THE RECHARGING INFRASTRUCTURE TO SUPPORT THE MOBILITY DEVELOPMENT IN ITALY OPTIMISING THE IMPACT ON THE NETWORK

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ABSTRACT

Electric Vehicles and the innovations recently introduced in the recharging systems of the batteries represent, now more than ever, the most important opportunity to create the conditions for a new urban mobility which improves the quality of life, in terms of environmental pollution , and enables a more efficient use of energy in the transport sector. The development of new urban mobility models, based on the use of electric vehicles, and all the associated advantages, are strongly linked to the availability of an extensive recharging infrastructure, both in public and private premises which is able to combine the needs of the customers and the need to reduce the impact on the electricity networks.
This fundamental requirement has been addressing the objectives of the main Italian pilot projects in the electric mobility where Distribution System Operators (DSOs) play a key role in developing and managing the recharging infrastructures, fully integrated within their grids. Moreover, this challenge is monitored by the Italian Electricity Authority (AEEG) through the implementations of new rules and minimum requirements of the electric vehicles recharge services.
In this scenario, ENEL is leading in Italy the deployment of a new smart recharging system for electric vehicles that fulfils the "Smart Grid" requirements by enabling advanced communication solutions between the new generation of electric vehicles and the electricity network.

INTRODUCTION

At the moment, one of the most exciting challenge the Italian industry is facing is the development of electric mobility, since the successfully implementation of this model would provide considerable benefits, such as reduction of pollution agents, advantages for involved industries and benefits for customers. ENEL wants to play a leading role in the development of the recharging infrastructure, which will be used by electric vehicles owners. In particular, ENEL aims to deploy an advanced infrastructure capable to maximize the quality of the service and, at same time, cooperate with the distribution grid. ENEL pays also particular attention to the development of a business model that can effectively support the e-mobility market creating business opportunities for both public and private operators. Only in this way, electric mobility shall be a win-win business, capable sustain itself because able to provide value to all the players.
To support its model, ENEL has officially launched on September 2010 the implementation of a very important pilot project in three Italian cities (Rome, Milan and Pisa) where ENEL is installing 500 charging points (100 in private garages and 400 in public places) that will be utterly operative by June 2011.
The proposed architecture will be capable to serve electric vehicles owners through innovative mobility services that manage in "real time" the needs of the DSO grid. This result has been achieved considering the extraordinary experiences acquired from ENEL during the last 10 years in the design, development, deployment and management of wide infrastructures of the remote control and network automation project and of the smart meter project.

THE ENEL SOLUTION

Looking at this project ENEL has been designing a solution to allow the EV recharge services pulling down the current barriers that prevent the e-mobility market development. For this purpose, ENEL is evaluating both the business model more suitable and the infrastructure more versatile and cost effective.
Considering the unsatisfactory results achieved by the experiences already performed in different cities in Italy, ENEL is now promoting a business models that allows:

- the customer to pay the recharges depending on the tariff offered by her/his energy supplier
- The asset owner to recover the huge investment, needed to implement a widespread infrastructure, without adding high mark-up cost over energy fess.

In particular the new EV recharging infrastructures:

- shall be widespread, covering all the private and public areas where traditionally the end user parks its car;
- shall be user friendly and safe;
- shall enable secure different payment procedures;
- must be compliant with the current rules of the energy free market, allowing the customer access with its energy tariff provided by her/his energy supplier;
- shall be strictly linked to the remote control system of the DSOs networks in order to check the capability of the grid during all the recharging procedure and to enable electric cars

to adapt the charging curve of the battery according to new levels of available current.

To design this innovative infrastructure, ENEL is leveraging on its unique know how, targeting a solution fully integrated in the ENEL grid asset and remotely manageable and controllable to guarantee the possibility to manage and control this new infrastructure as the already deployed ones applying the existing operational procedures. This kind of project takes into account that the development of the electric mobility represents an opportunity also for the grid management, considering the future massive introduction of Renewable and Distributed Energy Resources.

E-MOBILITY ARCHITECTURE

In the proposed architecture, public and private charging points are equipped with three communication interfaces: one for local communication with client/vehicle, one toward a centralized clearinghouse and one toward the DSO.

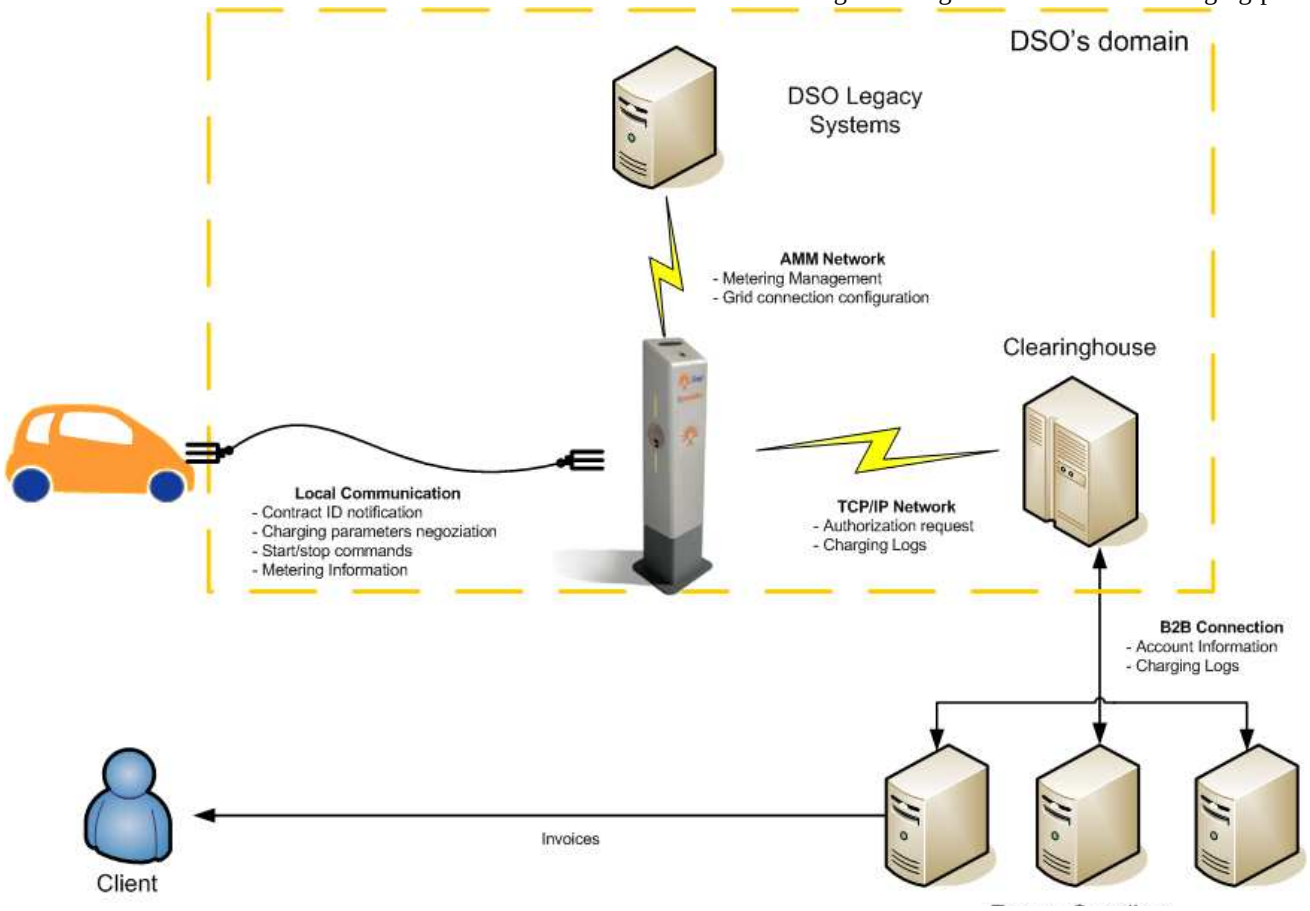

Figure 1 E-mobility architecture

The first interface provides different communication means in order to support both already existing electric vehicles and forthcoming "smart" ones. Its role is to identify the client and to control the charging operation allowing the client to start, to stop and to monitor the whole process and allowing the grid to adjust the recharging features according to the network power availabilities.

The basic step of this enabling procedure is based on a preliminary safety check implemented by a "control pilot circuit" which is stated in the standard IEC 61851 for "modes of charging" 2,3,4. In Italy the "mode 3" is mandatory in all publicly accessible premises.

The second interface, towards the clearinghouse, is needed to allow a real-time and centralized recharge authorization and to transmit the charging operations logs to the clearinghouse. The authorization is requested to the clearinghouse at the beginning of the charging operation, forwarding the contract ID and receiving, in response, client's profile details. Such details can then be used to determine the best charging profile (in terms of power and time) taking into account contractual tariffs and grid conditions. This process can also involve an active collaboration between the charging point and a smart vehicle taking advantage of the vehicle-to-charging-point communication.

The latter interface, toward the DSO, is based on the existing ENEL AMM network and it is used to retrieve cumulative metering logs and to configure the charging point grid connection parameters.

Such a solution allows the access to the recharging services to different energy suppliers' clients, since every supplier will receive from the clearinghouse the details of their clients' operations (energy distributed and timestamp). As a result, each client will receive energy bills from his/her energy supplier while being able to recharge at every charging point on the territory.

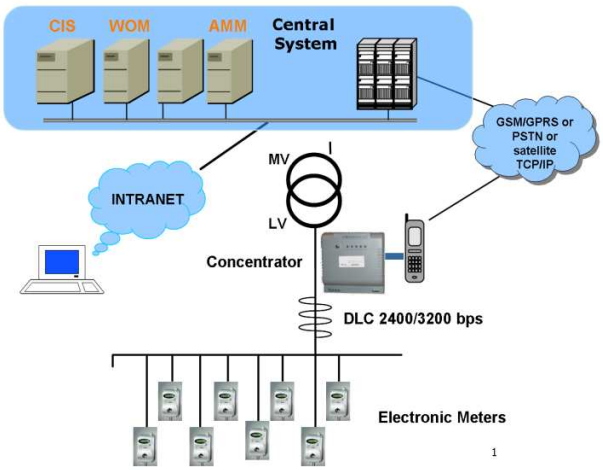

Figure 2 AMM infrastructure architecture

The fully integration of the recharging infrastructure with the electricity grid of the DSO enables a "real time" control of the capability of the grid; this is the first requirement to fulfil in order to manage dynamically both all the customer recharge needs and the future connections of the electric vehicle to Smart Grids.

E-MOBILITY PROJECT

Thanks to this new infrastructure, ENEL is able to implement a solution that enables a wide range of new services, setting an innovative way to recharge the electric vehicle. The customer will be able to:

1. find and book an available charging point close to his current position;
2. recharge his car, choosing the faster or cheaper mode in relation to the contract subscribed with its energy supplier and to the current grid availabilities;
3. recharge its electric vehicle in all new charging point installed in different cities;
4. pay all the recharges done both in private and public areas in only one invoice, according to the tariffs subscribed with its energy supplier

To implement this solution ENEL has decided to start with the Certification Tests of the first release of charging infrastructures to be installed in three Italian cities (Pisa, Rome and Milan).

Figure 3 ENEL charging infrastructures

This project envisages the development of an innovative infrastructure in which the charging points are fully integrated into the distribution grid and managed by the DSO. In particular, two different types of devices have been taken into account: simple and cheaper indoor devices to be used in private garages) and more complex and expensive outdoor devices to be installed in streets, parking areas, courtyards and similar places.

The proposed model is the same already in use in unbundled markets: the client shall be able to subscribe a contract with any energy supplier and to access any public charging points at any time.

The infrastructure will be the enabling platform to deploy a wide combination of charging offers maximizing the benefits for both clients and energy suppliers. The control of the DSO shall also enable the implementation of grid-friendly mechanism: for example, it shall be possible: to provide discounted prices for clients, which accept to suspend the charge during congestion periods. Concerning the possible business models for the development of the public recharging infrastructure, ENEL has performed an evaluation of the required investment. The evaluation started from the basic prerequisite that the charging network shall satisfy clients' needs.

The possible number of clients has been evaluated using forecasts of the e-mobility Italian market that shows an increasing trend with a potential penetration up to 30% of sales in 2020.

Moreover, clients' behaviour has been modelled taking into account two kinds of client:

- clients provided with a private parking place (e.g. house or apartment garage)
- and clients that normally park their vehicles on the street.

The clients without a private parking facility (approximately 34% in Italy) shall completely depend on public recharging infrastructure.

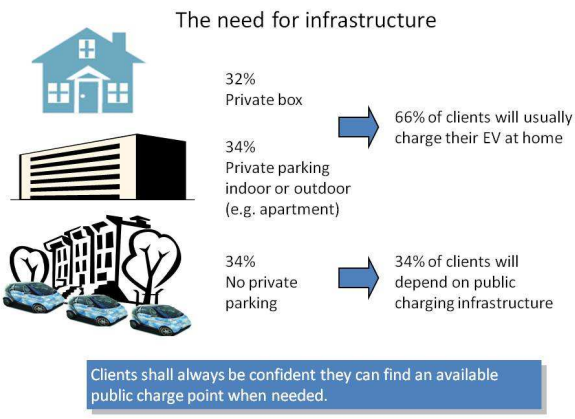

Figure 4 Clients parking facilities in Italy

On the contrary, it is assumed that clients provided by a private parking place, will mostly charge their vehicle while in the garage, while using the public infrastructure under some specific circumstances (for example when a journey exceeds battery capacity).
In both cases, clients shall be put in the condition to charge their vehicles when needed and without modifying their normal habits; hence the charge activity shall take place during normal parking time.
This means the charging infrastructure shall be highly available on the territory and carefully sized to avoid congestions. During the first years, the infrastructure should also be slightly oversized to give clients assurance they could certainly recharge when needed.
The study performed by ENEL suggests that, in urban environment, the optimal sizing is about 1 charging point for every 8 electric vehicles. This figure, together with the market forecast, shows the need for a great investment to be sustained over 10 years. Such a business would be hardly compatible with usual private investments, suggesting the DSO business model is the most appropriate one. To support a wider implementations of pilot projects the Italian Energy Authority (AEEG) has introduced new rules aimed to facilitate the payments for Electric Vehicle Charging.
The new rules is contained in a measure (ARG/elt 242/10) which outlines, in particular, a new tariff, effective from 1st January 2011, for network services offered by the public charging stations and provides simplified methods for testing the same services through competitive criteria in order to facilitate six pilot projects. These pilot experiments must meet well-defined requirements of efficiency and specific commitments to publicize and share results. The price of electricity, also for electric vehicles, will be the result of comparing the various offers in competition in the liberalized market.
Another AEEG measure (ARG/elt 56/10) has eliminated in April 2010 regulatory constraints to the installation of a second meter for electric vehicle recharge in private households, the new act will also facilitate solutions for recharging in publicly accessible premises.
The decisions taken are consistent with the ongoing initiatives to support the development of smart grids, to modernize and make more flexible and intelligent electricity distribution networks. This type of development also promotes the use of renewable sources and energy efficiency, to benefit the environment and consumers.

CONCLUSIONS

The success of e-mobility will indeed depend on clients' choices, therefore the necessity to offer a solution that provides them sound economical benefits compared to traditional vehicles.
From this prospective, it is fundamental to minimize the contribution for the cost of the infrastructure over the energy cost. Unfortunately, this objective is hardly achievable if the whole infrastructure shall be paid by the clients, which would see a perceivable reduction of their energy saving. This issue reveals critical when considering the actual costs of electric vehicle batteries, which alone can nullify the benefits.
A possible solution appears considering that, socializing the overall investment over all the clients of the electric market would cause a modest increase of energy tariff (less that 0.2 %). This consideration suggests that the infrastructure could be a regulated asset, whose cost could be socialized, hence suggesting that the DSO business model is the right solution to promote electric mobility and to maximize the integration of the electric vehicle in the Smart Grid.

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