Project proposal — Fabricator of an pure electric hybrid vehicle

Dr. Suresh Kumar Gadi

Objective — The objective of this project is to model, design and fabricate an pure electric hybrid vehicle with the following functionality.

- Steep acceleration curves similar to the petroleum vehicles (PV).
- Maximizing the energy harvesting at all the times, i.e. during all kinds of the breaking routine.

I. Introduction

Electric vehicles were introduced in the early nineteenth century. The electric automobiles were holding a greater market in comparison to the internal combustion (IC) ones [1]. The 2005 estimates indicate that PV constitute a 97% of the vehicles [2]. Recently there is a growing interest in the hybrid vehicles (a hybrid of petroleum and electric) and pure electric vehicles (PEV) [3], [4], [5].

Figure 1 shows the Ragone plot for the most common storage domains [7]. It is clear that combustion engines have high specific power and specific energy. In the context of automobiles, specific energy can be associated to the fuel autonomy measure, i.e. the distance covered by a unit mass of fuel, and the specific power can be associated to the acceleration. So from Figure 1, we see that a petroleum based automobile have an advantage over any other domain. However, a properly designed electric hybrid system can perform on par with combustion engines.

Figure 1 shows the Ragone plot of electric storage devices. We can ignore the Li-primary batteries option because they are not rechargeable. So, the solution to achieve high specific energy and specific power is the hybrid of super-capacitors (electrochemical capacitors) and the Li-ion batteries.

One of our objective is to achieve steeper acceleration similar to a petroleum vehicle, hence we have to use

In general the PEVs use rechargeable batteries to power a electric motor [6].

The batteries cannot be charged or discharged at high rate or in other words, battery's specific power is low. Super-capacitors provide high , hence in an electric these are not suitable for Figure 1

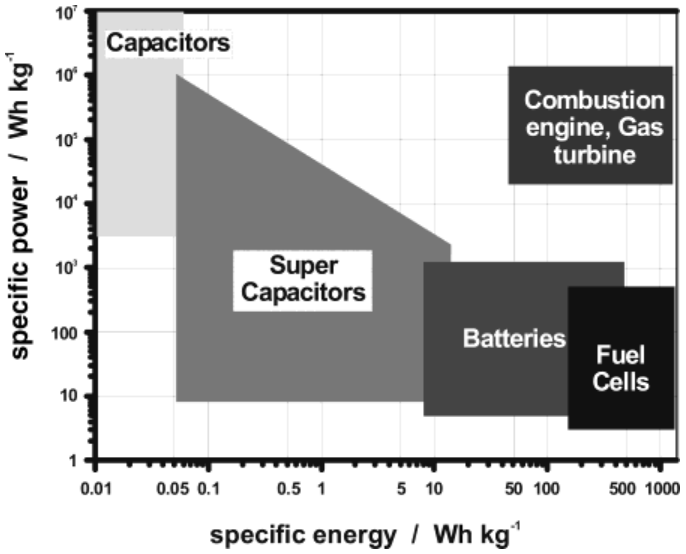

Figure 1. Ragone plot — Comparison energy density (specific energy) and power density (specific power) of most common storage domains [8].

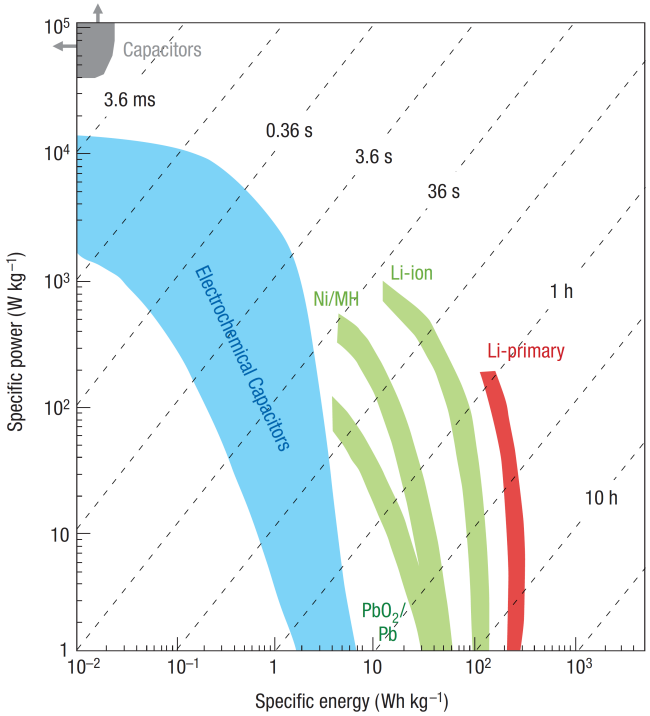

Figure 2. Ragone plot — Comparison energy density (specific energy) and power density (specific power) of various electric power storages [7].

References

[1] M. Guarnieri, "Looking back to electric cars," in *2012 Third IEEE HISTory of ELectro-technology CONference (HISTELCON)*, Sept 2012, pp. 1–6.

[2] J. De Santiago, H. Bernhoff, B. Ekergård, S. Eriksson, S. Ferhatovic, R. Waters, and M. Leijon, "Electrical motor drivelines in commercial all-electric vehicles: a review," *IEEE Transactions on Vehicular Technology*, vol. 61, no. 2, pp. 475–484, 2012.

[3] Y. Hori, "Future vehicle driven by electricity and control-research on four-wheel-motored" uot electric march ii"," *IEEE Transactions on Industrial Electronics*, vol. 51, no. 5, pp. 954–962, 2004.

[4] T. Turrentine, "Who will buy electric cars?" *ACCESS Magazine*, vol. 1, no. 6, 1995.
[5] J. Hildermeier, "Electric vechiles in europe - 2016," 2016. [Online]. Available: https://www.transportenvironment.org/sites/te/files/publications/TE%20EV%20Report%202016%20FINAL.pdf
[6] N. H. Kutkut, H. L. Wiegman, D. M. Divan, and D. W. Novotny, "Design considerations for charge equalization of an electric vehicle battery system," *IEEE Transactions on Industry Applications*, vol. 35, no. 1, pp. 28–35, 1999.
[7] P. Simon and Y. Gogotsi, "Materials for electrochemical capacitors," *Nature materials*, vol. 7, no. 11, pp. 845–854, 2008.
[8] M. Winter and R. J. Brodd, "What are batteries, fuel cells, and supercapacitors?" *Chemical reviews*, vol. 104, no. 10, pp. 4245–4270, 2004.