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Charge Scheduling Problems in Static and Dynamic Charge of EV

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Abstract: Due to regulatory and physical considerations, Electric Vehicles Aggregator (EVA)is necessary for EVs to participate in electricity markets. EVs can be efficiently integrated through power grid throughG2Vtechnology. The G2V scheduling of EVA turns out to be an emergent research focus exploring the opportunities and challenges ahead with smart grid integrated EVsecosystem and electricity markets participation. G2V scheduling can be employed for valley-filling and load leveling. The exact criteria this thesis is to introduce G2V scheduling in multiple electricity markets and to review important problems in the current G2V scheduling problem such as reduction of the EV owner cost, support the power grid,monetize and capture EVs' value, generate revenues for EVA. Money can be made by charging customers' batteries when it flows or the wholesale price is low, or vice versa; and by supporting the local distribution network during critical times. The more flexible the EVs fleet is, the better-positioned market will be to respond to coming changes in power system and transportation sectors, such as the addition of more renewable, the deployment of storage, and the provision of essential grid support services.
Keywords: EVA, V2G, G2V, SCSP, DCSP

Introduction

Utilizing a mobile energy storage system, EV batteries may store electric power which may assist as a grid source during peak periods. Employing distributed energy storage of EVs, EVAs could offer ancillary services *viz.* spinning reserves and frequency regulation. EV owners can be incentivized for motivation towards offering V2G services. In other words, their market participation can be facilitated to perform charging operation whenever the network experiences less demand and execute discharging at times when there is most demand on the network. Nevertheless, the V2Gmarket entails strict regulations and integration of demand response prioritize are desired to enhance the market efficiency of V2G scheduling. The dynamics of mobilitybehavior of EV owners elevates challenges to V2G scheduling of EVA.

The EV batteries usage standards are very strict from their state of health aspect. Flexibility services use EV's manageable charging/discharging capability to adapt power rates at the network contact notch. Conventionally this servicing is all activitiesnear elementary charging (whose intention is to upsurge the SOC to and to guarantee energy for driving) and they can be: Regulation-Up attained by decrease/increase of charging/ discharging power in charging G2V/ discharging V2G mode of operation, andstart discharging if in idle mode. Regulation-Down realized by increase/decrease of charging/ discharging power, in charging G2V/ discharging V2G mode of operation, and start charging if in idle mode.

Objective of the work

Each EV load has parameters lower/upper charging rate limits,amount/time of energy requirements, besides restrictions on the frequency of cycling. Aggregated EV loads will be able to draw some power between these lower and uppercharging rate values. The midpoint of this range would typically be bid in the ancillary

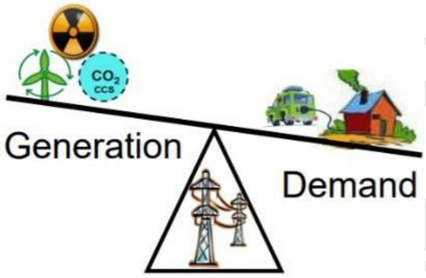
The proposed static G2V charging scheduling problem considers two conflicting objectives: reducing EV owners' charging costs and increasing EVA revenue limited by various technical and economic constraints. The optimal results include charging schedules, tuning capacity, and connected SOC EVs, all schedules have specific charging issues. By increasing the benefits of EV, charging costs for EV owners should not exceed the upper limit. As long as the EV owner's demand (determined by the charging function) and the system load are satisfied, any charging scheme will be considered feasible.

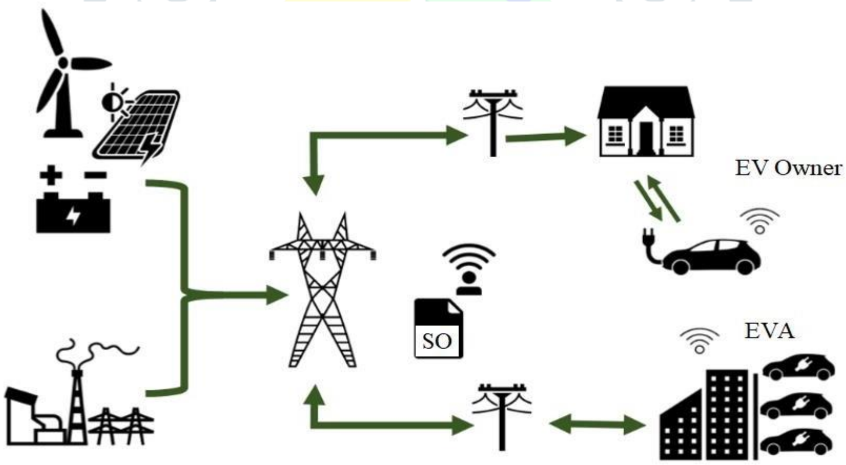
Literature review

International Energy Agency (IEA) reports [1-5] perceives EVs as a propitious pathway in the transportation sector contributing to alleviate greenhouse gas emissionsand aid reduction of mobility carbon footprint around the globe. However, large-scale integration of EVs can adversely impact grid stability and increased reserve requirements [6]. On way towards a transition to sustainable development desires cheap, reliable and clean energy through Renewable Energy Resources (RES): wind and Photovoltaic (PV) generation. RES has inherent intermittency issues requiring mobile energy storage of EVs as a cost-effective solution. Large-scale RE integration requiresbalancing services not only at the transmission level but also on the local level whereas massive EVs unregulated charging creates new peaks over existing peaks in evening hours causing network congestion and increased losses [7-10]. It may lead to grid instability and peak demand rise.

As an ancillary services product, the regulation provides market-based compensation to resources that can adjust output or consumption in response to an automated signal [11-16]. Regulation is a reliability product that corrects short-term changes in electricity use that might affect the stability of the power system. In technicalterms, the main goal of regulation is to keep the system's area control error, also calledACE, within acceptable bounds. ACE is the difference between scheduled and actual electrical generation, accounting for variations in the system's frequency. Regulation helps match generation and demand to keep the grid functioning normally by, maintaining a system frequency, tracking moment-to-moment fluctuations in customerelectricity use, correcting for unintended fluctuations in the generation (such as a largegenerating unit disconnecting from the system), and managing differences between forecasted or scheduled power flow and actual power flow on the system.

After restructuring and deregulation of the electricity industry, it is stated that the power system will be more efficient if the differences between peak and low load periods are kept as small as possible [17-29]. It has been demonstrated that the perfect balance between supply and demand in real-time is necessary for the reliable operation of the electricity system. Demand response program (DRP) is defined as changes in electric consumption patterns of end-user clients in response to changes in electricity price over time or to incentive payments designed to decrease high electricity usage at high wholesale market prices times or when the system reliability problems occur. Utilizing the DR concept that not all loads are equally urgent and so less urgent/flexibleEV loads may be shifted to other timeslots in a staggered manner alleviating stress on the system. Certain flexible loads, designated as a demand-side response, can be removed from the grid to provide reserves [15, 30]. Fig.2.1 illustrates the role of DR inenergy balancing for a typical power system.





Schematic of V2G Power Flow in the Smart Grid [25]

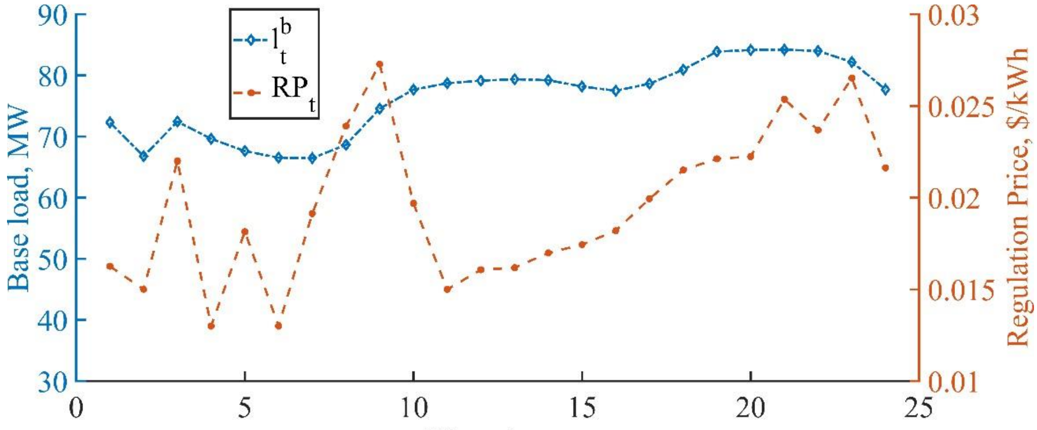
EVs are idle most of the time in the parking place and therefore can earn revenue by participating in flexibility services and DR programs. Due to their limited size and relatively low impact on the system, the participation of EV owners in DR programs is generally achieved through EVAs [31-47]. EVs can be effectively integrated with the power grid through V2G [10-11, 30, 50-55]. The schematic of V2G power flow in the smart grid is represented in Fig.2.2. V2G has been proven to reduce the EV owner cost, support the power grid, and generate revenues for the EV owner. Due to regulatory andphysical considerations, EVAs are necessary for EVs to participate in electricitymarkets. Restructured electricity markets make possibilities for the EVA to combine the capacities of many EVs and bid their aggregated capacity into energy and ancillarymarkets. Through market participation, EVA procures electricity in the wholesale market and earn revenues through the provision of reserve and regulation services [33-35,56-57]. It being a commercial entity aims at profit maximization through market participation.

Result analysis

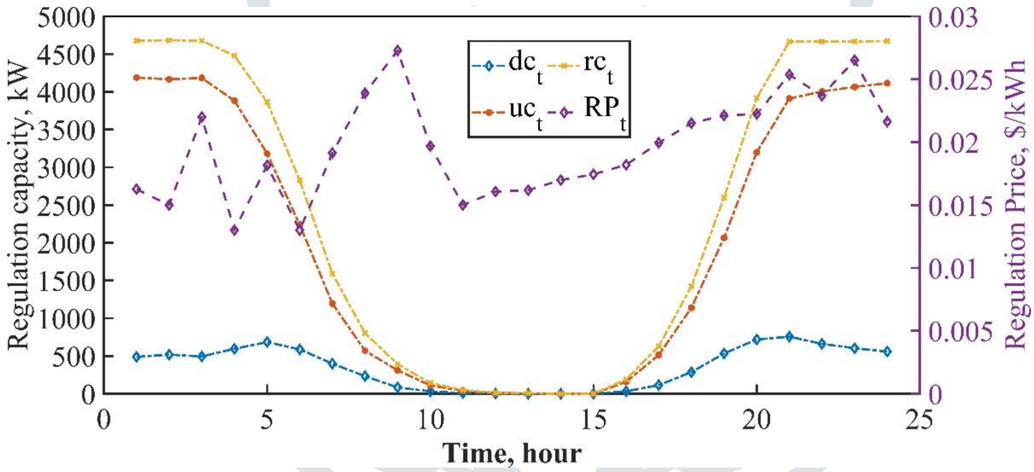
To verify the scalability of the proposed approach, 1000 EVs were deployed, corresponding to a penetration rate of 30%.
Examples of travel behavior were found from the NHTS database [93]. The impact of the actual total bill on the system is

analyzed using sensitivity analysis. To validate the optimization results, the average summer load profile from [134] was considered.

Prices for Regulation Capacity in $/kWh and Baseload Profile

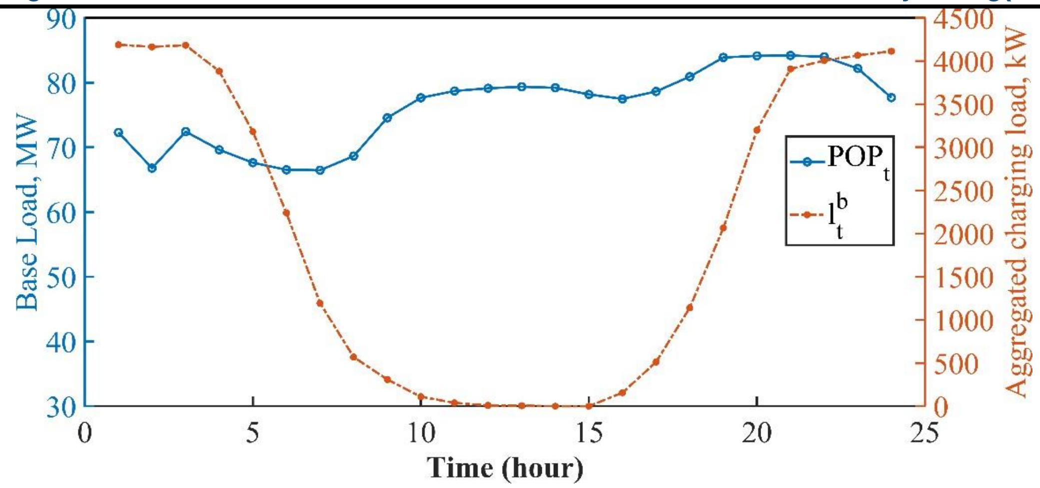


In particular, the regulation capacity value and the daily electricity hour value are obtained. Five levels of TOU values were developed using the AHC method, peak velocity, peak velocity, flat velocity, peak velocity, and peak height. The setting values are shown in Figure 4.10. As shown in Figure 3.1, the regulation value is higher for peak hours because the SO needs a reduction in regulation capacity for these hours. Regulatory services are provided to SOs when EVs are available (t1-t6 and t19-t24), and prices are higher, as shown in Fig. 4.11. Although regulation prices are high when most EVs are not available (t7-t18), significant regulation services are not provided. Compared to fee revenues, regulatory revenues are high because the prices of short-term regulatory services are more volatile.



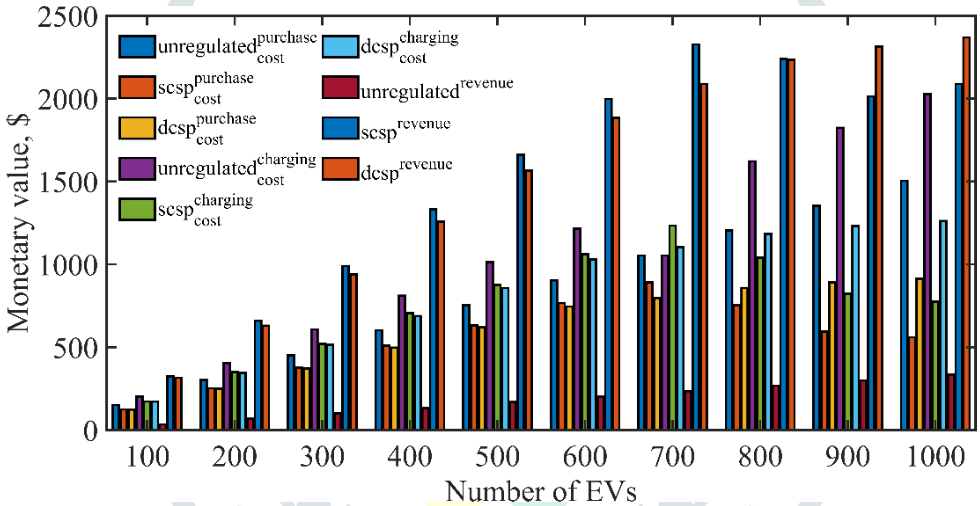
The base load specification is in accordance with the energy price. Charging load is also coordinated according to TOU-PBDR EV. If the price is low, the scheduled charging rate will be high and vice versa. Therefore, cumulative programmed charging rates exhibit Pareto-optimal behavior with respect to base load/energy price. Figure 4.12 shows that with the proposed tuning approach, a higher scheduled charging rate leads to a higher total charging load, i.e., EVs are charged during off-peak periods when the base load value is low. . Reducing the charging load during peak hours helps to improve the load factor of the system. By combining frequency control with regulating services, EVs can help manage peak load demand by keeping charging rates low during peak load periods, thereby helping to improve grid stability and reliability. In addition, charging rate regulation controls the charging behavior, thus reducing charging load pressure and the risk of transformer overload.

Regulation Capacity Provided by EVA at a Time t in Response to Regulation PriceSignals

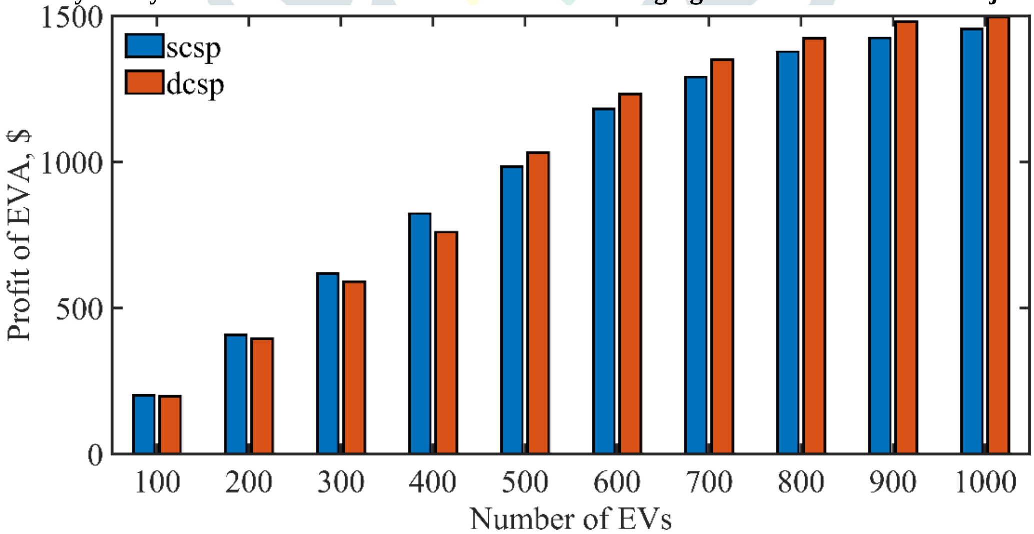


Aggregated Scheduled Charging Rate Adaptation in Response to Base load Profile

Unregulated charging has the adverse effect of causing spikes in system peak loads. The non-adjustable charging cost sets the upper limit of the charging cost (CB). Shape. 4.13 and 4.14 present the sensitivity analysis of EVA performance indices under different charging methods for different numbers of EVs, with the objectives of minimizing charging costs and maximizing profits. We observe that the purchase cost, EVA revenue and charging cost of EV owners increase with the number of EVs. Dynamically adjusted minimum charging based on SCSP costs less than non-adjustable charging.

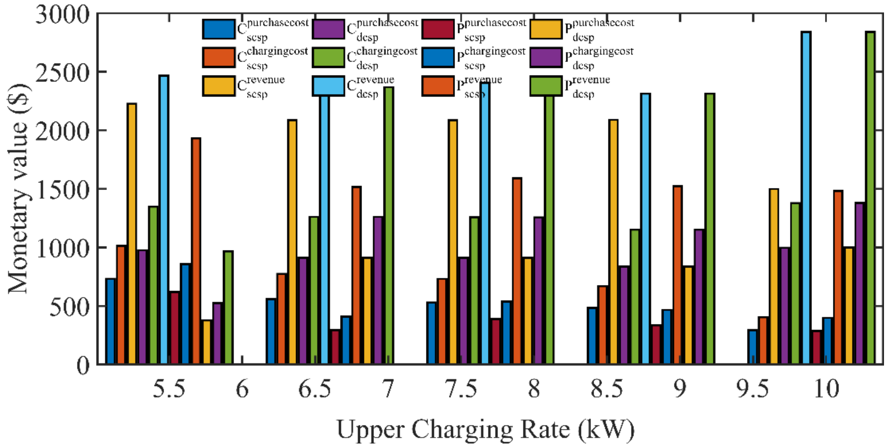


Sensitivity Analysis of EVA Performance Metrics with Charging Cost Minimization asObjective



Profit of EVA in Integrated TOU-PBDR and SCSP/ DCSP w.r.t. the Number of EVs

shows the sensitivity analysis of EVA obtained for different upper limits for purchase costs, accounting costs and settlement costs with different objectives (representing revenue growth, representing cost reduction objectives). From Figure 4.16, it is clear that the yield sensitivity for TOU-PBDR integrated DCSP is lower, and the sensitivity to the purchase price and charging costs is higher and the adjustment of the upper limit of charging speed. Therefore, the sensitivity to income is also low because it is the difference between income and expenses. Giant. 4.17 TOU-PBDR shows the upper limit of different charging rates, namely 6.6 and 9.9, for a group coordination group of 1000 EVs in an integrated DCSP Eva system. Charges are calculated based on scheduled charges aggregated in response to the TOU bid price. This valley is populated with the proposed TOU-PBDR DCSP and peak load control during low TOU speed (t22-t3) / night hours and high TOU speed period (t11-t15). It is difficult to change the EV charging rate in two consecutive intervals to obtain a value higher than the upper limit of the charging rate. Therefore, a higher charging rate will eventually lead to an uneven charging load and thus threaten the stability of the grid.



Charging Load in TOU-PBDR Integrated DCSP for 1000 EVs with Different UpperCharging Rate Limit

It does not represent the optimal system specifically for EVA / EV owners. Pareto-optimality exists between economic and technical goals. Based on the results of static and dynamic charging planning, the dynamic charging algorithm outperformed the static algorithm by achieving higher profits for large EV fleets. The proposed EVA business model benefits EVs, SOs, and EV owners, supporting the proliferation of EVs and green transportation in a sustainable energy and smart grid environment. Low charging costs and required SOC levels for EV owners motivate participation in providing EV services. The proposed daily strategy improves the economic efficiency of SO and the cost-effective model of the price-responsive behavior of EV owners.

Table: Purchase Cost and Revenue (Without and With Coordination)

	Unregulated Charge Scheduling	SCSP	DCSP
Purchase cost ($)	16142.032	289.51096	899.1859
Revenue ($)	299.9503	14999.61	2401.294

References

[1] S. Asadi, M. Nilashi, S. Samad, R. Abdullah, M. Mahmoud, M.H. Alkinani, and E. Yadegaridehkordi, "Factors impacting consumers' intention toward adoptionof electric vehicles in Malaysia", *Journal of Cleaner Production*, vol. 282, pp.124474. Feb. 2021.
[2] R. Hillerbrand, C. Milchram, and J. Schippl, "The Capability Approach as a normative framework for technology assessment: capabilities in assessing digitalization in the energy transformation", *Journal for Technology Assessmentin Theory and Practice*, vol. 28, no. 1, pp. 52-57, 2019.
[3] F. Esu, and F. Sindico, "IRENA and IEA: moving together towards a sustainableenergy future—competition or collaboration?", *Climate Law*, vol. 6, no. (3-4), pp. 233-49, Oct. 2016.
[4] Q. Tang, and L.M. Tang, "Developing Blockchain-Based Carbon Accounting and Decentralized Climate Change Management System", *Information forEfficient Decision Making: Big Data, Blockchain and Relevance*, pp. 431-450, 2021.
[5] C. Nardi, D. Consoli, E. Paglialunga, F. Cappelli, G. Marin, I. Fusacchia, L. Salvatici, and V. Costantini, "International trade and climate change: part of theproblem or part of the solution?", *Roma TrE-Press*, Feb. 2021.
[6] G.V. Kumar, R.K. Sarojini, K. Palanisamy, S. Padmanaban, and J.B. Holm- Nielsen, "Large Scale Renewable Energy Integration: Issues and Solutions", *Energies*, vol. 12, no. 10, pp.1996, Jan. 2019.
[7] A. Dubey, and S. Santoso, "Electric vehicle charging on residential distributionsystems: Impacts and mitigations," *IEEE Access*, vol. 3, pp. 1871-1893, 2015.
[8] Y. Parag, and B.K. Sovacool, "Electricity market design for the prosumer era", *Nature energy*, vol. 1, no. 4, pp.1-6, Mar. 2016.

[9] K.J. Dillman, R. Fazeli, E. Shafiei, J.O. Jónsson, H.V. Haraldsson, and B. Davíðsdóttir, "Spatiotemporal analysis of the impact of electric vehicle integration on Reykjavik's electrical system at the city and distribution system level", *Utilities Policy*, vol. 68, pp.101145, Feb. 2021.
[10]B.K. Sovacool, J. Axsen, and W. Kempton, "The future promise of vehicle-to- grid (V2G) integration: a sociotechnical review and research agenda", *Annual Review of Environment and Resources*, vol. 42, pp. 377-406, 17 Oct. 2017