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XXXIII Cycle

Vehicle-To-Grid Technology as a Flexible Resource for Grid Services: Economic and Technical Feasibility Studies

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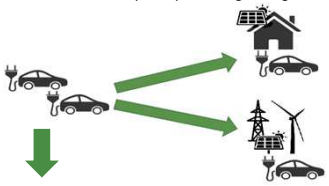
Research context and motivation

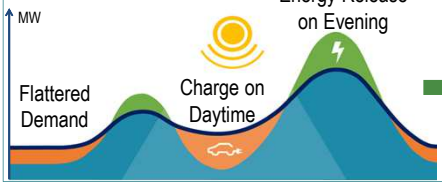
Electrical Vehicles (EV's) serving the grid



V2H: Self-Consumption improvement for Nanogrids with photovoltaic (PV)

V2G: Better management of intermittent renewable generation

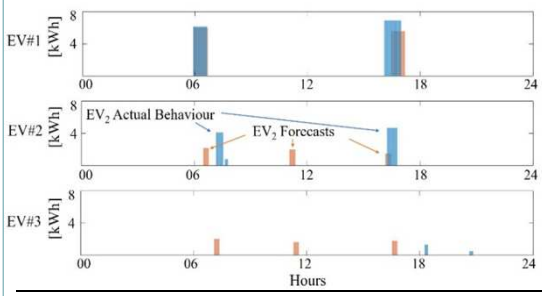
By Smart Charging:



Overall System Efficiency Improvement

Addressed research questions/problems

EV Usage Forecasts

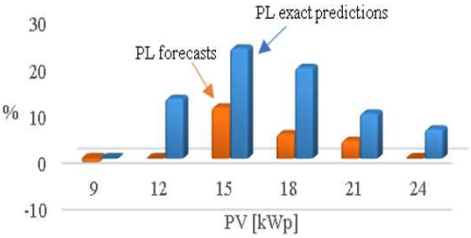


- Database: 3 years real usages of 215 EV's
- Choice of the most representative EV's of the database
- **Forecasts** based on statistics and Clustering analysis

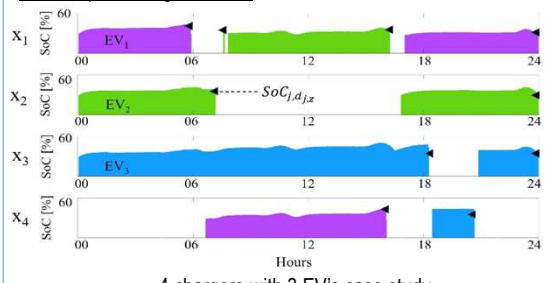
V2H Proposed vs Reference Logic

- Performance comparison between the **Proposed Logic** (PL) and the reference logic for different size of PV (orange)
- **Theorethical** maximum obtainable values with perfect EV predictions (Blue)

Self-Consumption Improvements up to 10 %



V2G Proposed Logic Results



4 chargers with 3 EV's case study

- 60 % **cost reduction** for the aggregator with respect to no V2G
- **Fulfilment** of all the mobility needs ($SoC_{j,d_{j,z}}$) even without any users additional information
- 54% balancing market potential

Submitted and published works

- F. Giordano, F. Arrigo, C. Diaz, F. Spertino, F. Ruiz; "Forecast-based V2G Aggregation model for Day-Ahead and Real-time operations, Submitted to IEEE ISGT 2020, September 2019
- F. Giordano, Z. Tulumen, R. Sánchez, G. Magnacca ;"White Roof as a Multiple Benefits Low Cost Technology", Submitted on CERN IdeaSquare Journal of Experimental Innovation (CIJ), June 2019
- F. Giordano, A. Ciocia, P. Di Leo, F. Spertino, A. Tenconi, S. Vaschetto; "Vehicle-to-Home Usage Scenarios for Self-Consumption Improvement of a PV-based Nanogrid, Submitted to IEEE Trans. on Industry Application, February 2019
- F. Giordano, A. Ciocia, P. Di Leo, F. Spertino, A. Tenconi, S. Vaschetto; "Self-Consumption Improvement for a Nanogrid with Photovoltaic and Vehicle-to-Home Technologies", EEEIC, Giugno 2018, Palermo.

Novel contributions

Study of the Integration of a single EV in a household with photovoltaic (V2H):

The majority of works in literature considers different levels of household aggregation. On the contrary, the work here proposed, considers the **EV user perspective**. Three categories of workers have been highlighted: *daily workers, shift workers, and freelance.*

EVs aggregate study (V2G):

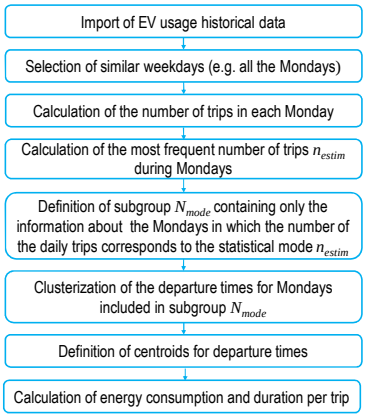
Works in literature rely on the active role of the user. This requires a high level of customer loyalty while the validity of the information is still not guaranteed. The vehicle onboard logic proposed, aims to overcome these problems providing **automatically** the EV future behavior.

Adopted methodologies

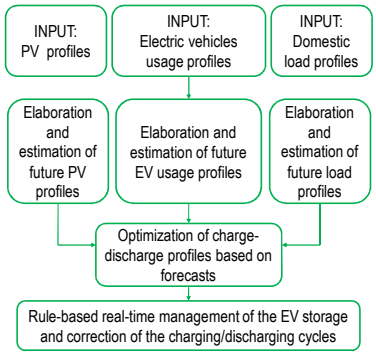
The proposed methodology is hybrid: combine a forecast based **optimization** with **hierarchical** techniques able to adjust the results coming from the optimization phase in order to guarantee the real-time operations.

Keywords-- Data-driven Statistics, Clusterization technique (k-medoids), Silhouette analysis, Forecasts, Optimization, Hierarchical technique

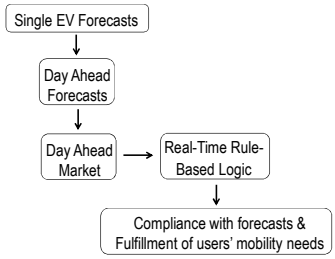
EV Usage Forecasts Algorithm



V2H Proposed Metodology



V2G Proposed Metodology



Future work

- Validation of the proposed logic for the entire sample of vehicles (about 200 vehicles)
- Enabling the participation of the aggregator (UVAM) at the **ancillary service market** (MSD)
- **Infra-day forecasts** and infra-day market study

List of attended classes

- 03SGVRV – Entrepreneurship and start-up creation from Research (04/07/2019, 8 credits)
- 01LYXRV– Electrical load management, forecasting and control (21/09/2018, 5 credits)
- European PhD School, Gaeta (26/07/2018)
- 01QORRV – Writing Scientific papers in English (23/05/2018, 3 credits)
- 02ITTRV – Generatori e impianti fotovoltaici (20/04/2018, 5 credits)
- 01SHCRV – Unsupervised neural networks (09/04/2018, 6 credits)
- 01SFIRW – Reti di trasporto stradali (06/03/2018, 3 credits)

Awards

- Member of the first classified team at "Innovation for Change (I4C) 2019" (27/06/2019) <http://dottorato.polito.it/it/innovation_for_change>

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PhD program in
Electrical, Electronics and Communications Engineering