The Integration of Electric Vehicles in National Smart Metering Program in IRAN

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Abstract – The coming intersection between a growing EV fleet and growth in smart grids implementation generation presents an opportunity for synergistic value. The main focus of the proposed roadmap is to decide on the control and telecommunication infrastructures which are essential for fully smart operated EV system. There will be more than 30 million vehicles in 2020 in Iran of which 10% is expected to be electric. The existing design for Iran smart grid has no special considerations for EVs in terms of telecommunications, control, tariffs, etc. but is completely capable of consideration of them as intermittent load and generation points. The main idea of this paper is to put an importance on this question that should Iran either stop its supports from EVs until completion of the essential infrastructures of EVs in Iran national smart metering program including software, hardware, firmware, etc. or develops these essential requirements in parallel with EV promotion? The authors believe that the latter seems more logical than the former.

Keywords: Smart grid; Electric vehicle; Roadmap; Smart metering.

1. Introduction

One of the keys to success integration of Electric Vehicles (EVs) into electric distribution network is establishing user confidence in their driving range and safety. To ensure sufficient driving range a charging infrastructure is required. Depending on battery voltage and charging station power capacity, vehicles can be recharged at home in several hours (6 to 12 hours in general for slow charging), or in service stations and public charging stations in a matter of minutes (fast charging). Vehicles can be adapted to one or the other charging mode, or to both [1].

Moreover, the following challenges must be successfully addressed: safety, affordability, interoperability, performance, and environmental impact. These also can be viewed as core values that will directly impact consumer acceptance of EVs. Standards, codes, regulations, and related conformance and training programs, are essential components that will aid in successfully addressing these concerns [2]. In order to develop a roadmap for EVs integration, it was necessary to frame activities under three broad domains: Vehicles, Infrastructure, and Support Services.

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The charging of EVs creates both risks and opportunities for service providers and consumers. For instance, energy service providers want to be able to push charging to off-peak hours to protect grid assets where consumers want access to a ubiquitous charging infrastructure that enables them to charge their EVs safely and quickly at the cheapest possible rate.

For home charging, the utility may communicate directly with the smart meter(s) installed at the home. These meters send consumption data to the utility, and the costs can be calculated according to the tariff schedules. This scenario only requires communication between the smart meter (operated by the utility) and the utility. This could happen over the Advanced Measuring Infrastructure (AMI) network deployed by the utility.

The commercial charging scenario includes entities such as corporations, supermarkets, universities, hospitals, etc where communication is required for authentication purposes, e.g., using an RFID card, credit card, QR code, smart phone application, etc. A commercial entity may offer different levels of service to different customers. For instance, a supermarket may provide benefits to customers who charge at their EVSEs. Hospitals and corporations may restrict EV charging to their employees only, in certain spaces. In other cases, charging may be allowed for everyone.

Public charging may require the authentication, authorization and accounting functions to be able to bill the appropriate consumer, i.e., the consumer must be

unambiguously identified such that the proper service can be provided, and the service (electricity delivered to the EV) must be metered accurately and securely, so that the consumer can be billed for their EV charging [2].
In this paper, the role of Iran smart metering program in integration of EVs in power system is investigated.

2. National Smart Metering Program in IRAN

Iran Energy Efficiency Organization (IEEO) is responsible for implementation and deployment of National Smart Metering program in Iran (that is called FAHAM) [3]. The smart metering system architecture of FAHAM is shown in Fig. 1 and consists of:

- Smart meters with Power Line Carrier communication (PLC), installed at the customer premises. They may be single phase or three phase smart meters. Also, the smart meter of medium and large customers could directly be connected to the utility by using General Packet Radio Service (GPRS). Moreover, the electric parameters of each feeder in the secondary part of the main substation (63/20 kV) as well as those in distribution substation transformers (20/0.4 kV) are measured by smart meters. So, the distribution losses of each line in Medium voltage (MV) and Low Voltage (LV) network can be easily calculated.
- Data concentrators (DC) installed in proximity of 20kV/400V substation distribution transformers in order to manage all smart meters measured data from each installation at LV network. Data concentrators integrate PLCC that exchange information with smart meters and communicate with central meter data management systems.
- Meter Data Management System mainly Meter Data Management & Repository (MDM/R) systems in which the received unprocessed data from all meters or sensors are collected and processed in order to deliver the required data to DSO and application systems.
- Electric vehicle charging point available at each home or workplace recognized as the charging plug that is an electricity plug equipped with PLC modem that sends the EV data to a smart meter.

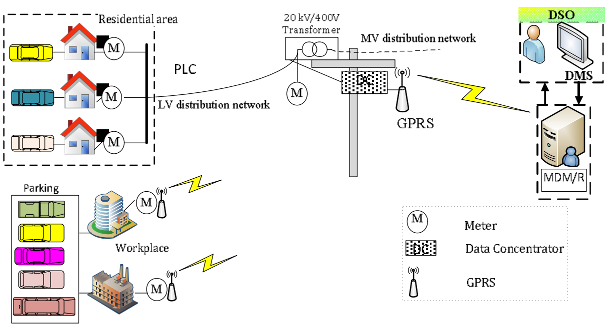

Fig. 1. Advanced metering architecture

3. The Integration of Electric Vehicles in Smart Grids

Smart grids are expected to be scalable, reliable, efficient, and secure. The modern communications and networking technologies will play a vital role in the smart grid by supporting two-way energy and information flow and enabling more efficient monitoring, control, and optimization of different grid functionalities and smart power devices [4].

Through monitoring capability, data integration, effective communication, advanced analysis and system control, the smart grid can meet the power demand as well as increase the total efficiency and reduce consumption and costs [5].

Electric Vehicles (EVs) can play a central role in decarbonizing road transport. But it will need careful management. Although electricity needs for EVs are likely to remain small relative to overall load in most regions for many years to come, they could have a much bigger impact on peak load as motorists seek to recharge their batteries during the evening. Smart grid and its core technological advances in electricity distribution and load management that make use of information and communications technologies, promise to facilitate the integration of EVs into electricity load with lower costs. Smart grids can enable EV-charging (grid-to-vehicle, or G2V) load to be shifted to off-peak periods, thereby flattening the daily load curve and significantly reducing both generation and network investment needs. Advanced metering equipment is an essential component, enabling a two-way flow of information and providing customers and utilities with real-time data and enabling customers to schedule charging intelligently [6].

In order to foster EV adoption, there is a strong need for designing and developing charging stations that can accommodate different customer classes, distinguished by their charging preferences, needs, and technologies. By growing such charging station networks, the power grid becomes more congested and, therefore, controlling of charging demands should be carefully aligned with the available resources [7].

The idea of fully automated integration of EVs in smart gird, necessitates, at least, the following communications [8]:

- Communication - vehicle to charging station
    - ISO/IEC 15118 enables intelligent communication
    - Automatic charging processes
    - Dynamic tariffing models of the smart grid
    - New authentication scenarios (plug & charge)
- Communication - charging station to control center
    - IEC 61850 makes the charging station a node

in the smart grid

- Monitoring of charging station status
- Control of charging settings

3. The Integration of Electric Vehicles in FAHAM

Based on the recent studies conducted by the Iran Energy Efficiency Organization (IEEO/SABA), there will be more than 30 million vehicles in 2020 in Iran of which 10% is expected to be electric.

The existing design for Iran smart grid has no special considerations for EVs in terms of telecommunications, control, tariffs, etc. but is completely capable of consideration of them as intermittent load and generation points.

The main idea of this paper is to put an importance on this question that should Iran either stop its supports from EVs until completion of the essential infrastructures of EVs in FAHAM including software, hardware, firmware, etc. or develops these essential requirements in parallel with EV promotion? The authors believe that the latter seems more logical than the former.

To be more in line with this proposal, as a result of the analysis of international experiences in EV integration in smart grids, it should be noted that the electricity market structures and regulatory frameworks will also need to adapt to facilitate the demonstration and commercial deployment of the integration of EVs in smart grids, including the specific technologies needed to make G2V and V2G technically and commercially viable. It is vital that regulatory frameworks be adapted to allow tariffs to be set to provide incentives for electricity transmission and distribution companies to invest in appropriate smart-grid technologies, for system operators to take decisions that ensure economically efficient operation of the entire system and for EV owners to optimize G2V and V2G load [6].

5. Conclusion

The main challenge concerning EVs integration into Iran power system is not actually the increased demand resulting from charging, but rather the timing of that demand. As the Iran smart metering program continues to grow, EVs also offer a significant future benefit such as the ability to help balance load. While the infrastructure does not currently exist at a large enough scale to allow this to happen, utilities should in parallel consider this in their smart grid plans, and conduct a careful cost/benefit analysis to determine if and when such a grid investment would be valuable.

References

[1] "Strategic roadmap for plug-in electric and hybrid vehicle charging infrastructure" French Environment and Energy Management Agency (ADEME), Online available at: http://www.ademe.fr/sites/default/files/assets/documents/88761_roadmap-plug-in-electric-and-hybrid-vehicle-charging-infra.pdf.

[2] ANSI EVSP Standardization Roadmap for Electric Vehicles. ANSI EVSP Roadmap Standards Compendium, Version 2.

[3] Specification of General, Economical, Functional, Technical and Communicational Requirements for the Advanced Metering Infrastructure (AMI), SABA, Online available at: http://www.iransg.com/en/home.

[4] Ekram Hossain, Mischa Dohler, Husheng Li, Dusit Niyato, and Hamed Mohsenian-Rad, "Special issue on communications and networking for the smart grid", Journal of Communications and Networks, Vol. 14, Issue 6, pp:591 – 596, Dec. 2012.

[5] M.C. Falvo, L. Martirano, D.Sbordone, and E.Bocci," Technologies for smart grids: A brief review", 12th International Conference on Environment and Electrical Engineering (EEEIC), Wroclaw, Poland, 5-8 May 2013.

[6] Trevor Morgan, "Smart grids and electric vehicles: Made for each other?", 2012 Summit of the International Transport Forum, on Seamless Transport: Making Connections, Leipzig, Germany, May 2012.

[7] Islam Safak Bayram, Ali Tajer, Mohamed Abdallah, and Khalid Qaraqe, "Capacity Planning Frameworks for Electric Vehicle Charging Stations with Multi-Class Customers", IEEE Transactions on Smart Grid (accepted for publication).

[8] SMARTV2G Workshop, Work Package: WP3, Munich, Germany, 2013.