International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

A Review on Electrical Vehicle Charging Stations Infrastructure

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A B S T R A C T

It is essential to create alternative modes of transportation due to the world's expanding population and recent worries about the depletion of fossil fuels and environmental damage. The market for electric vehicles (EVs) is growing globally. For EV adoption among the general public, building a charging infrastructure is crucial [1]. This term paper develops and enables the planning of the charging station infrastructure for a future smart world shortly. An objective-based multi-objective framework was used to outline the charging station allocation problem taking into account the economic variables, the voltage stability, dependability, and power loss of the power grid further to the comfort of EV users and erratic road traffic [3]. Using the positioning issue was resolved.

Keywords:Electricvehicle,Charging facility, Location-allocation model. High-density city,spatial planning,Transport infrastructur

1.Introduction

Energy transition and environmental protection concerns are receiving more attention internationally as a result of the sharp rise in global energy consumption and the pressure from environmental contamination [5]. Therefore, new energy vehicles (NEVs) have emerged as efficient means of implementing energy strategies, air pollution prevention, as well as the rapid development of energy conservation and emission reduction policies in nations all over the world due to their eco-friendly and energy-saving qualities[7]. India, a party to the Paris Agreement, intends to become an EV country by 2030. By the end of 2020, there were 10 million EVs worldwide, a 41% rise over the previous year despite the general car market's downturn due to the pandemic (International Energy Agency, 2021) [8]. Meanwhile, a number of nations, including Norway, the UK, Germany, and Singapore, have committed to outlawing fossil fuel-powered vehicles between 2025 and 2040. However, the widespread use of EVs is expected to present both possibilities and problems from a technological and economic perspective.

2.Literature review

Depending on the situation and need, electric vehicles (EV) can be charged in a variety of methods. As a result, there are several types of charging infrastructure for EVs that are created for various applications. Electric vehicle supply equipment (EVSE), also known as EV charger specifications and standards, differ from one country to the next depending on the types of EVs that are sold there and the power grid's features. In addition to highlighting the necessity of a contextual approach to local development and implementation of EV charging networks, this paper discusses the basic ideas of electric vehicle charging infrastructure [1]. Electric Vehicle Supply Equipment (EVSE) Basic unit of EV charging infrastructure. EVSE access electricity from local sources, Control system and cabling also used safely charge your electric vehicle. With the EVSE control system, various functions such as user authentication, charging, information recording, Exchange for network management and data protection and security [3]. We recommend using EVSE. At least basic control and management functions. All loading purposes. Conductive charging or plug-in charging (wired) Main stream charging technology is used. Requirements EVSE for conductive charging depends on factors Vehicle type, battery capacity, charging method, etc. Method and evaluation [5].

1. CHARGING METHODS AND POWER RATINGS:

EV charging involves supplying direct current (DC) to the battery. As power distribution systems AC power supply, an adapter is required to supply DC power to the battery. Conductive loads can be AC or DC [3]. In case of AC EVSE, AC power is supplied to onboard EV charger, converting it to DC current. DC EVSE converts power to the outside and supply DC power directly to the battery, by passing on-board charger. AC and DC loads are further classified into four charging mode, with modes 1 to 3 involving alternating current charging and mode 4 involves DC charging. Modes 1 and 2 are applied to connect the VE to standard electrical outlet, using cable and plug. Mode 1, also known as charging mute, does not allow communication between VE and EVSE and its use is not recommended [3]. Cellular cable used in Mode2 has built-in protection and control and usually used for home charging. Mode 3 and 4, provide a separate charger for power supply power for EVs, has an improved control system and used for commercial or public office**.**

2. INDIAN STANDARDS FOR AC CHARGING

The primary EV charging standard in India is IS 17017, which has three parts and six sections. All EV charging systems have the fundamental features listed in IS-17017-Part-1. This standard, as well as particular AC connector specifications in the IS-17017-Part-2, must be followed by an AC EVSE. Technically speaking, AC and DC EVSE must both meet IS-17017-Parts 21 and 22. Additional Indian specifications for AC EVSEs have been certified for usage in parking lots by light EVs and e-cars (in the form of inexpensive charging stations)[1].

3. INDIAN STANDARDS FOR DC CHARGING:

The specifications for DC charging stations with power outputs ranging from 50 kW to 200 kW are outlined in INDIAN STANDARDS FOR DC CHARGINGIS-17017-Part-23. In addition, in order to accommodate buses and other big vehicles, high power charging standards are needed. The IS-17017-Part-25, which is designed for providing low DC power of less than 7kW for light EVs, was just finalized by the BIS. IS-17017-Part 24 specifies data communication standards since digital communications between the DC EVSE and the EV are necessary [1]. Communications will follow the IS-15118 series after the Combined Charging System (CCS) standard is implemented, which can offer both AC and DC charging

CLASSIFICATION OF EV CHARGING INFRASTRUCTURE

Fig1: Ev charging station

In general, ownership and use determine how EV charging infrastructure is governed. Generally speaking, there are three types of EV charging infrastructure:

- Public
- Semi-public
- Private.

PRIVATE CHARGING [6]:

Fig 2: private eV charging stations

Application: personal electric vehicle or dedicated charging for electric vehicles own unit.

Location: Detached house with private parking Ownership: Individual EV owner, EV fleet owner/operator.

Operations: On-premises or CPO managed (for EV fleets)

Semi-public charging [6]:

Fig 3: semipublic eV charging stations

Application: Shared charging for a limited number of EV users

Location: apartment complex, office campus, gated communities, shopping malls, hospitals, Universities, government buildings, etc.

Property: Host Estate, Original Equipment Manufacturer (OEM) & Charging Point Operator (CPO)

Operation: CPO management.

Public charging [6]:

Application: Any EV user can use

Location: public parking lot, street parking, charging stations, gasoline pumps, highways, Subway station.

Ownership: Municipality, PSU, CPO, host properties.

Operations: CPO Management

3.Methodology:

Design, Location And Cost Of Ev Charging Infra Structure [7]:

Typically, charging stations are either wall- or floor-mounted. The primary parts of a charging station positioned on the wall or the floor are depicted in Figs. 8 and 9, respectively. Power supply, communication system, management system, and charging system are its typical four components.

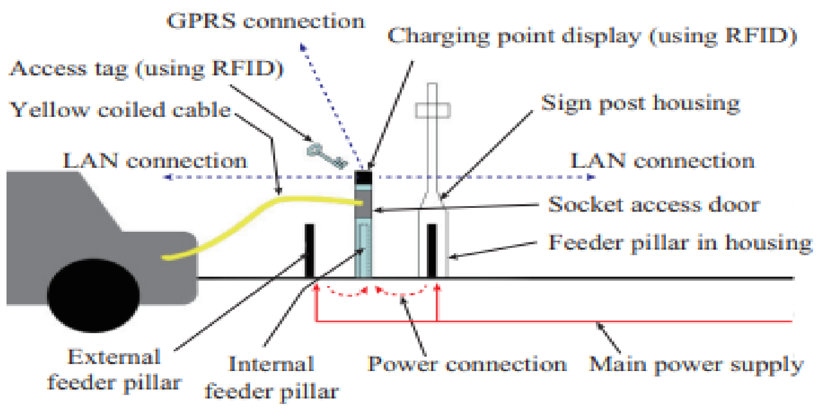

Fig4: on-street restricted access charging points(floor-mounted)

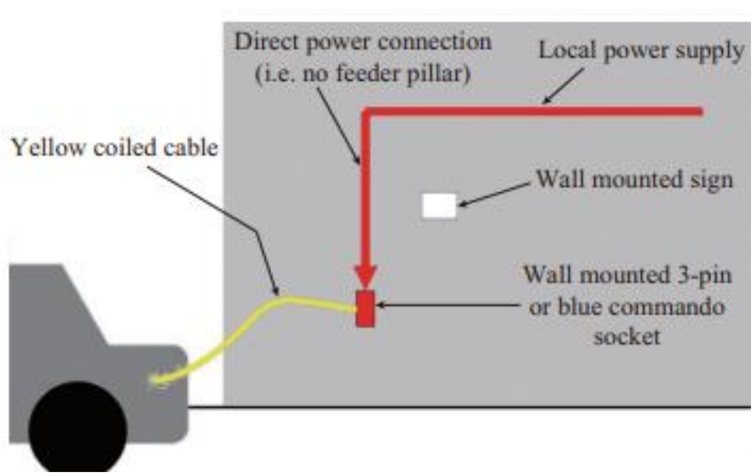

Fig5: of-street open access charging point

Circuit topologies for charging infrastructure [7]:

Several topologies for charging stations have been proposed around the world. These can be mainly categorized into his two most common types: back-to-back AC/DC converters and transformer less charging stations [7]. Back-to-back AC/DC converters consist of a front-end AC/DC converter connected to the grid via a transformer, whereas transformer less ones are typically used to supply current by directly connecting a charging station to a medium voltage level. Reduce the All of these topologies are capable of bi-directional charging that can be integrated into battery energy storage systems to provide grid support services [7]. Differences mainly lead in the direction of power density, modularity and reliability. In urban areas where space is at a premium, a power-dense transformer less topology may be a better option [7]. For malls and highways where infrastructure requires modularity and less control, back-to-back AC/DC converters can be an option. Highly modular and easy to control, AC/DC and /DC/DC charging stations are suitable for shopping malls and highway charging stations [7]. From a charging point of view, they can be further classified into conductive charging technology and inductive charging technology. There are five main types of converter topologies for conductive charging [7]. AC/DC rectifier topology with power factor correction (PFC), isolated DC/DC converter topology, on-board topology for two-stage plug-in EV charger, on-board charger Stage 3 on-board charging topology and off-board charging Topology The integrated on-board charger combines a charging stage and a DC/DC converter between the energy storage source and the DC link of the prime mover inverter. This reduces component size, weight, and infrastructure costs. For fast charging, traditional on-board chargers may not be a viable solution due to cost, size and weight issues. Therefore, off-board charging technology dominates the field. Charging units within a charging station can share the same common AC link or common DC link. It can adapt to both three-phase AC/DC converters and DC/DC power converters. Presents a modular converter-based solution for transport electrification. Both on-board and off-board charging solutions are shown here. A comparison of charging topologies is shown in Table 1. Inductive charging, on the other hand, is primarily based on inductive power transfer (IPT) technology, where power is transferred to a load through a changing magnetic field without physical contact [7]. There are two main types of IPT, the transformer type IPT method and the resonance converter based IPT systems, which the needs of EV users [3]. The charging station placement problem can be formulated with different goals. Maximize Coverage, Minimize Cost, etc

4. Iov-Based Framework For Charging Management

Two primary parts make up the IoV-based charge management framework: Placement of charging stations in the best possible locations and scheduling of EV charging are two examples.

Possible location for ev's:

To save installation costs, we suggest a method for strategically placing charging stations. In an IoV-based charging management system, the local server is in charge of all operations and is fully aware of the needs of EV users and their density in a particular area. Therefore, the location of charging outlets is the responsibility of the local server. We think about where to put stationary and portable charging stations [3]. Therefore, the placement of mobile charging stations could be an ongoing task based on the needs of EV users [3]. The charging station placement problem can be formulated with different goals. Maximize Coverage, Minimize Cost, etc. Suppose the charging station at the m-th Σ NP candidate location provides an estimated number of connections Ym and deployment coverage cost Zm. The number of ports Ym at the mth potential location depends on the flow of EVs passing through it. Assumes a known fixed number of connections at each charging station. We propose a solution to find the best location for placing charging stations from the possible potential NP sites. You can use the decision variable

$$X_m = \begin{cases} 1, & \text{if charging station is placed at } m\text{-}th \text{ location} \\ 0, & \text{otherwise.} \end{cases}$$

Then the total cost of placing a charging station

Written as: ΣPNPm=1ZmXm.Charging arrangement cost The station at the mth position can be represented as Zm=.(ACL+CC)Ym+Cinit,m where A is the required land area. For charging vehicle (A=25f t2)), CL is the land rental cost per f t2 and CC is the cost per connection. Connector cost is directly proportional to connector rating. Let Cinit,m be the cost of acquiring a charging station (the cost of basic structure and construction). Charging station electrification costs are considered part of Cinit,m and are not considered separately. We formulate an optimization optimization problem to minimize the total cost of deploying charging stations, considering the deployment costs and connectors of each charging station.

$$\min_{X_m} : \sum_{m=1} Z_m X_m$$
$$\text{Subject to} : \sum_{m}^{N_P} X_m Y_m \geq \beta N_V$$
$$X_m \in \{0, 1\}.$$

Where constraint mandates that the total number of connectors installed in all charging stations be sufficient to meet the charging needs of at least a percent of EVs in that region. To put it another way, less than 1% of EVs in the serving area must be able to charge at the same time. Mixed-integer programming, which is typically NP-hard, is the issue in .By listing all of the Xm-related combinations that are possible, the best solution can be found. However, considering the large number of potential locations and charging stations, this is a computationally inefficient option [3]. For the placement of charging stations, we used the branch and bound algorithm in Algorithm 1 to address this problem. In the majority of cases, the branch and bound algorithm has a relatively low computational complexity, which suggests that its performance can be reasonably estimated.

Algorithm 1 Charging infrastructure placement algorithm

Set $X_m^* = 0 \; \forall m \in \{1, 2, ..., N_P\}$ and $\xi^* = 0$
while there are active locations **do**
  Select an active location j and mark it as inactive
  Solve linear programming (LP) relaxation: denote solution as $X(j)$ and LP relaxation of Problem(j) as $\xi_{LP}(j)$
  if $\xi_{LP}(j) \geq \xi^*$ **then**
    Prune node j
  else if $\xi_{LP}(j) < \xi^*$ and $X(j)$ is feasible for integer program **then**
    $X^* = X(j)$
    Prune node j
  else if $\xi_{LP}(j) < \xi^*$ and $\psi(j)$ is infeasible for integer program **then**
    Mark the children of node j as active
  end if
end while
return The best solution and it's minimum value

5.Conclusion:

In this section, we evaluate the installation of EV charging infrastructure will necessitate rigorous long-term planning and advancement in design, not only in terms of locations but also in terms of converter circuit topology, price, customer-focused design, and recycling enforcement of the electric grid, as well as social environmental elements. In addition to increasing energy battery technology density and the advancement of EV charging needs substantial support for grid renewal and development[3]t. able integration of energy sources. Additionally, business models for which public EV charging should still be utilized regulated to ensure a long-term sustainable development term. While waiting, it's equally crucial to develop the design, instruments, and regulations to address EV-related problems charging the effectiveness of the framework that has been suggested for the ideal positioning of charging stations and the schedule optimization of the EV charging[7]. We assess performance in terms of normalized cost values and the number of connectors by taking into account the number of available locations to determine the best location for charging infrastructure.

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