DSO BUSINESS MODEL FOR SPEEDING UP EVS MASS MARKET

Federico CALENO
Enel Distribuzione - Italy
federico.caleno@enel.com

Giovanni COPPOLA
Enel Distribuzione - Italy
giovanni.coppola2@enel.com

ABSTRACT

This paper presents an overview of the results coming from the largest electric mobility pilot project currently running in Italy, where a nation-wide EV charging infrastructure has been deployed according to an innovative business model that allows a smoother transition towards an EVs mass market, lowering charging fees for the electric mobility end-user while guaranteeing a sustainable support from the already up and running electricity grid, minimizing its reinforcements costs for hosting such an innovative, massive and widespread load in the future.

INTRODUCTION

With several OEMs delivering new products this year, Electric Vehicles (EVs) appear to be definitely on the edge of mass market adoption, pushed by their highly welcomed impact on global climate policies and EU 20-20-20 targets. Electricity utilities industry and particularly DSOs are facing new technical challenges and business opportunities to guarantee a sustainable ramp-up of EVs penetration without significant impact on the Low Voltage and Medium Voltage electricity grid reinforcements, with costs that might delay the technology adoption as some current estimation rank them at 2B€ level per Million of EVs [1].
Although the EV adoption curve is still ramping up slowly, EVs impact on the electricity grid might significantly delay a future widespread adoption if EVs as energy loads are not properly included in the DSO planning criteria and operational procedures for managing the LV/MV grid.
Additionally, the EV business seems still to be locked in a "chicken-egg" loop, with OEMs production plans coped with charging points availability on one side, together with equipment suppliers/providers avoiding unfeasible investments on charging points due to low market shares of EVs on the other side.
A win-win disruptive business model for fastening the EVs mass rollout and break the aforementioned "chicken-egg" loop between EVs and charging infrastructure is the DSO business model, currently under test by Enel Distribuzione in Italy, with its results and developments promoted throughout Europe within the FP7 Green eMotion project [2], [3]. Such a test is included in a nation-wide pilot phase promoted by AEEG, the Italian regulatory body.
In this paper, after an overview of electric mobility national pilot and Enel Distribuzione's charging solutions, the benefits of DSO business model are presented in detail.

INFRASTRUCTURE DEPLOYED IN ITALY

Enel Distribuzione's involvement in electric mobility is dated back to 2009, with "E-Mobility Italy" project in cooperation with Daimler, soon followed by the first installations of EV charging points in Pisa, kicking off a subsequent national pilot phase (del. 242/10) promoted by AEEG, Italian Energy and Gas Authority. Such activity did foresee the possibility to get funding for pilot deployment of EV charging infrastructure according to different business models. Enel Distribuzione has been selected to test in a pre-mass market phase the EV charging infrastructure installed and operated by a Distribution System Operator. In the last 2 years and half, up to 150 charging stations have been installed in Italy under the DSO business model with a grant for future installations of 310 public charging stations until Spring 2015 to be managed by the DSO.

CITY	STATUS @ Q4 2012
PISA	47
GENOVA	17
MILANO	6
EMILIA	56
PERUGIA	23
PALERMO	1
CATANIA	1
BARI	1

Tab. 1 Status of public EV charging points deployment.

Public installations under DSO business model have been integrated by private installations operated according to the same business model, where the EV customer asks for a dedicated POD to the Energy Vendor that sells a service enabling the customer the recharge on his private charging point and on public ones, both installed and operated by the DSO. Until today, more than 100 private charging stations have been provided to Italian end-users through the DSO business model.

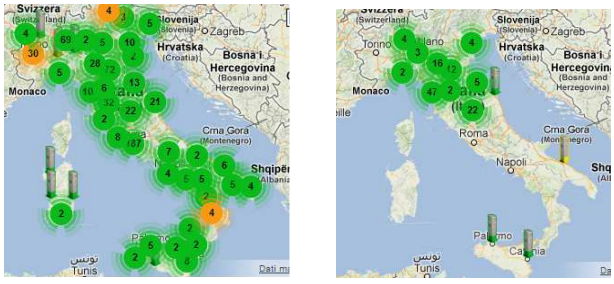

Fig. 1 A Overview of public CPs deployed by Enel up to Jan, 2013.
B Overview of public CPs deployed upon DSO model.

Home charging, seen as a significant use case in future EV business, happens at a lower power rate (3.3 kW in Italy) and allows for wider amount of time flexibility on which Valued Added Services like Smart Charging could be traded with the customer.
Results of this pilot phase are being judged by AEEG with regards to infrastructure interoperability for service providers, enhancements of competition between infrastructure operator, service providers and energy vendors, minimization of additional burdening for final customers and national economic system for a country-wide EV mass rollout.

In order to fulfill the deployment targets, Enel Distribuzione has in-house developed an EV charging solution as a complex system made by field devices, communication infrastructure and dedicated software products.

ENEL DISTRIBUZIONE'S CHARGING SOLUTIONS

The EV charging solution delivered by Enel Distribuzione encompasses public and private charging points as field devices operated through a specific communication infrastructure by a management system, the Electric Mobility Management system (EMMS), which is also in charge of enabling the provisioning of B2B and B2C services from (and between) third parties involved in electric mobility business.
Designed as the neutral enabling layer for services trading and provisioning between free-market Service Providers and their customers, the Enel Distribuzione's EV charging infrastructure is built on top of the smart metering infrastructure. At the very core of each charging point, both public and private ones, finds its place the Enel Distribuzione's smart meter [cfr. Fig. 2], previously deployed in 34 Mils. pieces in Italy and currently under deployment with 12 Mil. pieces in Spain.

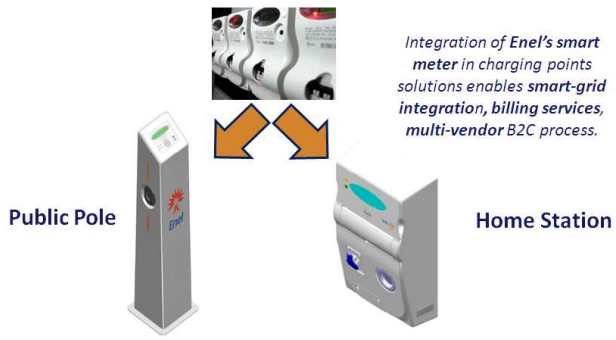

Fig. 2 Enel Distribuzione's charging infrastructure solutions.

The family of charging products include: public charging point at 43 kW for fast recharge (from 20% to 80% of EV battery capacity filled in 20 mins.); public charging point at 22 kW for medium-speed recharge (full recharge in 3 hrs, on the left in Fig. 2) and a single-phase home charging station with 3.3 kW power output.
Main features of Enel Distribuzione's charging points are enlisted below, as provided by the latest products installed in the Italian territory in January 2013:

- Network access with dedicated and customer-owned RFID card, which allows basic services e.g. identification, authentication and authorization but also advanced B2C services, e.g. roaming of between different vendors and providers, to guarantee a seamless service contract between provider and EV driver, acting in this context as a mobile energy consumer. Such a roaming service is made available by the EMM system.
- Power Line Communication between charging station and EV, compliant with ongoing international standards, incl. ISO/IEC 15118, enabling smart charging functionalities on compliant EVs.
- GPRS uplink communication for real-time sensing, monitoring and actuation through the specific IT system performing charging stations O&M.
- Data acquisition and transmission of each single charging process data compliant to Green eMotion CDR data format [4].
- Remote check for availability and booking of the charging station, enabling end-user application to manage the charging processes on customer's smartphone and in-car devices.
- 2 recharges per time on public station at 22 kW. Power portfolio range includes 3.3 kW and 43 kW.
- 2 different EV sockets. Compliancy with Mode 3 Type 2 and Mode 3 Type 3A.

The charging products get customized according to the market where is installed. In Italy, all charging stations deployed do embed Enel Distribuzione's smart meter.
Operation and Maintenance of charging stations and Customer Relationship Management take place through the EMMS, a multi-tenancy IT system used beyond the DSO business model itself, that enables infrastructure operator business to install, manage and maintain charging points and service provider business to trade basic and advanced services with the final customer. The EMMS as a concept is made up of three main families of functionalities as depicted in Fig. 3. On the top-left a typical user main page is reported, designed for O&M from asset ownership perspective. The EMMS concept, depicted on bottom-right of the picture, includes a Power Grid Control System, in charge of dealing with DSOs to maximize RENs hosting through EVs-related charging processes, a Commercial Management System, in charge of dealing with CRM functionalities for Service Providers and an Infrastructure Management System to perform O&M of charging stations.

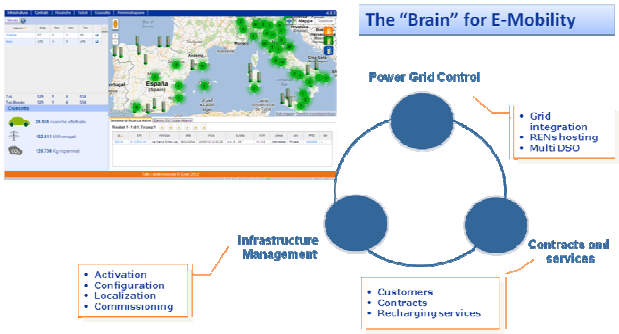

Fig. 3 EMMS concept and user main page.

The EMMS hosts a set of B2B and B2C services that Service Providers can be trading with their customers, including roaming as developed within FP7 EU R&D project Green eMotion (Fig. 4) and natively support services derived from Smart-Grid integration of EVs.

Fig. 4 Services roaming through Enel Distribuzione's infrastructure.

THE DSO BUSINESS MODEL

By being an intrinsic ecosystem opportunity, electric mobility involves different stakeholders and implies a massive cooperative innovation effort to be effective, mostly concentrated in multi-partners projects (e.g. Green eMotion, MOBINcity and Internet Of Energy projects where Enel Distribuzione is actively involved) and standardization activities covering all blocks of value chain, which includes representatives from a broad variety of industries, building up a truly ready-to-market application of Smart Grids business as discussed in the last paragraph of the present paper. The headstone for the DSO business model is the major involvement of the DSO in the EV charging infrastructure deployment, as the responsible party for the installation, operation and maintenance of EV charging points throughout its native natural concession of LV/MV electricity grid. Upon this condition, each DSO is in charge of charging infrastructure deployment according to pre-define rules and return on investment.

In order to discuss how the business model works, a fundamental glossary is reported below, as derived from current draft of ISO/IEC 15118 standard for communication between EVs and charging infrastructure.

ACRONYM	MEANING
EV	Electric Vehicle.
EVSE	Electric Vehicle Supply Equipment, a charging station providing electricity.
EVSE Operator	EVSE Operator, business actor managing the charging stations.
EVSP	Electric Vehicle Service Provider, a business selling services to the EV driver.
PWM	Pulse-Width Modulation, a technology to control a charging process.
PLC	Power Line Communication, a technology to manage the communication between EV and EVSE.
ISO 15118	Standard under design for managing communication in AC charging processes.
B2B/B2C	Business To Business and Business To Customer
EVSE back-end	IT system managing charging stations.
DSO front-end	IT system interfacing with DSOs.

Tab. 2 E-Mobility fundamental glossary for business model analysis.

In a general unbundled framework as depicted in Fig. 5, charging stations are installed and operated by EVSE Operators who is a business actor different than the DSO and the EVSP who holds the customer relationship. This unbundled framework fulfils the minimum requirements for provisioning of B2C services and B2B services traded in dedicated electric mobility marketplace, however does not help with the investments deadlock as previously anticipated in this paper: the risk for investing in infrastructure is assigned either to EVSP or the an independent EVSE Operator, who has to include a mark-up for infrastructure in the final charging service fee and copes its deployment plans according to the EVs sales.

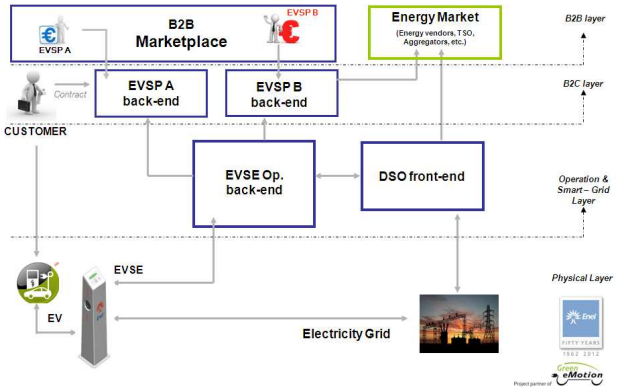

Fig. 5 General ecosystem architecture for electric mobility.

The general ecosystem architecture of Fig. 5 foresees a needed role of the DSO, as responsible for the electricity grid on which the EV charging infrastructure will increasingly be adding loads and issues. However, by not being involved in the charging infrastructure business, the DSO will perform a typical find & fix activity, increasing the expenses in grid reinforcements where needed, possibly ending up to an unfeasibility of EV mass adoption as a consequence of high – and countrywide – investments in paving copper down to the LV/MV grid. Smart charging service as a way to perform load management through the connected EVs and optimize the load distribution needs a

smart charging infrastructure. Such infrastructure includes metering and communication capabilities, which increase the cost in charge of independent EVSE Operator in Fig. 5, thus keeping away such a service from becoming reality and not helping in improving RENs hosting capacity of the LV/MV grid. Therefore, even if the DSO is in communication with EVSE Operators, the latter could not have smart charging infrastructure in place to modulate a charging process in a smart way.

The customer generally has a service contract with one (or more) EVSPs in Fig. 5, a business actor in charge of trading B2C services (charging, roaming, etc.) with customers and B2B services with other business actors. According to the business models for charging infrastructure, different patterns might be adopted, depending on the ownership and management of the EVSEs with multiple / shared access, like public charging points. Roles might be played by different stakeholders as hereby summarized:

- The EVSE is part of the regulated business of operating and managing the LV and MV electricity grid and its deployment is therefore included in the expected activities to be held from the DSO. In this case, the DSO acts as the provider of a neutral, natively multi-vendor technology platform by acting as EVSE Operator as well, installing and managing EVSEs, allowing different EVSPs to compete on the charging infrastructure and provide B2C services to their customers on a very same single EVSE. The charging services hereby becomes energy selling, and the DSO acts as Metering Point Operator by embedding a dedicated meter in the charging station, which steps into the Regulated Asset Base of the DSO. Pricing in this case for basic charging service is strongly correlated to the electricity price on the wholesale market, increasing the level of transparency for the final EV user. Such a pattern, as described in Fig. 6, sustains the business model for EV charging infrastructure.
- The EVSE is owned and managed by a specific and independent business actor, that might allow or not different EVSPs to get their customers recharge on its EVSEs. The EVSE Operator could eventually the EVSP himself in this case, implementing a sole service provider business model, with a gasoline station-alike scenario. The embedment of a smart meter in the charging station for the provisioning of revenue-grade billing to the final customer is upon EVSE Operator convenience, thus the final charging service could not be directly linked to energy sales and regulated/more guaranteed pricing.

The former case, implemented in the test conducted by Enel Distribuzione in Italy, enables a more active role of the DSO. In such a business model, the DSO plays the role of EVSE Operator as shown in Fig. 6, allowing access to EVSP at non-discriminatory conditions, as the EVSEs are deployed as a regulated activity similarly to LV/MV assets.

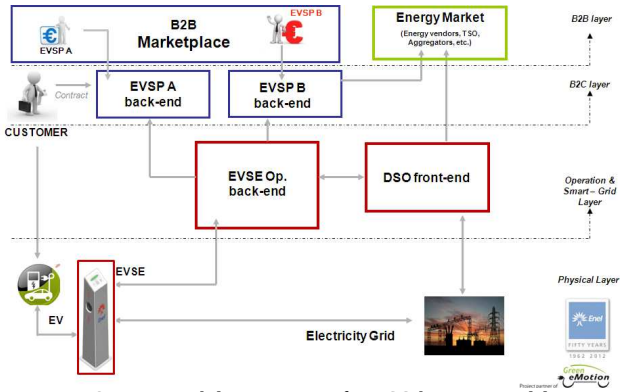

Fig. 6 E-mobility ecosystem for DSO business model.

From technology adoption and thus customer perspective, this business model lowers the investment risks for charging infrastructure which becomes natively embedded in the RAB of the DSO and is included within its duties and responsibilities. Such a condition reduces the mark-up for infrastructure in the final charging service fee of electric mobility customers as summarized in Fig. 7.

Fig. 7 Benefit of DSO model over final customer charging service fee.

Additionally, the DSO business model could also lead to side benefits at a later stage in lowering service and grid fees in the charging service global fees, as it allows a simpler implementation of smart charging services since the enabling technology platform which allows such services is natively integrated with the DSO legacy systems. Easiness of implementation of smart charging can be key to guarantee the smallest Time To Market for value added service by which the user could significantly lower charging prices by getting his charging process modulated (either through PWM or PLC according to his EV capabilities) as a consequence of grid constraints and opportunities dispatched by the DSO. Furthermore, within the DSO business model the customer gets the same electric mobility tariff at home and public spots, as the tariff components and their range get fixed by law. Therefore as the customer signs a contract with his favourite Energy Vendor, he gets the same tariff both on private and public charging points.

Besides an expected lowering of charging service fees for the end-user which significantly impact technology adoption rate in the early adopters phase of EV technology, the major benefit of DSO business model is opening the EVs-Infrastructure “chicken-egg” loop, as the Infrastructure investments gets covered by a regulated party, delivering a neutral technological and business enabler to the entire ecosystem, including the final customer. This also impacts

on technology adoption, as such remuneration let business actors to compete on services reducing the investment needed for their provisioning to the final customer.
These features directly lead to an expected speeding up of EV rollout, since a reliable and granular charging network could be guaranteed by law to the final users.
Additionally, the DSO is already in charge in some EU countries of metering duties towards consumer, regulation and energy marketplace. By integrating such metering subsystems in the charging infrastructure managed by the DSO, such role is naturally developed in the new electric mobility marketplace. By playing a third-party and neutral role in such market, providing the technological enablers for the EV mass rollout, the DSO can guarantee an interoperable system, open to all market actors, ensuring the benefits for the users coming from a native multi-vendor approach. Since a regulated part is in charge of the infrastructure deployment, universal access can be guaranteed, as the rollout is not linked to a profit-based strategy, thus avoiding technology divide to take place within the country.
By the time of relevant EV penetration in the market, several issues for grid reliability have been forecasted as analyzed in [5] and a reliable integration of EVs into Smart Grids strategies is natively guaranteed by the DSO business model. To accomplish with such strategies, the DSO should be leveraging a smart charging infrastructure that necessarily includes a smart meter. In this way the charging station with the smart meter integrated can be considered as a new connection to the grid dedicated to recharge EVs. Thus the EV charging station can be truly considered as a DSO asset and the possibility for the DSO to include the EV recharging infrastructure in the RAB . gives the unique opportunity to deploy in a cost-effective way the needed smart EV recharging infrastructure able to support value added services for all stakeholders.
Finally, in order to make this business model fully operative, the EU legislation should give the chance to DSOs to step into charging infrastructure deployment upon involvement of Regulator Bodies at national level, with the aim of defining convenient application rules to enable such a business model. This can be simply accomplished by adding the EVSE deployment, operation and maintenance to the perimeter expected for the DSOs by European Directive 2007/72/EC [6]. At a second stage, the EVSEs deployment plan, when implemented according to the DSO business model, should be coordinated at national level, establishing different timing and charging stations amounts for ramp-up and mature phases of the market, through a flexible regulatory mandate which could be re-tuned according to the market evolutions and/or national needs. The principles to be followed should be that the availability of charging points for an EV driver is no under doubt in each city and that the growth rate of available charging stations is correlated the EVs in the market. Finally, a sustainable return on investment should be guaranteed to the DSO to get an effective compensation of WACC in unstable financial period, as already successfully demonstrated by remuneration policies that led to the massive smart meters installation upon favourable regulatory framework in Italy, Spain and Finland [7] and Smart Grids projects in Italy.

FUTURE OUTLOOK: EVS AS MARKET-READY APPLICATION OF SMART GRIDS

Global warming and climate change appears to be the most complicated issue that is currently facing the world's political and business leaders. Enel Distribuzione's strategic answer to this challenge is the Smart Grids concept, with electric mobility at the very heart of it as a ready-to-market application and the first opportunity to dramatically change the role of the DSO.
The DSO business model delivers a turn-key opportunity to speed up the EV mass rollout and implement attractive form of responsive demand that can be used to provide operation flexibility for the electricity grid. Controlling the process of charging EVs by taking advantage of their flexibility could lead to increase the RENs hosting capacity and have a significant impact in the long term on the national electricity mix, by using the EVs as dynamic and controllable loads to counter-peak RENs fluctuations and guarantee grid safety. Such a scenario would benefit the customer as well, as RENs increase and electric mobility adoption will improve his quality of life at first, and the native Smart Grid integration guaranteed by the DSO business model will ease the adoption of the latter to improve the former.

REFERENCES

[1] EDSO 4SG, Position Paper on Electric Vehicle Charging Infrastructure, Position Paper, 2012
[2] Website of Green eMotion project: www.greenemotion-project.eu
[3] Gallo, "Smart Grids: The key enabler for electric mobility development", UNFCCC COP 18 edition
[4] Coppola et al., "Green eMotion Deliverable 3.5 : Core Services and Transactions design specifications", 2012.
[5] Silvestri et al., "Green eMotion Deliverable 4.2 : Recommendations on grid-supporting opportunities of EVs", 2012.
[6] European Commission, Directive 2007/72/EC.
[7] Eurelectric, "Regulation For Smart Grids", Position Paper, 2011