Modeling And Integration Of Electric Vehicle Charging System

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Abstract - **The major concern of 21st century is it increasing green house gases emissions which are severely harming the planet. Major steps are taken all over the world to counter the problem. The area which is in lime light currently is the automobile sector as it is greatly responsible for emission of a major portion of green house gases. The vehicles we use today are run by conventional fuel which pollutes the environment. So several attempts are made all over the globe to replace the conventional fuel vehicles by electric vehicles (EVs). But the attempts made to replace the conventional fuel vehicles with electric vehicles were not much successful. Although many companies have launched electric vehicles but they were unable to get popular among people of the world. There were many problems related to electric vehicles which were responsible for this. The major loophole was not having a proper electric vehicle charging infrastructure. Only home charging systems are available in modern day electric vehicle charging which limits people from using electric vehicles. So a proper and well defined plan is proposed in the paper. Motivated by the above mentioned reasons, here this paper is addressed which aims on modeling and integration of electric vehicle charging system. The system designed here is will be connected in the already developed charging stations. The system will monitor the charging percentage and identify the user through a special identification method which will be unique for every user. Each system connected to each charging station will also have a unique identity in itself. The charging stations throughout the city will be connected with this system and the system will centralize them to a common server. Thus making it a smart system which can be implied in big cities and will be a major breakthrough in deciding the future scope of the electric vehicles in the country and also throughout the world.**

keywords - **elctric vehicle, charging stations, integration.**

Introduction

India is focusing plenty on introduction of electric vehicles and it is estimated that by 2022, 80% of vehicles seen will be electric vehicles. It is clear that electric vehicles (EVs) will be available on the market because most manufacturers are developing EVs. Also a proper planning is required for establishing a centralized electric vehicle charging system for the vehicles. Optical locations for setting charging stations in big cities with a tight land availability are keys factors to be worked upon.

So a proper planning of centralized charging infrastructure and model of electric vehicle charging is proposed here. A basic method to evaluate the planning schemes in terms of economy, flexibility and convenience is proposed.

It is clear that electric charging method requires more time than traditional refueling methods in modern day vehicle. So it is required to develop a proper design of centralized charging grid in a city so that in spite of consuming more time on charging, the everyday life goes on at its regular pace. The centralized grid plan also requires hi-tech instrument to reduce charging time and increasing the overall efficiency of the charging system which are worked upon in this report.

The system is made more reliable and easy to manage by proper planning. The electric vehicle charging system is also made user friendly with some important features like easy payment methodology and easy to use charging systems. The charging is not only confined to charging stations but can also be rented to the company through local public. Charging systems are distributed among the city rather than just being concentrated on just few charging stations. Easy payment, fast charging, easy availability of charging points are key design features of the proposed system. Multiple charging options like fast charging and slow charging is made available. One can charge vehicles at various places throughout the city like home, office, mall and local owners make this system very convenient for consumers. Electric charging holds ample of advantages which have encouraged many countries to leave the traditional fossil fuels powered vehicles and look forward to smart electrically powered vehicles. Here we present a plan for the electric vehicle charging infrastructure and also the required devices for the project.

Electric charging can be classified in three categories:

Home charging

To charge electric vehicle at home, the user needs a home charging point installed where he can park his car. Charging at home will be most convenient as people will usually prefer a dedicated which will be faster and has built-in safety features.

A home charging point is a compact waterproof and installed by proper backup and safety unit that is mounted to a wall with a connected charging cable or a socket. This makes is a safer means. One can charge vehicle at home with no time boundation which makes it convenient for users.

The most important benefit of home charging is that user can use renewable sources of energy like PV cells to charge the vehicles. Slow charging also doesn't create any major problem as vehicles can be parked for long hours at home. Moreover post

paid payments are also possible in home charging.

Public vehicle charging

This charging will be used for charging public vehicles like city bus which have a big battery which needs to last whole day without any further charging. Public transport need to rely on a single time charge for the whole day because they have to be in service for whole working day. So they have a big battery which can work for long range. For charging such public transports special charging stations will be set up which can charge the vehicles overnight and bear almost negligible load during day time. This will help in proper distribution of load on grid also. They are completely isolated from commercial vehicle charging.

Commercial vehicle charging

This is the most crucial classification in electric vehicle charging. The success of electric vehicle majorly depends of this because people are mostly concerned about charging their vehicle when they are not around home. The commercial charging points are designed in such a manner that people can access them anywhere like in office, at mall parking, at rented places.

The system allows company to rent charging stations to local people for business purposes. The user can directly pay to the owner or may pay by him. This gives access to different payments modes like prepaid and postpaid schemes run by the commercial owner. The owner can use his wallet for the instant payment and thus can provide users with flexible schemes. Whereas the user can directly pay by his wallet at public charging stations through the system.

Thus the system makes it possible to prepare a complete plan of charging infrastructure within a city. As discussed the city will have three levels of charging namely Home charging, public charging stations and commercial charging.

Problem Identification

Electric cars hit a new global sales record in 2017 — 1 million cars sold, with more than half of that in China — but there may be a hitch to mass adoption: the number of adequate charging stations available. Before consumers take the plunge on a new electric car, they need to know that they can charge it. It is clear that soon electric car are going to be launched in Indian market with which will come the same charging problems that are faced worldwide. Refueling of crude oil fuel was an easy and fast refueling method but the case is not same with charging of electric vehicle. No matter how fast charging it is (DC fast charging) it will consume some time. The problem can be eliminated with a proper charging infrastructure for EV (Electric Vehicle).

The longer-range EVs that are coming to market to allay drivers' range anxiety will have larger and more powerful batteries. That means they will require larger charging systems to expedite dwell times, or the amount of time it takes to charge the battery. Automakers have a choice: build their own charging networks or rely on third-party networks. What they choose will determine whether electric cars can go main stream.

Also setting up charging stations will also require a proper planning to manage such a huge Indian consumer section. The power is needed to be very regular because a small breakdown in power may create a huge blunder. Also heavy vehicles like buses will be demanding more time and more powerful charging stations as they will have bigger batteries which can sustain for longer duration as such vehicles travel longer distances continuously. This will be difficult to match with smaller a vehicle which requires fast charging and can't go much with the smaller batteries. They are needed to be regularly charged and will also require less power to charge their batteries. Also a proper power system will be required to supply for the charging stations.

The load must be divided in a very proper an efficient manner to increase system efficiency. The load division is very crucial to provide a continuous and quality supply to the end users.

The charging stations must have efficient working devices embedded to make the charging system successful in every aspect. Proper devices are must needed which are capable to charge continuously for long hours without breakdown. Proper backup devices are required if in case any device fails to do as desired or is damaged.

Motivation

Although electric vehicles are available in India but are owned by few people. We can simply say it is non popular due to the fact that the no proper electric vehicle charging infrastructure in India. So there are many plans been proposed to develop a proper charging infrastructure in the country. Government is investing a lot in this field which is encouraging large firms to participate in solving this problem. This field has a vast research possibility and new plans and proposals are being accepted from all over India. India already have efficient electric vehicles but they only require a proper charging methodology which have highly motivated people and firms to participate in development of electric vehicle charging infrastructure. Since the cars, battery technologies, charging standards are still under various stages of evolution we are looking at an infrastructure which would be future ready. This field has tremendous possibility as it a future scope which will hit the Indian market soon. This project is a milestone for the golden Indian dream of replacing the traditional vehicles with the electric vehicles. This will ultimately tend to reduce the great threat of global warming which effects can be seen currently.

The research and development (R & D) sectors of India are looking forward for new possibilities this project. This is going to be very important project in many aspects. So a well-engineered electric charging infrastructure project will play in shaping the future of the nation. The present day energy sources are soon going to exhaust and can imbalance the economy of the world. So the world is looking forward for such projects which will shape our future. The electric vehicle field is going to be very popular in upcoming years.

Literature Survey

The need of electric vehicle is increasing rapidly in present world. There are many reasons behind this including some important issues like increasing green house gases, limited availability of fossil fuels etc. Government is trying to increase awareness in

people regarding the use and advantages of electric vehicles. Just like Indian Government aims to replace all conventional petrol diesel vehicles by electric vehicles[1]. But there are many problems regarding electric vehicles such as lack of a proper charging infrastructure in the country. Also there in limited land availability in India so selecting a proper location for setting up charging station is also a crucial point to be kept in mind[2]. The next major problem related to charging is the charging speed. The public vehicles can be kept for longer duration for charging. They can be kept for long hours for charging, usually night. This is usually slow charging which takes long hours for charging. But for it is not possible to apply slow charging method in city as people don't have long hours for charging their vehicles. So fast charging stations must be included in the infrastructure[3]. The slow charging stations can be used for the home charging purpose. The vehicle can be easily charged at home. Also renewable sources of energy can also be used for charging a vehicle at home[4]. The charging station can fetch energy from the batteries which are charged using renewable sources of energy. Solar panels can be placed at roof to charge the battery. Also small size private wind mills can also be placed on the rooftop to charge the battery. Thus this also reduces the power load on the grid. Also this is eco friendly way of charging electric vehicle and it restricts the emission of green house gases to the environment.
But in spite of this, electric vehicle cannot be made comfortable to use on large scale if we don't have a proper charging system which includes using of smarter means to charge the electric vehicles and a proper infrastructure regarding the charging options spread throughout the city. Thus smart charging of electric vehicles is required[5]. Keeping in mind the pros and cones of the electric vehicle charging system, a complete city plan as well as a smart charging system is required.

Methodology:
The method of charging electric vehicle is quite simple. The user has to perform few simple steps to charge his/her electric vehicle. The charging stations remains the same but a smart system is developed to centralize all the electric vehicles charging stations throughout a particular are which will be connected to n numbers of servers.
Here in this report we present a demonstration of a single system installed at a charging station in a particular area. We will demonstrate a electric vehicle is connected to the system and how the system will connect to the server. The server may any number depending on the numbers of systems installed throughout the area.
The system can also be used as a security for the vehicle of the owner. There may be a common identity card with and with that card the vehicle will also be registered. As anyone of the user connects the vehicle to the charging system, the server will send a notification on the registered mobile number on which the car is connected. Thus, the location of vehicle is known. As from the user's point of view the process will be completed in following steps:

User connects his car to any charging station and automatically also gets connected to the system.

- The station will have a QR code which user will scan and will wait for further instructions from the server.
- The process will take minimum time and a response will be generated from the server and will be displayed on the screen of the system.
- The user can now respond as per signal generated that is either yes and no.
- If yes, user's vehicles have begun to charge.
- User will can the charges as per the power consumed.
- User can use various methods for making the payments.
- Finally user disconnects the vehicles.

Some important features related to the system are as follows:
1.The system is very easy to use by the user and is not complicated from the user's point of view.
2.The system is based on electronic elements which makes the system very compact and the system can be easily installed without worrying for space.
3.Cheap and effective technology.

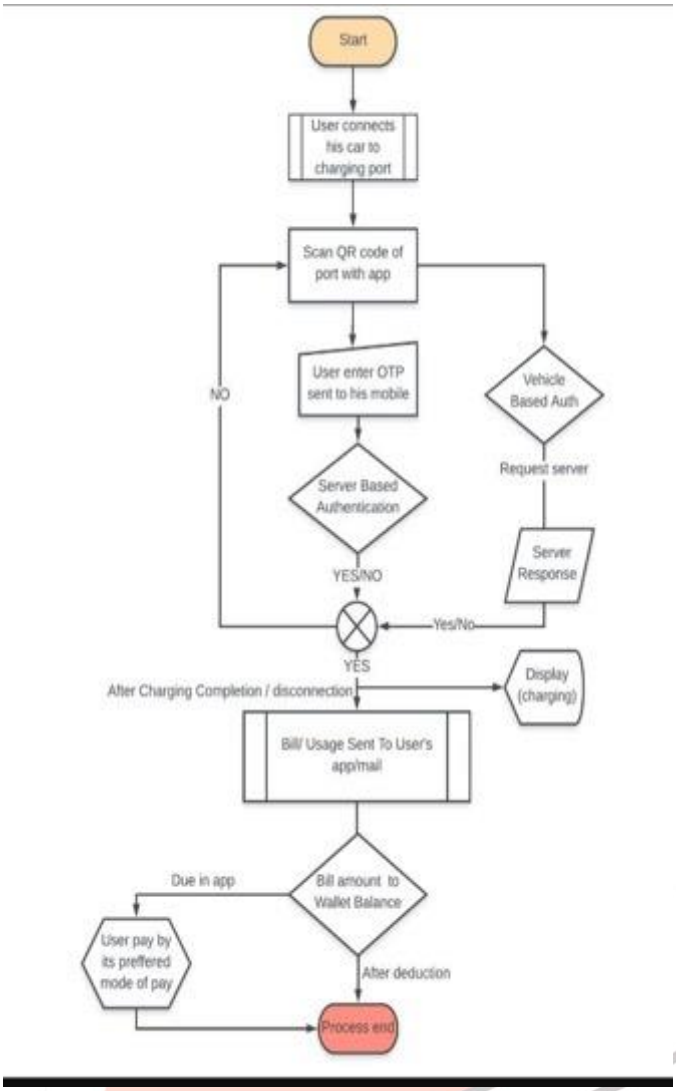

Fig.i. (Flowchart)

The above flowchart explains complete methodology of the system. How the system works after it is installed at the charging station is presented above. The very first step begins with the user connecting his vehicle to the output port of the system. After that to proceed further the users have to scan a QR code present on the system. Each system installed will have its own unique code which will be identified by the mobile app which will be installed in the mobile of the user. The scanned QR code will be sent to the server and the unique charging system will be identified by the server. An OTP code will be sent to the user mobile from the server for further processing. The user will then enter the OTP sent to his mobile and then it will be sent to server for authentication. The user will get a reply as YES or NO. If the user gets a YES from the server the charging of the user's electric vehicle will begin. If the user gets NO from the server, he has to again scan his QR code and further processes will follow.

After the charging has begun, the required information will be displayed on the screen like the percentage of battery charged and the power consumes by the electric vehicle of the user. The power consumed will be monitored and the amount for the power consumed will be calculated. The bill\charged amount will be sent to the user trough and will be displayed to the user in the mobile application. The payable amount can also be sent to the user through mails. The user can pay the amount by his preferred means of payments and thus the process will finally come to an end.

Hardware Design

The hardware devices used for the project contains NODE MCU (ESP8266), BREAD BOARD, RELAY SWITCH DIGITAL TRIGGER (1CH), CURRENT SENSOR (ASC712), BASIC CHARGER. The integration of these hardware forms a system which is connected on charging station between the charger supply and the input to the vehicle.

NODE MCU (ESP8266)

NODE MCU (ESP8266) has operating system XTOS. It has a memory of 128kBytes and storage of 4Mbytes.

Fig.ii (NodeMCU)

Node MCU is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module. The term "NodeMCU" by default refers to the firmware rather than the development kits. The firmware uses the Lua scripting language. It is based on The eLua project, and built on the Espressif Non-OS SDK for ESP8266.

RELAY SWITCH DIGITAL TRIGGER

1. Two separate LEDs for On/Off indication of the Relay.
2. Triggering input voltage 3.3V – 5V
3. Two separate LEDs for On/Off indication of the Relay
4. Triggering input voltage 3.3V – 5V
5. Back EMF protection
6. Back EMF protection 2 LEDs to indicate when relays are ON.
7. Works with logic level signals from 3.3V or 5V devices
8. Opto isolation circuitry
9. Module with diode current protection, short response time
10. AC Control Voltage: 250V max.10A
11. DC Control Voltage: 30V max. 10A

Fig.iii (Relay switch)

The relay will operate when the current reach a limit value which is already fed in the relay. The relay can be used for various applications.

ASC712 CURRENT SENSOR

1. Low-noise analog signal path.
2. Device bandwidth is set via the new FILTER pin.
3. 5 µs output rise time in response to step input current.
4. Small footprint, low-profile SOIC8 package.
5. 2.1 kV RMS minimum isolation voltage frompins 1-4 to pins 5-8

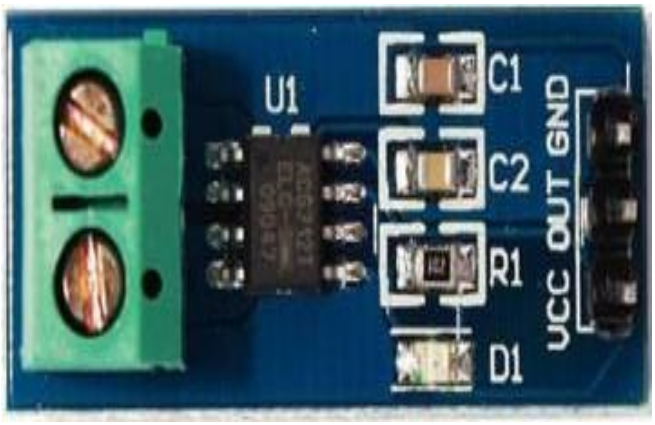

Fig.iv (Current Sensor)

This is used to measure the current delivered from the charger to the input charging port of the vehicle. The current measurements are required for further necessary calculations.

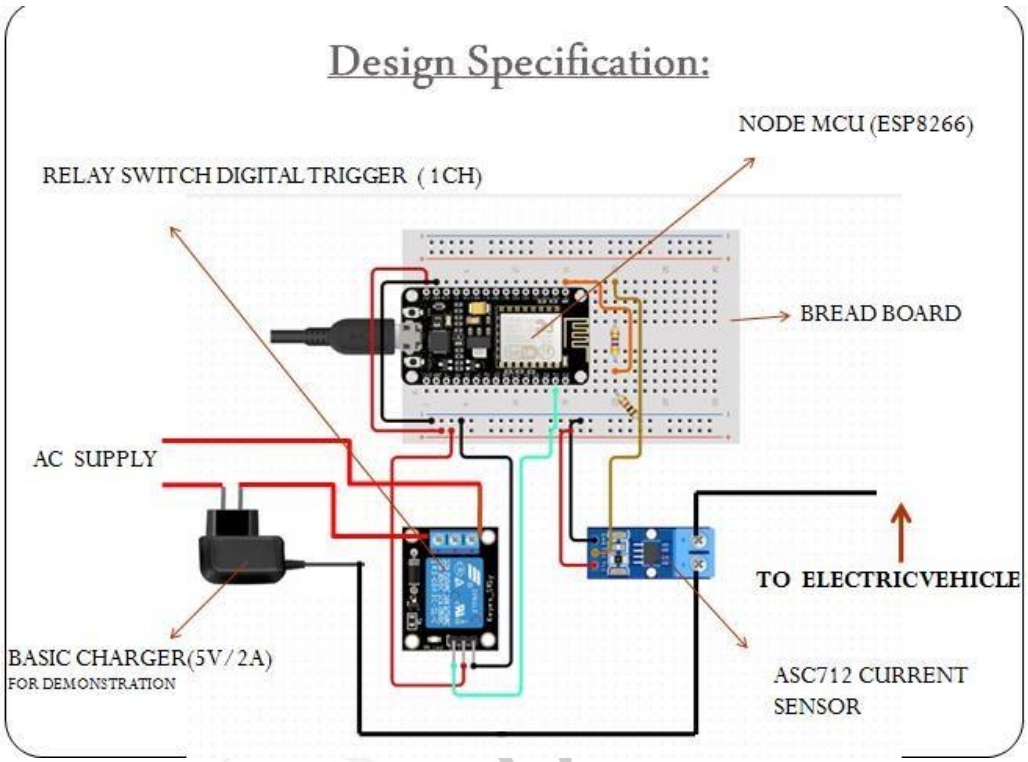

Fig.vi

As shown in the above figure the system is connected between the charging station output and the electric vehicle input charging port. The system is an integration of various electronic hardware. A complete circuit is shown in the above figure. NODE MCU (ESP8266) is used in the system which will control the rest of the system hardware like RELAY SWITCH and is programmed as per the requirement of the system. A basic charger is connected to the (System Design) supply mains of the charging station which will covert ac supply to dc supply and will bring supply to the desired limit. Further relay is connected for tripping actions whenever it will be required. Current and voltage measurement devices are included in the circuit to measure the power consumed by the user by calculating the value of current and voltage. The collected data will be sent to the server for further processing and applications.

Result and Discussions

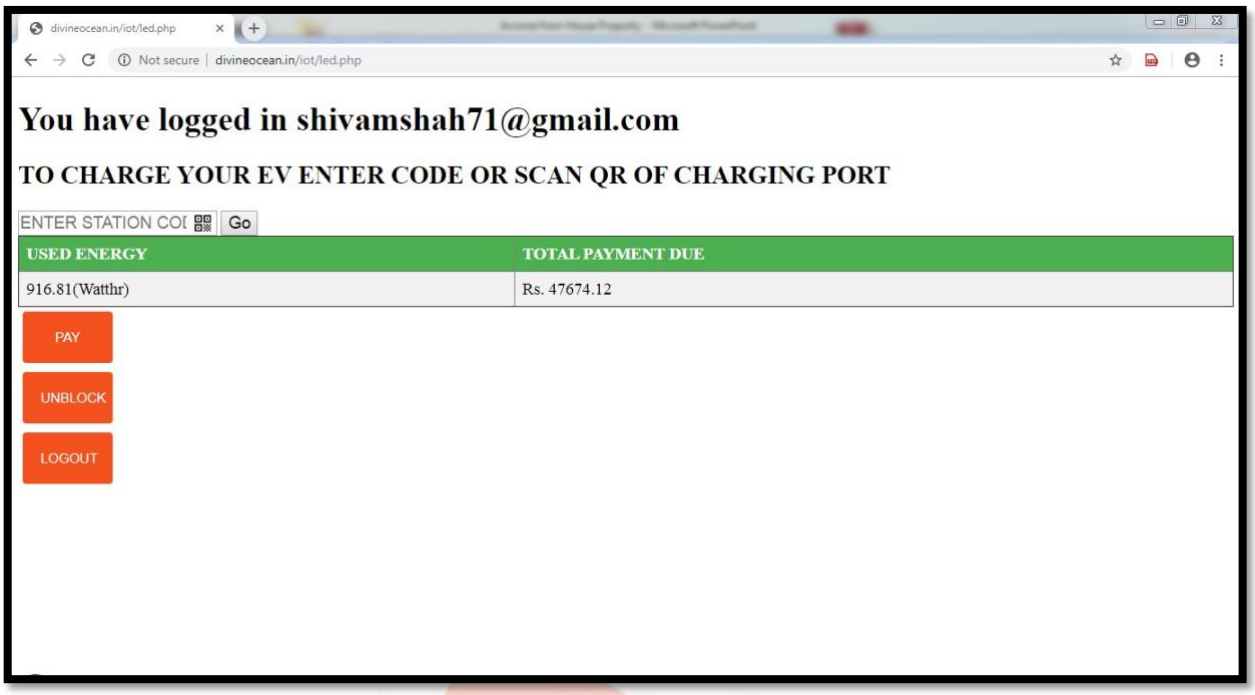

Fig.vii (User Interface)

The above figure shows the output as seen from the user's point of view. User can see the following things on the screen:

- The top most corner shows the information about the charging station on which the vehicle is being charged. One can either scan the QR code available at the station or can enter the unique station code and gets connected to the server.
- Down to that user can see the energy used by the vehicle which is being charged. The power being shown there is the electrical energy used by the vehicle while charging.
- Right to the used energy user can see the billing for the energy used by him. The billing rate may be anything and could be in any quantity.
- After the completion of charging, the amount will be fixed which is to be paid and user can click on the PAY button for the payment. The payment mode may vary as per the comfort of the user.
- Then there is an option as UNBLOCK. If the vehicle gets disconnected from the charging system either accidently or intentionally, the system will wait for 5 seconds for the vehicle to again get connected to the charging system and after that it will automatically cut the power supply to the vehicle. This situation is called BLOCKING and the user can again restart the charging process by pressing the UNBLOCK button on the screen.
- After completion if charging and payment of bill, the user ends the process by pressing the LOGOUT button on the screen. By this the system ends its charging process and is ready for charging another vehicle. The server also gets signal and it gets logout.

Summary and Conclusion:

This above project is the presentation of a single system which is installed on any one of the charging station. The charging stations spread throughout the city are having this system installed on them. This system provides an identity to the charging station which is unique for each of the system. This unique identity helps the server to detect several systems spread throughout the city and thus will centralize them all to itself. All the charging systems collects data and send it to server and server responds as per the instructions fed to the server. The action to be taken is fed already and system responds as per the data fed. So concluding all the points we can say that a complete electric vehicle charging system is ready. It is ready to control and monitor the charging of any electric vehicle. The system consist of billing facility which makes it future ready. The system centralizes all the charging stations on which it is installed. It connects all the stations to a common server system which controls the working of system. Thus Modeling And Integration of Electric Vehicle Charging System is successfully.

Reference

[1] Epica Mandal Sarkar, Ashish Nigam, "100% Electric mobility in India by2030." The Indian Express, 2017.
[2] Mehmet Cem Catalbas, Merve Yildirim, Arif Gulten, Hasan Kurum, "Estimation of optimal location for electric vehicle charging stations." Working of charging stations, IEEE 2017.
[3] R. Benger, R. Heyne, A Haubrock, "Sustainable fast charging stations for electric vehicles." 5th international renewable energy storage conference(IRES), 2017.
[4] Ciprian Vlad, Gabriel Murariu, "Using renewable energy sources for electric vehicle charging." IEEE 2013.

[5] Joao C. Ferreira, Vitor Monteiro, Alberto Silva, "Smart electric vehicle charging system." IEEE.
[6] Zhou, Z; Chan, W; and Chow, J. 2007. Agent based simulation of electricity markets: a survey of tools. Artificial intelligence.
[7] G. Franco and A. Sanstad, 2008. "Climate change and electricity demand in California."
[8] C. Crowley and F. Joutz, 2003. Hourly electricity loads: Temprature elasticities and climate change. In 23rd U.S. Association of Energy Economics North America Conference.
[9] Ugedo and E. Lobato, 2007 Generator Load Profiles Estimation using Artificial Intelligence. Intelligent Systems Applications to Power Systems, 2007