Efficient Energy Metering for Electric Vehicle Charging Infrastructure

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Abstract

In the 21st-century, our planet is facing global warming because of high carbon emissions. Every country has acknowledged this issue and is taking steps to push the Electric Vehicle (e-vehicle or EV) system within the trade. For this purpose, e-vehicle charging infrastructure is required with less capital investment. Several trade consultants see charging infrastructure as a key hurdle for the expansion of this market and hence, the need for big-ticket investment. Public Electric Vehicle infrastructure is often settled in massive metropolitan areas. Supporting facilities like DC/AC charging with sensible energy metering using the support of leading eye technology is important element charging infrastructure. All of these make charging infrastructure one of the key areas to stress upon for native communities who wish to partake in the economic advantages that Public Electric Vehicle represents.

In this paper we propose smart metering system to measure the electricity consumed by the Electric Vehicle during charging at these stations and dispatch the bill as per consumption. IOT system is also proposed to collect data of the charging vehicle along with its billing history, to analyse utilisation and efficiency of the charging infrastructure.

Keywords: *E-vehicle, DC/AC charging, IOT.*

1 Introduction:

IN 2020, under developed countries have proven the potential in the development of industrial goods, automotive, packaging, import and export business, etc.

India has shown faster economic growth rate with large consumer base and highest young population. India has capacity of good volume of export in some sector but largely depends on oil import (9.7% of total. World volume) from various countries. The air quality index (AQI) of India is poor. India's CO2 emission is somewhat slowdown in 2019 due to some important measures taken and focusing on renewable energy generation (175 GW target by 2022).

Air pollution contributed by vehicles is 27% and is a key area providing challenges in the design of sustainable mobility services. The design of Electric vehicles and supportive charging infrastructure is a need of time for each country.

2 Necessıty

What are the challenges faced by India’s electric mobility initiatives?

• Rising oil imports – A vital security challenge

Since the early 2000s, India's fossil fuel imports have steadily increased, reaching a peak of 4.3mb / d1 in 2016. In 2016, oil demand increased by 5.1% in 2016 compared to the US (0.7%) and China, the world's largest net importers. (2.9%), India is the world's third-largest fossil fuel consumer. India's petroleum deficit is $ 52 billion in 2017 and a total loss of $ 109 billion. This petroleum deficit is projected to reach $ 100 billion in 2019, of a total of $ 202 billion.

• Rising pollution levels – An environmental challenge

India is the third-largest carbon emission country in the world, representing six of the total CO2 emissions from fuel combustion. In India, 14 of the 20 Dirty Urban Networks on the planet are united with the WHO Overall Deflation Database (2018).

• Rising population – A sustainable mobility challenge

India's current population is expected to grow from 1.2 billion to 1.5 billion by 2030. Of the 1.5 billion population, 40% of the population is measured in urban areas, compared to 34% in the 2018 population projection. An additional 6% increase is likely to put further strain on the country's struggling urban infrastructure, including the growing demand for sustainable mobility solutions.

• An evolving global automotive market – Resulting in transition-based challenges

India is the fourth largest in the world producing combustion engine (ICE) based automobiles. Vehicle advancement in India has been phenomenal in 2017, achieving 9.5% speed in 2017. Nonstop improvements in the manufacture of ordinary vehicles and the rapid growth of electric vehicles are likely to provide a test for the current car showcase. The country does not plan its transition to new mobility solutions and develops the desired productivity. Electric mobility is a good solution for India.

3 Market Analysıs

In India, the Bureau of Indian Standards (BIS) has written IS 15886 for the standardization of electric and hybrid vehicles. ARAI has written some standards. These include current international standards IEC 61851-1 (General requirements), IEC 61851- Bias 3 (Electric Vehicle Charging Station) and IEC 61851 Charging System). -24 (digital communication). The ARAI Automotive Trade Commonplace (AIS) document must be booted for CMVR-like approval for hybrid electric vehicles located next to AIS-102 (Part One and Two), AIS-123 Hybrid Electrical Approval and Approval Process of CMVR-like Retro-Fitment AIS 131 State plans for electrical and hybrid electrical vehicles offered in the market for pilot/demonstration are considered. At the end of 2017, the Great Industry Ministry set up a committee on the standard of protocols for electric vehicles, which set standards for charging stations - the Asian Nations EV Charger AC - 001 and the Asian Nations EV Charger DC – 001 [1].

They need to be deployed to better operate the charging infrastructure for electric vehicles with a focus on electro-mobility. This paper aims to develop a framework for proposed methods for the infrastructure of EVs and also compares the various technologies available in the current scenario. In addition, different charging methods and parameters are considered for the practical understanding of the different charging characteristics and comfort infrastructure of battery electric vehicles[2].

Infrastructure charging can be a major factor for EVs to move smoothly to e-mobility. Smart charging of EVs provides greater penetration and renewable power of EVs, reduces charging costs and makes better use of grid infrastructure [3].

Battery-to-wheel use of EVs is part of basic mechanical imperialism on wheels, guided by moving parameters such as headers, drivetrain capacity, and auxiliary power. As a part of the kinematic parameters that reflect the development of the vehicle, all the mechanical force required on the wheels can be expressed in the position of the vehicle elements.

Parameters describing vehicle movement can be expressed in the vehicle dynamics equation:

$$\mathbf{E_{ij} = 1/3600[m_{ij}.g.(f.\cos\text{Ø}+\sin\text{Ø})+0.0386(\rho.C_x.A.v_{ij}^2)+(m_{ij}+m_f).dv/dt]d_{ij}}$$

Where,

E_{ij}= mechanical energy required at the wheels to drive a distance d_{ij}[KWh]

m_{ij}= total vehicle mass [kg]

m_f = fictive mass of rolling inertia [kg]

g= gravitational acceleration [m/s^2]

f= vehicle coefficient of rolling resistance [-]

Ø= road gradient angle

ρ= air density [kg/m^3]

C_x= drag coefficient of the vehicle,

A= vehicle equivalent cross section [m^2]

v_{ij}= vehicle speed between the point I and the point j[km/h]

d_{ij} = distance driven from point I to the point j[km]

Service Addressable Market:

As per the analysis of passenger vehicle sales in India and GDP per capita, barriers cited for E-mobility, and the analysis of charging infrastructure is increasing w.r.t per year and has gave rise to increase in e-vehicle infrastructure.

Major hurdles in deployment electric vehicles in India:

The deployment of electric vehicles in public and personal transport has some barriers as shown in Fig 1.

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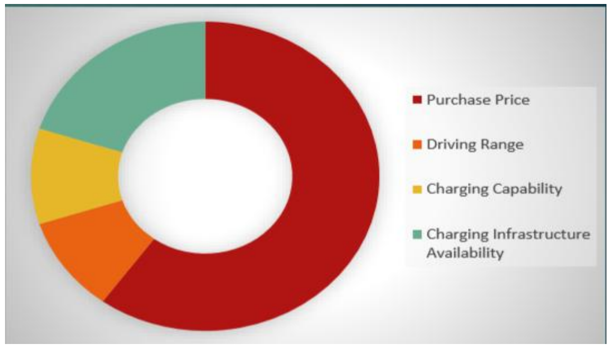

Fig 1: Highlights of Consumer Survey on Barriers to purchase electric vehicles in India.

The investigation of passenger electric vehicle sales in India and GDP per capita is shown in Fig 2. The ANS Market analysis Group has predicted the market potential for e-vehicle sales. Along with this, the e-vehicle charging infrastructure is necessary to develop and deploy as shown in Fig 3.

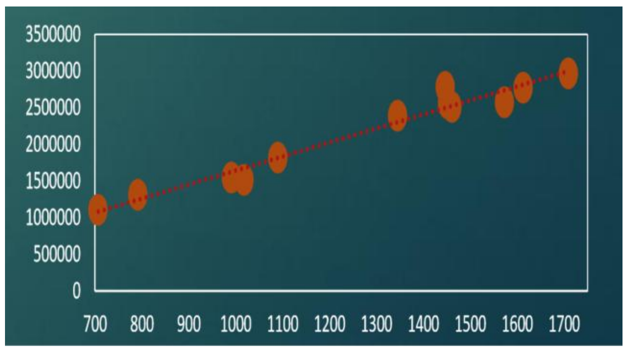

Fig 2: Passenger electric vehicle Sales in India and GDP Per Capita.

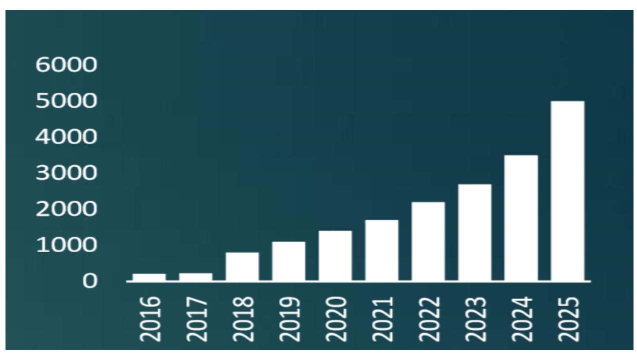

Fig 3: Charging infrastructure increasing w.r.t to per year.

The lawmaking body of the Asian nation needs to check around 6,000,000 electrical and creamer vehicles in the city by 2020 underneath the National electrical quality Mission engineer (NEMMP) 2020 besides, speedier adoption and creation of Hybrid and Electric Vehicles (FAME).

• FAME Asian country topic was implemented with the objective to help crossover/electric vehicles' market improvement and delivering eco-framework.

• The theme has three focus areas, i.e. Technology development, Demand Creation and Charging Infrastructure.

• The Asian countries had 1, 63, 032 electric vehicles on street till October 2017. They were mostly 2-wheelers and 3-Wheelers in Tier I and II cities. With the value per capita growth, increase in personal income and heightened environmental issues by the voters of Asian nation the electric vehicle market is slated to grow at healthy rate within the forecast period of 2017-2025.

In Reference [6] Fast charging for an e-vehicle with the photovoltaic power generation system. This power study about the layout of charging station and its benefits.In Reference [7] A probabilistic approach to combining smart meter and electric vehicle charging data to investigate distribution also impacts. Paper gives probabilistic method to combine smart meter and real world electric vehicle. This is to study the ……… of e-vehicle. They had considered urban and rural area to show That distribution networks are not homogeneous and can have different capabilities to find the best way to charge E-V. In reference [8] The world electric vehicle journal accepts the information from various sources like battery technologies, charging infrastructure etc., so that one can gain latest knowledge, technology about E-vehicle. In reference [9] represents the study about the fast charging of batteries in E-vehicle, which is the most important factor. For this purpose they consider AC-DC power supply which is use to verify AC voltage from power grid and it is followed by DC-DC converter which is used to control battery charging and discharging process. In Reference [10] This paper studies about smart EV charging system. The system uses vehicle to grid technology (V to G), so that not only electric vehicles but also renewable energy sources can be connected to Smart grid. Also they are using mobile application mobile application to store login ID, password, personalize charger information, weekly, monthly charging statistics. Also they are calculating distance of travelling through map so as to calculate battery efficiency of e-v. In Reference [11] This paper presents the study about charging of an electric vehicle using photovoltaic(PV) technology. It is expected that the PV grid integration with charger will be more demanding because of several reasons like continuous reduction in the cost of PV modules, availability etc.

4 System Methodology

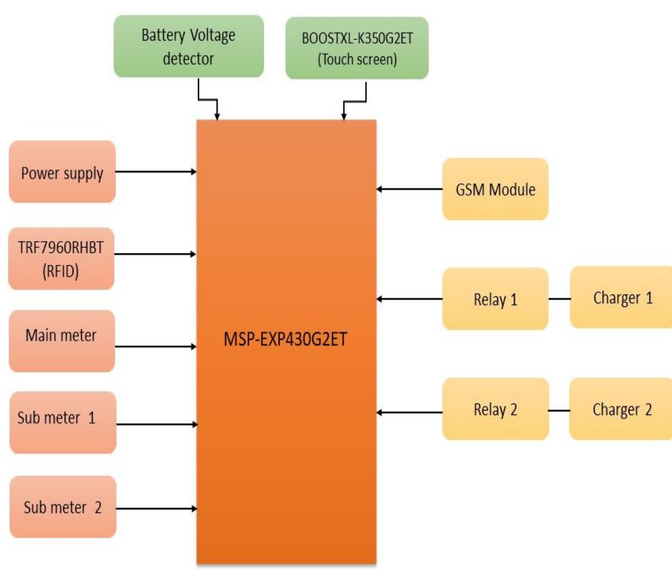

Fig 4: Block Diagram of E-metering.

1. LCD display:

In this project, we are using Nextion display (480*272). Following messages would be displayed:

a. Battery status (in percentage)

b. Previous balance (in Rs)

c. Remaining balance (in Rs)

d. Customer's name etc.

We have chosen this display because of its high resolution which can enable the display of long messages and is also suitable in IOT (Internet of Things).

2. Radio Frequency Identification (RFID):

RFID system is used to identify the customer. For this we are using RFID tags which can store information electronically. By putting RFID tag per user module data of a client can be taken.

3. Analog meter:

Analog meter is used to measure the amount of electric energy consumed in kilowatt per hour (KWH).

4. SIM 800 module (GSM module):

After complete charging of a vehicle, message will be displayed on customer mobile. This message will include information such as previous battery status, current battery status, amount which is required to charge the vehicle (in rupees).

5. Relay (10A 250v AC, 10A 30v DC):

A relay is an electrically operated switch. It contains a great deal of information terminals for a lone or different control signals, and a ton of working contact terminals. The switch may have any number of contacts in different contact structures, for instance, make contacts, break contacts, or blends thereof. Moves are used where it is imperative to control a circuit by a free low-power signal, or where a couple of circuits must be obliged by one sign.

6. MSP430G2ET

The MSP430G2ET is part of the MSP430 family of ultra-low-power MCUs, which include a variety of devices with different types of peripherals intended for different applications. Architecture, combined with five low-power modes, is optimized to achieve extended battery life in portable measurement applications [4].

Working:

Ideal orchestrating of Electric vehicle charging is a need to check the broadening burden on the cross-area by utilizing battery voltage indicator as often as possible, the yield of the comparator used to least microcontroller in the system that the battery is low and needs to be charged. By using RFID cards on an electric vehicle approaching the charging station, the card would be scanned using the RFID System and the user's name will be detected. Time selection screen will pop on the display to select the time and charging relay will turn on. The data would be flashed on the screen- battery status, remaining time, and balance amount and it will additionally message this detail through the GSM Module on the Mobile Handset. All the data (charging time, battery status, balance, time at which it was associated etc) will be sent to the cloud for examination.

Flow chart of the system:

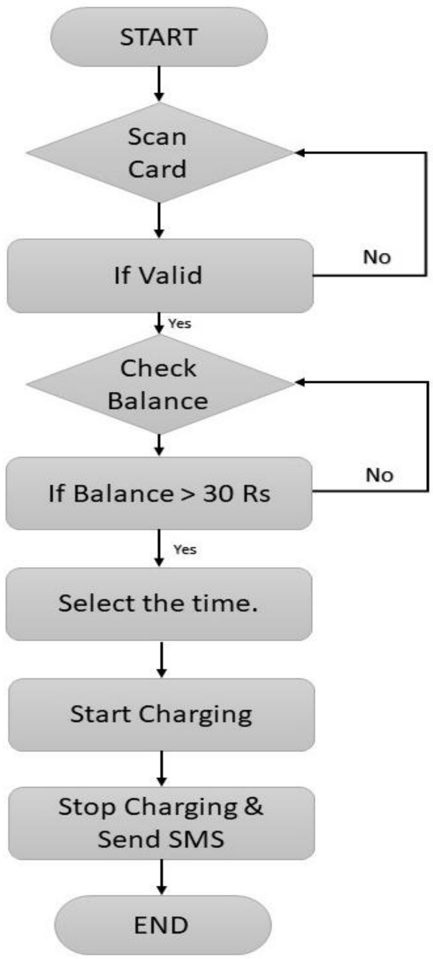

Fig 5: Flowchart of system

Result Analysis:

Initially e-vehicles arrives at the charging station, the user will scan the Provided RFID card where the Screen will popup the message as shown in Fig. 6. After swiping the card this screen will popup the message where user has to select the time vehicle charging (see Fig. 7).

Fig 6: Swipe the card for charging vehicle

Fig 7: Select time with respect to price

When user selects the time the information about the amount balance in the RFID card, the battery status and the time left for the charging will be reflected on screen as shown in Fig. 8. After completing charging of the electric vehicle, the message of "Charging Completed" will get displayed (see Fig. 9).

Fig 8: status of the Electric vehicle.

Fig 9: charging completed

The GSM module would send a text message saying “Electric vehicle is charged__ %” on the user’s mobile device.

IOT Results:

During the charging process, real-time data is uploaded on cloud through the process of IOT Function. IOT plays the major role by providing access to real time data during charging of e-vehicle. Data of following things can be shown with the IOT system: Balance (in rupees), unit consumption (in Kwh) & real time battery status. Fig. 10, Fig. 11, Fig. 12 shows data and its graphical presentation in real-time.

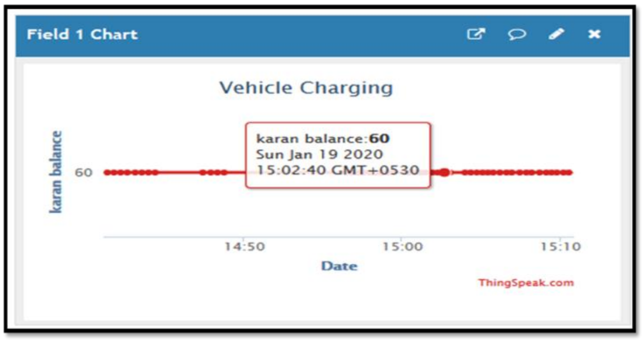

Fig. 10: Balance on RFID Card with Respect to time

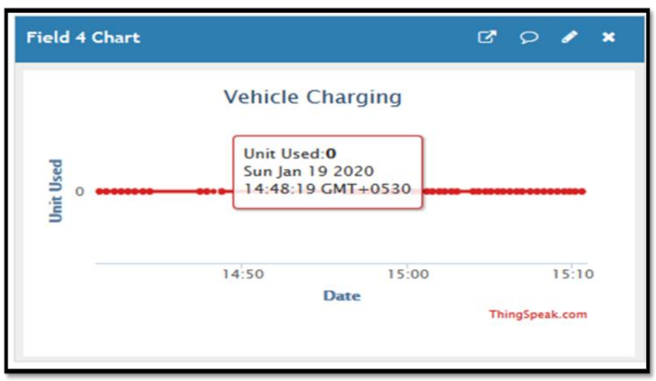

Fig. 11: Amount of unit Consumed with respect to time

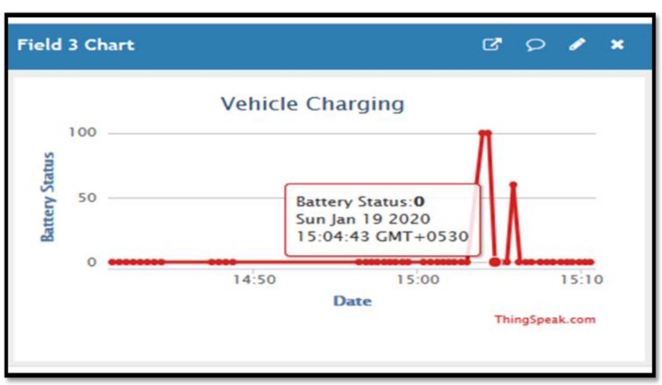

Fig. 12: Battery status when connect for charging with respect to time

5 Advanatages

- It can be used for the mapping the future electric energy requirement for the EV charging infrastructure system.

- It will also enable real-time tracking of electrical consumption and vehicle charging infrastructure utilization.

- IOT enhances the charging infrastructure system with data base analysis.

6 Future Scope

- Mobile app can be developed considering the customer and e-vehicle user requirement.

- The IOT data can be shared with e-vehicle industries. This would help in their evaluation and performance and its supporting system.

7 Conclusıon

Smart energy metering for an Electric Vehicle charging station is an integrated part of complete infrastructure. This enables charging infrastructure operator to charge the Electric Vehicle in the form of INR/kWh, INR/min, etc. The system has additional feature of Internet of Things (IOT) where we are monitoring status of energy unit consumed, time required and battery charging status. The statistical analysis on this parameter can be shared with vehicle owner /automobile industry/ battery manufacturer. Tariff shall be charged as per state government guidelines. Utilities can install and maintain the Public Smart Energy Metering for an Electric Vehicle charging stations while the participants like housing complexes or shopping malls will own and operate them. Utilities could build, own and operate the charging stations and offer customers the facility to charge their Electric Vehicles at standardized rates.

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