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EVs Dynamic Charging Platoon Technology

Technologies that enable an in-motion transfer of power to convoy of electric vehicles on highway

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Summary

It is looking increasing likely that Electric Roads System ERS will play a major role in the future of roads transportation, but all types of existing ERS technologies has a significant challenge with, Efficiency, and Safety and long installation time, and the cost of ERS installation and its associated maintenance and also the grid capacity and connections at the roadside issues.

V2V Dynamic Charging Platooning technology is a system that enables DC electrical power will transfer to the electric vehicles from the power bank truck or from electric generator truck in the (car or truck) platoon (Road Train) (1) on the go.

In this technology, there is no need to installation of charging infrastructure on the road or roadside, and also didn't need to have grid connection all roads long, and this means Dynamic Charging Platoon technology can significantly reduce the cost, and time of implementation of ERS, and also in other hand, because of using platooning with dynamic charging in this technology, It can increase safety and reduce congestion by more efficient use of the road network and It can also increase more than %20 fuel efficiency (2) compeer to other ERS methods..

SOLOTION

Dynamic Charging Platoon technology is a number of electric vehicles that are traveling automatically together at short distances in (Road Train formation) and electrically and electronically connected with each other with plug in retractable rail charging cable and receiving electrical energy from Power Bank or Power Generator Truck as a lead vehicle on the go. (Fig 1).

Dynamic DC power sharing technology allows a charging system to charge the fleet of the electric vehicles inside the Platoon simultaneously and different types of electric vehicle can receive a charge in this method, such as Car Truck, Bus or HGV and they can be BEV / PHEV Vehicles.

V2V Dynamic Charging Platoon Technology.

Dynamic Charging Platoon technology consist of two major part:

1-Power Bank Truck (fig 2)

In Dynamic Charging Platoon technology Power bank truck, or Power Generator Truck, or Fuel Cell truck, as a lead vehicle of platoon, can provide constant energy supply to all vehicles inside the Car/ Truck platoon and be acting like Rang Extender for all convoy.

Power bank truck can be Autonomous truck or Semi-autonomous truck and each truck is outfitted with world-class sensing capabilities that are combined with common-sense design to be easy for the driver to use and effective in supporting the driver to lead the Dynamic Charging Platoon.

The type of platoon lead truck power sources can be: (Battery (3), Electric Generator, (4) and Fuel Cell (5)) and charging capacity of each truck will depends on road length and type of EVs convoy can be different.

2- Plugin Extendable Charging Cable (Fig 3) and (fig 4).

Each EV with **platooning technology,** fitted during manufacturing or retrofitted after manufacturing with retractable and adjustable plug in charging cable reel management system.

This Charging and CAN Bus connection cable, can handle easily vehicle to vehicle Longitudinal and Lateral and vehicles up and down movements and it also safe in front of bad weather and dust.

Plug in Charging and CAN Bus connection cable, connecting first flowing vehicle (FV) to Power Bank Truck as lead vehicle (LV) of platoon, and all other flowing electric vehicles connecting to each other by same manner.

This method makes a dynamic network of standalone electric grid and power source for charging of EVs, on dedicated lane on highway on the go.

Joining the platoon and leaving the platoon

Joining the platoon (hub to hub platooning) (Fig 5)

1- EVs owners at the beginning of the highway, entering to the Platooning terminal.
2- After choosing the Platoon that goes to their destination and getting behind other vehicles on that convoy the terminal staff connect the EVs, plugin cables to other Electric Vehicles in front of it and in the end to the Power Bank Truck.

3- After automatically double-checking the V2V Power and Communication Network connection, under Platoon formation, (Power Bank Truck) driver undertake the control of all vehicles and leave the terminal to the high-capacity dedicated Platoon lane on highway.

Leaving the platoon

1- After arriving at the destination Platoon Terminal, The terminal staff disconnect the EVs, cables from each other and from the Power Bank Truck, and EVs Drivers then take manual control of the vehicle on non-platoon roadways to reach their final destination

Dynamic Charging Platoon, Cost and Capacity

Were applied this data, for calculation of capacity and cost of (hub to hub platooning) for Dynamic Charging Platoon technology on **highway**:

1- Heavy Vehicles traffic volume was initially set to 300 unit per 100 Km per hour.
2- Light Vehicles traffic volume was initially set to 1500 unit per 100 Km per hour.
3- Were applied BNEF's annual long-term forecast of global electric vehicle (EV) adoption (3) to calculate EVs traffic size on highway per 100 Km per hour as showing in table 1:

	Light Vehicles	1Heavy Vehicles
2025 = %4	60	12
2030= %10	150	30
2040= %20	300	60
2050=%30	460	90

(Table 1)

4- Each LV and HV platoon fleet size:
- Light vehicles **20** cars per platoon / Dedicated platoon for (LVs).
- Heavy Vehicles **8** Truck/Bus/HGV per platoon / Dedicated platoon for (HVs).

5- Total platoons number which need per 100 Km per lane and cost of electrification of road for 100 Km and 1 Km by estimating €300.000 for cost of each Power Bank Truck.

Light vehicle Platoons	Heavy Vehicle Platoons	Total	Total cost for 100 Km per lane	Total cost for 1 Km per lane
3	2	5	€300.000*5=€1.500.000	€15.000
8	4	12	€300.000*12=€3.600.000	€36.000
15	8	23	€300.000*23=€6.900.000	€69.000
20	11	31	€300.000*31=€9.300.000	€93.000

Table 2

BENEFITS

1- Providing on-demand power transfer to any type of EVs, with any different energy demand even provide higher levels of power suitable for HGV, whilst travelling at low and normal traffic speeds or when traffic completely stop, power used directly to drive the propulsion unit and also can be stored in batteries for later use (i.e. when not travelling along an dedicated Dynamic Charging Platoon Lane).

2- No need to any road or roadside equipment installation, includes transformers, grid connection, installation of Inductive (wireless embedded in the road) or Conductive rail (in-road) or Conductive rail (side rail) or Conductive overhead line and also this method not impact the pavement structure and routine pavement maintenance activity.

3- Dynamic Charging Platoon system can be easily inspected, as most components are visible and accessible.

4- Platooning increases fuel efficiency of systems by reduction in aerodynamic drag of vehicles (especially for freight industry). And it translated to significant benefits for GHG, and local air quality, it also improved on-road safety (i.e., fewer collisions and fatalities), additional road capacity (i.e., less gap between vehicles, better physical road us.

5- Dynamic Charging Platoon is so safe, and no risks for road users (regarding electrocution, electromagnetic radiation, vulnerable road users and so on) and it also has no visual impact.

6- Dynamic Charging Platoon is fastest and most affordable method for road electrification, in this method there is no need for huge upfront investment for installation of ERS on road or roadside and investment can increases step by step according annual global electric vehicle (EV) adoption.

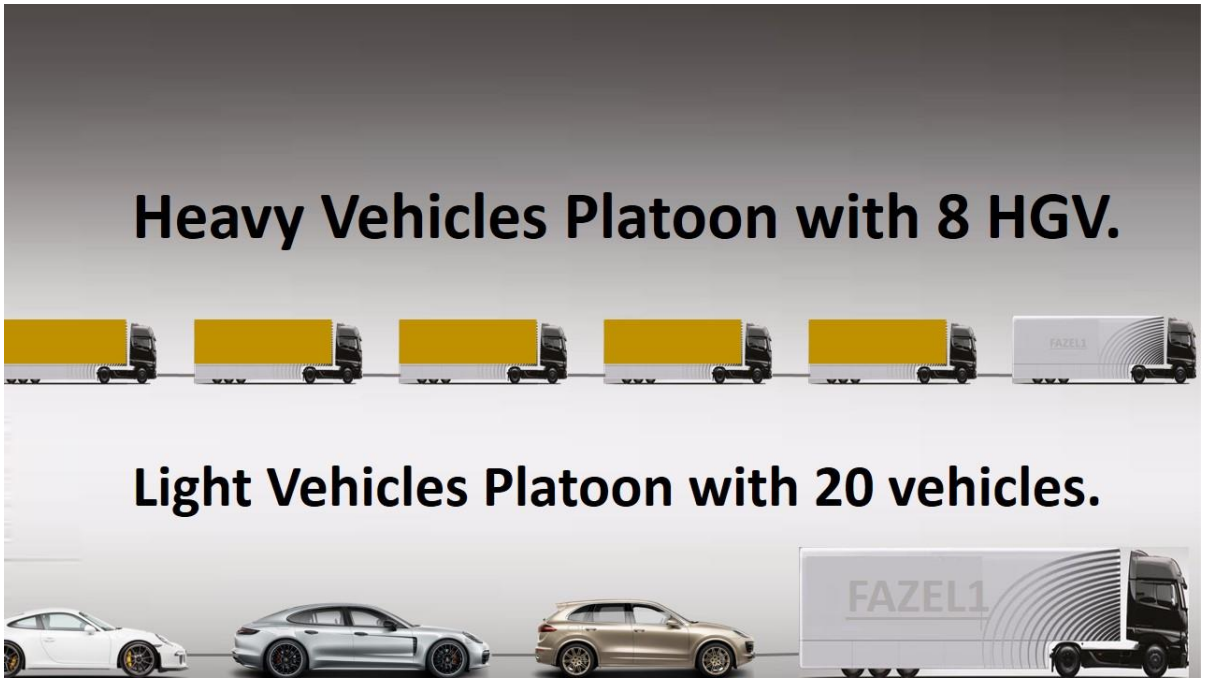
7- For drivers, Dynamic Charging Platooning could completely cut the charging related time and ease tediousness of long shifts and allow drivers to engage in other tasks during driving and it can cut significantly the labour costs.

Results

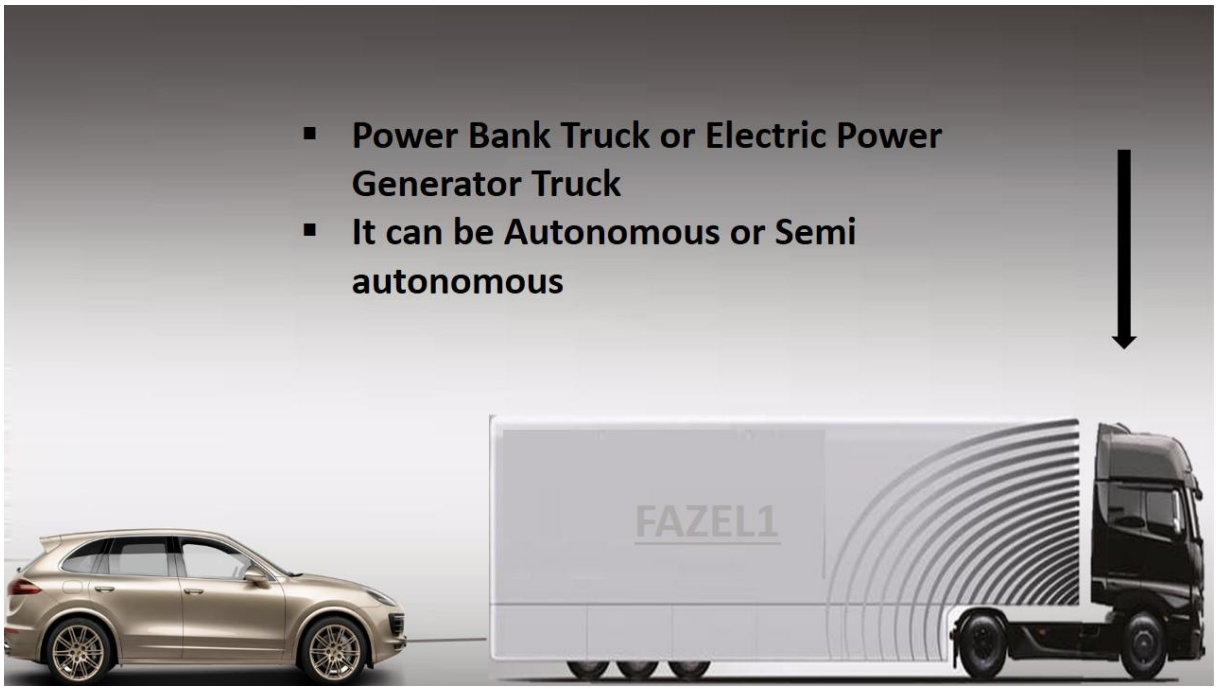
The technology shown in this paper suggests that, Dynamic Charging Platooning has potentially to be technologically and economically feasible and it has also the potential to alleviate some of today's main ERS challenges, such as high cost and long installation time.

Platooning has been shown to dramatically reduce the coefficient of drag of the cars/trucks within the platoon, it could obtain up to a 20% reduction in fuel consumption in a best-case scenario and also it help to reduce environmental impact, and also enable vehicles automation and charging task and reduce significantly labour cost for road fright.

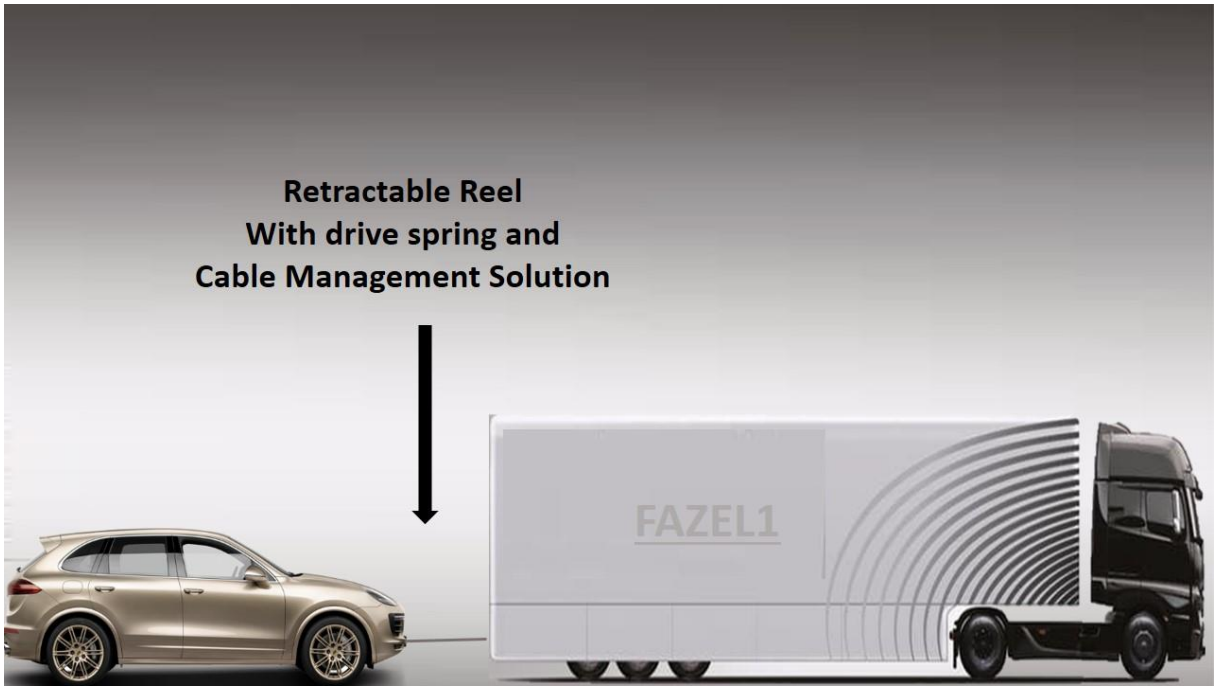
Dynamic Charging Platoon technology help further reducing EV lifecycle footprint and also reducing EV total cost of ownership (TCO) and help for mass adaptation of electric vehicles.


Heavy Vehicles Platoon with 8 HGV.
Light Vehicles Platoon with 20 vehicles.
FAZEL1

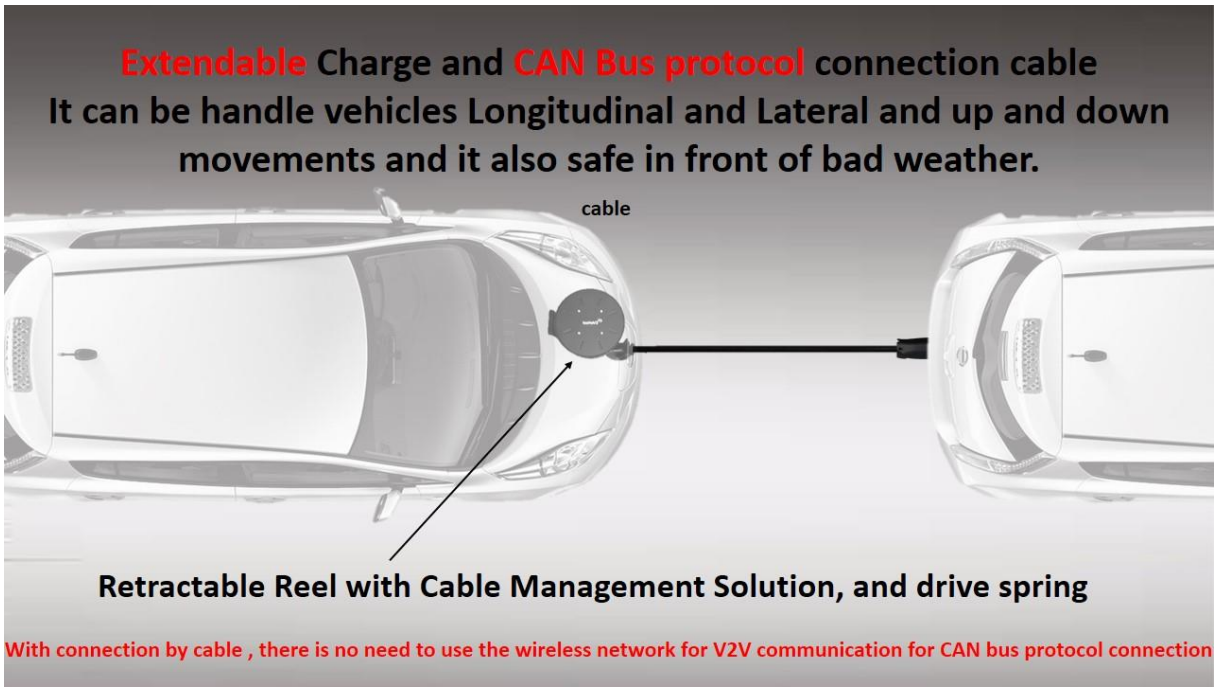
(Fig 1)


Power Bank Truck or Electric Power Generator Truck
It can be Autonomous or Semi autonomous
FAZEL1

(Fig 2)


Retractable Reel
With drive spring and
Cable Management Solution
FAZEL1

(Fig 3)


Extendable Charge and CAN Bus protocol connection cable
It can be handle vehicles Longitudinal and Lateral and up and down movements and it also safe in front of bad weather.
cable
Retractable Reel with Cable Management Solution, and drive spring
With connection by cable , there is no need to use the wireless network for V2V communication for CAN bus protocol connection

(Fig 4)

(Fig 5)

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