Side Conductive Electric Road System for Heavy-duty Trucks to EVs

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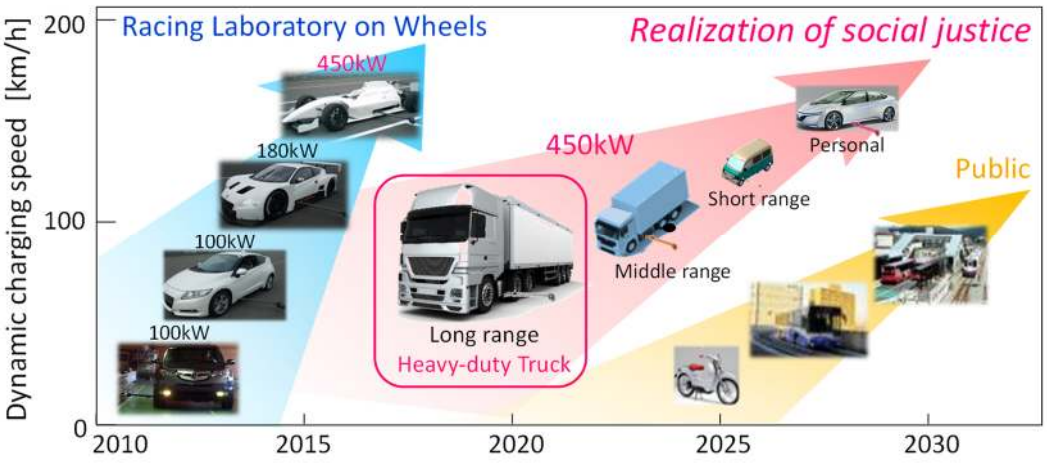
Summary

The spread of EVs is a key point for reducing CO2 emissions while driving. In order to achieve this, it is important to introduce an Electric Road System (ERS) that charges the electric vehicle directly from the power supply road. In this report, Honda describes the development of a 450kW ERS by side conductive method (Dynamic charging EVs and Electric roads) to achieve this. In addition, this system makes it possible to charge while driving from heavy-duty trucks to .passenger cars.



Development Questions

The development and market introduction of electric vehicles (EVs) is proceeding rapidly as a means of addressing the issue of global warming in our mobile society. However, EVs still present major issues. The driving distance of the vehicles, charging (nuisance, charging time, congestion at charging stations, provision of infrastructure, etc.), securing resources for use in onboard batteries, the scrapping of batteries, and a decline

in dynamic performance due to increased vehicle weight can all be indicated as the main issues of EVs.
Two main methods can be considered in order to address these issues. One approach is to increase battery performance, or increase the capacity of the batteries employed in the vehicles. The other is to employ dynamic charging, charging of the battery while the vehicle is in motion. The issues associated with increasing the capacity of the batteries employed in the vehicles include securing resources (battery materials), attempting to help ensure an adequate production volume, measures for the scrapping of the batteries, a proportional increase in charging time with the increase in the energy capacity of the batteries, and measures to respond to the heat generated when charging with a high power level. In addition, the fact that vehicle weight increases with increased battery capacity, making it challenging to extend the driving distance of the vehicle, represents a major issue.
The goals of our development is promotion of substitution of internal combustion engine vehicles and realization of carbon free society by ERS. In the case of dynamic charging, it is necessary that the energy supplied to the battery while the vehicle is in operation should at least exceed the drive energy of the vehicle. In addition, dynamic charging of large vehicles sharing the road with passenger cars and heavy-duty trucks would necessitate the supply of high levels of power, in the range of 450 kW.
Against this background, the development discussed in this report is proceeding with the development of ERS that will help realize an unlimited driving distance for EVs by supplying the vehicle with a high power level during vehicle operation.
This report will discuss the results of a development of future infrastructure installation methods and vehicle specifications with dynamic charging conditions in relation to passenger car and heavy-duty truck operation when the vehicle is dynamically charged at a high power level of 450 kW (DC 750 V, 600 A), and the results of actual dynamic charging vehicle tests, using a charging power of 450 kW and conducted at a vehicle speed of 150 km/h, in addition to considering the future outlook for the system.
If the system were introduced to expressways, the supply of 450kW of power would represent a ratio of vehicle cruising range to charging lane length of 7:3. This would mean that the restrictions on EV cruising range could be removed by the installation of approximately 16 km of charging lane per 53km. It was estimated that the infrastructure installation cost in this case would be around 1/20 of the cost for installation of wireless charging equipment.

Methodology

The system is composed of low-cost infrastructure and a dynamic charging EV. The infrastructure is made up of high-capacity storage batteries (lead acid battery) or power grid and a ERS lane. In the vehicle itself, the system consists of a power collection arm, a dynamic charger, an instantaneous-charging battery pack, and the standard EV system. This system have applied Japanese rail safety standards (JRIS), said to be the world's highest, to the system to help us ensure the safety of insulation and other system components. JRIS has been introduced to provide safety guidelines.
The high-capacity storage battery supplies DC power to the ERS lane, and the ERS lane supplies DC power to the vehicle.

On the vehicle side, the power collection arm receives the power, and the dynamic charger distributes power simultaneously to the motor, which is driving the vehicle, and to the battery. Each of these units is controlled by an individual ECU, and the ECUs are collectively controlled by an integrated control ECU.
The maximum output of the infrastructure described here is 552 kW (max. DC 920 V, 600 A), the power received by the vehicle is 450 kW (DC 750 V, 600 A), and the power transmission distance (space between the infrastructure and vehicles) is from 0.1 to 1.3 m.

Results

Infrastructure and a vehicle system able to realize ultra-high power (450 kW, DC 750 V, 600 A) and high vehicle-speed (150 km/h) dynamic charging were developed. [1]-[3]
The heavy-duty truck maximum motor power is 350 kW and its maximum dynamic charging speed is 90 km.
The results of dynamic charging tests conducted using a newly manufactured vehicle demonstrated that the system possessed the potential to realize the following effects:
- Remove restrictions on EV cruising range
- Reduce charge waiting time to zero
- Reduce battery weight in the vehicle (by less than 1/10)
- Increase driving pleasure by doing away with EV power restrictions

It was also shown that a 450 kW ERS would make it possible to considerably reduce battery capacity, helping to ensure the ability to supply batteries and secure resources for their manufacture.
In the future, Honda intend to continue efforts to boost the reliability and safety of the ERS, attempting to realize practical application of the system at an early stage.

References

[1[Takamitsu Tajima, Wataru Noguchi, Tomohisa Aruga: Study of a Dynamic Charging System for Achievement of Unlimited Cruising Range in EV, SAE Technical Paper 2015-01-1686 (2015)
[2] Takamitsu Tajima, Hideki Tanaka, et al.: Study of High Power Dynamic Charging System, SAE Technical Paper 2017-01-1245 (2017)
[3] Takamitsu Tajima, Hideki Tanaka: Study of 450-kW Ultra Power Dynamic Charging System , SAE Technical Paper 2018-01-1343 (2018)