The production and use of hydrogen from renewable energy sources in the wine sector

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The energy demand in remote rural areas can be satisfied in a competitive manner with the use of renewable energy sources. In the framework of the *EU LIFE+ program*, this demonstration project (*Profitable Small Scale Renewable Energy Systems in Agrifood Industry and Rural Areas: Demonstration in the Wine Sector*) proposes a feasible alternative for long period storage, using hydrogen as an energy vector. In the present case, part of the energy required by Viñas del Vero S.A., a winery in Barbastro, Spain, will be supplied by the production from a photovoltaic panel array.
The general idea is to hydrolyze on-site available water using the exceeding electrical energy, and to store the generated hydrogen in pressurized tanks. In this project, the end-user consists of a PEM fuel cell system that re-converts the hydrogen to electric current.

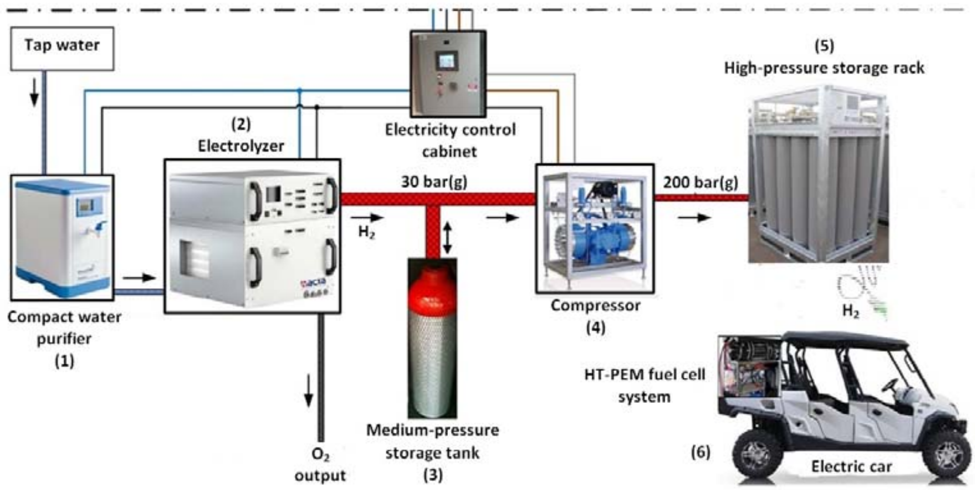

Figure 1. General scheme of the hydrogen production, the storage system, and the end-user commercial electric vehicle properly modified to be powered by a hybrid powertrain

The hydrogen generation and refueling station has a bespoken design, comprising mostly commercial components in order to minimize the overall capital costs and to ensure the reliability of the installation in the terms specified by the manufacturers. Basically, the system is composed by (see Figure1): (1) a compact purification system that produces ASTM Type II grade analytical water with tap water quality as input, (2) an electrolyzer based on an Alkaline Solid Polymeric Membrane (3) a buffer tank at low pressure for the generated hydrogen, (4) a metal diaphragm compressor and (5) a storing rack of medium-to-high pressure cylinders to be used as refueling bank for the mobile tanks of a fuel-cell powered vehicle. Besides these components, power and control electronics panels have been also designed and built, together with the necessary inter-connections.

The end-user is primarily a commercial *ePath-7500* electric car (6) suitably modified to be powered by a hybrid powertrain based on PEM fuel cell and batteries. This is an all-wheel drive (AWD) 4-seat vehicle designed to travel on bumpy and irregular terrain, ideal for agricultural or industrial work regimes. Originally, the 7.5 kW 72 V electric motor of the car was powered by a set of 12 gel-type 225 A-h batteries, which provides a range of 100 km when moving at a constant velocity of 30 km/h. Several modifications were performed to adapt both the pure electric battery powertrain and its tilting rear load platform to include a 72-cells, 3 kW, PEM fuel cell stack with its corresponding gas storage and supply system (GSS) and the electronic devices used for hybridization, as shown in Fig. 2, and it is allowed to roughly double the vehicle autonomy. The GSS is formed by four 10 l aluminum cylinders from Luxfer, which can store 0.64 kg (7.12 m^3) of hydrogen when compressed at 200 bar.

a) b)

Figure 2. Photos of the commercial *ePath-7500* electric car and the fuel cell system assembled at the rear platform

The work describes the design and operational tests for both the hydrogen refueling station and the hybrid electric vehicle. The overall efficiency for the electricity conversion of the plant (from the PV panels to the vehicle wheels) ranges from 29.40% to 36.41%. The upper limit is reached when the electricity to produce hydrogen is directly obtained from PV panels, while the lower one corresponds when the hydrogen is produced from the energy stored in the batteries.