Two-Tier Energy Compensation Framework Based On Smart Electric Charging Station

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Abstract: **Traditional cars produce a lot of carbon dioxide (CO2) emissions that are ejected into the atmosphere, causes pollution and greenhouse gases today, electric vehicles (EVs) have received much attention as an alternative to traditional vehicles. The traditional vehicles are powered by internal combustion engines. The electric vehicle is developed because of the advancement in battery technology and motor efficiency. The secondary batteries are the main energy sources of the EV. Thus, energy management is the key factor in EV or Hybrid Electric Vehicles (HEV) design. Moreover, the charge capacity of the battery will influence the endurance of electric vehicles. The main challenge in the HEV is the charging time required for the batteries and insufficiency of charging stations (CS) and therefore charging within existing distribution system infrastructure is problematic. Up to now the HEV‟s CS is in the range of 100 km per charge due to the on-board energy which is needed to be optimized. The second challenge for the EV‟s is their battery capacity which ranges from 8.6KWh to 15.2KWh. The consequent disadvantage is that the charging time for above mentioned size, in a level 1 household charger (120V, 50Hz, 15-20A) is more than 15 hours. Due to these constraints, the vendor (EV charging station supplier) needs a convenient distribution system to cater to customer demand as well as maximize benefits. A special attention must be given to the charging station. In future, the number of electric vehicles will be increasing to a greater extent; these electric vehicles have to re-charge their battery in a place (i.e.) charging station, so there will be a growing need of public accessing charging stations. This will have a significant impact on the power systems like transformers, protection devices etc. With respect to the varying load, it will have an impact on the consumers and vendors due to the traffic at this station, waiting time for charging the vehicles will increase etc.**

Therefore both the consumer and vendor will get assistance from a communication system which shares useful data regarding the charging station, whether the charging slots are free, rate at which charging is done, cost per unit etc.

Index Term-Energy Compensation, Charging Station, Electric Vehicle

I. INTRODUCTION

Smart Charging is an umbrella term that defines all intelligent functionalities in EVBox‟s charging stations that optimize the charging infrastructure by creating and distributing the available power in efficient and flexible manner. With smart charging, not only would you avoid unnecessary costs such as overcapacity fees, but you will also get the most out of your charging stations in case of limited power capacity, anytime, anyplace.

Plug-in electric vehicle (PEV) commercialization propels an extensive charging station deployment in a power distribution system to satisfy fast growing PEV charging demands.

Considering the power distribution, some stations deployed at limited capacity feeders may undergo power overload at peak hours due to time-varying traffic and PEV demands. The potential power overload could lead to severe transformer degradation or even black-out on the aged power infrastructure. To avoid power overload without excessive expenditure on the infrastructure upgrade, proper energy compensation at limited capacity station is highly effective. In this project, we investigate an energy compensation problem based on utility-owned mobile vehicular electric storage (MVES), aiming to mitigate the overload issues among a group of charging stations (GCS). In this project, theory-based GCS transportation model is developed to facilitate on-road MVES all location. Then, a two-tier energy compensation framework is introduced to efficiently schedule MVESs to minimize the scheduling cost.

1.1 Need of this concept
Fast Charging stations.
Overload on system gets increase due to large increase in electric vehicles.

2.1 Objectives of concept:
To avoid overload on system.
It avoids manpower as good as possible.
To develop an automatic system.

II. LITERATURE SURVEY:

2.1 What is Two-Tier Energy compensation framework: -

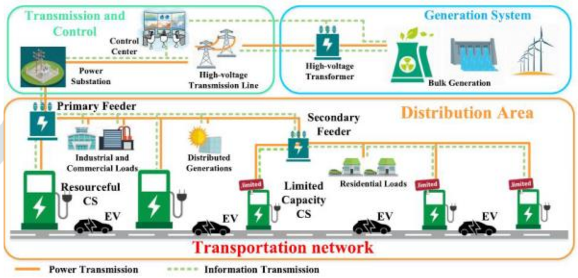


Fig. Transportation network

The goal of this project is to develop an energy compensation scheme that uses MVESs to effectively mitigate the overload issues timely and cost-efficiently. The incorporation of GCS operation modeling and a two-tier energy compensation framework guarantees a predictable and timely energy balance among GCS with minimal cost. To fully utilize the on-road local resources, an energy compensation framework is introduced, as shown in Fig. 4. The framework is operated on two tiers with central controller on the upper tier and charging stations on the lower tier. In terms of fluctuating traffic volumes, the framework operates hourly to provide analysis and guidance for the next-hour operation.
A. Upper Tier Operation
The central controller on the upper tier starts to perform the hourly operation scheme at time Tclock by requesting the energy information of each station (e.g. MVES energy demand of limited capacity station and MVES charging capacity of resourceful station). Once the central controller receives the energy demand information from all stations, it starts to schedule MVESs charging and discharging, which consists of two stages:
Stage 1. MVES Transportation Route Scheduling
Stage 2. MVES Energy Scheduling
B. Lower tier operation
Limited capacity station qf - once station qf receives the Information request from the upper tier, the station dynamics will be analysed with the traffic data input. Through the Two-dimensional markov‟s chain analysis, the next-hour energy Demand forecast will be obtained and sent to the upper Tier. Then, upon receiving the scheduling results from the Upper tier, station will operate accordingly. In this project, we study an energy compensation problem that utilizes MVESs as flexible energy porters via Vehicle to grid (V2G) technology. Belonging to the local power utility company, MVESs are large battery-capacity PEVs that specialized in being recharged with additional energy at nearby available resourceful stations, and then deliver the energy to overloaded stations in their peak hours. Since the charging demands are strongly correlated to the on-road traffic condition, the service requests modelling at the charging stations should consider the stochasticity of PEV traffics. In terms of power balance at a charging station, the heterogeneity of arriving PEV State-of-Charge (SoC) also affects the station dynamics over time. From the resource allocation perspective, energy demands need to be satisfied while minimizing the MVES scheduling cost and enhancing the time efficiency of energy transmission. In this problem, the challenge can be abstracted as how to allocate the MVES energy distribution and transportation route among a GCS to balance the power and minimize the scheduling cost.
In general, the reviewed works either use the existing energy in PEVs as additional energy source or consider PEVs as energy porters to transmit additional energy. However, PEVs‟ potentials of mitigating

PEV charging overload remain open. The goal of this paper is to develop an energy compensation scheme that uses MVESs to effectively mitigate the overload issues timely and cost-efficiently. The incorporation of GCS operation modelling and a two-tier energy compensation framework guarantees a predictable and timely energy balance among GCS with minimal cost.
During the last years, Uppsala municipality has tightened its climate policies. In 2030, the goal is that emissions from energy use, transports and work machinery should be close to zero. By 2040 the gathered emissions from the whole municipality shall be close to zero, corresponding to a decrease of almost 90% of 1990"s emissions. By 2050 Uppsala strives to become climate positive, which means exceeding 100% decrease in gathered emissions (Lindström, 2015). New smart technologies must be implemented in order for these goals to be reached. One proposal is a wider use of electric vehicles. Today an increasing number of car manufacturers are offering EVs in their range of products, leading to a growing electric vehicle fleet in society. EVs need to be charged, implying an additional load for the electric grid. The current passenger car fleet in Uppsala municipality consists of 84 137 vehicles (SCB, 2018a). On average, every vehicle is driven 12000 km per year. If every vehicle were supposed to be electric and is consuming 20 kWh per 100 km on average, the estimated consumption is 0.20 KWh per year, which makes up about 6.25% of Uppsala municipalities total yearly consumption (Länsstyrelsen, 2015). Research shows that energy usage (unit: kWh) will not be the problem but the instantaneous power demand will (unit: kW) (Nordling, 2016, p. 15-17). Electrical grids are designed with an upper load limit, expected to be exceeded with an increasing number of electric vehicles on the roads. Instead of raising this limit, one idea to solve the problem could be to use smart charging.

I. Block Diagram Of The System:

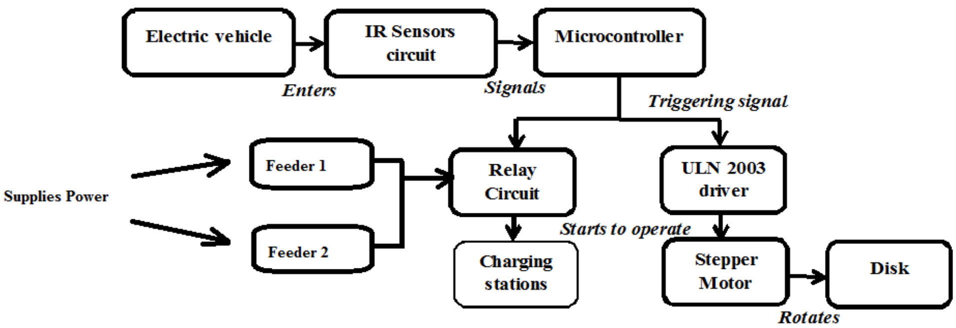


Fig: Block Diagram Of system

Block Diagram of overall system is shown in fig 3.1. All components in the working model are illustrated in above block diagram. As vehicle enters in gate, IR sensors mounted at entrance will gets triggered and starts operating and gives signal to microcontroller as shown. Microcontroller controls every operation performing in the circuit. After the IR sensor's signals relay and ULN driver starts to operate. In that case, by using relay interlocking mechanism, when feeder1 is gets overloaded supply automatically switches on feeder 2. And after obtaining relay signal the charging station gets on and vehicle starts charging. After charging completion signal is again sent to microcontroller, and thus microcontroller again provides signal to relay and charging stops. In parallel the programs in ULN results in rotation of disk platform in correct angle and placing vehicle at suitable charging station.

II. Working of Project Model

Three charging stations of different capacity are designed near the disk platform. Each charging station has different capacity i.e. 500W, 1000W, and 1500W for Cars, Minitrucks and Trucks respectively and they are named as Charging station 1, Charging station 2, Charging station 3 respectively. IR Sensors are connected beside the road at entrance in order to determine size of vehicle and by which capacity of battery should determine.
The size of car is determined by signals of IR sensors i.e. how many rays are get cut by vehicle. IR Sensor is a device that emits in order to sense some aspects of the surroundings. As size of vehicle get determined

signal is sent to controller and it is given to stepper motor through ULN. Thus, the vehicle gets placed on disk platform and disk starts rotating as per given angles. As per the vehicle size disk rotates till it comes in front of its suitable charging station. Charging stations are represented by batteries in working model.
The LCD will indicate the battery charged in percentage. After charging completed the vehicle exits through disk. And system works similarly for different sizes of vehicles.

While developing Two-Tier energy compensation framework the automatic system is designed to prevent overloading on feeders. It is such that when one feeder is gets overloaded while charging two batteries system automatically switches on feeder 2.

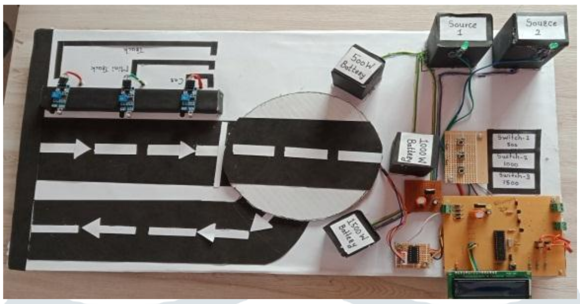


Fig. Working Model of project

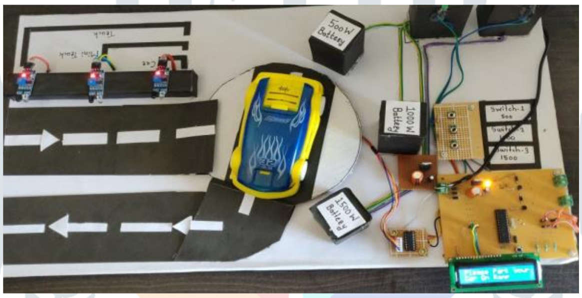


Fig. Vehicle is detected (Initial Position)

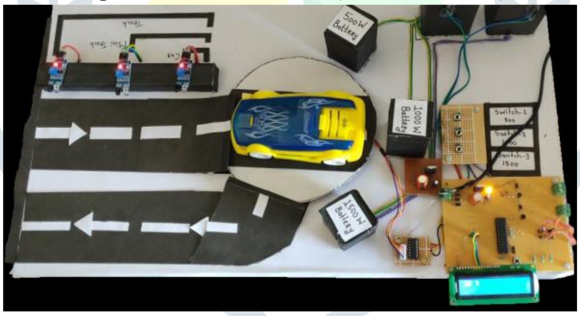


Fig. Vehicle is charging

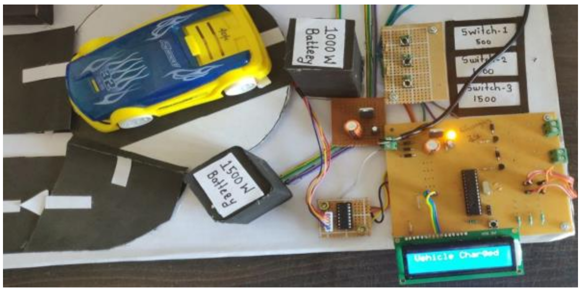
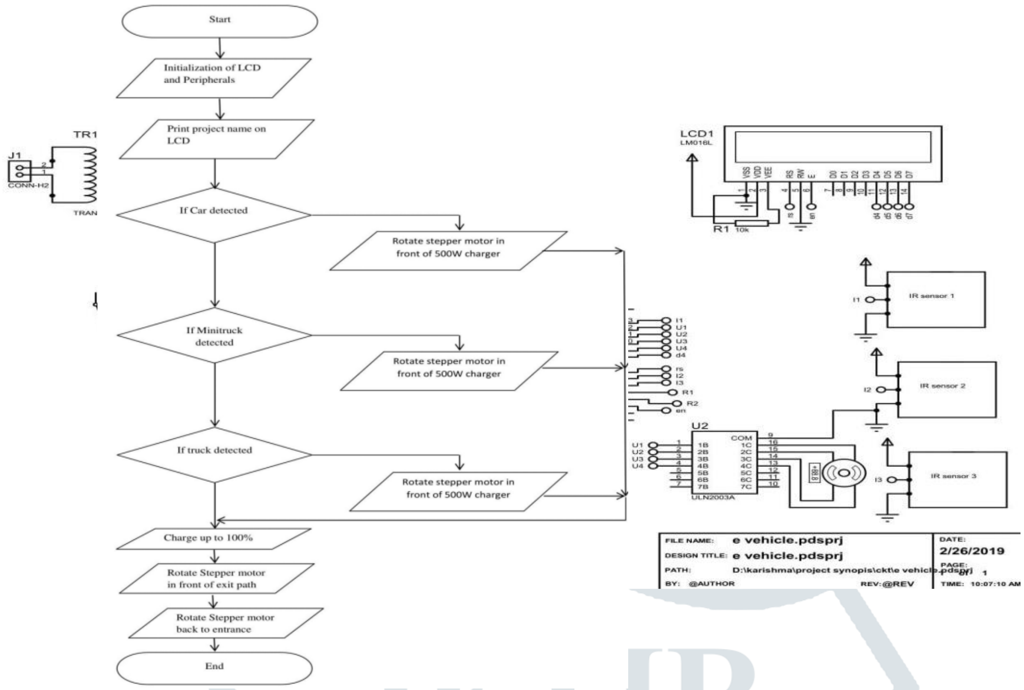


Fig. Charging is completed

Flowchart:



III. Circuit Diagram Of Module

Fig: Circuit diagram of working module

In 16*2 LCD there are 16 pins over all if there is a back light, if there is no backlight there were 14 pins. One can power or leave the back-light pins. Now in the 14 pins there are 8 data pins (7-14 or D0-d7), 2 power supply pins VSS&VDD, 3rd pin for contrast control (VEE- controls how thick the characters should be shown and 3 control pins (RS&RW&E).
The connections which are done for LCD are given below:
PIN1 or VSS to ground
PIN2 or VCC to +5v power
PIN3 or VEE to ground
PIN4 or RS to PIN7 of ARDUINO UNO
PIN5 or RW to ground
PIN6 or E to PIN2 of ARDUINO UNO In 16*2 LCD there are 16 pins over all if there is a back light, if there is no backlight there were 14 pins. One can power or leave the back-light pins. Now in the 14 pins there are 8 data pins (7-14 or D0-d7), 2 power supply pins VSS&VDD, 3rd pin for contrast control (VEE- controls how thick the characters should be shown and 3 control pins (RS&RW&E).
The connections which are done for LCD are given below:
PIN1 or VSS to ground
PIN2 or VCC to +5v power
PIN3 or VEE to ground
PIN4 or RS to PIN7 of ARDUINO UNO
PIN5 or RW to ground
PIN6 or E to PIN2 of ARDUINO UNOThe stepper motor has 4 terminals namely Terminal 1, Terminal 2, Terminal 3, Terminal 4. They are all connected to ULN 2003 driver on PIN 13 to PIN 16 respectively and PIN 1 to PIN 4 of ULN 2003 is connected to PIN 9 to PIN 12 Of ARDUINO UNO.

The IR Sensors consists of 3 terminals named as V0, +5V VCC, GND. The connections of three IR Sensors used in this project are below:
VCC terminals of All IR sensors are connected to +5V DC supply.
GND terminals of All IR sensors are connected to ground.
The V0 terminal of IR Sensor 1 is connected to PIN 13 OF ARDUINO UNO.
The V0 terminal of IR Sensor 2 is connected to PIN 6 OF ARDUINO UNO.
The V0 terminal of IR Sensor 3 is connected to PIN 5 OF ARDUINO UNO.

IV. Future Scope :

Due to energy compensation concept and smart charging station leads to minimum human errors occur, less time, automatic working.
1. A lot of advancement can be done in this project in future. We can design the model in which more than single vehicle can charged.

2. While charging multiple vehicles in future we can also increase number of charging stations according to requirement.

3. Wireless charging also can be implemented on disk platform.

4. By using this technique very fast work will done without any load on system and which will also lead to sustainable growth towards renewable sources.

V. Result

1. Automatic car charging is possible.
2. Compact in size so takes less space.
3. Overload on system reduces.
4. Renewable energy sources can be used efficiently.
5. Time saving due to DC fast charging technique.
6. Human errors can be avoided.
7. Only one vehicle can be charged at one time.

VI. Applications

1. It can be used in the big companies for charging facility.
2. It can be used in commercial purpose.
3. It should be used by government by which will give rise to use of renewable energy sources.

VII. Conclusion

In present days, vehicles are charged manually the main disadvantage of this is that one person must be engaged for this. At the same time during that time he could not be engage in another task. To overcome from this, we have decided to prepare the circuit which will be operated automatically and charging of vehicle will start by its own time. This circuit is simple to prepare and easy to install.
A two-tier energy compensation framework has been introduced to effectively use MVESs as energy porters at peak hours. It is concluded that as battery technology develops, the increasing MVES energy transmission efficiency can lead to a wider transmission coverage and more flexible scheduling. Further, strict station availability requirement can result in drastic increment of scheduling cost, leading to a trade-off between the station availability and scheduling costs.
Based on the introduced energy compensation framework, the cost-efficient MVES scheduling scheme can be applied to the local power utility company to address the overload issues without excessive facility upgrade expenditure. In our future work, we will propose an incentive mechanism to encourage private MVESs participating in the energy compensation scheduling to fully utilize the on-road energy sources.

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