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20/07/2015

Reinventing the idea of mobility: how electric vehicles fit into a smart city

Cet article a obtenu le 10ème prix au concours étudiant Génération Energies sur le thème "Comment repenser le nouveau monde de l'énergie à partir des réseaux intelligents ?", organisé par Sia Partners et en partenariat avec RTE. Félicitations à Elena Fini (Université de Bologne), auteur de cet article.

Even if Global transportation is still 95% reliant on oil, PEVs (Plug-in Electric Vehicles) have recently started to compete with their gasoline counterparts: between 2013 and 2014, their sales in Europe increased by 79%. Despite this, the potential ecological benefits of electricity are not yet fully exploited, since a large part of it is produced from non-renewable energies. Researches have recently suggested that smart grids could be the key for mutual development of renewable energies and PEVs.

What actually are smart grids?

A smart grid isn't just an advanced electrical grid; in addition to the traditional distribution network, it includes a secondary infrastructure for the gathering and transport of information, so that it can organise the dispatch of energy according to individual needs.

An exemplification of how a smart grid organises the flow of energy

Source: Jason Munger

The implementation of smart grids goes hand in hand with the decentralization of electricity generation. New nodes of production are – for example - spread out wind farms and fleets of photovoltaic panels.

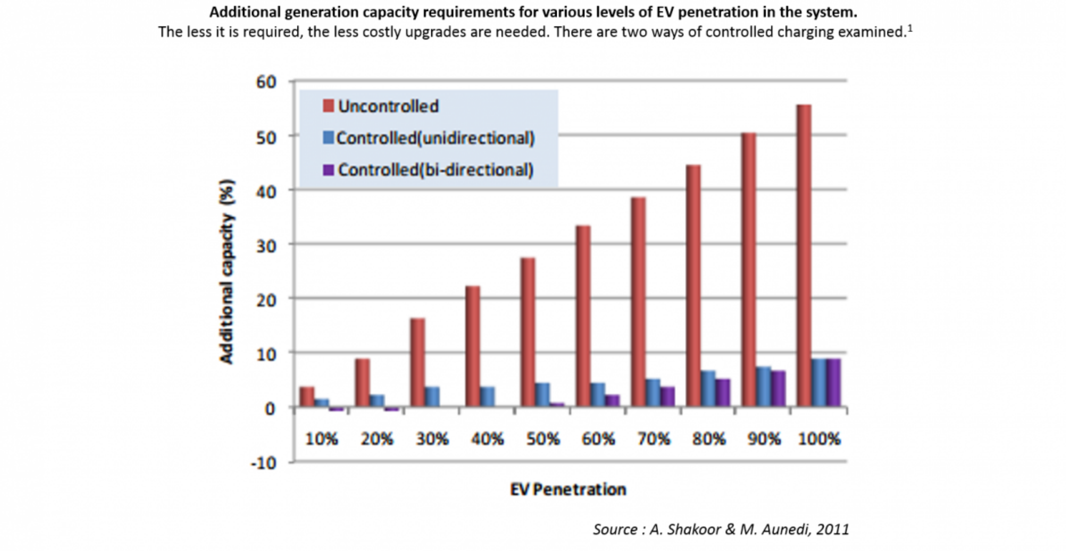
How the improvement of smart grids can encourage the use of electric vehicles ...

According to current projects, PEVs could be recharged at home or at various recharge points in the city. This has already been experimented with good results in Paris, Copenhagen, Rome and other cities, where many parking lots have been provided with charging stations.

But problems rise in the hypothesis of a large number of users. In this regard, the impact on the existing network has been carefully analysed: too many PEVs connected could cause voltage drops due to overloading. The costs of grid reinforcements are examined in the 2013 report of Green eMotion (which coordinates pilot projects in Europe), where it is also shown that reinforcement could be avoided by implementing a load dependent charging system, which means the voltage applied to each PEV will be calculated according to real-time data in order to never exceed the grid capacity. This idea was already supported by a 2011 analysis, illustrated in picture B.

So the most cost-effective solution needs, in order to be applied, a more intelligent - and dense - network that organises the flow of energy; the more we try to reduce wastes, the more we need complex algorithms to handle them.

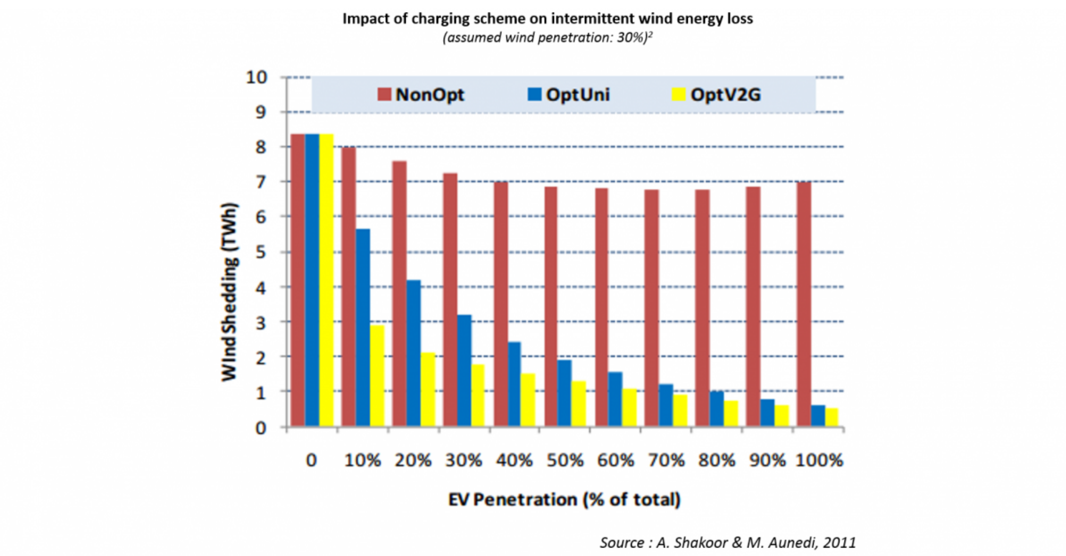
… and how PEVs can help stabilizing the electrical grid, thus promoting renewable energies



The benefits of the interaction between EVs and the grid are not one-sided. It is known that the electrical grid may suffer from disturbances as voltage fluctuations; this happens few times per-year, but with a massive use of renewables (which are naturally intermittent) it will be more frequent.

Taking into account that most vehicles are parked an average of 95% of the time, we could see them just as a backup storage for the grid: PEVs connected can either inject electricity to provide a stable voltage, or they can absorb the excesses.

A regulated charge would optimize the integration of renewable sources - and especially wind, since surpluses caused by wind variations could be stored and not lost (as shown in picture C: the more EVs are is in the system, the less we lose energy). Also EVs could compensate brief imbalances in energy dispatch, when wind variates rapidly and unpredictably.



For an applied example[3], we can consider the short-time car rental service Autolib, which offers in Paris 3000 blue cars. Given 13000 rents per-day (supposed to happen between 6:00 and 00:00), each on the average of 35 minutes and needing 1 hour of charging to refill the battery, it can be estimated that cars are connected to the grid and fully charged for about 62% of the day. This means that the grid would have an average support of 92 MW, even if only for a very short time (battery's capacity is limited).

So EVs would be useful in case of momentary lacks of power, maybe caused by intermittent sources. Lastly, it is remarkable that if we increase the number of EVs in the system, the power available will increase too: with 9000 blue cars on the streets, we'll have 275 MW.

Electric vehicles and smart grids may be relevant for the family economy

All of this might be economically important: the cost of electricity differs through the day, depending on the use of appliances and industrial consumes. So people should be able to store energy when it is cheaper, then sell it back when the grid needs it - that is when the demand and value of energy are higher.

A 2013 experiment in the state of Victoria (Australia) shows that users can reduce their charging costs by 50% if they adopt this charging system: with the aid of smart meters, which in minimum time provide them with all the information about cost and availability of energy, they could charge their vehicles in low-cost hours.

The core of this "demand-response" technology is the active participation of users, which empowers their decision capability.

However, there is skepticism regarding the constraints brought by such technology

In order to make this work, there must be an adequate number of users willing to allow the system operator control the charging, and suitable market mechanism attracting them. A percentage of charge would be guaranteed, while the leftover could be taken by the system in case of grid necessities, in return for a minimal - but still consistent - remuneration.

The point is that the combination of smart grids and electric vehicles would set many little revolutions in people's life; on one hand, consumptions could be managed more cost-effectively both inside and outside the house. On the other hand, a controlled charging would affect independence for what regards mobility.

The integration of PEVs in the urban landscape involves a different approach to mobility and new market regulations. But first, the development of smart grids is essential to set the stage for this project in the most cost-effective way.

Benefits would be both ecological and economical, as exposed: this solution might be decisive for a massive employment of renewable sources and users would also have their profit.

Finally, even if it's true that there might be some discomforts, they can be worked around with efficient infrastructures and communication systems (for example: users could differently arrange the charge schedule before a long-distance journey, or they could be guided by a navigator to a nearby station when running out of power). It only requires a sort of psychological adjustment, while the gain will be considerable.

Elena Fini

About Elena Fini

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Notes

[1] Unidirectional charging allows the flow of power only from the grid to the vehicle, while bidirectional also implements a V2G (vehicle-to-grid) technology.

[2] Losses are calculated assuming that the electricity production relies on wind for its 30%.

[3] Data for the estimation are taken from http://www.bluecar.fr/

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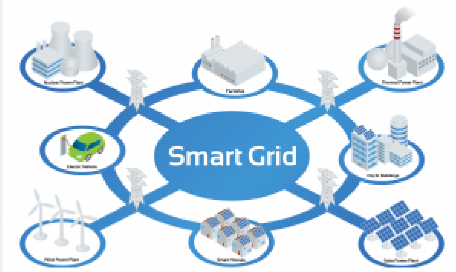

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