Energy Storage Technologies for Hybrid Electric Vehicles

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Abstract

The hybrid electric vehicle is a new technology that is improving ecology and environmental awareness worldwide through the transportation sector. The energy storage system is vital to the effectiveness of the electric vehicle. The first stage in the energy storage design process is to choose suitable energy storage resources. This article describes the various energy storage systems for hybrid electric vehicles and their benefits and drawbacks in a detailed manner. It demonstrates that hybrid energy system technologies based on batteries and super capacitors are best suited for electric vehicle applications. This paper also examines the hybrid energy storage system's basic parallel design.

Introduction

- The energy is a crucial factor in human growth; in fact, some researchers have used energy consumption as a measure of economic advancement [1].
- developments in technology and society over the previous few decades have resulted in a significant increase in energy usage, the primary source of which is fossil fuels.
- A rise in the usage of fossil fuels has major environmental consequences due to the release of poisonous and greenhouse gases such as CO2 [2-3].

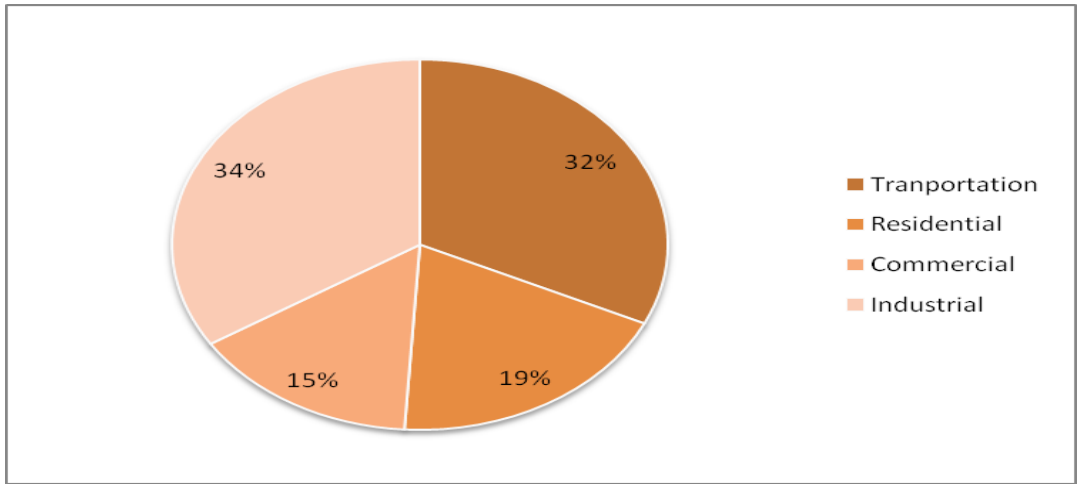


Fig. 1.CO2 emission in various sectors

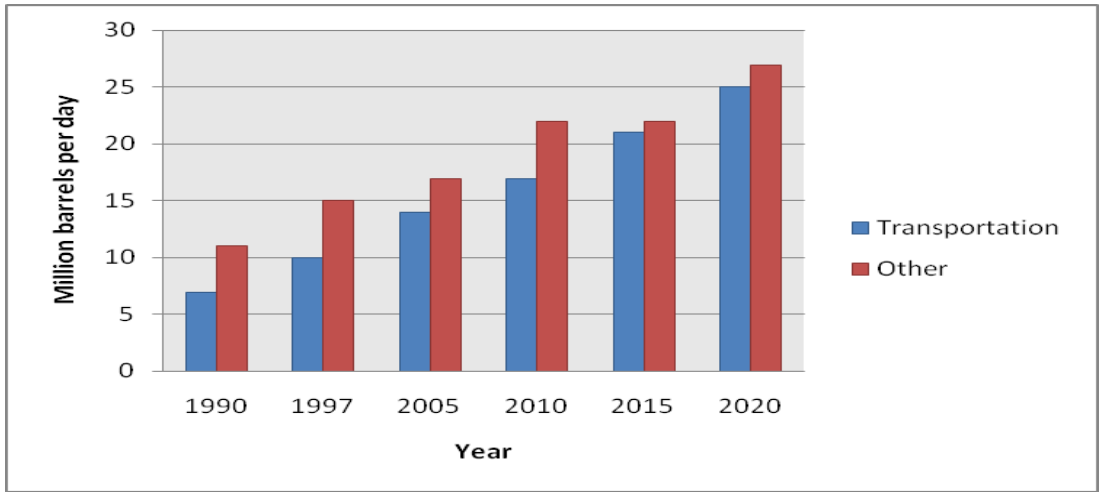


Fig. 2.Worldwide oil consumption

Battery Operated Electric Vehicle

- A battery is an electrochemical device that stores electrical charges through chemical processes.
- Two types of batteries namely primary (disposable) and secondary (rechargeable)
- A primary battery turns chemical reactions to power just once. In large-scale ESSs, secondary/rechargeable batteries are used [8].

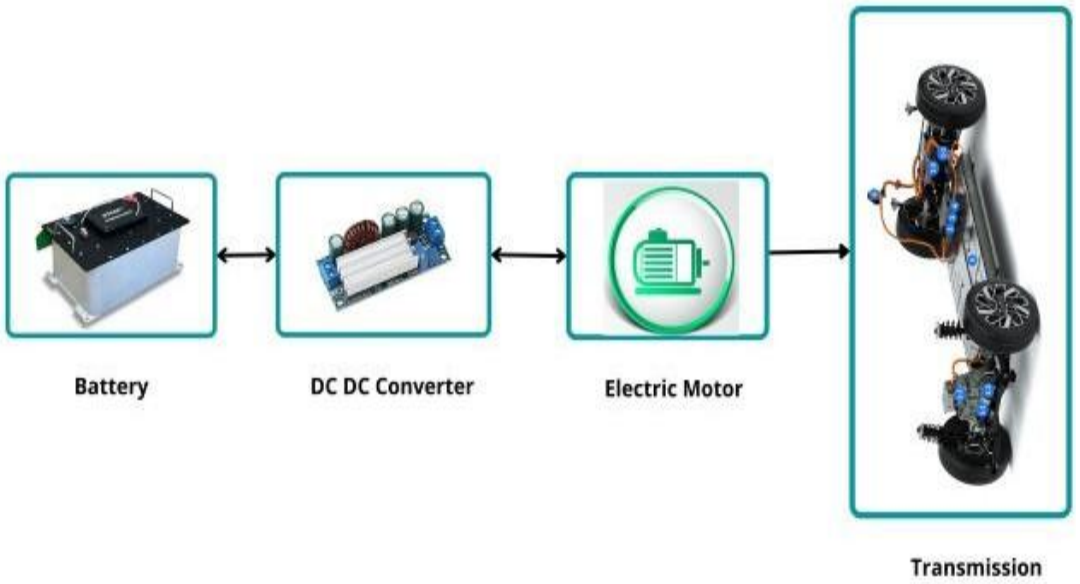


Fig. 3.Battery operated electric vehicle [6]

TABLE-I Different batteries used in Electric vehicle

Batteries	**Energy Density (Kw/Kg)**	**Efficiency (%)**	**Life in Years**	**Eco-friendliness**
Lithium-Ion (Li-Ion) Battery	150	95	10-15	Yes
Redox Flow Battery (RFB)	60-80	70-75	5-10	No
Sodium–Sulfur (Na–S) Battery	125-150	78-85	10-15	No
Lead–Acid (PbA) Battery	30-50	60-70	3-6	No
Nickel–Cadmium (Ni–Cd) Battery	40-60	60-80	10-15	No

TABLE II Specification of Battery

Parameter	**Specification**
Type of Battery	Lithium Ion Battery
Voltage of Battery	24 V
Rated Capacity Battery	7Ah
Initial state of charge	90%

Parallel combination SC with Batteries

- To power the electric vehicle drive train, the hybrid energy storage system employs a battery as the primary energy source and a super capacitor as an auxiliary source.
- Super capacitors have a high specific power density of over 2000 W/kg and a low specific energy density of 2-5 Wh/kg.
- They can meet peak power demand requirements during transients because to their intrinsic high power density.

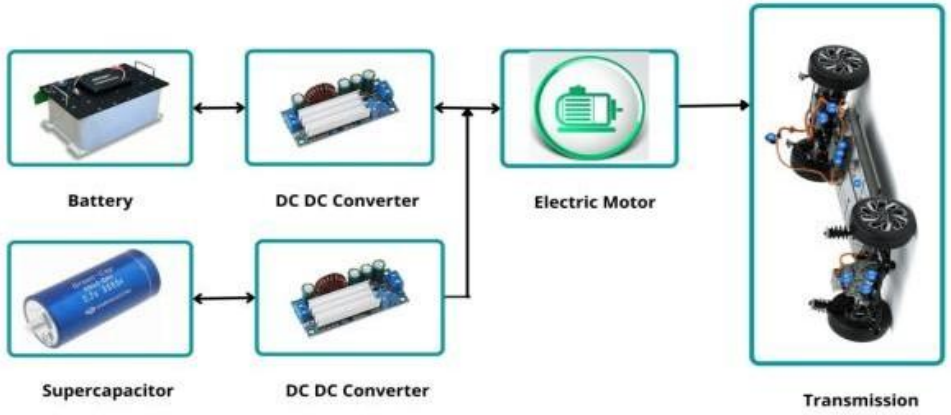


Fig. 4.Parallel configuration super capacitor with battery operated electric vehicle [11]

TABLE III Specification of Super capacitor

Parameter	Value
Capacitance	500 F
DC Series Resistance	10e-3 Ohm
Rated Voltage	24 V
Operating Temperature	25^0C

Simulation of Result and Discussion

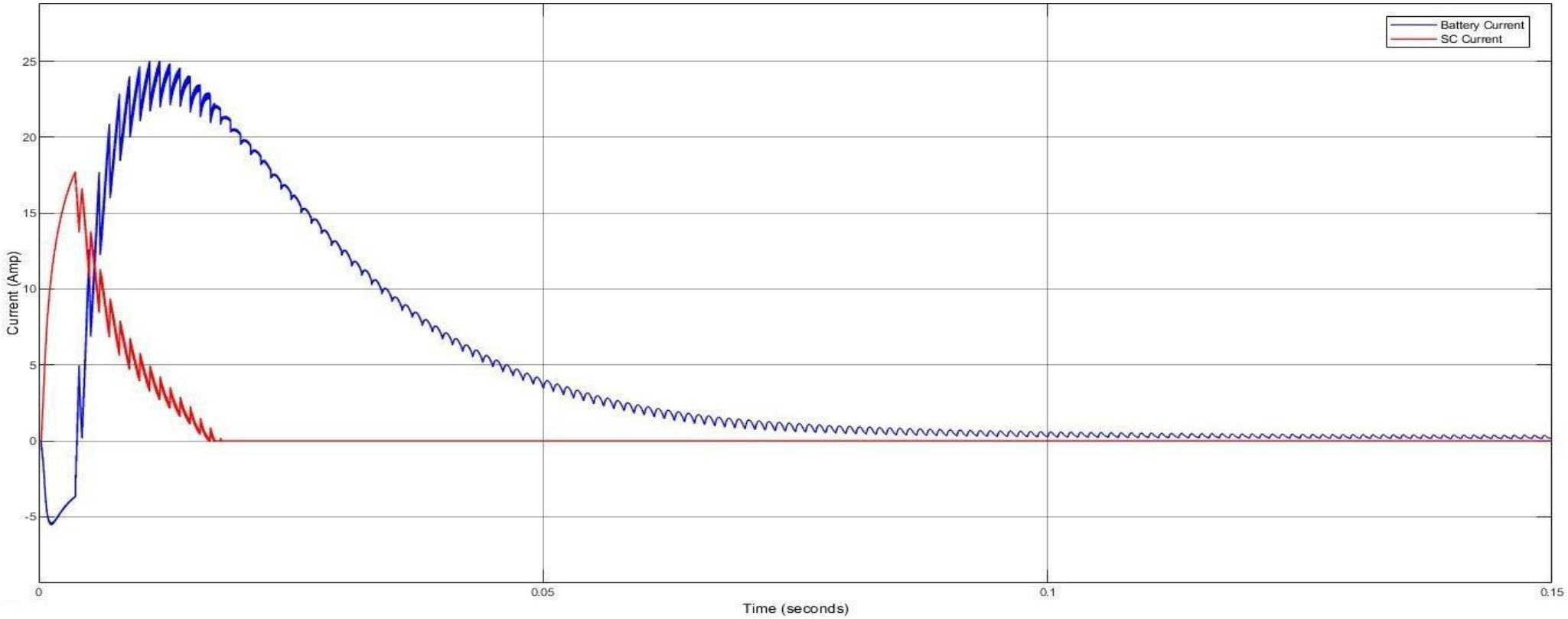


Fig. 5. Simulation current for parallel combination of battery & super capacitor

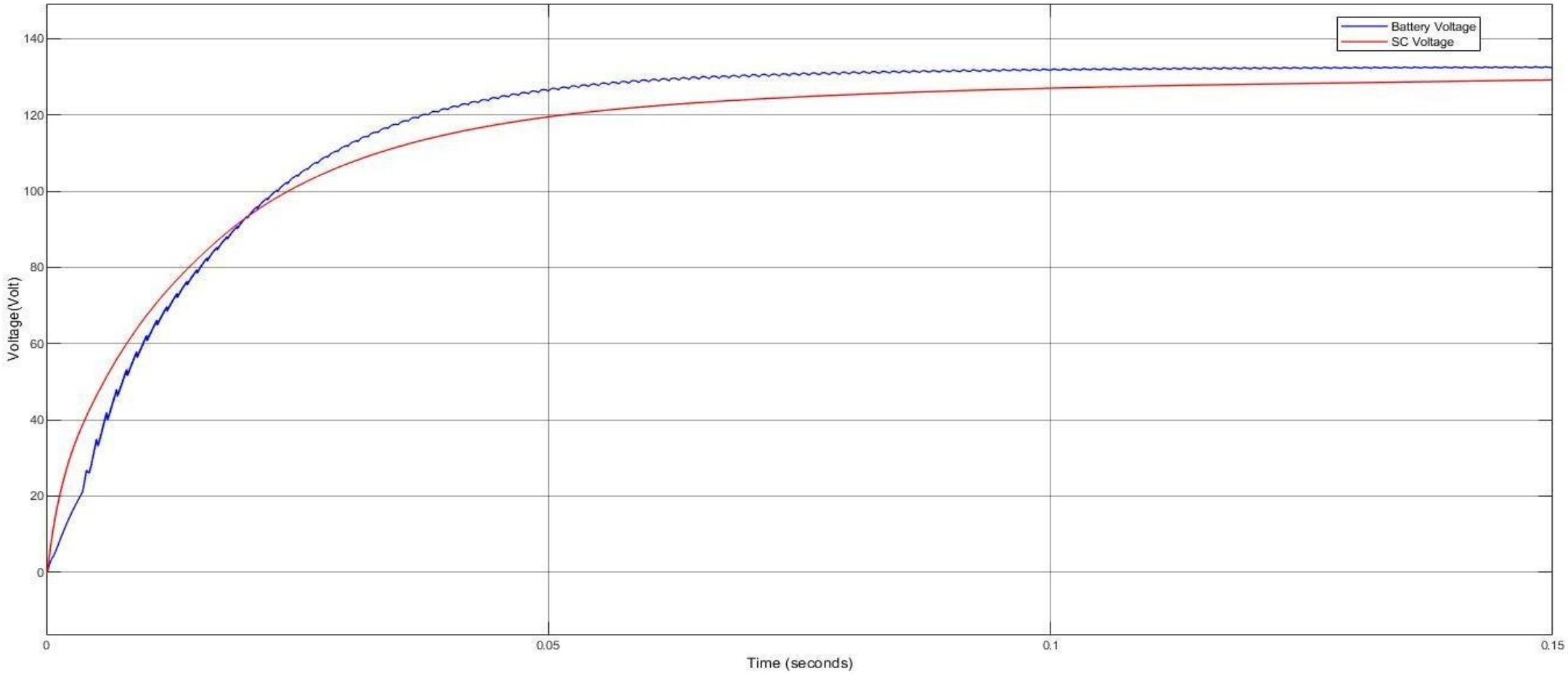


Fig. 6. Boost converter voltages with parallel combination of battery & super capacitor

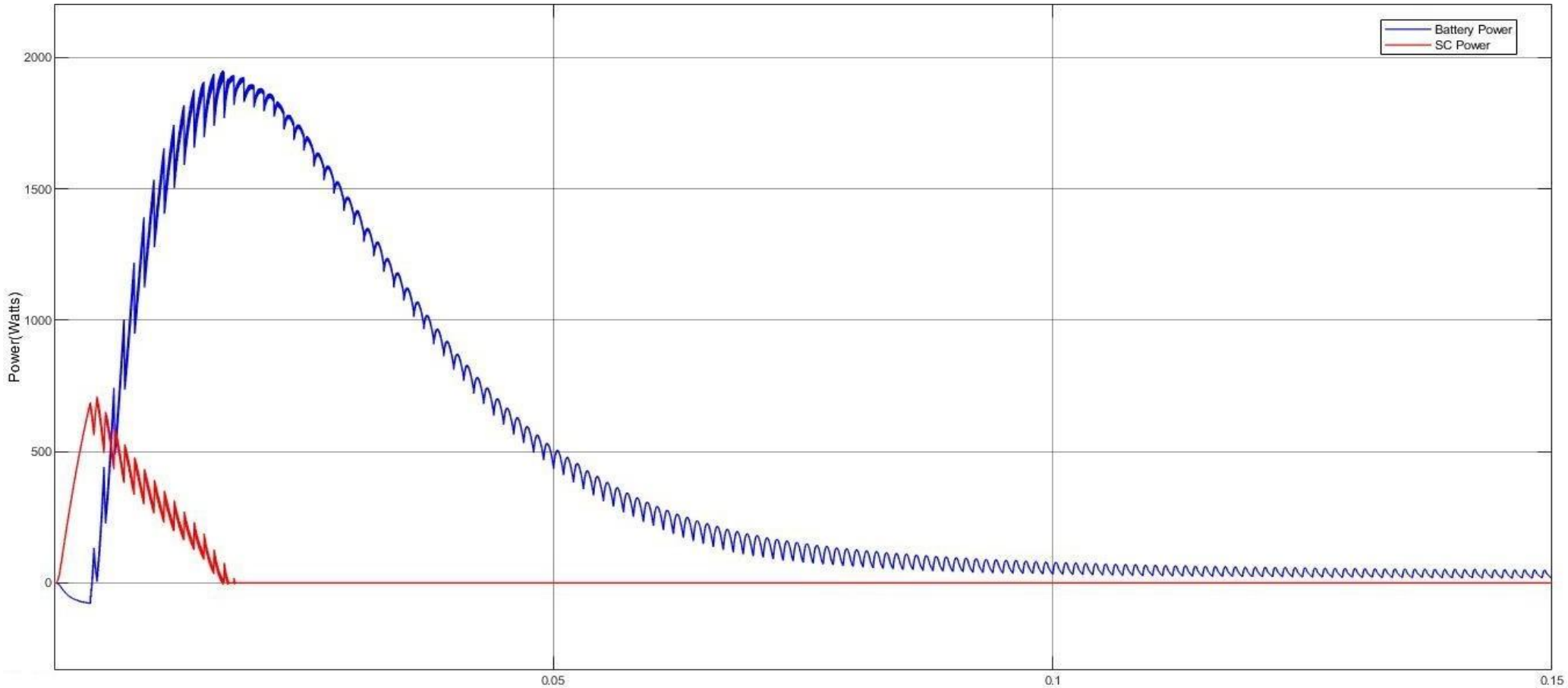


Fig. 7. Power Simulation for parallel combination of battery & super capacitor

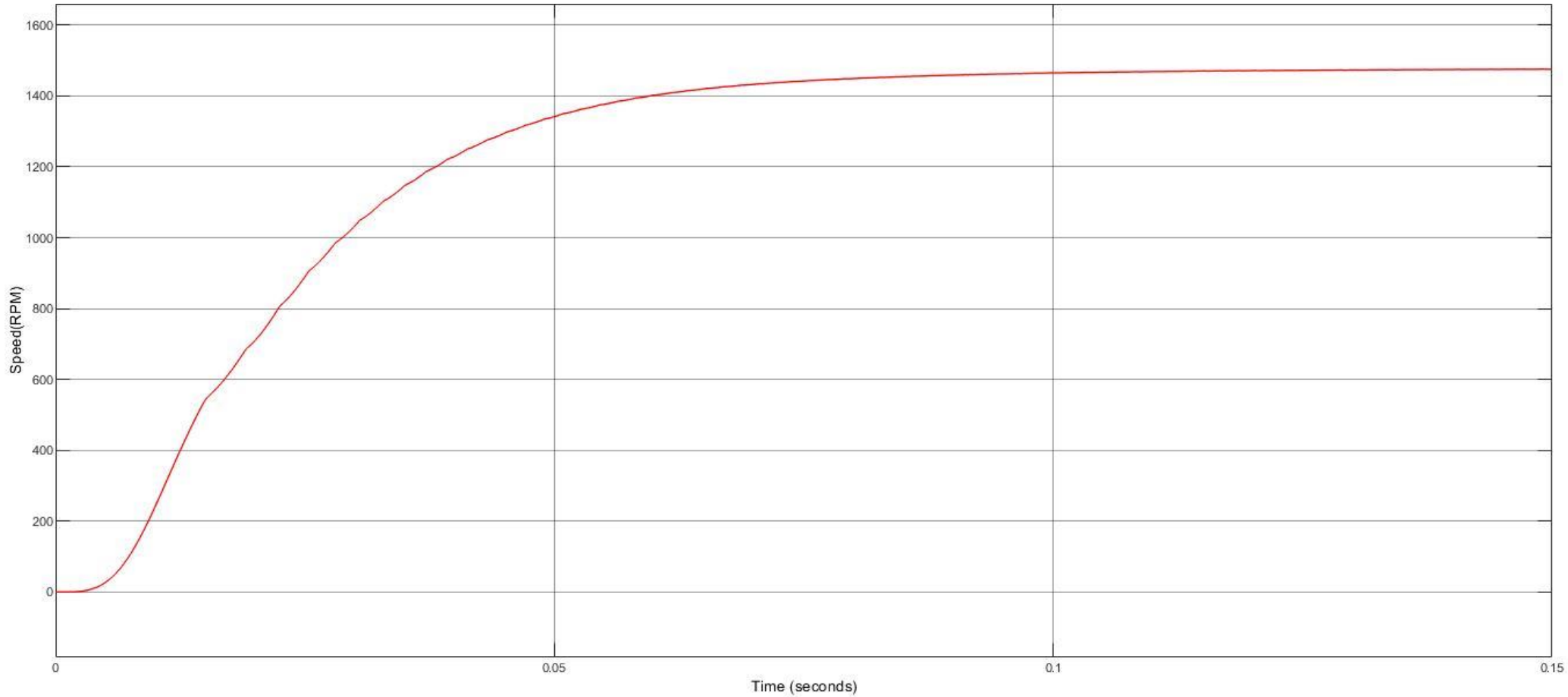


Fig. 8. Speed of BLDC Motor

Conclusion

- Effectively address the issues of growing carbon emissions and dependence on fossil fuels. choosing the storage system for electric vehicle design is then addressed
- The most practical alternative is by far a battery/super capacitor hybrid energy storage device.
- An excellent driving performance is experienced because to the complementary characteristics and cohesive operation of both sources
- The super capacitor unit can meet the high power demand during transients.

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