

Horizon Hydrogène Energie : 19 Partners for Breakthrough Innovations on Early Markets

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Horizon Hydrogène Energie : 19 Partners for Breakthrough Innovations on Early Markets

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Introduction

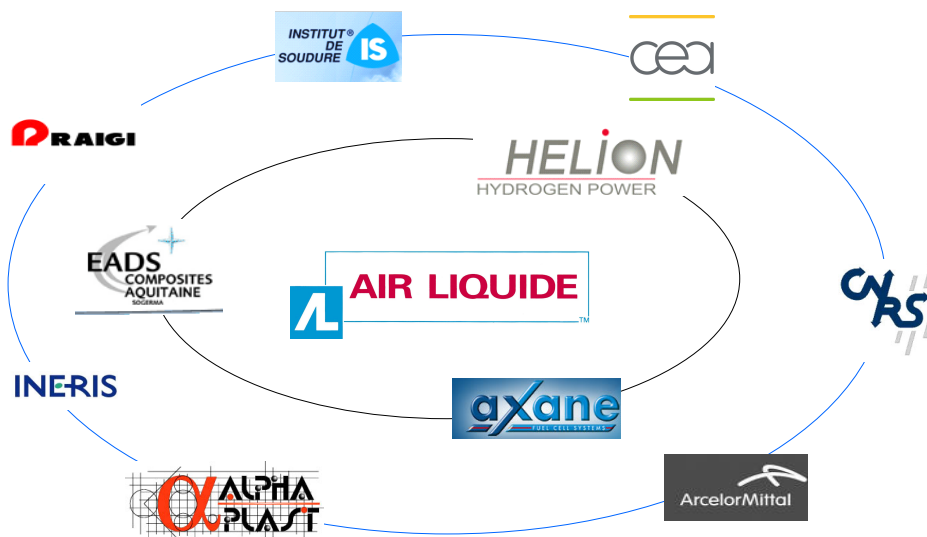
Early hydrogen energy markets offer opportunities to optimize and reduce the cost of technologies, introduce codes and norms adapted to the use of hydrogen in small quantities and raise public acceptance of the use of hydrogen outside industrial fences.

These markets offer a natural path towards the transportation markets for players such as Air Liquide and its partners, willing to build know-how and reputation and be ready for a wider use of hydrogen and hydrogen fuel cells.

Around this vision, 19 French partners have built the “Horizon Hydrogène Energie” Program” in order to leverage their competences and resources to build competitive offers to early customers as soon as 2012. Partners are industrial companies, technology associations and academic research centers.

This 7-year innovation Program has a total budget of 190 M€ and is financed by the industrial partners (65%) and by OSEO Innovation (35%). OSEO Innovation is a French Agency leveraging innovation by private companies by bringing methodology and sharing financial risks.

More than 200 experts are directly contributing to the seven work packages of the Program.

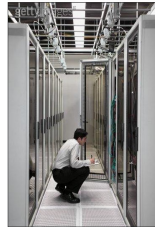


Do early markets really exist?

Early hydrogen energy markets have been identified and qualified in various sectors such as telecommunication, datacenters, medical centers, construction...

Targeted customers' need is the reliable production of electricity either for stationary use in places or at times where electricity from the grid is not available, or for mobile use when electrical batteries do not provide the autonomy required.

The opportunities we see



Stationary
back-up power



Remote
sites



Special Fleets



Portable
generator

- ✓ Applications with lower **cost & performances** constraints
- ✓ Large enough **Market volumes**
- ✓ **Can initiate industrialization and accelerate cost reductions**

By integrating one of our different types of fuel cells, one of our three hydrogen storages with a customized logistic and maintenance service, we aim at building complete solutions to address customer needs at the lowest total cost of ownership.

Market studies for Europe show great potential for the substitution of existing technologies through fuel cell solutions providing cost reduction targets are met and/or special institutional support to the deployment of the technologies are put in place, such as tax credit have been implemented for use of fuel cell in forklift in the United States.

Table 1: Data communicated in this table have been compiled by Air Liquide Hydrogen Energy using various information sources. They are shared to support our communication and do not engage Air Liquide responsibility.

Market Segment	Solution characteristics	Estimated European market size in 2015 (1)	Driver for introduction of fuel cell type solutions
Off-grid equipment Telecommunication infrastructure, highways, sensors ...	Baseload electricity 0.5 to 5 kW	50 M€ opex/year	Total cost Reliability Carbon footprint
Back up service for critical equipment	Reliable peakload fuel cell with adapted H2 storage size	200 M€ opex/year	Autonomy and reliability
Special Fleet of utility vehicles	H2 fuel cell "range extender" feeding an electric engine	500 M€ opex/year	Total cost Time for tank refilling
Portable electricity generators	Robust, easy to handle compact equipment up to 5 kW	30 M€ opex/year	Total cost Reliability Safety perception H2 logistics

Where are breakthrough innovations required?

Several hundreds of hydrogen fuel cells operating in the middle power range required for the early markets described above are now produced and sold through the world every year.

Fuel Cell Cost

Reducing costs while maintaining a high reliability and offering a large range of operating conditions (power produced, temperature...) is the challenge the H2E Program is focusing on. Systematic standardization of components is investigated in relations with critical component suppliers.

Efficient production and logistics

Production: About 60 industrial hydrogen production sites are operating today in Europe and constitute the current potential sources for the delivery of hydrogen to fuel cell applications. Large Steam Methane Reformers can produce up to 150 000Nm³ hydrogen per hour from Natural Gas. Their technology and process design are constantly evolving to optimize efficiency, reduce CO₂ emissions and be ready to cost-effectively capture CO₂ when CO₂ underground storage sites will be accessible.

New decentralized production sites, using electrolysis equipment or small Steam Methane Reformer fed with biogas are also required to further reduce the carbon footprint of the complete solutions.

High pressure composite cylinders: the fact that hydrogen can be stored is a real advantage over electricity and electrical batteries and the degree to which we can store hydrogen in a safe and cost-effective manner will partially determine the share it will take in our future energy infrastructure. Nevertheless, technological and regulatory ruptures are required to build and operate composite cylinders. They can already now be investigated through the deployment of solutions on early markets.

The composite cylinders will also be used in the short term to transport hydrogen from centralized source to the point of use. Their design is optimized to reduce transportation cost and ensure operational flexibility.

Pressure regulation system

Using high pressure (up to 700 bar) to reduce the size of hydrogen storages requires advanced pressure regulation system and special safe connection device between the storage and the fuel cell. Air Liquide teams have worked within the HyChain European Project is designing such systems. Our goal now is to further reduce the cost of the equipment by optimizing the design while working with manufacturing experts.

Social acceptance and RCS

However, if breakthrough innovations are one of the key factors of the hydrogen early markets success, the public acceptance is another one. In order to facilitate the technologies introduction on the early markets, the hydrogen industry needs to convince society of the value of the technological innovations (social acceptance) and implement regulations, codes and standards (RCSs) with the authorities for daily use.

RCSs need to evolve from the current industrial hydrogen standards to lighter and easier procedures for uses of smaller quantities in our daily environment. On the other hand, hydrogen is almost unknown and unreferenced within the general public. Therefore, creating the conditions of hydrogen acceptance amongst the general public can be summarized as to make people climb one or more of the 4 levels of the so-called 'social acceptance ladder':

1. **Opposition/Ignorance:** the interlocutor is opposed to hydrogen and/or its applications as a whole, or simply does not know hydrogen or its applications.
2. **Acceptability:** the interlocutor is not against the use of hydrogen by a third party.
3. **Use:** the interlocutor himself uses hydrogen or one of its applications.
4. **Purchase:** the interlocutor is ready to acquire a product that uses hydrogen as an energy vector.

The H2E program encompasses those two aspects (social acceptance and RCS) as essential elements of markets creation and growth.

To conclude

Early markets offer opportunities to anticipate some of the breakthrough innovations required for the wider use of hydrogen in our energy infrastructure, especially for transportation. Breakthroughs are required in many domains: from product design, manufacturing, regulation and standards, to project management practices to include early users in the decision process to deploy H2 type solutions.

The "Horizon Hydrogen Energy" partners are organized to tackle those challenges, driven by the common vision that hydrogen and electricity need to become fast the main energy vectors of our economy.