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Study and Analysis of Electric Road (E-Road)

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ABSTRACT: The widely adoption of Electric Vehicle (EV) has been identified as a major challenge for future development of smart grids. The ever increasing electric vehicle charging further increases the energy demand. Many different types of electric vehicle (EV) charging technologies are described in literature and implemented in practical applications. This paper presents an overview of the existing and proposed EV charging technologies in terms of converter topologies, power levels, power flow directions and charging control strategies. An overview of the main charging methods is presented as well, particularly the goal is to highlight an effective and fast charging technique for lithium ions batteries concerning prolonging cell cycle life and retaining high charging efficiency. EV owners understand their energy usage and thus may perform energy saving activity efficiently. Experiment and evaluation of the proposed system show that the throughput achieved is about 5 Mbps at 10 ms end to end delay in Power line Communication. By introducing two dimensional dynamic pricing and charging schedule, the proposed EVAMI successfully reduces 36% peak consumption and increases the “off peak” consumption by 54%. Therefore the EVAMI does not only reduce the peak consumption but also relocates the energy demand effectively.

KEYWORDS: Electric vehicle, Plug-in electric vehicles, Battery charger, Charging infrastructure, Power Line Communication, Demand Response.

I. INTRODUCTION

The population and related crisis are increasing day by day in India and becoming worst day by day. The main crisis facing is the pollution of various natural resources like air water, noise etc. The main cause for air pollution is the gas exhausted by petrol and diesel cars which emits CO₂ and creating air pollution on large amount. As motor industries are evolving to minimize this by manufacturing electric cars in large amount, the emission of CO is getting reduced so as to minimize air pollution. As electric vehicles need charging points to charge themselves for run, the number of fuel stations (charging points) is less as compared to electric vehicles which lead to rethink manufacturing of electric vehicles. The less number of charging points leads buyers to rethink about the electric vehicle. Denmark has the goal of becoming independent from fossil fuels by 2050, as it is outlined in their “Energy Strategy 2050” [1]. In order to achieve this goal, the transport sector must transition from fossil fuels (95% of all the energy consumed by this sector [2]) towards renewable energy sources. Moreover, such a transition would have a significant impact on the total consumption of fossil fuels in the country as transport accounts for 66% of the total energy consumption from non-renewable sources in Denmark. Within the Danish transport sector, road transport presents a particularly interesting case, as it is responsible for 75% of the energy consumed in this sector.

Therefore, in order for Denmark to achieve their goal of being fossil fuel independent, it must find a cost-effective way of using renewable energy sources for road transport without modifying, in a significant way, the driving patterns of private and commercial vehicles. Battery electric vehicles (BEV) are one of the most promising and popular technologies to lead this energy transition. However, this technology still presents some drawbacks that need to be overcome such as its higher cost, limited driving range and longer charging times when compared with conventional vehicles. In this context, Electric Road Systems (ERS) that allow BEV to charge while driving have emerged as an alternative to deal with the main drawbacks of BEV.

Since ERS are expected to be deployed in highways and roads connecting urban and industrial areas, the required battery capacity in the vehicles can be reduced without sacrificing the range and simultaneously reducing the vehicle's cost. Moreover, the fact that charging is performed while driving eliminates the need to stop at fast charging stations. Despite all the aforementioned advantages, since the implementation of a nationwide ERS requires a significant



investment, it is necessary to evaluate the different ERS technologies in order to determine which one is the most cost-effective for the Danish society.

II.METHODOLOGY

We are planning to do this where we built a separate carriage way of 20 Km with width of 7.5 Km on either side of expressway. Geological surveying of field, to understand the exact soil conditions. To get the materials from nearby locations, considering all the market prices and availability of materials as per the requirement. Burying of copper wires under the road which we are planning to provide on the carriageway. Installing the RPG (Road Power Generation) at the site. We are going to install the Generator to store energy from RPG. The copper coil will provide the electricity to the ongoing vehicle to charge throughout the run. Provide the sensors at the starting and ending point of lane, so as to get the fare as per the capacity of the electric vehicle battery. We are planning to install the electric meter or current measuring

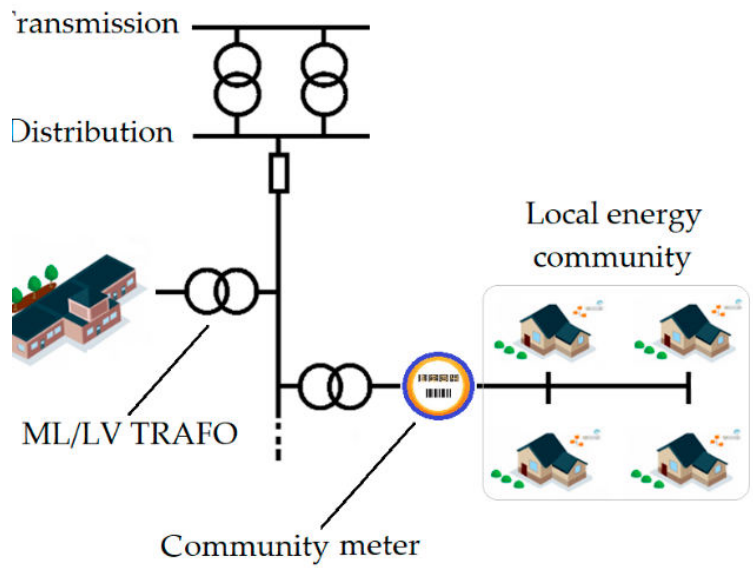


Figure1 : The energy community

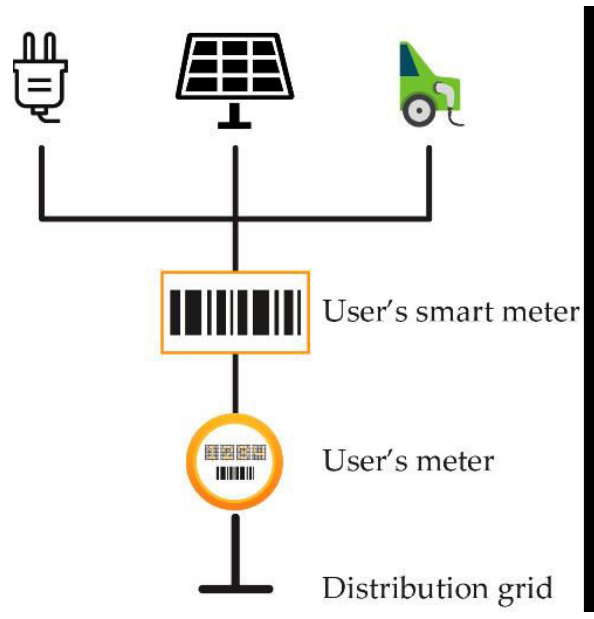


Figure 2 : The community members' equipment



device to measure or to record the amount of current consumed by the vehicle. This device also measures the battery charged status of the vehicle at the starting point when it crosses the sensor one and it analyses the status of charged battery of electric vehicle when it passes through the sensor two. We are planning to collect the fare by making a toll booth/ electric booth so that the vehicle owner can pay the fare. The following tasks are to be carried out in order to achieve the research objectives:

Table: Static Cable Charging overview

Level	Power Rating	Estimated Charge Time
AC Level 1	120 Volts AC, 1.4kW, 12 Amps	PHEV: 7 hours (0% to full)
DC Level 1	120 Volts AC, 1.9kW, 16 Amps	BEV: 17 hours (20% to full)
AC Level 2	200-450 Volts DC, up to 36kW, 80 Amps	PHEV: 22 mins (0% to 80%) BEV: 72 mins (20% to full)
DC Level 2	240 Volts, up to 19.2kW, 80 Amps	3.3kW PEV: 3 hours (0% to full) 3.3kW BEV: 7 hours (20% to full) 7kW PEV: 1.5 hours (0% to full) 7kW BEV: 3.5 hours (20% to full) 20kW PEV: 22 mins (0% to full) 20kW BEV: 72 mins (20% to full)
*AC Level 3	200-450 Volts, up to 90kW, 200 Amps	45kW PHEV: 10 mins (0% to 80%) 45kW BEV: 20 mins (20% to 80%)
*DC Level 3	>20kW single phase and 3 phase	*To be determined, not yet finalised
*DC Level 3	200-600 Volts, up to 240kW, 400 Amps	BEV: <10 mins (0% to 80%)

Defination of charging level

Level 1 “Basic”/“Trickle” Charging	110 V (volts) - 120 V alternating current (AC), single phase, 15 A (amps) continuous.
Level 2 “Quick”/“Standard” Charging	208 V - 240 V alternating current (AC), single phase, typically 220 V/30 A continuous but up to 80 A specified.
Level 3 “Fast”/“DC”/“Commercial” Charging	408 V - 480 V 120 A Converts three phase alternating current (AC) to direct current (DC) for ~80% to full charging in 15 - 30 minutes.

Summary of Voltage generated versus speed of vehicles

Sr. No.	Speed of vehicles (Km/hr)	Voltage generated (volts)
1.	10	8.93
2.	20	7.32
3.	30	6.05
4.	40	5.65

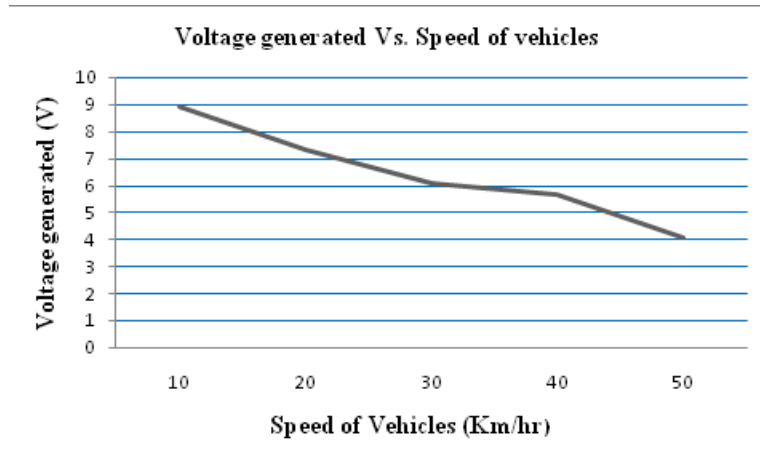


Figure 3 graph between voltage generated & under different speed of vehicles

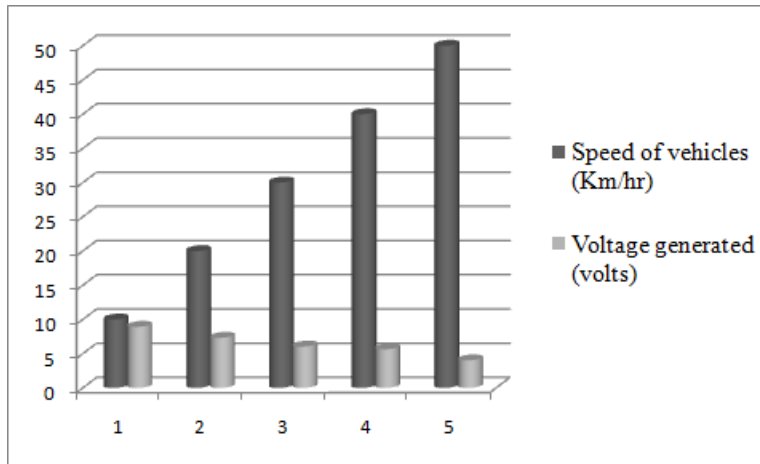


Figure 4 The bar chart between voltage generated & under different speed of vehicles

III.EXPERIMENTAL RESULTS

From this experiment we got to know that using RPG we can generate enough electricity to charge the road, which minimises the need of extra or artificial generated electricity for charging electric vehicles.

Parameters	Comparison of different batteries		
	Lead acid	NiMH	Li-ion
Nominal cell voltage (V)	2.1	1.2	3.6
Specific energy (Wh/kg)	30-40	50-80	150-250
Specific power (W/kg)	250	<1000	<2000
Energy density (Wh/l)	50-90	150-200	150-250
Charge/discharge efficiency (%)	70-92	66	98

The rated power of batteries of this 100% full electric vehicle is equal to 50 kW, whereas the rated capacity is equal to 40.0 kWh; the time for fully charging the batteries at User10s home is about 16 h since the EVSE sets the power to 2.5 kW. The contractual power



for User1 is 4.5 kW. The remaining three users—User2, User3 and User4—are prosumers since they have a photovoltaic generator on their roof; the peak power of these generators and the contractual powers are in the last three rows of Table Technical parameters.

PV Generator Storage Meter

(kW) (kW) (kWh) (kW)

User1 Consumer - 50 40.0 4.50

User2 Prosumer 2.25 - - 3.00

User3 Prosumer 4.50 - - 4.50

User4 Prosumer 6.27 - - 4.50

Summary of voltage generated & load of mans and vehicles for the RPG

Sr. No.	Load of man & vehicle (kgs)	Voltage generated (V)
1.	360	8.33
2.	430	9.57
3.	470	10.44
4.	500	11.34

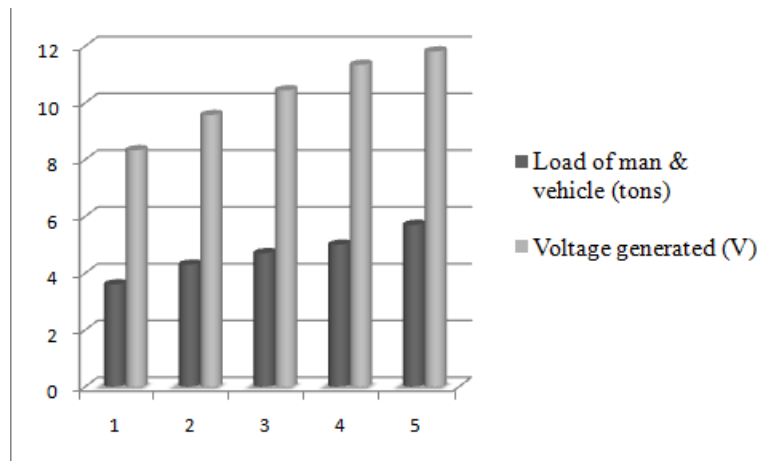


Figure 5 The bar chart between voltage generated & load of man and vehicle

IV.CONCLUSION

Using the technology of electric road (E-Road) we can save a lot of artificial generated electricity and investment in place for charging points. This technology also minimise efforts which an electric car owner has to take for charging point to charge the vehicle. This technology also could be good to down the rates for electricity for charging on vehicles.

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