claudio Carnabuci: focused on the processing of data from the experimental tests conducted at SSC and acted as team controller.

Gregorio Cioppa: analysed the Italian EV market situation, later proposing infrastructure-centered incentives for the EM-2030 plan.

Federico Consonni: performed the value chain analysis and business models proposal, followed by TCO calculations for the EM-2030 plan.

Emanuela Di Carlo: took care of the LCA part, performing comparisons and sensitivity analyses by using the commercial software SimaPro.

Qianqian Li: elaborated experimental test results, analysed EV markets in pioneer foreign countries and contributed to the technological roadmap development.

Abstract

Climate change concerns, urban air pollution and new regulations in the transport sector are shifting the attention to Electric Mobility, recognised as the most sustainable solution to alleviate these environmental problems. However, technological and infrastructure problems are limiting its scale-up only to few countries, and Electric Vehicles in Italy still represent a niche market.

The E-MOD project was developed in this framework, with the aim of:

- analysing if the current Italian socio-economic context is suitable for an EV scale-up;
- assessing local and global-scale environmental benefits given by wider EV adoption;
- investigating what new business opportunities a shift towards EM could give;
- propose a strategy for EM development in Italy.

The first task was carried out by comparing Italian sales and government incentives with those of pioneer countries in EV adoption. Social aspects were then assessed creating the EV & Dieselgate web-platform to monitor people's interest in the topic from social networks, through Word Association and Thematic Cluster analyses.

Experimental tests at Stazione Sperimentale dei Combustibili allowed to show EV benefits compared to Internal Combustion Engine Vehicle (ICEV) in terms of noise, brake wear Particulate Matter (PM), heat release and Electro-Magnetic Field (EMF) emissions. Carbon emissions were instead compared through the LCA method, highlighting the limits of EVs by analysing the sensitivity to battery size and electric energy mix.

A Value Chain analysis allowed to assess which new business models could arise from a shift towards EM, and vehicle-to-grid together with battery 2nd life were selected as the most attractive ones.

Based on the above, we developed a technological roadmap for a wider EV adoption in Italy: the EM 2030 plan. A strong incentive campaign, focused on infrastructure development, should precede a second phase, when the implementation of a proposed Vehicle-To-Grid (V2G) business model would lower EVs Total Cost of Ownership (TCO) in such a way to make them an economically viable option, even more convenient than ICEVs.

Understanding the problem

Our project investigates Electric Mobility from a multidisciplinary perspective, aiming at studying the strict influence between social, political, economic and environmental issues.

EVs for the moment only accounts for 0.1% of sales, because of the lack of stable EV companies interested in the Italian market. In addition, synergic approaches are required for an effective infrastructural development, providing both fast and slow recharging stations, due to the need to integrate urban driving and medium-long range transfers. Furthermore, the diffusion of EVs in Italy will be also related to the regulatory incentives and policies at local or national level, which are the key-priorities in other countries already experiencing a large-scale EV adoption.

EVs are generally associated with both positive and negative environmental issues. The former include the absence of tailpipe emissions, the lower CO2 emissions compared to ICEVs (fundamental in order to match the objectives of COP 21), the possibility to exchange energy with the electric system as energy storage devices, and the lower noise emissions. The latter are often associated with the possible exposure to Electro-Magnetic Fields during driving or to the global concerns in case of using electric energy coming from dirty sources such as coal. However, in general, EM is seen as an interesting starting point for urban air quality improvement and lower carbon emissions.

Finally, it is important to mention the social aspects, which are the influencing factors for the raise of EVs market in Italy. Indeed, the presence of physical and ideological barriers can heavily prevent users to opt for EV mobility. Generally, citizens are uncertain about the technology and its potential, or about the possible risks and opportunities.



Experimental tests at Stazione Sperimentale Combustibili

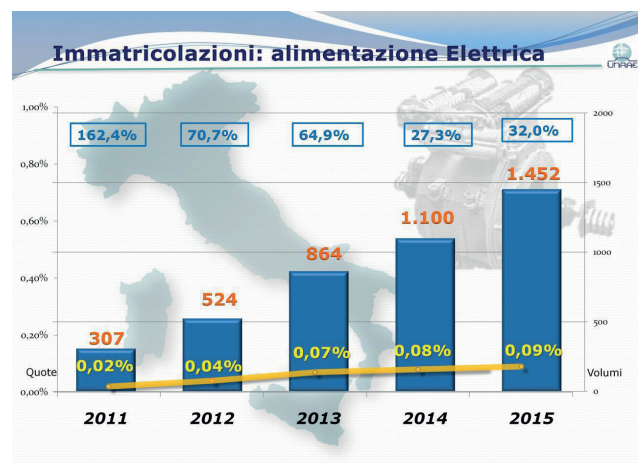
Exploring the opportunities

The widespread diffusion of any new technology represents a challenging task from a practical, economic and social point of view: these struggles have to be faced by any innovation, and obviously, EVs are not excluded from the list. Although EVs were born before ICEVs, their decline was due to lower driving ranges, scale-up difficulties and scarce economic appeal: these problems need to be solved if a wider EV adoption is desired.

We therefore analysed which factors were able to trigger a robust growth in EV sales in pioneer countries such as USA, Norway and China. In all cases, EVs share is proportional to both the number of promotion actions taken by governments and the number of installed chargers.

In China, tax-free policies allowed EV sales to increase by an impressive factor of 25 from 2012 to 2015. In Norway, benefits such as road-toll exemption, free parking and bus-lane access were introduced, and EVs now have a 22% market share. In the US, incentives were extended to cars, battery and charging station manufacturers, showing how the government role is fundamental if EVs want to be pushed in the market.

However, government incentives cannot represent a long-term solution to increase EVs economic appeal. Therefore, a Value Chain (VC) analysis was performed, showing how a wide EV adoption could affect the traditional automotive VC, creating new business opportunities, which could make EM profitable in the long term.



Electric cars sales in Italy

Value Chain analysis showed how the presence of a large battery pack significantly affects the manufacturing part, but the major transformation is due to the substitution of the fuel value chain with energy distribution and charging. In particular, the inexperienced connection of electricity generation and automotive value chains is the key factor for the rise of new business models, which could help making EVs more economically viable. Last, a literature survey highlighted how studies on the local-scale environmental impacts of EVs are absent, while only few LCA studies focused on the Italian energy mix are present, thus proving the great innovation potential of our analyses.

Generating a solution

On the environmental aspects side, the tests conducted at the Stazione Sperimentale dei Combustibili highlighted significant environmental benefits given by the use of EVs in substitution of conventional ICEVs:

- Sound pollution proved to be at least 20% lower, and higher benefits were observed at low speeds typical of urban traffic;
- PM emissions from brake wear resulted about one order of magnitude lower (in terms of maximum particle concentration) than in ICEVs. Moreover, the possibility of regenerative braking allows to use brake pedals less frequently, further reducing solid emissions;
- EMFs exposure proved not to be dangerous for human health, being the reported value more than 60 times lower than the limit.
- Heat release was assessed to be 1/5 of the corresponding EV counterparts.

LCA analysis showed the benefit of EV adoption also in terms of Global Warming impact: a reduction of Greenhouse Gas (GHG) emissions of 11% and 25% was observed compared to respectively Diesel and Petrol vehicles, whereas Biomethane-powered cars give similar results to EVs.

Sensitivity analyses demonstrated how EVs might give climate change benefits only as long as a sufficient share of renewables is present in the energy mix (lowering emissions up to -60%), and if battery pack weight does not exceed certain limits (in terms of capacity, 40kWh).

From the EM promotion point of view, our study was focused in three directions:

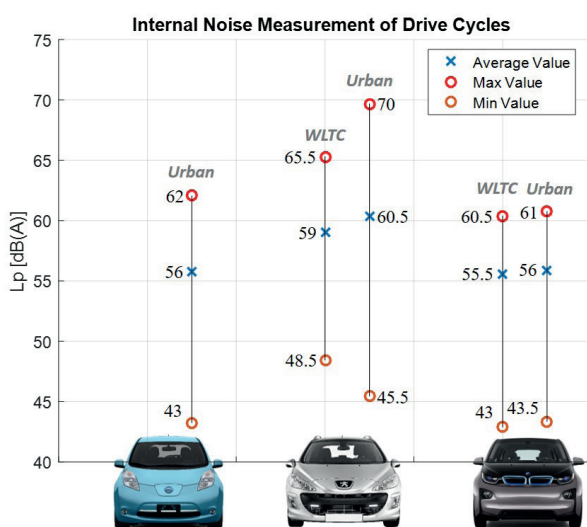
- Creation of a list of possible profitable business activities, that start-ups or venture capitalists might consider when investing in the EM sector.

The list has been drawn after performing the Value Chain analysis and analysing the 3 case studies of Tesla, BYD and FastNed.

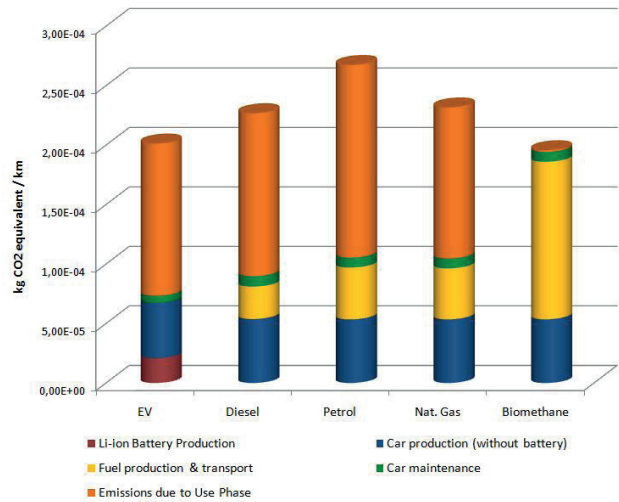
- Selection of Vehicle-to-Grid and Battery 2nd life as the activities with the highest economic potential. From this perspective, utility companies would operate as intermediaries between EV owners and grid operators. The former would take advantage of discounts in charging rates if they leave part of their spare battery capacity available to the latter. Battery capacity could be exploited either to provide grid ancillary services or to balance fluctuations in energy demand and supply, especially in a future with high renewable energy generation.

- Suggestion of a technological roadmap to be implemented in Italy in order to trigger EVs' sales, considering the current market situation and the experience of successful countries in EV promotion. A first

Internal Noise EV vs ICEV



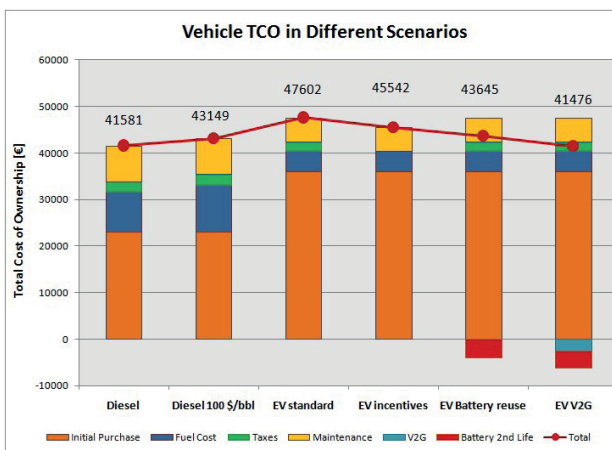
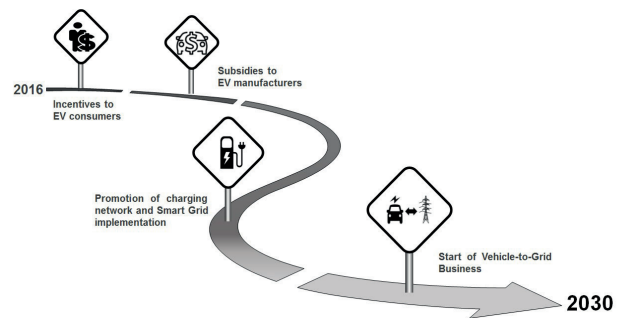
phase characterised by significant government incentives, and especially by the implementation of a robust charging and Smart-Grid infrastructure could pave the way to a second phase, where V2G technology could be the key player in making EV even more economically convenient than ICEV. Indeed, the Total Cost of Ownership of EVs and Diesel cars could be practically equal in case of a widespread use of V2G technologies. Increasing oil prices could then even make EVs a more convenient option. Finally, among the outcomes of our project we have created the EV & Dieselgate web platform: this tool could be extended in the future for an assessment of social perception of EM on both national and global scale.



CO₂Emission Comparison

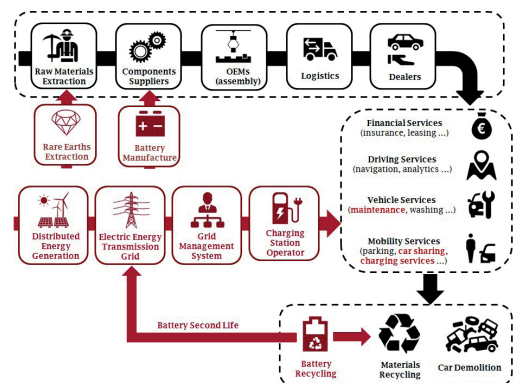
Innovative Business Models in Electric Mobility				
Battery Services	Charging Infrastructure	Electricity Distribution	Mobility as a Service	Vertical OEM Offerings
Battery Leasing	Charging Services	Smart Grid Applications	Parking and Payment Services	Tesla Case Study
Battery Swapping	Charging Point Installation & Maintenance	Demand-side aggregators	Car Sharing Systems	
V2G Battery Use	Supercharger Network (FastNed case)	Stationary storage with 2 nd Life Batteries	Full Mobility Solutions	BYD Case Study
2 nd Life Batteries	Retail + Charging Combination			
	Navigation Software and apps			

Business Models in EM



TCO Comparison

Modified EV Industry Value Chain



Modified EV Industry Value Chain