General Overview of Technical/Economical Constraints in Grid Connected Systems for Hybrid Cars Operation

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Abstract*- It is anticipated that the current electrical power grid systems change from the electro-mechanically controlled systems to an electronically controlled networks within the next decade. An important challenge is to redesign and upgrade the existing grid systems into a smart self-correcting grid. Various developments in information technology, science and engineering promise major improvements in the security, reliability, efficiency, and cost effectiveness of electric power delivery systems. In this paper, the connection of the hybrid cars to smart grid is presented.*

INTRODUCTION

Hybrid electric vehicles [1], are vehicles that combine the internal combustion engine with high-voltage battery/electric motor of electric cars. To operate the high voltage battery of a hybrid car, the following critical question arises: Is There a way to recharge the battery without using the combustion engine ''capacity''?. The answer to this question leads us to the definition of a ''plug-in hybrid electric vehicle (PHEV)''. In general PHEV can be recharged by using an external power source, usually a grid connected system. There are several constrainsts pertaining to recharge of the batteries by power grid. In this paper, such constraints are briefly discussed.

GENERAL ISSUES FOR GRID CONNECTED SYSTEMS

As all new applications in the area of sustainable/alternative energy, PHEV's (see figure 1) design and implementation process has some issues, that government[2] and private companies are trying to solve, in such a way that this technology can be used in large scale within a couple of years. We can mention some constraints:

- Extensive Research needed to develop the components for operate and control adequate grid connected systems, in order to charge the batteries of PHEV's.
- Improvement of adequate infrastructure technologies necessary to produce and ''put in the market'' a significant amount of cars and trucks that uses PHEV' technology.
- Fueling infrastructure for PHVE's as well as efficient and fast ''charging systems''.
- PHEV's large scale implementation, without having problems with people' mobility.
- Reduction of cost for production and commercialization of PHVE's.
- How to implement cars for public transportation (i.e. bus, taxis).

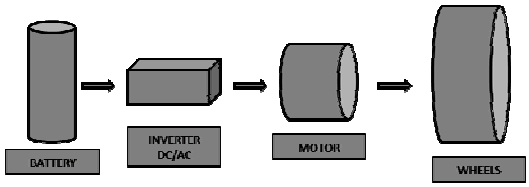

Figure 1: Main components for a hybrid electric vehicle.

There are important constraints linked to the concerns and challenges mentioned above. Those constraints are based on grid connection technologies and operation to recharge PHEV's batteries:

- Vehicle-to-electricity grid interaction: it is necessary to find the best schedule for charging PHVE's, in such a way that the cost can be minimized, and also without affecting the stability and quality of energy that grid is transmitting for other loads.
- Technology and related investment for grid-connection equipment.

Some research work have demonstrated that PHEV's technology represent a good alternative for improve grid operation. Let's study one specific case [3].

Case: Study made for Belgium car's fleet; for this case it is necessary to define the facts and assumptions.

- Facts: Belgian fleet of vehicles consists of about 5 million vehicles. Also, each vehicle travels 41 km a day on average.

- Assumptions: PHEV's drive in electric mode as much as possible to minimize the use of a conventional fuel. An average of 6 kWh/day of energy is required for each PHEV.

In general, PHEV can travel with minimal usage of the internal combustion engine for ''assistance'' and can be recharged by using an external power source (see figure 2). Thus, total energy consumption of these vehicles's fleet is calculated to be around 30 GWh/day. Stability [4] of grid can be affected in a large scale, in the scenario of meeting the 30GWh/day by using energy from grid, even more if the information about time (what time of day) PHEV's will be connected to the grid (i.e. it could be a completely random process), is unknown,. Therefore, one good alternative is PHEV's charging during nights, taking advantage of low electricity prices for night-time and by analyzing the fact that grid load is also reduced.

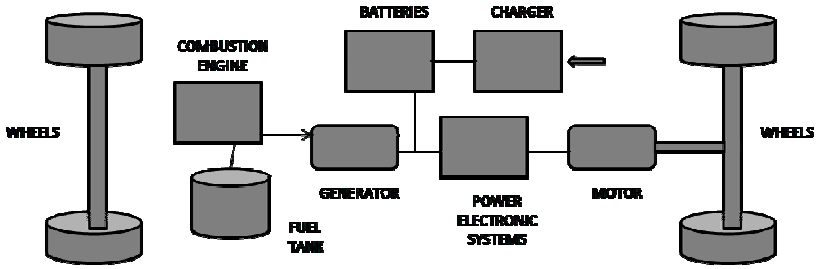

Figure 2: Concept of PHEV.

At this point one important thing arises: we already know that we are in front of a real sustainable/alternative application, and we also know about the capabilities of the PHEV technology. But the key point here is that the economics of producing a complex hybrid power system is ''complex'' itself. Some major issues are represented by:

- Find the best combination for batteries/motor or storage system/propulsion systems, in terms of efficiency, safety and positive impact to the environment.
- Best schedule for grid-recharge process. This represents a big constraint because of the aspects related with grid stability, special equipment, and safety for those who are charging their cars at any desired time of day.
- Some other political issues must be analyzed in more detail.

CONCLUSIONS

PHEV's represent a 'hot topic', not only for the low fuel consumption and low emissions to the atmosphere, but also because the performance of physical components of a PHEV (i.e. batteries, fuel cells) are subject of study for many academic centers around the world, which is a good incentive for young people, who wants to research about this topic and discover new a better ways to improve components' efficiency.

In general, PHEV's mean ''clean and sustainable transportation''. We can just imagine thousands of people driving these cars, going from home to work, using less gasoline, and making a big contribution to the ''environment preservation''. As we have seen, the topic related to PHEV's implementation represents a big challenge, in terms of technology and economy, for government and companies around the world. In general, the question is: How to lead PHEV's to become the next generation of vehicles of cars, worldwide?...this question can be solved by making a tradeoff between cost and Efficient/Safe technology.

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