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Revamping of Existent Chlor-alkali Plants for Conversion of Hydrogen to Electricity, Hydrogen Community Germination Step

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Abstract

The transition towards hydrogen becoming widespread in future energy systems and may be one of the greatest social and technical challenges facing society. A wide range of stakeholders will need to work together over extended periods of time to make the sustainable hydrogen “vision” a reality. Community-based projects are seen as a route to stimulate the start of the transformation, leading to more widespread early adoption of these new technologies.

Valcea have premises to develop some local projects in order to become a Hydrogen Community. This “Community” fulfils both an economic-technical background and a scientifically potential.

1 Hydrogen Community

Hydrogen is an indispensable co-product of the chlorine production process. Hydrogen can convert chlor-alkali technology into a more efficient one and may save a certain amount of energy. EU-27 chlorine producers know as Euro Chlor, want to increase recycling and re-use of hydrogen gas from 80% (2001) to 95% by 2010, difficult to achieve, into the opinion of many. The companies improved their utilization rate, others however did not, and this has had a negative influence on the consolidated result [1]. The fuel cell stationary applications are one of the additional efforts necessary in order to achieve 2010’s goal.

A Hydrogen Community refers to an early adopter of Hydrogen and Fuel Cell technologies, having the potential to lead to a coordinated, larger-scale adoption of such technologies within a coherent end-user grouping. Although, the specific costs of current prototype PEMFCs are still high, large cost reduction potentials are expected during the next years which shall enable mass penetration of this technology into several markets. Various small and large industrial enterprises worldwide are developing commercial PEMFC systems and preparing their market introduction. First prototype applications are tested in pre-commercial applications together with prospective future customers [2].

Revamping of existent chlor-alkali plants (92 into Europe) for conversion of hydrogen to electricity is a germination step in order to growth up a Hydrogen Community.

In practice, other types of hydrogen communities could be regions, cities, remote locations (such as islands), self-contained entities (airports, seaports, industrial complexes, etc), or distributed entities (hydrogen highways, etc).

In a Hydrogen Community, hydrogen plays a significant role in the community as an energy vector. A Hydrogen Community may evolve out of, or in parallel to, large demonstration projects. Possible cluster activities within the Community can include fundamental or applied research and demonstration projects that feed new technology into the Community.

For a lot of East European country where exists regions with a strong technology or manufacturing base, but with declining industries, a chlor-alkali plant could regenerate itself by becoming a centre for hydrogen technology. This could create jobs and bring money into the local economy. In the longer term, it could allow the region to establish itself as a major innovator/manufacturer of hydrogen technologies. As a technology that is new, and is expected to become very significant, hydrogen represents an attractive option for regional growth.

Existent chlor-alkali plants with municipalities and authorities form an important base of Hydrogen Community early adopters. The revamping of existent chlor-alkali plants project will represent an useful tool as early adopter: establishing a database of potential technology demonstrations; characterizing these early adopters in terms of their drivers and capacities, enabling conclusions to be drawn regarding key success factors; studying relevant policy measures, and drawing conclusions on critical points for the future in terms of general policies and regional cluster development in hydrogen and fuel cells; give an overview of the technologies, planning establishing and running a project, monitoring its success, financing and exploitation, etc.

For the commercialization of hydrogen and fuel cells, it is essential that the immature technologies are able to be demonstrated in real world conditions. This is also crucial from the point of view of the technologies gaining public acceptance. Developing of this type of revamping project, for example, could be national or on a private individual basis. The concept of a community, as an end user, is very promising.

Communities can support hydrogen and fuel cell industries. Hydrogen and fuel cells is novel developing technologies and many regions are interested in claiming some value in the area of the technology supply chain – from research to manufacturing and distribution.

Communities are trying to develop ‘clusters’ where a number of hydrogen technology-related organizations are geographically localized, and are able to benefit from being close to one another. This is seen as a way to promote regional innovation, and contributes to the development of hydrogen technologies.

Depending on its specific circumstances, there are a number of reasons why communities could be stakeholders in hydrogen projects. Expertise in cutting-edge technologies like H_2&FCs might improve the competitiveness of local firms, or generate new high value organizations. New clusters combining competences on energy, transportation and services may emerge. Aside from business and economic growth the community as a whole would benefit via learning processes and strengthened cooperation between different actors in the field of high-technology (universities, research institutes, public actors etc.). The community would acquire eco-innovative credentials which later on could attract new investments and funding.

Some towns, cities or regions have a strong economic dependency on industries that are now in clear decline. Engaging with a growth industry like hydrogen can offer a chance to reinvigorate a local economy. This could mean manufacturing hydrogen technologies, producing hydrogen from a local energy source, or expanding research facilities. Apart from providing platforms for new industries in hydrogen and fuel cell technologies, these technologies could affect existing industries. In the first place they could replace older technologies such as batteries and small combustion engines. Services are also likely to be needed to facilitate the introduction of a hydrogen economy. These include specialized financial services, insurance, logistics, shipping, truck transportation, retail, surveillance and overhaul and maintenance. Furthermore, hydrogen and fuel cell technologies can be the technological platform for developing totally new services such as energy storage. Some regions might prefer to promote such service industries instead of traditional industrial manufacturing.

2 Premises for a Hydrogen Community at Rm. Valcea, Romania

1. In November 2004, the Romanian Ministry of Education and Research promoted the Sectorial Plan of Research & Development which aims are the support of Romanian economy competitiveness and the preparing of integrating in the European research space and accessing EU. Developing a Hydrogen and Fuel Cells R&D Integrated Platform was one of the Sectorial Plan projects. The financial support, of 325,000 euro, is provided by the Ministry of Education and Research 250,000 Euro, and by the partners themselves 75,000 euro. The platform, managed by National R&D Institute for Cryogenics and Isotopic Technologies ICIT Rm. Valcea, it is networking nine R&D organizations acting in the area of Hydrogen and Fuel Cells in Romania, in order to develop the Romanian capabilities in this domain and to reach the level permitting the connection with the European HFP. Leader of the Consortium: ICSI Ramnicu Valcea H2-FC (PEMFC) RD&D, members: National R-D Institute for Electrical Engineering-Advanced Research, ICPE-CA, Bucharest, National R-D Institute for Materials Physics, Bucharest-Magurele, National R-D Institute for Isotopic and Molecular Technologies - ITIM, Cluj-Napoca, National R-D Institute of Technical Physics - IFT, Iasi, Petroleum and Gas University, Ploiesti, University Politehnica Bucharest, ZECASIN SA Bucharest, ICEMENERG SA Bucharest.
2. OLTCHIM is one of the biggest Romanian chemical companies end one important chlor-alkali east-European producer, established in 1966 with the name of Chemical Works Ramnicu Valcea, by Minister Council Decision 1046/26.05.1966. The erection has begun in July 1966. The first plant, Mercury Cells Electrolysis, was commissioned on 28 July 1968. In 1990, by Government Decision 1213/20.11.1990, based on the Law 15/1990, the Chemical Works Ramnicu Valcea turned into a joint-stock company, called OLTCHIM S.A.
3. Ministry of Industry (now Economy) from Romania and World Bank has done a study that explores six Romanian companies where it could be located fuel cell plants. Consulting firm, hired by above mentioned institutions, concluded that the most attractive location is a OLTCHIM S.A., it can produce hydrogen for capacities greater than 3MW [3].

4. The integration of fuel cells into electrochemical plants is a method for the direct connection of fuel cells to electrolysers of electrochemical plants producing hydrogen as a by-product. The by-product hydrogen is fed to the fuel cells and the electric energy thereby produced is transferred to the electrolysers, with the consequent saving of the overall energy consumption. The direct coupling avoids the need for DC/AC converters or voltage adjusters and may be affected either in series or in parallel. In the latter case the fuel cell are assembled in modules, the number and voltage of which is regulated by means of interrupters activated by a computerized control and supervision system. As an alternative, the voltage of the modules may be varied by varying the pressure of the air fed to the fuel cells.

One of the earliest markets applications are using of fuel cells for recovering hydrogen from industrial chlor-alkali processes (electrolysis process) [4].

UHDENORA and OLTCHIM SA have contacts for the installation of the first industrial fuel cell plant at the OLTCHIM's chlor-alkali production site at Ramnicu Valcea, Romania. One similar application, 120 kW, was installed at a sodium chlorate production plant, Caffaro Chimica, Brescia, Italy. This industrial installation represents a successful step in the development and commercialization of the green energy [5].

The goal of this project was to produce clean electricity by using the hydrogen co-generated in the electrolytic process [6].

Fuel cell reality premise:

- around 84 stationary fuel cell systems with hydrogen have been installed all over the world. Some of them have an high installed power, 125 or 250 kW, but the biggest majority provide power between 1 and 5 kW,
- Uhdenora and Caffaro have installed and started up of the first industrial fuel cell system for electricity production and savings in the electrochemical industry, Caffaro Chimica, Brescia, Italy.
- Chlor-alkali reality premise:
- the recycled or re-used hydrogen produced by the chlor-alkali plants was less than 90% in 2006 and the target will not exceed 95% in 2010,
- at each tone of chloride is produced 28 kg (310 Nm^3) of hydrogen,
- the world chloride capacity was estimated to approximate 60 million metric tons.

3 Conclusions

The term 'Hydrogen Community' refers to early adopters of hydrogen and fuel cell technology, who have the potential to become large scale adopters. Cities, regions, islands, and industrial zones are examples of potential hydrogen communities.

Communities are important for the commercialization of H_2&FC technologies: providing willing consumers, developing H_2 infrastructure, developing production of H_2.

Communities may be interested in adopting H_2&FC technology, as it can offer: innovation and growth, publicity, prestige, branding, a solution to local air quality, reduced CO_2 emissions, and practical advantages over existing technologies.

The aim of this presentation is to point out some ideas about research state of the art and trends into, hydrogen, fuel cell and chlor-alkali, and the possibility utilizes both, technical improvements for environmental protection and European scientifically mechanisms, in order to develop a Hydrogen Community at Rm. Valcea, Romania.

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