

“Green Hydrogen from Wind and Solar: Design, Construction and one year operation of the IHER Project”

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Abstract

The IHER project, “Technology Infrastructure for Hydrogen and Renewable Energies”, promoted by the Foundation for the Development of New Hydrogen Technologies in Aragon, comprises a whole test and demonstration facility for photovoltaic, wind energy and hydrogen. This 3 M€ project developed during the last two years, has been completed in early 2008. Since December 2006 hydrogen from the sun is being produced.

The facilities display a complete picture of current PV and wind technology, consisting of a 635 kW wind farm with three different turbines, a 100 kW grid connected photovoltaic installation (three panel technologies, four different sun-tracking systems), and an isolated 2.7 kW photovoltaic application (1 kW concentrated PV, 1.7 photovoltaic roof with two advanced panel materials). The facility includes hydrogen production by a PEM electrolyser, storage and fuel cells. Up to date, it is the only renewable-to-hydrogen project in the world that includes so many different technologies.

The IHER project serves as showcase for renewable electricity and hydrogen production, for training and researching purposes at the Foundation, as well as for raising awareness on the future energy challenges. Recently, the Foundation for Hydrogen in Aragon and Swiss-based Company Industrie Haute Technologie signed an agreement to jointly develop wind-to-hydrogen solutions. IHT will install a high pressure alkaline electrolyser at the premises of the Foundation. The paper will depict in detail the project, shedding light on technical and managerial issues, as well as describing the progress made in R&D up to date

Introduction

The aim of the IHER Project is the start-up of an installation that allows tests of hydrogen generation by electrolysis, with electricity obtained from renewable sources, with the most diverse available technologies. The project tries to cover all the hydrogen chain (production, management and efficient use), obtaining the primary energy from renewable sources by means of processes currently available (photovoltaic and wind).

The secondary goal of the mentioned installation will be the learning of integration at real scale of renewable sources and temporary hydrogen storage, technological diffusion, "green" hydrogen generation of renewable sources for their consumption in stationary or portable applications, and evaluation of the efficiency and functionality of the transmission systems in AC current and continuous, all that in an operation frame that guarantees an economic return by the sale of the excess of electricity in Special Regime that facilitates the financing of the project and covers its operation and maintenance costs.

Project Description

The activities to be done within the framework of the present Project include the basic and detail projects, the supplying of the main equipment, and the construction and start-up of each one of the electrical subsystems and hydrogen:

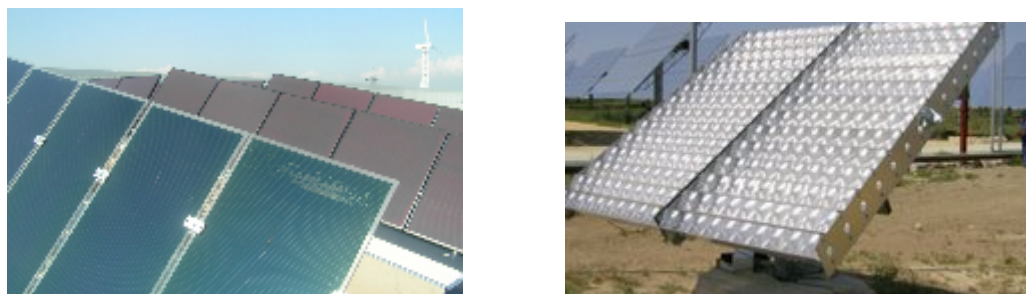
1-Photovoltaic Generators: Installation of fixed panels: a parking zone has been built to obtain an efficient use of the land and to equip with shade the parking, increasing the aesthetic of the surroundings. There are 60 kW installed on the 3 marquees of the parking with a total of 300 panels, 210 Wp, monocrystalline, brand MSK, model TFC 210-W and 6 investors of 10 kW each one, brand SUNWAYS, model NT 10000. Due to the direction of the marquees, oriented longitudinally towards the south, FV panels are perfectly oriented in that direction, nevertheless, although the maximum possible performance would be obtained with an inclination of 32°, by aesthetic and looking for the maxima architectonic integration, has limited the inclination to 15° of the marquees cover, assumed that the losses for this reason will be of a 3.15%.

Installation of panels in sun followers: the referred installation is constituted by four solar followers of two axes that allow the pursuit of the annual solar trajectory in inclination and azimuth with a nominal installed power of 40,000 W, and 44,568 Wp of power installed in panels, using different designs and pursuit technologies. The specifications of the followers are show in the Table 1:



Picture 1 – Photovoltaic grid Installation.

The photovoltaic project, is completed by an isolated installation, with one 1 kW sun concentrator, and 0,7 kW thin film and 1 kW amorphous panels on the roof, as appear in the pictures below.



Picture 2 - Photovoltaic isolated installation

2-Wind Turbines (Walqa Wind Farm R&D): It consists of three turbines, each one with a type of technology and on an average rank of powers (80, 225 and 330 kW). With this infrastructure it is expected to be pioneering not only in Spain, but also at international level, due to the rank of powers that are handled, constructing the infrastructure necessary to have a real test bench of hydrogen production by renewable energies. This situation in the market of the turbines, is taking to the non-existence of models in the average rank of powers (100 kW- 400 kW), which is entailing to the non-operation of the wind resource in those zones near the energy consumption, like can be farms, etc, due to the elevated impact that would imply the positioning of the sizes of the turbines that are settling in the rank of the MW at the moment.

Before this emptiness in the market of the turbines in the rank of intermediate powers, the proposal that is made for the configuration of the Walqa Wind Farm is the reusability of turbines in

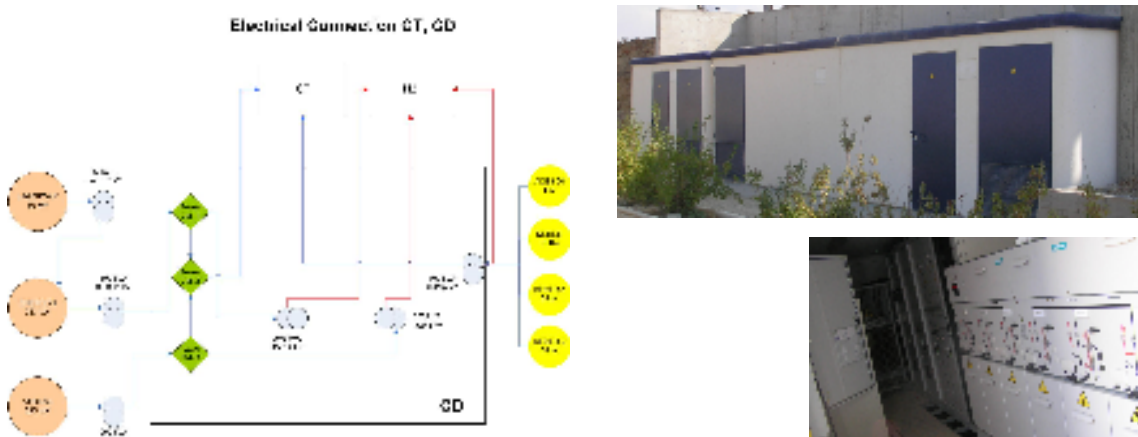
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the intermediate rank of powers, that at the moment are being replaced by models of greater power, following the present tendency that has arisen at world-wide level from "re powering".



Picture 3: Turbines Pictures

3-Energy System Management: Includes the electronics of power (to turn the electrical power at acceptable levels for the electrolysers), the control system and supervision (SCADA), the connection to the electrical grid to spill the excess of production, and the additional devices to improve the electrical power quality. It has been chosen to divide this system in two: the interconnection to the grid (Transformation Centre, CT) and the interconnection to the hydrogen generation (Distribution Centre, CD). In order to calibrate properly the complexity of the IHER Project it is enough to point out that there are not antecedents of a wind and photovoltaic mixed installation, which is the reason why the CT has certain innovating characteristics. Of course, the CD concentrates most of the innovation. Both centres will be located in individual buildings prefabricated in parcel 24. Next are the Single-wire schemes of the CT, CD.



Picture 4: Single-wire schemes CT,CD

4-Hydrogen generation and plant balance: it is foreseen to equip with the infrastructure for two electrolysers, totalizing about 70 kW of installed power, and to install two representative units of the two dominant technologies: PEM and alkaline. The elements of the plant balance must be also considered: water desmineralitation, hydrogen refrigeration, electrolysis, compression and storage. For the storage the Foundation has a metal hydride (OVONICS) with a capacity of 90 g and three hydride metal (LABTECH) with a capacity of 7 Nm³ each one in order to store 100 kWh of energy. As well as the metal hydride there are two options, one is to store hydrogen gas at 45 bar in tank and the second option would be a trailer of cylinders at 200 bar, with a total capacity of 400 Nm³. The hydrogen is use in two fuel cell Ballard 1.2 kW integrated in a kart, and Plug Power 5 kW, which is integrated as back-up system in the building.

With IHT is being developed a high pressure (32 bar) alkaline electrolyser to get a wind-to hydrogen complete solution, in the picture below can appear the stack for the IHER project, this

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technology is able to reach large hydrogen production up to 760 m³ N/h, which match with huge wind parks which are install nowadays, in the size of 20 MW. IHT is the only electrolyser manufacture all over the word able to produce large pressure electrolyzer.



Picture 5 – Left (760 m³ N/h), Right (ITHER stack 10 m³ N/h)

5- Foundation Building: the Foundation has a land in the Walqa Technology Park with a surface of 3,979.75 m². The building has an useful surface of 1,170.50 m². The distribution of the building allows the lodging of those companies, research centres, Universities departments that want to research about the new hydrogen technologies.



Picture 6 – Aragon Hydrogen Foundation Research Center

Conclusions

ITHER project is the main bet of the Aragonese society in order to be on the head of the hydrogen economy. The Region of Aragon has an important wind and solar resource that together with the hydraulic resource will allow reducing the external dependency that exists at the moment. Due to all mentioned before, the project will allow to undertake new lines of investigation, such as:

1. Wind – Hydrogen, Photovoltaic - Hydrogen integration tests and optimal sizing.
2. Durability and efficiency tests in the chain of hydrogen production.
3. Characterization and improvement of components: turbine, electrolyser.
4. Optimization of mixed systems renewable-hydrogen and development of control systems.
5. Improvement grid quality systems, using part of hydrogen generated in engines or fuel cells.
6. Development of guidelines for operation and maintenance of the system.
7. Efficient use of hydrogen for electricity generation, co-generation and tri-generation.
8. Technical formation of personnel in the hydrogen technologies.
9. Diffusion and spreading of ITHER project.