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RESEARCH ARTICLE

UNDERSTANDING THE ROLE OF V2G TECHNOLOGY ON GRID STABILITY DURING PEAK HOURS IN INDIA

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Abstract

India has set an ambitious goal of becoming Net Zero in carbon emissions by 2070. To achieve this goal there are significant steps being taken especially in the power and electric vehicle sector. A revolution that involves symbiosis of both the sectors, is the integration of V2G (Vehicle to Grid) technology in India. This paper gives an overview of power sector and electric vehicles market in India followed by need, benefits, and infrastructure required for bringing V2G in India. It also includes theinsights froman interview with the founder of SHERU, a start-up which provides cloud energy storage and is working closely with the related concepts. The methodology to calculate crude oil saving, C02 emission, journey cost, public charging and home charging is also discussed. The paper looks into the case studies of few developed countries that have been using V2G and emphasizes on how this technology can help to achieve sustainability goals.

Introduction:-

Overview of Power sector in India

India is the third-largest producerof electricity in the world. Power sector involves three significant process areas from generation to transmission to distribution. In India there exists both private sector and public sector electricity generation companies. Public sector is further bifurcated in the Central and State sector. According to the Ministry of Power, total installed generation capacity as on 31/05/2023 is 1,00,055 MV by Central sector, 1,05,726 MV by State Sector and 2,11,887 MV by Private sector. This shows that India depends majorly on the private sector for electricity generation. Figure 1.1 shows the contribution of all the three sectors in the total power generation. Figure 1.2 shows the growth in total electricity generation (including renewable source) in India. The upward trend in growth of electricity generation shows immense opportunities that can be capitalized from a business point of view. The dominance of the private sector can be targeted towards creating more sustainable ways of electricity generation and distribution.

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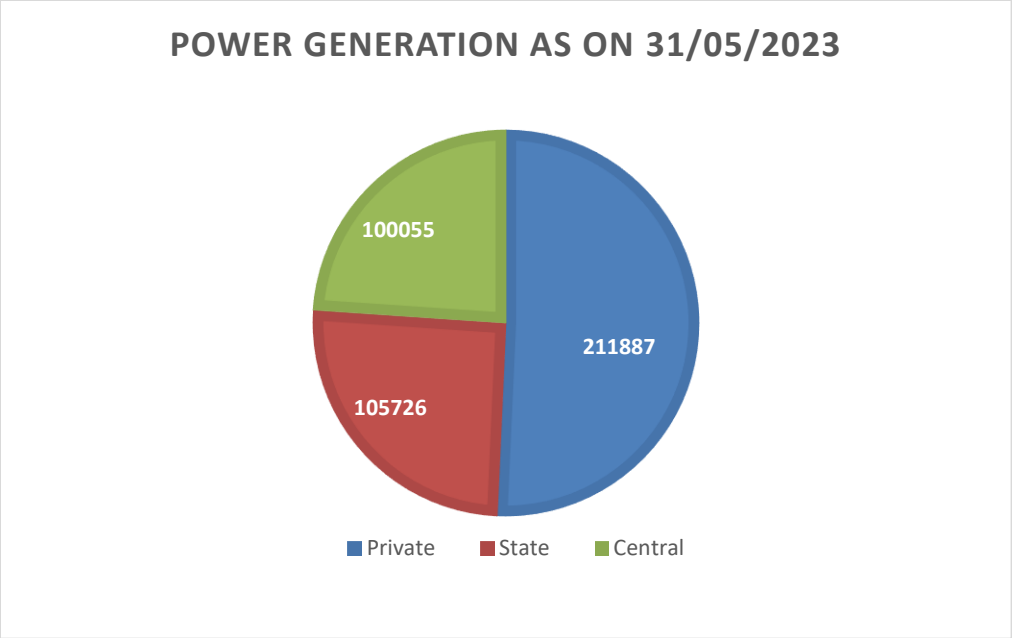

Figure 1.2:-Source Ministry of Power

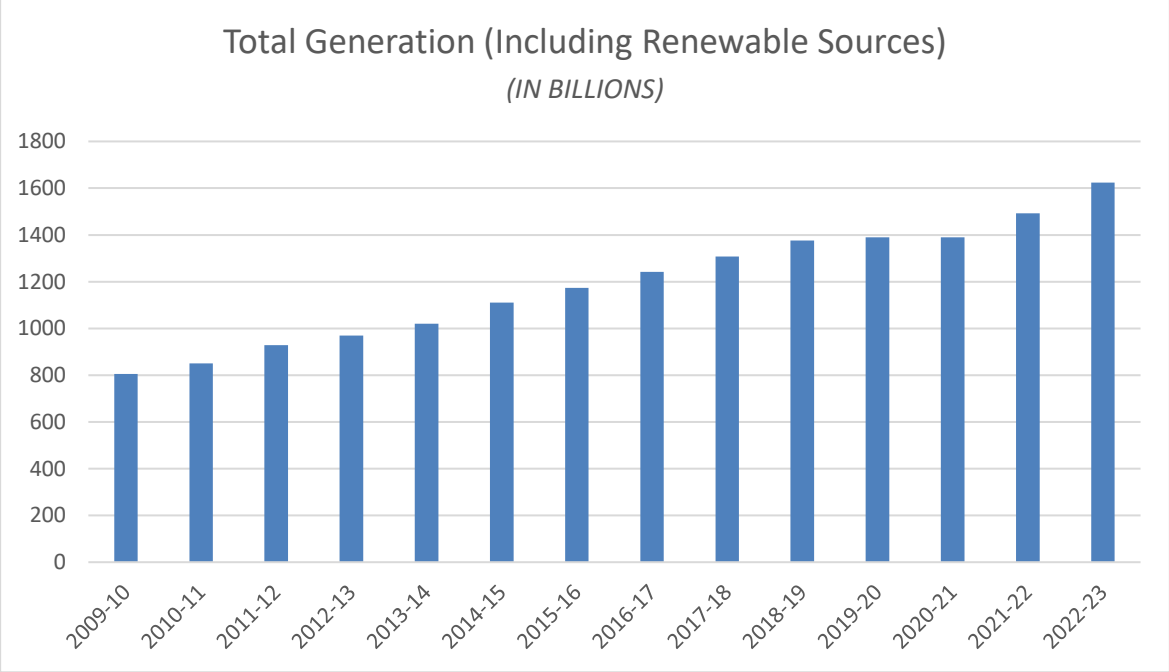

Table 1.1 which has been created from the data given by Ministry of Power on their official website, itsshows the difference between the demand and supply of power over the years from 2009-10 to 2023-2024. One can see the deficit reducing over the years but still we have a long way to go to create a surplus for the same. The table differentiates between the difference in total deficit and deficit during peak hours. The major deficit is seen because of insufficient supply in peak hours only. This can be reduced through more sustainable and renewable adaptations in the power sector to manage demand and supply mainly in peak hours. Reaching the goal of surplus power, which can only be achieved through the contribution of masses. But the question arises how can the masses contribute? The solution lies in the V2G (Vehicle to Grid) system. The vehicle-to-grid or V2G is a technology involves electric vehicles (EVs) supplying electricity back to the power grid to meet the energy demands in peak hours. V2G

technology powers bi-directional charging which makes it possible to charge the EV battery and take the energy stored in the battery of the EV and push it back to the power grid. Currently the power is generated through both renewable and non-renewable sources. According to Ministry of Power, fossil fuels like coal, ignite, gas and diesel collectively constitute to 56.8% whereas non-fossil fuels sources like Hydro, solar, wind, nuclear, and waste to energy, Cogen collectively contribute the remaining. After the first step of generation is done, the power is transmitted to substations where the voltage is lowered to safety limits and sent to smaller power lines. This power is further transmitted to distribution stations from where they are finally transferred to households and institutional users. PowerGrid is a 'Maharatna' Public Sector Enterprise of Government of India which has played a strategic role in timely execution of large transmission projects redefining the strength and coverage of the National Grid. After transmission is done, the final stage is distribution.

Table 1.1:- The Power Supply Position in India during 2009-10 to 2023-24.

	Energy			Peak		
Year	Demand (MU)	Availability (MU)	Surplus/deficit (%)	Demand (MW)	Availability (MW)	Surplus/deficit (%)
2009-2010	8,30,594	7,46,644	-10.1	1,19,166	1,04,009	-12.7
2010-2011	8,61,591	7,88,355	-8.5	1,22,287	1,10,256	-9.8
2011-2012	9,37,199	8,57,886	-8.5	1,30,006	1,16,191	-10.6
2012-2013	9,95,557	9,08,652	-8.7	1,35,453	1,23,294	-9
2013-2014	10,02,257	9,59,829	-4.2	1,35,918	1,29,815	-4.5
2014-2015	10,68,923	10,30,785	-3.6	1,48,166	1,41,160	-4.7
2015-2016	11,14,408	10,90,850	-2.1	1,53,366	1,48,463	-3.2
2016-2017	11,42,929	11,35,334	-0.7	1,59,542	1,56,934	-1.6
2017-2018	12,13,326	12,04,697	-0.7	1,64,066	1,60,752	-2
2018-2019	12,74,595	12,67,526	-0.6	1,77,022	1,75,528	-0.8
2019-2020	12,91,010	12,84,444	-0.5	1,83,804	1,82,533	-0.7
2020-2021	12,75,534	12,70,663	-0.4	1,90,198	1,89,395	-0.4
2021-2022	13,79,812	13,74,024	-0.4	2,03,014	2,00,539	-1.2
2022-2023	15,11,847	15,04,264	-0.5	2,15,888	2,07,231	-4
2023-2024	2,66,951	2,66,360	-0.2	2,21,370	2,21,347	-0.01

The power distribution has been a major concern for India. Till now the focus was on the power generation to meet the highest demands but as we gradually navigate towards reducing power deficit and entering the surplus stage, the focus is shifting from generation to distribution of power as well. Around 93% of power distribution is conducted through central and state governments whereas the rest is conducted by private discoms. Majority part of the country operates with a monopoly of a local discom which is usually a state government owned entity. There has been a significant improvement in the distribution sector but still many of the discoms have been layered under heavy financial debts and losses.

Electric Vehicles in India

The first electric vehicle was manufactured in India which was called the lovebird. It was manufactured by Eddy current controls in collaboration with Japan's Yaskawa Electric Co. The manufacturing was done in Kerala's Chalakudy and Coimbatore, Tamil Nadu.Figure 2.1 shows the increase in the sales of electric vehicles(SMEV 2024,https://www.smev.in/statistics), it further states the rate of increase from 2023 to 2024 is 29.678 percent for E-2 wheelers, 57.381 percent for E-3 wheelers, 90.387 percent for 3-4 wheelers and 81.139 for E-Buses. There is an increase in the sales due to infrastructure development, consumer's concern for the environment, subsidies and incentives provided by the government, and electric vehicles awareness schemes of the government. Table 2.2 shows the distribution of the EV charging infrastructureinIndia. Although it is unevenly distributed, according to industry experts India is likely to surpass one lakh by the end of the decade due to the country's rapidly increasing use of electric vehicles.

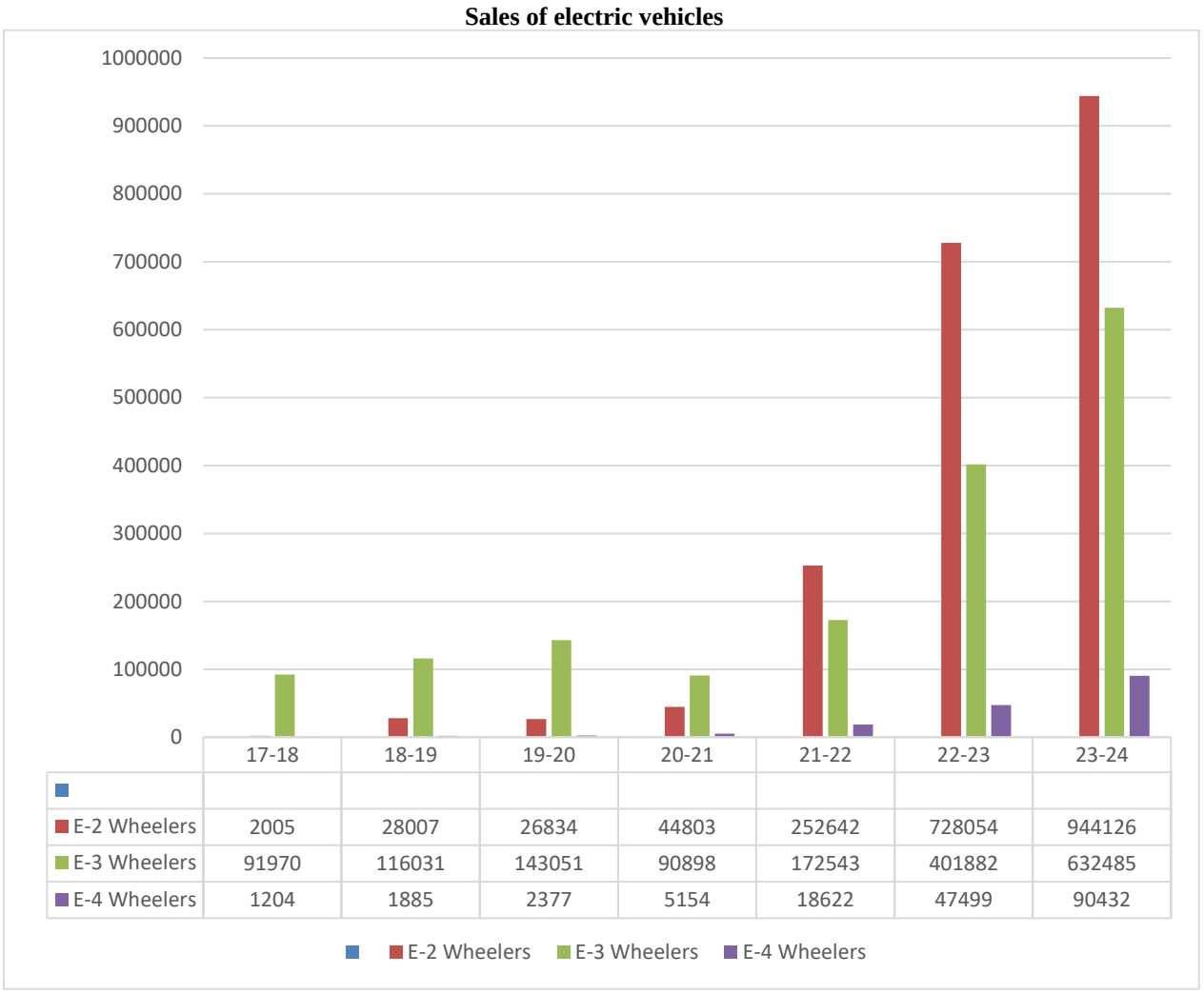

Figure 2.1:-Source - Vahan Portal

Table 2.2:- Distribution of EV charging stations according to states and union territories.

State	Number of EV charging stations	States	Number of EV charging stations	Union Territories	Number of EV charging stations
Jammu and Kashmir	47	Chhattisgarh	149	Puducherry	23
Punjab	158	Andhra Pradesh	327	Andaman and Nicobar Islands	3
Chandigarh	12	Tamil Nadu	643	Lakshadweep	1

				Islands	
Haryana	377	Kerala	852	Delhi	1886
Himachal Pradesh	44	Karnataka	1041	D&D and DNH	1
Uttarakhand	76	Goa	113		
Jharkhand	135	Rajasthan	500		
Sikkim	2	Gujarat	476		
Arunachal Pradesh	9	Uttar Pradesh	582		
Assam	86	Madhya Pradesh	341		
Nagaland	6	Bihar	124		
Manipur	17	Odissa	198		
Tripura	18	Maharashtra	3079		
Meghalaya	21	Telangana	481		
West Bengal	318				

Source - Ministry of Heavy Industries

As the Niti Aayog, the Government of India(2024) is providing various subsidies to the electric vehicle users such as [(2)]:

1. Purchase incentives: In this, direct discounts are provided to the buyer on the cost of the electric vehicle.
2. Coupon: In this, the amount is later reimbursed.
3. Interest subventions: In this, Discount is offered on the interest rate while availing loan.
4. Road tax exemption: In this, road tax at the time of purchase is waived off.
5. Registration fee exemption: In this, one time registration fees applicable on new vehicle purchase is waived off.
6. Income tax benefit: In this, deduction is provided on the tax amount payable by the individual.
7. Scrapping incentives: In this, incentives are provided upon de-registering old Petrol and Diesel vehicles.

These incentives have helped in the adaptation of electric vehicles which promotes economic growth with environmental sustainability. Consumer savings are increasing as the operating costs of electric vehicles are lower compared to conventional vehicles.

The government has implemented several schemes to spread awareness on the use of electric vehicles. They are as follows:

1. FAME India Scheme [(3)]: Government has approved phase II of FAME scheme with an outlay of Rs. 10000 crores commencing from 1st April 2019 for a period of 3 years. Out of the total budgetary support, about 86 percent of the fund has been allocated for demand incentive so as create demand for electric vehicles.
2. NEMMP 2020[(4)]: This scheme was launched by the government in 2013 with an aim to achieve national fuel security with the promotion of hybrid and electric vehicles. There is an ambitious target to achieve 6-7 million sales of hybrid and electric vehicles year on year from 2020 onwards. The government aims to provide fiscal and monetary incentives.
3. GO Electric [(5)]: An exhibition was organized by the industry players on the side-lines of the event displaying EVs including e-buses, e-cars, e-2W, e-3W, and EV chargers by various OEMs manufacturers.
4. PMPs [(6)]: It promotes indigenous manufacturing of Electric vehicles.

Vehicle to Grid Technology

What is V2G?

V2G is a technology that allows the power to flow from the electric vehicle to the power grid and send electricity back to it when not in use. Usually there is high demand for power during the day and low demand during night times. During the time of peak demand, the power can be transmitted from vehicle to the grid and when needed it can be transferred back to the vehicle during low demand time by simply charging the EV battery. As we saw earlier in the table 1.1 that major deficit is shown because of deficit during the peak hours. Therefore, this system can reduce the pressure on the other power plants during the peak hours. It is safe to say that technology has advanced exponentially in a way that it is making sustainable living so easy.

Why to use V2G?
Research done by EV Connect (2024, www.evconnect.com) shows that just to drive 100 miles, an average EV uses the same amount of electricity that it takes to run a typical U.S. home a day. One can imagine the immense potential lying in these batteries? Imagine there is a power cut in an area. How simple it would be to just to connect one's EV to the power grid and run the home appliances. The major burden on the power plants lies during the peak hours. If we have already existing power stored in an EV which is temporarily unused, we can collectively share the burden to reduce dependency on limited number of power plants during peak hours.

How to apply V2G?
V2G requires a smart grid and a bidirectional charger. EV's absorb the alternating current from the socket and convert it to direct current for storage. Bidirectional charges further convert back the direct current to alternating current to power your home, another vehicle, or any other appliance. To make V2G a convenient approach, appropriate energy stations need to be set up. The EV is simply connected to a socket which sucks out its power during the peak time and supplies it to the grid. The best part is that the user can control how much power to be transmitted to make sure that EV has enough power to function. For example, a user can set a limit of extracting only 30% of the EV's power. The user is paid for electricity supplied. This leads to an additional income for the user.

Methodology[7]:-
This paper gives thorough insight on how V2G can benefit India. The methodology provided to calculate certain sustainability factors can guide individuals in making day to day decisions. There is a lot to learn from government policies of other countries mentioned which are mentioned below. The information for this paper has been collected through various online resources as mentioned in the references. The corresponding reference number is mentioned as a superscript to the respective points. Few deep insights have been collected from a personal interview with Mr. Ankit Mittal, Founder of SHERU. Sheru is an Indian company that offers cloud energy storage services for grid operators.

There are various tools introduced by the government that can be used by the consumers. The tools are: Choose your electric vehicle, Home charging calculator, Public charging calculator, Journey cost calculator, CO2 emission calculator, Tax saving calculator and Crude oil saving calculator.

Choose your Electric Vehicle:[7]
There are numerous factors that need to be considered before buying any electric vehicle. The factors are vehicle price, battery price, battery size, charging time, and many more. This tool helps in choosing electric vehicle according to one's lifestyle. In this tool, one needs to add the type, the manufacturer and the model. After selecting search, one will get the ex-showroom price, Battery size, Battery type, Charger Rating, Driving Range, Charging time.

Home charging calculator:
It helps in calculating the charging time and the charging cost of the electric vehicle. Home charging is the most convenient option, given that the cars are parked overnight and can be used in the morning. It is the cheapest method of recharging.The consumer needs to add his vehicle segment, battery capacity, range, home charger and distance to travel. Then he adds the state and the domestic tariff, thus automatically filling the petrol or diesel price in that state. Then click the "Calculate Total Cost."After clicking on it, the results are shown. The results will show the charging time, kWh, charging cost and the cost per km. It calculates the amount that a consumer can save if he uses electric vehicles instead of conventional vehicles.

Public charging calculator:
It is used to find out time taken and cost to charge the electric vehicle with a slow, fast, or rapid charger at a public place. One can also calculate by using battery level. For that, one needs to add the Battery capacity, Range, Public charger, Cost per Kwh, Distance or Battery level and Distance needed to be travelled.After clicking "Calculate Total Cost," the results are shown. The results include charging time, kWh, charge cost, and cost per km. It also gives the reasons to prefer home charging or not.

Journey Cost calculator:

Electric vehicles offer a lot more benefits compared to the internal combustion vehicle. The operational costs are low comparatively. This tool shows the total savings and the annual savings. One needs to add the vehicle segment, Battery capacity, Electric vehicle range, Percentage of vehicle battery charged at home, Percentage of battery charged at public, Journey distance, Journey frequency, Annual journey distance, state, public charging cost, petrol or diesel, conventional vehicle average mileage.The results will show the difference between the journey cost of electric vehicles and conventional electric vehicles. It will also show the annual cost savings if the consumer shifts to electric vehicles.

CO2 emission calculator:
The lifestyle which we choose impacts our climate. The CO2 emissions from conventional vehicles have an enormous impact on the climate. Here one needs to add the vehicle segment, journey distance, comparable EV battery capacity, battery needed for total journey, lifecycle of the vehicle, petrol or fuel, journey frequency, CO2 emission factor, EV range, electricity CO2 emission factor. On clicking "Calculate", CO2 emissions from conventional as well as electric vehicle will be calculated, Annual CO2 emissions savings by opting EV and CO2 emissions reductions during the lifecycle of the vehicle is also shown.

Tax savings calculator:
The government of India has implemented a lot of tax benefits to encourage the people to shift from conventional vehicles to electric vehicles. This tool helps in calculating the taxes a consumer can save. One needs to add vehicle segment, conventional vehicle GST, base amount of vehicle and electric vehicle GST. On clicking "Calculate", one can receive the saving and the GST.

Crude oil savings calculator:
According to the Oil Ministry data(2023), "India paid $82.4 billion for the crude oil it imported in the nine months through December 2021, a 108% jump over $39.6 billion paid over the same period in 2020". India has to import crude oil and the prices are rising day by day due to covid, Russia-Ukraine war and many more factors. Here one needs to add vehicle segment, distance, annual distance, lifecycle of the vehicle, petrol or diesel frequency, average vehicle mileage. On clicking calculate total cost, one will receive the annual crude oil savings in litres.

Benefits
Benefits to user:
V2G technology increases ROI on EV. Introducing V2G makes your EV as a side source of income. One can generate electricity through renewable sources and during peak times and can sell it at higher prices. On the other hand, during peak times using it for one's own house also reduces your household electrical expenses.

Benefits to business:
Businesses with large vehicle inventories can make a power station out of their charging fleets and generate a profitable business. There can be many disruptive innovation business models that can be introduced in the market.Utilitycompanies can have a huge benefit with the help of V2G, the infrastructure can get huge support during the peak times.

Benefits to the grid:
As mentioned earlier, EVs convert AC to DC, it is highly adaptable to sudden demand and supply changes. For example, if a large scale nuclear or coal power generator suddenly trips, the frequency falls to extremely low operational limits which can have a negative impact on the generator. Currently these large-scale power generators are operated majorly by gas "Peaker" power plants. Thousands of EVs can replace these stations. It reduces the need to install expensive gas "peaking" power plants which are used to sustain the high demand during the peak time. The burden during the peak time can be shared by V2G thereby reducing the cost of expensive gas peaking power plant with respect to increasing gas prices.

Infrastructure
The increase in EV adoption rate was due to the public awareness and infrastructure development. Within the two years from February 2022 to March 2024, the number of charging stations increased from 1800 to 16347 (Ministry of Heavy Industries, 2024).

Vehicle to Grid technology is a technology which allows the transmission of power and electricity from the grid to the batteries of EVs and which sends the stored energy back to the grid. To implement V2G technology various infrastructure the components are needed, such as:

Bidirectional Charging stations
Bidirectional charger is a system in which electricity is delivered from the grid to the batteries and vice versa. In this, when an EV is charged, AC (alternating current) in the grid is converted into DC (direct current) that can be used by a car. When the energy stored in the battery is to be used for a house or is to be sent to the grid, the DC electricity present in the EV is sent to the grid by converting it into AC. Currently, India does not have a bidirectional charging system.

Charging system
V2G involves two charging systems: AC and DC charging system. While the AC charger charges the battery via the on-board charger of the vehicle, the DC charger directly charges the battery of EV. Although India is in the early stage of V2G, the AC and DC bidirectional charging systems are not yet common.

Communication system
The communication between the electric vehicles and grid to transfer data should be dependable, incorrupt, and efficient. NSGM and FAME schemes of Government of India work on smart grid development which can help in the development of communication channels.

Renewable sources
Increasing the use of solar and wind energy in the smart grid can reduce the use of electricity from non-renewable sources. It can reduce carbon emissions to great extent.

Aggregator
It coordinates and manages the bidirectional flow of electricity from electric vehicles to the grid and vice versa. It maximizes the efficiency and minimizes the cost. It provides ancillary services of organizing and optimizing the EV charging and managing the load profile.

Insights From the Founder of Sheru
Researchers had an opportunity to interview Mr. Ankit Mittal and have included his insights on how to create a successful V2G business model. Ankit Mittal is the co-founder and CEO of Sheru. Sheru's vision is to support the energy sector transmission by interconnecting energy networks with software. Sheru is a B2B (Business to business) company. It works with grid operators (TATA, Reliance) and with the government to evolve the standards. Its aim is to make the adoption easier by providing patents, and software. It is a marketplace connecting everyone on a single platform.

They started working with grid operators back in 2021, that is when they realized the energy storage problem deeply. Energy storage is a very deep operational problem, it is not a new subject for electricity regulators. The stakeholders are either the central electricity authority or private entity. V2G is a feature that will allow them to maximize the utility value of their car's operators as the electricity was not built around distributed and intermittent power generation. They were primarily built around coal plants with decent work round the clock and supply power. It was a complex subject for the grid operators and thus were not able to understand what was pulling them behind creating a supply that can allow renewable transmission to happen. They analysed the storage requirements, i.e., what kind of storage, for how long, how much, when, and what kind of unit economics makes sense.

Grid requires energy storage for 6 hours per day for short duration energy storage. There are two kinds of energy storage required by the grid i.e., long duration storage (interday energy storage) and short duration energy storage (intraday energy storage). In interday energy storage, we store electricity today for tomorrow. It is to regulate seasonality in supply and demand. A country needs 20 percent of its energy storage in long duration energy storage and 80 percent in short duration energy storage. In intraday storage, we store electricity for regulating supply and demand within the day. In short duration energy, there is a requirement of a marketplace. A marketplace format of supplying energy storage rather than building infrastructure which can have utilization issues. The utilization issues extend the payback due to which the cost of capital, capital expenditure and the unit economy start falling apart. The grid requires energy storage on demand and hence there is a need for an energy storage marketplace.

The world is not looking at it from the right perspective, it is not a material's problem i.e., the batteries do not need to get cheaper, instead it needs to be available to grid on demand. Vehicle to grid technology is needed to participate in the energy storage marketplace. V2G is always promoted in the marketplaces by two types of companies. It is marketed by companies like Sheru or regulators. The stakeholders are either the central electricity authority or private entity. V2G is a feature that will allow them to maximize the utility value of their cars. V2G is a term that has been coined recently but the technology is far older. V2G began as vehicle-to-vehicle (V2V) charging, as introduced by California company AC Propulsion in the early 1990s and later on went ahead with V2G. In Mr. Ankit Mittal's words, "It is not an innovation problem, it is an adoption problem."According to him, every policy required to do this has been present since 2003. The fundamental goal of India to create net zero by 2070 and get to 60 percent renewables by 2030 is creating enough urgency in stakeholders to adopt solutions like this. The hurdles faced are in educating stakeholders and helping them to absorb that change. Sheru has been at it for the last 5 years and now it is very deeply connected in the ecosystem. Sheru collaborates with senior stakeholders at power grid, senior stakeholders at ministry of power. In his words, "It is a tremendous change that looks extremely exciting but one may feel why it is not happening tomorrow, but it is happening as fast as it can.

Sheru has partnered with a team that has built Aadhar card, and UPI. This entire stack of Aadhar, UPI, MSME is called India stack. It is also called Digital Public Infrastructure (DPI). The company is working with India's stack team to build out a protocol called United Energy interface (UEI). It will be like UPI for energy but not a B2C UPI, but more of a B2B. The company is taking these initiatives early on to expand the access throughout the country and then to the countries that are alike to India and where DPI is scaling up. DPI is scaling up in G20 countries very aggressively. Countries are adopting DPI to minimize the cost of digital services for its citizens. The company will expand in the countries having DPI, but for now, it is India-centric.

After India, the company will prefer to get the adoption in China as that is 50 percent of the world's energy market. According to Statista (2024), China holds 42 percent of the energy market, followed by the US with 21 percent and India with 7 percent. The company itself is not going to launch V2G. The manufacturers of EVs will be launching the technology. Sheru will be providing this technology to integrate in their system. Right now, the company focuses on Delhi's grid demand. But while the company is aggregating supply in Delhi, it is enabling large businesses to be ready with the supply. This can help the company to expand the technology throughout the country at once.

Discussing about other countries, Mr. Mittal further states that, V2G is taken very seriously in the US.Tesla's V2G feature is generating about 500 million dollars in revenue for the people who allow their cars to be used in V2G. It is getting adopted increasingly as the batteries are improving. Mr Mittal said that their company is giving 40 percent benefit to the grid operators in sourcing energy via platforms like Sheru rather than building out infrastructure. It is passing out the benefits to the battery owners and the vehicle owners.

Case Study

When studying about V2G, the technology appears quite complicated to implement but is it really complicated? There are few countries who have adopted this technology, and it has only given them unprecedented benefits. Few countries like UK, Germany, Denmark, Japan, and USA have been prompt enough towards implementing this modern technology to reduce their carbon footprints. In this case study we will be looking at how few countries have adopted this practice and what can India take from them.

United Kingdom [8]

According to www.gov.uk, UK has set an ambitious goal of achieving net zero status by 2050. To achieve its goal, it is highly educating its citizens and encouraging them to adopt sustainable policies. The government is providing various subsidies and infrastructure that can make it easy for people to adopt green practices. One of them is the availability of a V2G facility to its citizens. EV companies like Nissan and Enel together conducted the first V2G test in the UK in 2016. Back then the UK's EV market share was just 0.4% and over the years it has grown to an all-time high of 16.5% in 2023. V2G implementation along with other benefits and growing consumer knowledge led to this upward movement in EV market share. According to www.gov.uk 30 million pounds have been invested by the UK government in V2G technologies. The fund was divided in 21 projects targeted towards researching, analysing, and implementing V2G in the national grid. The government is also providing various subsidies to households who adopt V2G technology. The government has focused immensely to integrate best quality smart grid system to maximize the compatibility of V2G technology. UK is one of the most progressive countries to adopt this modern technology.

Germany [9]

Themarket share of battery EVs is about to rise exponentially by 2030. According to Statista, in 2024, it is expected to reach a revenue of $36.7bn. The market is expected to show annual growth rate of 18.17%. This has been quite attractive for the EV manufacturers to stock up their profits in future. For the same, many companies have been trying to put their best foot forward to gain competitive advantage by building a better brand image. How can these brands build a better brand image for Germans? Simply, by giving customer cost benefits and by increasing their reputation by adopting sustainable practices. Both targets can be easily achieved by one single technology that is V2G. Germany has been slow in utilizing its V2G potential. The Charging Infrastructure Master Plan II set a target of Q2 2023 to enable fully operational bidirectional charging. The framework has been implemented but still there have been multiple challenges to increase the convenience of the process.

United States of America [10]

According to Precedence Research 2024, V2G market size in 2023 was USD 0.96 Billion. The growth rate of this market from 2024 to 2033 is expected to be at the CAGR of 47.42%. Therefore, by 2033 the market is expected to be valued at USD 46.21 Billion. Bidirectional charging is getting a lot of importance from federal and state initiatives in USA. The National Electric Vehicle Infrastructure (NEVI) programme was enacted in November 2021 which provided funding to states to develop EV charging stations and launch projects to deliver a better overall EV infrastructure. This programme can encourage Bidirectional charging equipment as well. In 2020, the first instance of a bus providing power to the Con Edison customers was recorded. The upward trend in increasing market share of V2G is highly attracting private companies as well to invest in the modern technology.

India [11]

In India, the Ministry of Power(2024), requested the Central Electricity Authority (CEA) to form a committee to formulate policies on bidirectional charging and integration of V2G. In India, the Bureau of Energy Efficiency is the central authority for all public charging infrastructure. According to Ministry of Power guidelines, the aim is to have a mandatory charging station in a grid of 3 km by 3 km and one station every 25 km on both sides of the highway. As per the Ministry of Power currently there are 12146 EV charging stations in India as on 2/2/2024. To meet the initial goals of the Ministry of Power, there is a need to increase the efficiency of developing smart EV stations in India. These EV stations are encouraged to implement V2G technology as well. An energy software company called SHERU is in process of launching the first V2G bidirectional charging in India. To increase the convenience of bringing V2G in India, there is a strong policy framework required for maintaining regulatory standards. There is a strong need for standardization and interoperability among the EV charging ecosystem with a string open-source protocol. Still India has a long way to go to implement V2G and integrate it into its national grid system.

Conclusion:-

This paper gives emphasises on how V2G can benefit India. The methodology provided to calculate certain sustainability factors can guide individuals in making day to day decisions. There is a lot to learn from government policies of other countries mentioned in the case study. The insights from SHERU, can be a reliable source of information to start implementing V2G in India. Often,one looks at it like just the responsibility of the government to bring the changes but forgets that as citizen one can take so many steps at the individual level, that can collectively leave such a larger impact. To achieve the sustainability goals of India, individuals need to adapt to the government policies which will eventually make this world a better place to live in.

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