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Hydrogen Fuel Cell Vehicles Powertrain Possible Future Roles in a Global Perspective

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ABSTRACT

Overview

The notion of Levelized Costs of Generating Electricity (LCOE) is a handy tool for comparing the unit costs of different power generation technologies.

The Vehicle-to-Grid (V2G) concept is well known but it is possible to consider the Hydrogen Fuel Cell Vehicle (H2FCV) power generation system hydrogen fuel cell based not only in V2G perspective, but as a power generation plant, smart grid connected. Today this option is not considerate in the policy portfolio options.

In recent years I published different studies where I compared the Hydrogen Fuel Cell Powertrain (H2FC Powertrain) LCOE (based on the U.S. public data) with the traditional power generation technologies LCOE in different geographical zones with very promising results.

In this study I collect these different works in a global perspective detailed for the main geographical areas with the same promising results. Observing these H2FC Powertrain data, in a global perspective, it will be necessary to think the H2FCVs link to energy sector considering also the possibility to utilize H2FC Powertrain as a Power Generation Plant, smart grid connected, with relevant and positive consequences for a rapid development of this break-through low-carbon technology.

Methods

In LCOE financial model, different cost components are taken into account: capital costs, fuel costs, operations and maintenance costs (O&M). These costs are an average over the life of a project and for a specific technology, based on a specific and particular set of assumptions. The costs cash-flow is discounted to present (date of commissioning) using assumed specific discount rates. The resultant LCOE values, one for each generation option, are the main driver for choice technology.

In my analyses I chose to consider the Hydrogen Fuel Cell Powertrain (PEM Fuel Cell based) as "Power Generation Plant" because, if the current U.S. Hydrogen and Fuel Cell Vehicle Program, as defined by the Public Law 109-58 (also known as the Energy Policy Act of 2005), is able to meet all the 2017 technological targets, in the subsequent year, the high volume associated with the HFCV mass production (up to 500.000 units sold per year) will permit to reduce dramatically the Fuel Cell system manufacturing costs, in order to be competitive with gasoline in hybrid-electric vehicles (HEVs). In fact, in a mass production perspective, Hydrogen Fuel Cell Powertrain will be so cost competitive to be useful adopted also for stationary power generation application.

Using the U.S. DOE data (Current or Targets) I calculated the H2FC Powertrain specific LCOE cost range and I compared the H2FC Powertrain LCOE cost range with the generation costs of the traditional power generation technologies (EIA 2013 data).

Recently, in different studies, I made this kind of LCOE comparison with reference to different geographical zones. In this study I collected these different works in a worldwide perspective and the H2FC Powertrain LCOE data are compared in a global perspective (detailed for the main zones: the U.S., Europe, Australia, China, Japan and South Korea) utilizing the most authoritative LCOE power generation sources (EIA2013, EC 2008, IEA 2010, Japan 2011 and Australia 2012).

Results

Results were very promising. Using the U.S. DOE 2012 H2FC Powertrain data (referred to high projected production volume) I found that the LCOE would be of USD 173 for MWh. Using the U.S. DOE 2017 data target the H2FC Powertrain cost range moves to USD 107-207 for MWh, and, for the lower value of this range, it appears competitive with many of the U.S. power generation technologies analyzed.

In this study H2FC Powertrain LCOE data are compared in a global perspective for the main geographical zones: the U.S., Europe, Australia, China, Japan and South Korea.

In the U.S., Europe, Australia and Japan context, for the lower value of the 2017 range (USD 107-207 for MWh), the U.S. data appears competitive with almost all the power generation technologies considered, so the H2FC Powertrain will be so cost competitive to be useful adopted also for stationary power generation application.

In South Korea and China context, mainly due to the peculiar energy system of these countries (with LCOE generation plant and electricity market prices, very low), the U.S. data doesn't appear competitive with the other power generation technologies considered. But:

In South Korea (according to KEPCO data of Korea Power Exchange prices) the lower value of the 2017 U.S. H2FC Powertrain LCOE data range appears competitive with the 2011-2012 Korean non-base load power generation plant price (or 28% of the produced power).

In China (according to *Demonstration Project for Fuel Cell Bus Commercialization* data) the hydrogen production costs appear substantially different from the U.S. ones. Considering local hydrogen production data, the U.S. 2017 H2FC Powertrain LCOE value range change completely and, for the lower value of the range, it appears competitive with all, or almost all, the power generation technologies considered also in China.

Having in mind these results I observed that, in the current energy policy debate, H2FC Powertrain is not considered in the range of feasible power generation options.

Conclusions

It is long time that I underlined the possible relevant implication of Hydrogen Fuel Cell use in stationary and transport applications and I argued that it's time to consider H2FCVs as a relevant possible solution in energy debate.

If the current U.S. Hydrogen and Fuel Cell Vehicle Program is able to meet all the 2017 technological targets the high volume associated with the H2FCVs mass production will permit to reduce dramatically the Fuel Cell (PEM) system manufacturing costs, in order to be competitive with gasoline in hybrid-electric vehicles. In this mass production perspective, H2FC Powertrain will be so cost competitive to be useful adopted also for stationary power generation application.

Observing these H2FC Powertrain data, in a global perspective, it will be necessary to think the H2FCVs link to energy sector considering also the possibility to utilize H2FC Powertrain as a Power Generation Plant, smart grid connected, with relevant and positive consequences for a rapid development of this break-through low-carbon technology.

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