Project Report on

Battery Swapping Station (BSS)

AT

TATA POWER DELHI DISTRIBUTION LIMITED

SUBMITTED BY:

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Roll No: 2K21/EMBA/06

Under the Guidance of

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CERTIFICATE

This to certify that Anuj Sharma, 2k21/ EMBA/06 has submitted the major research project titled `Battery Swapping Station` under the guidance of Mr. Dhiraj Kumar Pal, in partial fulfilment of the requirements for the award of Master of Business Administration (Executive) from Delhi School of Management, Delhi Technological University, New Delhi during the academic year 2022-23.

Research Supervisor	HoD, DSM
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Assistant Professor, DSM	Associate Professor, DSM

DECLARATION

I, the undersigned, solemnly declare that the report of the project work entitled Battery Swapping Stations, is based my own work carried out during the course of my study under the supervision of Assistant Professor Mr. Dhiraj Kumar Pal. I assert that the statements made, and conclusions drawn are an outcome of the project work. I further declare that to the best of my knowledge and belief that the project report does not contain any part of any work which has been submitted for the award of any other degree/diploma/certificate in this University or any other University.

Name of the Candidate: ANUJ SHARMA

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1 ABSTRACT:

Tata Power Delhi Distribution Limited (TATA Power DDL) is a joint venture between Tata Power Company and the Government of NCT of Delhi with the majority stake being held by Tata Power. It distributes electricity in North & Northwest parts of Delhi and serves a populace of 50 lakh. The company started operations on July 1, 2002 post the unbundling of erstwhile Delhi Vidyut Board. With a registered consumer base of around 18 lakhs and a peak load of around 2000 MW, the company's operations span across an area of 510 sq. km.

TATA Power DDL in its area has approx. 60 grid/offices for electricity distribution. Today transportation sector has facing many problems with conventional vehicle like petrol, Diesel and CNG vehicles which releases most of the pollutants like CO2 and nitrogen oxide emissions which ultimately have effect on human health, so decrease this problem there is introduction of Electric vehicle but to fix battery EVS the owner of the vehicle should wait for long hours to charge one vehicle and if vehicle stops in any remote area then it is difficult to charge the battery. So to reduce this problem and to increase electrical vehicle usage the solution is to use battery swapping stations and mapping the arear for easily adoption of the EV vehicles.

The BSS may calibrate its subsystem for the EV deployment by accomplishing similar idea as in refuelling stations, in this the discharged batteries are being replaced or swapped by partially or fully charged ones by spending a few minutes. The BSS approach has arisen as a promising technology to the traditional EV recharging station approach as it provides a broader experience of business prospects to the market. This work deals with the introduction to BSS including infrastructure, techniques, benefits over charging station and key challenges associated with BSS.

2 EXECUTIVE SUMMARY:

Battery swapping technology offers the best alternative to slow charging and helps the drivers make optimum use of the operational hours. Providing adequate charging infrastructure plays a momentous role in rapid proliferation of Electric Vehicles (EVs). A Battery Swapping Station (BSS) is an effective approach in supplying power to the EVs, while mitigating long waiting times in a Battery Charging Station (BCS). In contrast with the BCS, the BSS charges the batteries in advance and prepares them to be swapped in a considerably short time. Considering that these stations can serve as an intermediate entity between the EV owners and the power system, they can potentially provide unique benefits to the power system.

As we set out towards a 'greener environment' and government acting sternly towards achieving the targets, the emergence of electrically powered vehicles is more evident than ever before. National capital region is one of the most polluted cities across the world and use of EV is the ultimate solution to curb the issue. After an extensive market survey and discussion with various interested stakeholders/investors, it was concluded that if land is made available to such investors at affordable rates, they are ready to invest in creation of charging infrastructure/battery swapping station for promotion and use of E vehicles. A sustainable model was worked out in which Tata Power-DDL offers space on rates per sq. feet with Revenue sharing model at various Locations spread in North & Northwest Delhi.

3 INTRODUCTION:

Going green" dominates the entire world because of sustainability. But the dependence on energy intensity upsurges the chances of environmental degradation over time globally. According to the IEA, one of the largest contributors to change climate is carbon dioxide emission. It represents two-thirds of emissions dominated by the transportation sector. Most of the emission emerges from cars, contributing the highest amount to the environment. Hence, the agency implies that fuel economy could enhance vehicle energy use efficiency and diminish fuel combustion emission statistics globally. Thus, it is clear that there is a requirement for an energy-efficient vehicle in the transportation sector.

One approach is to convert from gasoline-powered automobiles to cleaner energy alternatives. Because there is growing consensus that electrification and the possibility for 'decarbonization' are critical, this sector appears critical, as it tends to minimize reliance on fossil fuels and carbon emissions. However, the adoption rate of cleaner energy vehicles, such as electric cars, remains low globally. So the study focussed on the adoption or conversion of vehicles into the green vehicle. Accordingly, a study is done on adoption of Battery Swapping Stations globally.

A Battery Swapping Station is a facility that allows for the quick and easy replacement of depleted batteries with fully charged ones. It is a vital component of the Micro-Mobility Battery Swapping project, including micro-mobility vehicles such as e-bikes and e-scooters which aims to provide a sustainable and efficient solution for urban transportation.

The project aims to promote the use of electric two-wheeler and 3-wheelers, such as e-bikes, carrier vehicle, e-rikshaws and e-scooters, as an alternative to traditional fossil fuel-based transportation. The project utilizes a battery swapping model, whereby users can swap their depleted batteries for fully charged ones at designated battery swapping stations located throughout the city.

The Battery Swapping Station is designed to be modular and scalable, allowing for easy installation and maintenance. The station consists of a charging and storage unit for the batteries and a docking station for e-vehicles. When a user needs to swap their depleted battery, they simply dock their vehicle at the station, and the battery is replaced with a fully charged one.

The project aims to provide several benefits to users and the environment. It offers a sustainable and convenient alternative to fuel transportation, reducing carbon emissions and traffic congestion. Battery swapping also eliminates the need for lengthy charging times, allowing for a more seamless and efficient transportation experience.

Adoption Drivers for Electric Vehicle:

1. **Rapid urbanization**-As per report published by Oxford Economics on the global urban landscape scenario in 2030, the list of fastest growing cities shall be dominated by India, and $1.7 trillion will be expenditure on cars.

2. **Advances in renewable energy-**The penetration of Renewable Energy sources in India's energy mix has increased from **11 GW in 2008 to 69 GW in 2018** thus signifying the exponential growth of energy from Renewable Energy sources.

3. **Climatic change**-As per NASA, the global average surface temperature has risen **by** 0.6-0.9^{0}C and the rate of temperature increase has nearly doubled in last 50 years. India has committed to cutting its GHG emissions intensity by 33% to 35% percent below 2005 levels by 2030.

4. **Data capture and analysis: -**Digital revolution has created possibility of a greater utilization of existing transportation assets and infrastructure.

5. **Energy security: -**India needs to import oil to cover over 80 percent of its transport fuel. That ratio is set to grow as a rapidly urbanizing population demands greater intra-city and inter-city mobility.

4 METHODOLOGY:

A methodology was designed for carrying out the activity for implementation of Battery Swapping Station in Tata Power-DDL operational area. The development of a Battery Swapping Station (BSS) for a Micro-Mobility Battery Swapping project involves several steps and methodologies to ensure its successful implementation.

Policies and Guidelines for Electric Vehicle by Government:

1. Funding to the extent of 100% of cost depending upon Project Proposal.
2. To enable faster adoption of electric vehicles in India by ensuring safe, reliable, accessible, and affordable Charging Infrastructure and eco-system
3. To promote affordable tariff chargeable from EV owners and Charging Station operators/Owner
4. Energy Operators' (EOs) will be invited to set up charging and battery swapping stations across Delhi in multiple phases by pooling and providing Concessional Locations for charging stations at bare minimum lease rentals. Delhi government shall provide a capital subsidy for the cost of charger's installation.
5. 100% of net SGST will be provided as reimbursement to EOs for purchase of Advanced Batteries to be used at swapping stations.
6. Purchase incentive of ₹5,000 per kWh of battery capacity for 2-wheelers, ₹30,000 per vehicle (E-AUTOS)/E-Rickshaws/E-Carriers, ₹10,000 per kWh of battery capacity for first 1000 cars subject to a cap of Rs 1,50,000 per vehicle for 4-wheeler (E-CARS).
7. Delhi government to provide a 100% subsidy for the purchase of charging equipment up to ₹6,000 per charging point for the first 30,000 charging points at homes/workplaces. Subsidy to be routed through DISCOMS who in-charge of charger installations will be.

Here is the methodology adopted for successfully implementation of Battery Swapping Station in various locations of Tata Power Grid/ Substations.

1. Site selection: The first step is to identify suitable locations for the BSS, taking into consideration factors such as accessibility, traffic flow, and demand for micro-mobility vehicles. A feasibility study should be conducted to evaluate the site's suitability and potential for profitability.

2. Station design: The BSS should be designed to meet the specific needs of the project and users. This includes the selection of appropriate charging and storage units for the batteries, the design of the docking stations for the micro-mobility vehicles, and the layout of the station is to be finalized accordingly.

3. Battery management system: A battery management system (BMS) is a critical component of the BSS, responsible for monitoring the state of the batteries and ensuring their safe and efficient operation. The BMS should be designed to provide real-time monitoring and control of the battery charging and discharging process, ensuring that the batteries are charged and discharged at the appropriate rates and frequency with time.

4. Charging infrastructure: The BSS should be equipped with the necessary charging infrastructure to support the charging of batteries. This includes charging cables, power distribution systems, and charging controllers.

5. Operations and maintenance: The BSS should be operated and maintained by trained personnel to ensure its efficient and safe operation. This includes regular maintenance, cleaning, and repair of the station and its components. Help in swapping of batteries while in operation.

6. Monitoring and evaluation: Regular monitoring and evaluation of the BSS performance should be conducted to identify any issues and ensure continuous improvement. This includes monitoring the usage rates of the station, the charging and swapping times, and user feedback.

There is list of Tata Power-DDL Grid/ Substations identified for installation of Battery Swapping Station.

Table-1

S.No	Name	Location	District	Zone	X	Y	Site Included
1	SGTN NAGAR	Sanjay Gandhi Transport Nagar,	BDL	507	28.745026	77.150303	L2
2	SGTN-2 GRID	Sanjay Gandhi Transport Nagar,	BDL	507	28.744491	77.15037	L2
3	BADLI	Badli Indl Area, Bawana Road,	BDL	516	28.745486	77.128783	L2
4	POOTH KHURD GRID	Near Balmiki Hospital,	BWN	521	28.774792	77.050976	L3
5	BAWANA-6	DSIDC indl Area, Nr Ganga	BWN	521	28.783382	77.063367	L3

6	BAWANA CLEAR WATER	Bawana-Narela Road,	BWN	521	28.81489	77.056575	L3
7	BAWANA-7	DSIDC Indl Area,Nr 400KVgrid	BWN	521	28.794394	77.076034	L3
8	BAWANA-1	DSIDC BAWANA	BWN	521	28.796695	77.044212	L3
9	RAMPURA	Near Railway Crossing,Rampura	KPM	501	28.680184	77.153078	L2
10	TRI NAGAR	Trinagar,Near Booster Pump Stn	KPM	501	28.686416	77.158796	L1
11	WAZIRPUR-2	Wazirpur-2,Near Prembhari Pul,	KPM	502	28.69888	77.157817	L1
12	ASHOK VIHAR	Nr. Sports Complex,Ashok Vihar	KPM	502	28.683181	77.165589	L1
13	G.T.K. ROAD	Near Gas Godown Gujrawala Town	MDT	402	28.697639	77.18301	L1
14	INDIRA VIHAR	Indira-Vihar Near BBM Depot	MDT	413	28.704239	77.214393	L2
15	AZADPUR	Near Subzi Mandi,Azadpur,	MDT	415	28.711621	77.175592	L2
16	MANGOL PURI - 1	MangolPuri Indl. Area Phase-I	MGP	515	28.687612	77.082028	L2
17	ROHINI - 23	Sector-23 Rohini	MGP	519	28.717878	77.072236	L2
18	ROHINI - 22	Sector-22 Rohini	MGP	519	28.713647	77.06107	L2
19	SUDARSHAN PARK	Nr PunjabiBagh Crimation grnd	MTN	1303	28.663062	77.131277	L1
20	SARASWATI GARDEN	Saraswati-Garden D- block	MTN	1303	28.644932	77.138434	L2
21	REWARI LINE	Near Maya Puri chowk	MTN	1303	28.637264	77.131038	L2
22	INDER PURI	Opposite Pusa Gate	MTN	1304	28.632881	77.147839	L3
23	PUSA	Near chidya Colony (Pusa)	MTN	1304	28.630951	77.168049	L2
24	66 KV Grid sub Station No.-1	DSIDC BHORGARH	NRL	514	28.817347	77.093464	L3
25	66 KV Grid sub Station No.-2	DSIDC BHORGARH	NRL	514	28.826271	77.0872	L3

26	66 KV Grid sub Station No.-3	DSIDC BHORGARH	NRL	514	28.826601	77.088374	L3
27	DSIDC NARELA-1	H-Block, Narela Indl Area,	NRL	522	28.826384	77.110759	L3
28	A-7 NARELA	Near Raja Harish Chander Hosp.	NRL	522	28.844027	77.107133	L3
29	DSIDC NARELA-2	BhorgarhVill.Rd, Nrla IndlArea	NRL	522	28.828244	77.095768	L3
30	PITAMPURA-2	Opp.Mangolpuri Pathar Mkt,	PPR	504	28.693434	77.104981	L1
31	MANGOL PURI - 2	Phase2, Indl. Area,Mangolpuri	PPR	504	28.687958	77.097395	L2
32	PITAMPURA-1	Outer RingRoad,Nr MadhubanChowk	PPR	508	28.707742	77.135591	L1
33	RANI BAGH	Nr LaluBhai Gurudwara,Raniba gh	PPR	510	28.69137	77.12991	L1
34	PITAMPURA-3	Opp. Netaji Subhash Palace	PPR	530	28.692053	77.14473	L1
35	ROHINI - 2	Avantika Nr budh vihar	RHN	551	28.707271	77.092044	L1
36	ROHINI-1	nr NDPL Shakti Deep Building	RHN	551	28.703316	77.114341	L1
37	Rohini District Office	NDPL Shakti Deep Building	RHN	551	28.703317	77.114342	L1
38	ROHINI-4	Nr Rithala watr treatment plnt	RHN	561	28.721616	77.107496	L2
39	ROHINI-5	Near Schdava public school,	RHN	561	28.726016	77.128196	L2
40	ROHINI-6	Near sec-11 Petrol Pump,	RHN	561	28.735714	77.113979	L2
41	ROHINI-24	Opp baaz shopping centre	RHN	561	28.727857	77.080699	L2
42	ROHINI-3	near fire station building.	RHN	571	28.70711	77.127365	L2
43	BHALSWA	BHALSWA DAIRY GURU NANAK NAGAR	SMB	503	28.751218	77.170719	L3
44	JAHANGIR PURI	GTK depot, Near Mukarba chowk.	SMB	505	28.734647	77.158841	L2
45	SMB - KHOSLA	opp. jaspal Kaur pub school	SMB	506	28.709288	77.152596	L2

46	SMB FACILITY CENTER	Near Ambedkar nagar,	SMB	531	28.727533	77.150921	L2
47	Dheerpur Grid	Near CV raman ITI	SMB	532	28.725236	77.204451	L3

Source: Tata Power-DDL database

As per the data available to Tata Power DDL, accordingly the survey of the sites has been started for identification of the sites in lieu of space availability with Tata Power Grid/substations.

After getting the feasibility study from site, the said 47 sites are marked with the priority list with respect to our perspective. The study is carried out with the EV players in the market for installation of battery swapping on various models available.

Then, a survey is done along with the EV service providers for mapping the area to cover the EV traffic/ potential available.

Each district is mapped, and locations are identified district-wise to make the EV network viable and make the infra designing accordingly.

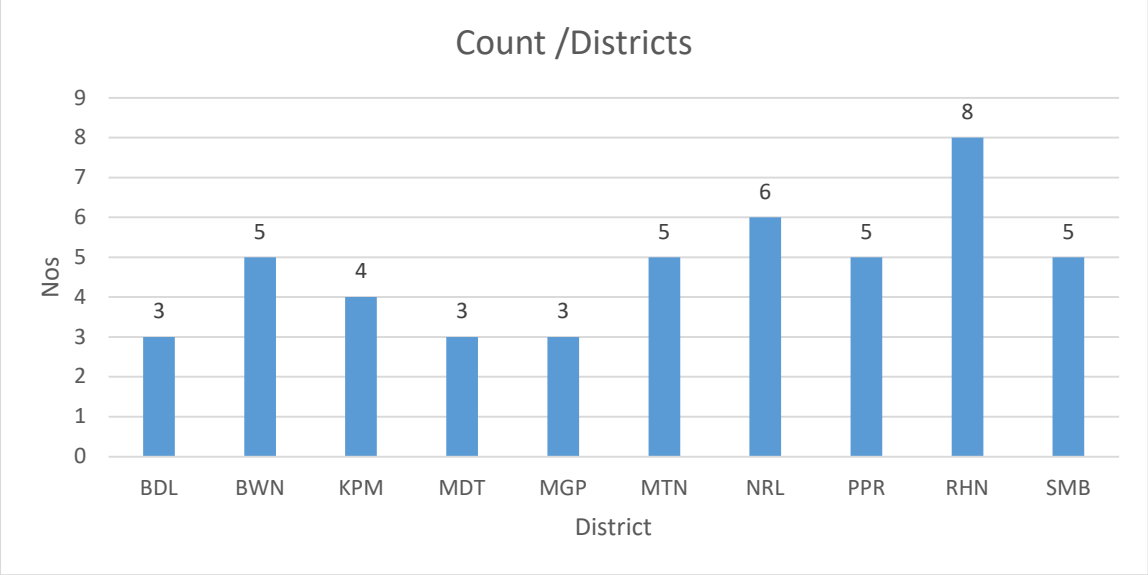

Figure-1

The EV service providers and CPO`s (charge point operator) have started visits and joint survey from the PPR, RHN and MDT Districts. The reason for selecting the said Districts is to map the maximum number of flows of e-rickshaws, 2 wheelers and 3 wheelers.

To start the said activity a methodology is created, and two locations are identified in a first phase as a pilot project for mapping the activity growth.

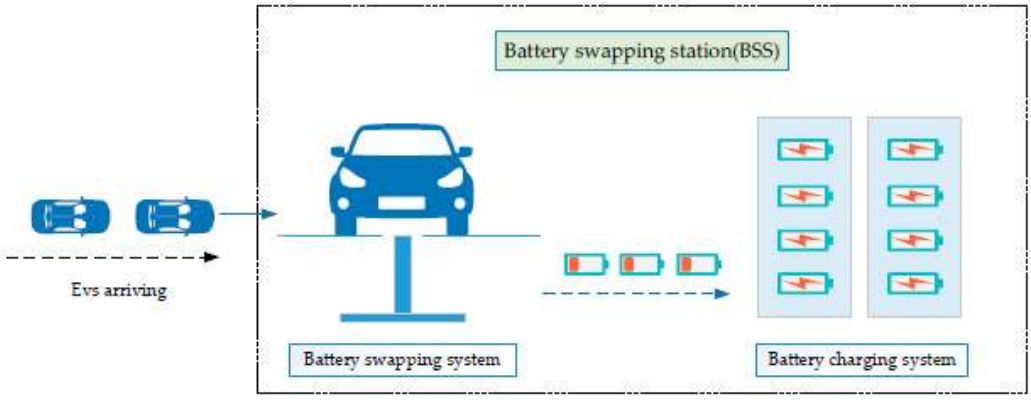

Figure-2

Then the identified locations are taken into further study for installation and commissioning of Battery Swapping Stations.

Now the two models are prescribed for installation of Battery Swapping Stations for changing charged battery to the depleted one and a model is formed for operation of the battery swapping station in the districts area mapped.

Here is the sample model/ framework for the operation of the BSS in the Tata Power-DDL operational area.

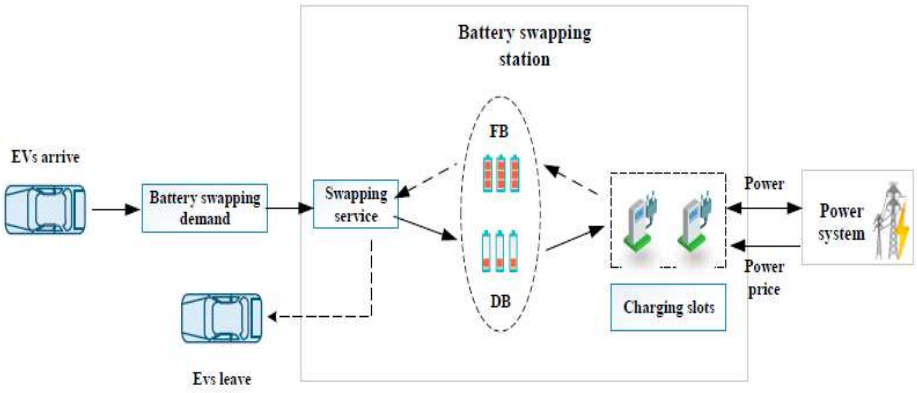

Figure-3

Design: The Battery swapping station is designed in such a manner that the vehicle coming over there will not make hinderance to the other transport running over there in the public.

The design of the structure basically includes the specifications of the charging machine and the area where the station is to be set up. The swapping station is designed in such a way that the power connection can be easily available with the nearby utility equipment to avoid any delay in getting the supply for the swapping station.

It is designed in way that the in and out of the vehicles is smoothly done with no long queue while swapping the battery for 2 wheelers and 3 wheelers. The swapping machine can be decided on the type of battery that is to be used in the swapping station.

The location of the swapping station is to be finalized in respect to the connectivity and the parking space of the vehicle coming over there for swapping the batteries. Layout of the swapping station must be finalized in advance in order to not to make the delay while operation of battery swapping station. The swapping machine has to be selected on the basis of batteries and the charging type being used. We will have to determine the count of chargers and the number of stations to be installed in the dedicated area as per the potential in the specified area.

While dealing with the stations operations the safety is also to be considered while operating with the high voltage batteries and the environmental factors also.

Operation and Maintenance: Safety should be priority when operating a battery swapping station. Proper training should be given to the staff operating the swapping station to ensure all the safety procedures and personal protective equipment (PPE`s) when necessary.

A team of trained staff is to be required to operate and maintain the battery swapping station. The responsibility of the staff includes replacing the batteries, inspecting vehicles, and troubleshooting the technical issues.

The swapping station's infrastructure and equipment, including battery racks, charging equipment, and control systems, will require regular maintenance and repair to ensure proper functioning. Preventive maintenance should be performed regularly to avoid unexpected downtime.

The swapping station should be monitored, and data collected on usage, battery life, and other key metrics. This information will allow for better planning, maintenance scheduling, and informed decision-making.

Good customer service is crucial for the success of a battery swapping station. Staff should be knowledgeable, courteous, and able to answer customer questions and concerns.

The station must comply with all relevant laws and regulations, including those related to the storage and handling of hazardous materials. Environmental regulations must also be considered.

Battery swapping solution Fundamentals include various steps that we have done for doing the activity in swapping of batteries.

Provision of RFID Card & Mobile App to the Auto Drivers.

- RFID Card –User authentication for accessing swapping station
- Mobile App
    - Geo fenced
    - Battery Charge Status
    - Battery Health
    - No. of Charge
    - Distance to the Charging Dock

Charging Dock includes:

- Smart Chargers with different capacities
- Charged Battery Stack
- Discharged battery Stack
- Rotational Charging
- Operations & Maintenance + BMS by Charger OEM
- Manned Location
    - Authentic use of RFID cards & battery swap
    - Charging Fees collection from auto drivers

Figure-4

So, the business methodology that has to be used in the installation and operations of the Battery swapping stations is defined in such a way that the operations are handled by the one person or the operations are handled by the dedicated manpower of the service provider for current state itself.

There is a form factor-based charging system in which the different service providers have their own form factor but the formalization of the same is under considerations and working on the same is to be done to make the form factor of the battery as per the government guidelines followed.

The customer that has to be approached for the said activity is most focused on the B2B customers ie business to business customers where the customers base is less but the quantity is very high. Introduction of light weight battery with minimal charging time. Strategic partnership with last mile operating partner.

5 RESULT:

Tata Power-DDL has been actively looking at ways that it can support vehicle electrification in its service territory. This is in support of the policies at all government levels to encourage electrification to improve air quality and reduce costs. After extensive sub–Station survey and discussion with various interested stake holders/investors, we have come across that if land is made available to such investors at affordable rates they are ready to invest in creation of charging infrastructure/battery swapping station for promotion and use of E vehicles.

Primarily, such battery swapping stations shall cater to the demands of E-Rickshaws/3-Wheelers & electric cars. The benefits envisaged from these activities are listed below:

- Promotion of use of E-Vehicle
- Improvement in Delhi's air quality by bringing down emissions from transport sector
- Reduction in noise pollution
- Reduction in greenhouse gas emissions

As per the study and methodology used in establishing Battery Swapping Station, we have started survey and feasibility checks with M/s Sun Mobility, M/s Battery Smart and M/s OLA for the specified site like grid, office, and substations. The pilot is studied and implemented on the first phase of the study i.e. first six sites are being identified and a joint survey is done for the feasibility and potential checking of the stated sites.

Accordingly, the BSS study is done on the below sites:

Table-2

S.No	Name	Location	District	Zone	X	Y	Site Included
1	AZADPUR	Near Subzi Mandi,Azadpur,	MDT	415	28.7116	77.1756	L2
2	INDIRA VIHAR	Indira-Vihar Near BBM Depot	MDT	413	28.7042	77.2144	L2
3	MANGOL PURI - 1	Mangol Puri Indl. Area Phase-I	MGP	515	28.6876	77.082	L2
4	ROHINI-3	near fire station building.	RHN	571	28.7071	77.1274	L2
5	PITAMPURA-1	Outer RingRoad,Nr MadhubanChowk	PPR	508	28.7077	77.1356	L1
6	PITAMPURA-2	Opp.Mangolpuri Pathar Mkt,	PPR	504	28.6934	77.105	L1

Source: Tata Power-DDL database

As per the above stated sites, feasibility checking, and the joint survey was done with the mentioned EV service providers for further way forward on the operation and commissioning.

There are various models in EV battery Swapping Stations for installation and commissioning on the DISCOMs level. The model selected for the BSS with the two EV service providers are one is Land Leasing model and the second one is Revenue Sharing model.

In the land leasing model, the DISCOM have to provide the dedicated space, or the space decided at the time of joint site survey to the charging point operators for installation of Battery Swapping Station. The fixed rental is given based on space occupied by the charge point operator as per the market rates of the premises or mutually agreed. Subsequently in the Revenue sharing model, the charge point operator will share the mutually decided percentage of share from the earning of the battery swapping stations. In this model the dedicated space for installation of charging point is given by the TPDDL and the model of Battery swapping station will be installed over there by EV charger providers. The revenue we are getting from the installed unit will be divided as per the mutually agreed shared mentioned in the MoU.

With respect to the model discussed above the MOU get signed with M/s Sun Mobility Pvt Ltd and M/s UpGrid Solutions Pvt Ltd (Battery Smart) for installation and commissioning of Battery swapping stations in TPDDL grid/substations.

Under the land leasing model, Battery Swapping Stations have been implemented and work has been started initially on the two sites i.e., Azadpur Grid and RG-3 Grid (Rohini sec-3 area). The swapping stations has been installed in the Azadpur grid with the 15-dock battery swapping station machine having the 14 slots charging and the charged battery will be replaced with the depleted one. In the first phase there is tie up with the various EV charging service provider running 2-3 wheelers and having e rikshaws and e-scooters. The companies that are approached for the usage of BSS is Sun mobility, OLA, and Battery smart etc.

There is only two service providers who shown interest on installation of Battery swapping station on the Tata Power-DDL sites and the mapping of locations provided for the installation is done by M/s Sun Mobility and M/s Battery Smart for potential sites. Among both the feasibility checking is done and work is carried out on the potential sites.

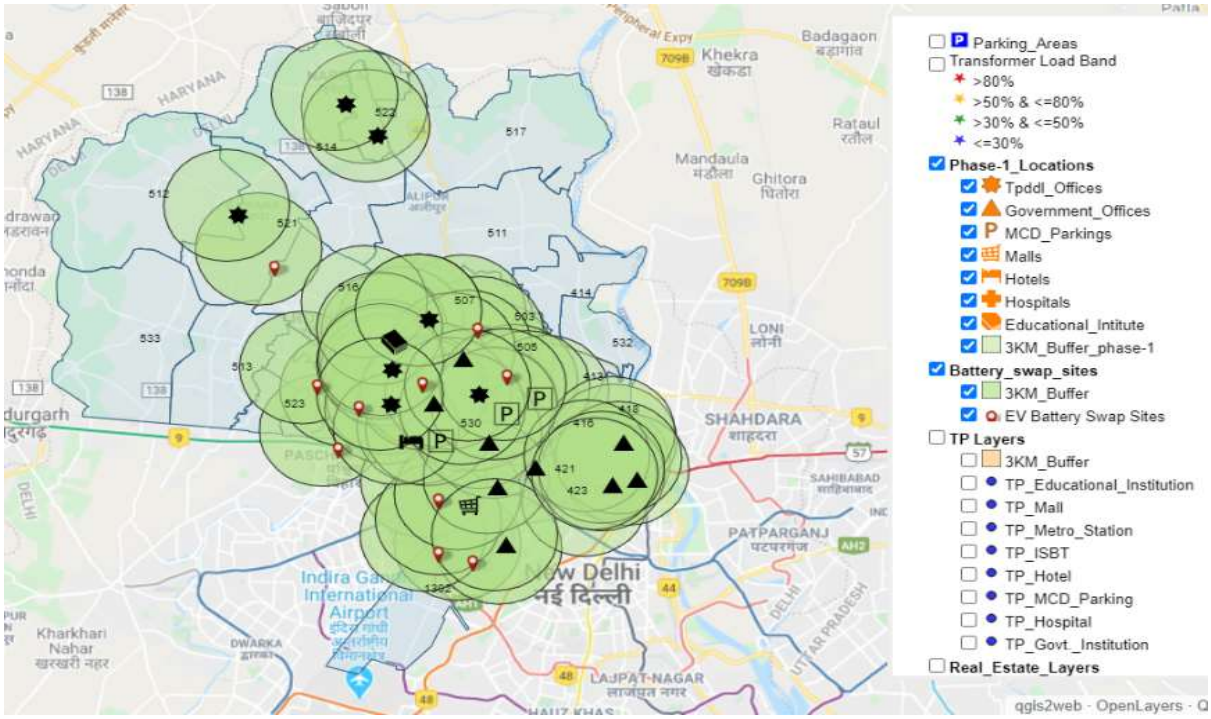

Figure-5

Figure-6

6 CONCLUSION & RECOMMENDATIONS:

The Battery Swapping Station is implemented initially on the two sites. One BSS is installed in Azadpur Grid and another one in RG-3 grid under the land leasing model. The charges are mutually agreed accordingly with the service providers and the fixed charges agreed is Rs.70 per square ft for the allocated area in the Grid substation.

So, the agreement is signed with the interested service providers for installation of battery swapping station in the Grid/substation with the agreed rates and terms of the agreement. Initially the setup is installed at Azadpur grid with two machine of Battery swap having 15 docks in one machine. The supply or the designing of the electricity network is done for feeding the load of BSS.

After successful completion of implementing the stations at two sites the installation is further progressed to the said 06 battery swapping sites. Now the same methodology is used in the left-over sites for BSS deployment and now the BSS deployed at Azadpur Grid, RG-3 Grid, PP-2 Grid, MGP-1 Grid, Indra VHR Grid and PP-1 Grid.

Table-3

S.No.	**BSS Sites**	**Monthly Revenue (in Rs.)**	**Area Occupied**	**Rate**
1	Azadpur Grid	13009	300 sq.ft	36.75 rs/sq. ft
2	RG-3 Grid	4336	100 sq.ft	36.75 rs/sq. ft
3	PP-2 Grid	8260	100 sq.ft	70 rs/sq. ft
4	MGP-1 Grid	24780	300 sq.ft	70 rs/sq. ft
5	Indra VHR Grid	16520	200 sq.ft	70 rs/sq. ft
6	PP-1 Grid	18585	225 sq.ft	70 rs/sq. ft
TOTAL		**85490**	**1225 sq ft.**	

Source: Tata Power-DDL

Now the conclusion is mapped for the one site Azadpur Battery swapping stations and the findings of the same is mapped for further BSS installed. The research is done on the single site with the outcome of the project is as below.

The average footfall for the vehicles per day is 190-200 electric vehicles including the vehicle category of commercial and e-rikshaws and carrier vehicles.

The data which is populated from the battery swapping machine installed at Azadpur is in tabular form providing the swap date and time, charging load, type of vehicles and more.

Table-4

Vehicle Type	Swap Type	Swap Start Time	Swap End Time	Swap Duration	Max Temp	Total Kwhr Consumed	No. of Bp's
eBike	Fleet	01-03-2023 00:03	01-03-2023 00:03	00:00:49	22	0.73	1
eBike	Fleet	01-03-2023 00:08	01-03-2023 00:08	00:00:55	22	0.75	1
eBike	Fleet	01-03-2023 00:14	01-03-2023 00:14	00:00:38	24	0.74	1
eBike	Fleet	01-03-2023 00:18	01-03-2023 00:18	00:00:45	21	0.85	1
eBike	Fleet	01-03-2023 00:26	01-03-2023 00:26	00:00:37	20	0.78	1
eLoaderL5-3D	Fleet	01-03-2023 00:29	01-03-2023 00:30	00:01:20	22	2.92	3
eBike	Fleet	01-03-2023 00:38	01-03-2023 00:39	00:00:40	23	0.96	1
eBike	Fleet	01-03-2023 00:39	01-03-2023 00:39	00:00:40	24	0.92	1
eBike	Fleet	01-03-2023 00:56	01-03-2023 00:57	00:00:53	18	0.9	1
eBike	Fleet	01-03-2023 00:57	01-03-2023 00:57	00:00:34	24	0.86	1
eBike	Fleet	01-03-2023 01:07	01-03-2023 01:08	00:00:36	22	0.57	1
eBike	Fleet	01-03-2023 01:08	01-03-2023 01:08	00:00:42	25	0	1
eBike	Fleet	01-03-2023 01:21	01-03-2023 01:22	00:00:39	22	0.58	1
eLoaderL5-3D	Fleet	01-03-2023 01:27	01-03-2023 01:30	00:03:07	15	2.86258	3
eBike	Fleet	01-03-2023 01:38	01-03-2023 01:39	00:00:59	23	0.59	1
eBike	Fleet	01-03-2023 01:38	01-03-2023 01:39	00:01:20	23	0.79	1
eBike	Fleet	01-03-2023 01:42	01-03-2023 01:43	00:01:08	22	0.54	1
eBike	Fleet	01-03-2023 01:44	01-03-2023 01:45	00:00:57	28	0	1
eBike	Fleet	01-03-2023 01:56	01-03-2023 01:56	00:00:41	25	0.7	1
eBike	Fleet	01-03-2023 02:14	01-03-2023 02:17	00:02:18		0	1
eBike	Fleet	01-03-2023 02:16	01-03-2023 02:16	00:00:45	22	1.16	1
eBike	Fleet	01-03-2023 02:34	01-03-2023 02:35	00:00:56	20	0.72	1

eBike	Fleet	01-03-2023 02:44	01-03-2023 02:46	00:01:30		0	1
eBike	Fleet	01-03-2023 02:45	01-03-2023 02:45	00:00:38	28	1.26	1
eBike	Fleet	01-03-2023 02:46	01-03-2023 02:46	00:00:35	25	0	1
eBike	Fleet	01-03-2023 02:47	01-03-2023 02:47	00:00:38	25	0.34	1
eBike	Fleet	01-03-2023 02:53	01-03-2023 02:54	00:01:13	21	1.04	1
eBike	Fleet	01-03-2023 03:31	01-03-2023 03:32	00:01:13	22	1.3	1
eBike	Fleet	01-03-2023 03:39	01-03-2023 03:40	00:01:07	20	0.78	1

Source: Sun Mobility Database

As per the swapping done in the past 2 months the data is populated by the one station installed at the tata power DDL grid premises for evaluating the Actual Carbon footprint saving by taking the initiative of installation of Battery swapping station in the organization. The Average Carbon Dioxide Emission from a diesel car driving for 1 Km id approximately 121.5 g CO_2. The distance travelled by the vehicle or the utilization of the battery in Km is 56804. If we compare the emission for the average Diesel car in the city, then it would come like. Average Carbon Dioxide Emission from a diesel car driving for same distance as travelled by Vehicle with Battery (g CO_2) is 69,01,686 g CO_2 or the actual saving of the Carbon Dioxide in the past 2 month is around 6901.69 Kg.

7 LIMITATIONS:

- The study is only limited to the usage of grid/substations available in Tata Power-DDL operational area only.
- Research cannot be implemented on the other available assets apart from Battery Swapping Stations.
- Lack of previous research studies on the topic described.
- Only physical survey can be used to collect the data and information.
- Time Constraints.
- Lack of Financial models and revenue opportunity under regulated framework
- Conflicts arising with the local authorities while conducting the research.

8 REFERENCES:

www.tatapower-ddl.com