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Renewable Energy and Hydrogen On-Site Generation for Drip Irrigation and Agricultural Machinery

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Abstract : The energy used in agriculture is a source of global emissions of greenhouse gases. The two main types of this energy are electricity for pumping and diesel for agricultural machinery. In order to reduce these emissions, the European project LIFE REWIND addresses the supply of this demand from renewable sources. First of all, comprehensive data on energy demand and available renewable resources have been obtained in several case studies. Secondly, a set of simulations and optimizations have been performed, in search of the best configuration and sizing, both from an economic and emission reduction point of view. For this purpose, it was used software based on genetic algorithms. Thirdly, a prototype has been designed and installed, that it is being used for the validation in a real case. Finally, throughout a year of operation, various technical and economic parameters are being measured for further analysis. The prototype is not connected to the utility grid, avoiding the cost and environmental impact of a grid extension. The system includes three kinds of photovoltaic fields. One is located on a fixed structure on the terrain. Another one is floating on an irrigation raft. The last one is mounted on a two axis solar tracker. Each has its own solar inverter. The total amount of nominal power is 44 kW. A lead acid battery with 120 kWh of capacity carries out the energy storage. Three isolated inverters support a three phase, 400 V 50 Hz micro-grid, the same characteristics of the utility grid. An advanced control subsystem has been constructed, using free hardware and software. The electricity produced feeds a set of seven pumps used for purification, elevation and pressurization of water in a drip irrigation system located in a vineyard. Since the irrigation season does not include the whole year, as well as a small oversize of the generator, there is an amount of surplus energy. With this surplus, a hydrolyser produces on site hydrogen by electrolysis of water. An off-road vehicle with fuel cell feeds on that hydrogen and carries people in the vineyard. The only emission of the process is high purity water. On the one hand, the results show the technical and economic feasibility of stand-alone renewable energy systems to feed seasonal pumping. In this way, the economic costs, the environmental impacts and the landscape impacts of grid extensions are avoided. The use of diesel gensets and their associated emissions are also avoided. On the other hand, it is shown that it is possible to replace diesel in agricultural machinery, substituting it for electricity or hydrogen of 100% renewable origin and produced on the farm itself, without any external energy input. In addition, it is expected to obtain positive effects on the rural economy and employment, which will be quantified through interviews.

Keywords : drip irrigation, greenhouse gases, hydrogen, renewable energy, vineyard
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