

FRANCE

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INTRODUCTION AND BACKGROUND

Following the major energy debate (the so-called "Grenelle") that took place in recent years, an application law (Grenelle 2) was published mid 2010; this law elaborates on the first general law (Grenelle 1) and implements six priorities at a local level: building and urban architecture, transportation, energy, risks, and governance.

UPDATE ON MEMBER'S ENERGY FRAMEWORK

UPDATE ON RELEVANT POLICIES

After the economic crisis in 2009, the French government decided to initiate an "investment for the future" plan was launched in 2010 with a 35 B€ budget for the next 5 years. Sustainable development and energy will have a large share (more than 7.6 B€). It will be mainly loans, repayable and interest subsidies, guarantee and equity. The main goal is creation of jobs and economical value. Several pre-call (Call-for-Interest) were launched this year and managed by the French energy program agency ADEME. One is devoted to renewable and green chemistry with a budget of 1350 M€.

UPDATE OVERVIEW ON RELEVANT PROGRAMS AND PROJECTS

It is the commitment of France to reach 23% of renewables in consumption energy mix in 2020, mainly through wind and biomass development.

Two of the largest research French institutes on energy, CEA and IFP, officially changed their names in 2010 to "Commissariat à l'énergie atomique et aux énergies alternatives," the French institute for nuclear energy and alternative energies, and IFP Energies Nouvelles. CEA carries out research programs on nuclear, renewables (solar, biofuels, hydrogen, fuel cells, batteries, energy efficiency and energy systems for smart building, smart energy grids, and electric and hybrid vehicles) with a budget of near 100M€ in 2010 and 700 employees. A new General delegate director for renewables function was created. IFP devotes near 50% of its budget to efficient vehicles, hybrids, electric vehicles, biofuels, and CCS.

HYDROGEN R,D&D PROGRAMS AND PROJECTS

PROGRAMS, PROJECTS, INITIATIVES IN BRIEF

Status and accomplishments

Program from French research agency ANR:

After a three-year program called PAN-H (2005 to 2008, with 73 projects and a funding of 84 M€), a program called H-PAC is being implemented from 2009 to 2011. It is focused on hydrogen production and storage, stationary applications, and coupling with renewables. In 2010, 10 projects were funded by a 9 M€ grant.



VITAL STATISTICS

Population

64,500,000

Territory

554,000 km²

Capital

PARIS

GDP in 2010

1643 B€, 25 000 €/capita

GDP Growth

+1.5% in 2010

Primary Energy Structure (2008)

Primary energy resources in toe (Tons of Oil equivalent),

Total 274 M Toe:

	Mtoe
Coal	13
Oil	91
NG	38
Uranium	113
Renewables	19

Import

137 Mtoe, 48 % of total

Final Consumption 162 M toe:

	% of Total
Coal	4 %
Oil	48 %
NG	20 %
Electricity	21 %
Other Renewables:	7 %



Electricity in 2009

Production	
518 TWh (-5.5 % compared 2008)	
	TWh
nuclear	390
renewables	75
fossil	55
Total	518

France consumption

486 TWh (-1.6%)

Net Exportation:

32 TWh (-47%)

GHG emissions in 2009

Total 362M ton CO₂

5.8 ton CO₂/inhabitant

200 T CO₂ / 2M US\$ @ power purchase parity



National structures:

HyPaC platform, created in 2009, numbers almost 70 members from industry, regional authorities, and R&D partners. An internal road map for France was finalized and sent to the Energy Ministry in spring 2010. Following these documents, the French government decided to launch an official French road map coordinated by ADEME. The French ministry of energy (DGEC direction) organized workshops in order to start the first steps towards a national structured industry for fuel cells and hydrogen.

Finally, the French parliament approved the transcription in the French law of the EC regulation (CE) n° 79/2009 defining the CE rules to admit a hydrogen type vehicle and its CE label on it or on its component.

Regional initiatives

In “Midi-Pyrennées Region,” a regional road map for hydrogen was launched in 2010, coordinated by Hinicio.

A private-public company “EVEER’HY’POLE” was created on November 26, 2009 with local authorities and private sector partners. Its goal is to develop R&D competencies for green cars and transportation vehicles around the car competition circle of Albi, and especially to create an unique test center for hydrogen cars.

In “Bretagne,” a new regional network “ERH₂” was launched to develop applications of hydrogen from renewables and for smart building and smart grids.

A small company in Brittany, “Nass&Wind Offshore” is deploying a LIDAR-type (Light Detection and Ranging) measurement system on top of the Phare on Grand Léjon, off-grid Island, close to Saint-Brieuc city. The fuel cell will supply energy for the LIDAR system.

In Normandy, a new ecosystem demonstration building was inaugurated at Ecosite of Fleurion, near Saint-Lô with a energy high quality and bioclimatic label (“TPHE” label, energy consumption 142 KWh/year/m²). Different renewable were installed and a fuel cell 3kW served as a back up power.

Photosynthesis

A team from university Paul Pascal de Bordeaux (CNRS) realized a bio fuel cell, operating from synthesis: glucose and oxygen. The main applications are for medicine, in order to put in vivo biofuel cells under the skin with oxygen and glucose as a fuel naturally present in living organisms. With enzyme-modified electrodes, the fuel cell was implemented in a cactus, and the electric activity due to the photosynthesis was observed; therefore this fuel cell could reach a power density of de 9 μW par cm² (published in Analytical Chemistry review).

Results from HyFrance3 project

Hyfrance3 is a national project with 10 partners (Air Liquide, Total Raffinage Marketing, EDF R&D, GDFSUEZ, CNRS-LEPII, IFP Energies nouvelles, AFH2, ALPHEA, and ADEME) and CEA (coordinator). Hyfrance3 project was focused on hydrogen markets from a mid term perspective (2020-2030).





Four topics were studied:

- 1) Hydrogen demand for industry (chemistry, refinery, transports) from now until 2030
- 2) Hydrogen from wind and for transportation, grid-connected and off-grid; the results show great variability for cost from 4€/Kg to 20 €/Kg
- 3) Massive storage design for H₂ in Rhone Alpes and Provence regions to balance electricity demand, determination of Hydrogen capacity storage (a few dozen of thousands tons/year)
- 4) Determination of costs associated to distribution of Hydrogen for car application: according to 2 penetration rate of fuel cells cars in 2050: 16% and 40%; costs associated with storage are varying from 0,4€ to 0,6 €/Kg



AIR LIQUIDE

Hyfrance3 in continuity with former projects Hyfrance offers a technical and strategic French platform to discuss the scenario on H₂ introduction in synergy with European and international projects.

Althytude project

The project led by GDF-Suez, “Communauté urbaine” of Dunkerque, finished in 2010 demonstrated the potential of new fuel Hythane® – 80% natural gas and 20% hydrogen – for 2 transportation buses. This project (2005-2010) gathers 12 partners, a budget of 4,4 millions €, with a grant of 1,2 millions € by French ADEME. Two buses from French company DK’Bus Marine were tested. The need for hydrogen was 120 Nm₃/day, around 10 kg/day to be mixed inside Hythane®; hydrogen was produced by water electrolysis from renewable the greenhouse gases were reduced by 8% and Nox emissions by 10% compared to a 100% natural gas bus.



H₂E project (Horizon Hydrogène Energie)

Large project H₂E, led by Air Liquide, is funded at 200 M€ over 7 years and subsidized at 68 M€ by French innovation agency OSEO. The project, covering the full hydrogen energy value chain is now in its third year of realization. In particular, it will investigate the development of innovative technologies for hydrogen production using renewable energy, hydrogen storage and industrialization of fuel cells. H₂E will also contribute to the setting up of a suitable regulatory framework, and will include a program of demonstrations and educational measures to familiarize the wider public with this new, clean energy vector. The H₂E program aims at markets with wireless energy needs not met by any current solutions. For example, captive vehicle fleets, and portable generators or the supply of backup energy.

H₂E gathers 19 partners, for a total involvement of 150 people: CEA, Héliion-Areva, Axane, le CNRS, EADS Composites Aquitaine, Institut de soudure, Arcelor Mittal, and l’INERIS. One result in 2010 is the presentation during JEC composites show in Paris, April 2010, of Cargobike: a tricycle demonstration with a fuel cell and high pressure fiber carbon hydrogen tank. Cargobike has a 250 W fuel cell, a 250 km range thanks to a 2.4 liter tank storing 95g of hydrogen. This tank has a certification according to EN 12245 standard, certified by European directive 99/36/EC.



Zero-emission and Hydrogen powered Yacht: the first European sailing yacht with an H₂ fuel cell

”Zero CO₂” Sail boat Project:

A 12-meter length sailing yacht built by RM shipyard (La Rochelle), integrating a PEMFC fuel cell system for APU auxilliary power unit supplied by CEA. It is a scientific platform for FLORALIS and the University of Grenoble, and experimentation took place in 2009 on Bourget Lake and the Mediterranean Sea. Hydrogen will be produced by solar energy and wind in the harbour. The yacht is equipped with solar PV panel and is able to analyse local atmospheric and water pollutant along the seashore and study human impact on environment (CO₂, COV).

In 2010, the yacht was sailing in Marseille Harbor and the Mediterranean Sea (Corsica, French Riviera) for over a month. The 35 kW fuel cell was realized in September, and the hydrogen tank (10 Kg Hydrogen at 30 MPa) was integrated.

The restrictions due to ship integration were a maximum volume of 2 m³, a maximum weight of 500 kg, corrosion resistance in marine atmosphere, specific movement of a yacht, and start and stop cycles; finally, the regulation issues were solved by VERITAS company.

MYRTE PROJECT

The MYRTHE project in Corsica was launched in 2009. The project aim is to study the coupling of a 550 kW PV farm to a system of hydrogen production (200kW equivalent, 40 Nm³/hr) storage and use through a fuel cell; the aim is to avoid the electricity peak in an island system thanks to H₂ storage system. In 2010, the old concentrated solar farm, designed by CEA in the eighties (Segmented mirrors technology), was removed and the field prepared for future facility. Areva's subsidiary Helion, CEA, SME Raffali, and University of Corsica are the main partners of the project.

In the Shell Eco Marathon race, the team formed by Polytech Nantes (France) established a new record in the category fuel cell: with 1 liter of carburant equivalent near 4896 km were driven.

Education facility BAHIA from HELION (Areva)

18 education facilities BAHIA were sold and installed in different high schools, universities, in France since 2008. The 1 kW power facility integrate a fuel cell, a user-friendly interface, a simulating tool able to apply to different applications: naval applications, energy storage, and many others applications.

Participation

VI-SME

CETH

The CETH company carried out an increase in shared capital with a new reference stakeholder SPTI. SPTI, and its subsidiary SPTI Experts. CETH will continue to develop a new family of electrolyzers with high efficiency and high reliability. CETH also developed bioethanol reformers. CETH sign a R&D agreement with CETIM, French institute for mechanical engineering to improve the eco-design of the products.

After assembling a first prototype of 8 Nm³/h (up to 12 m³/hr without load regulation), CETH launched the commercialization of a new electrolyser technology this year. PEM



GENHY, multi-stacks with a load regulation, continuously produce hydrogen at 99.5% purity and are suited for coupling with intermittent renewable energy. This technology allows the operator to manage the load without stopping production all day.

HYCAN

The HyCAN consortium (ADVENTA, McPhy, Paxitech, Boxal) developed new mini hydrogen storage technology for different applications like lightning for nomad applications with portable fuel cell systems.

MAC PHY

SME Mac Phy carried out an increase in its share capital of 13.7 M€. Investors are Sofinnova Partners and Gimv et Amundi Private Equity Funds. Mac Phy created and developed innovative solid state hydrogen storage in 2008.

In 2010, Mac Phy delivered to French laboratory CEA-LITEN a prototype storing 15 kg of hydrogen to test a global renewable energies storage system.

REFERENCES

MEMBER WEBSITE

AFHYPAC association française de l'hydrogène: www.afh2.org

ALPHEA: www.alphea.com

CEA: www.cea.fr

CNRS: www.cnrs.fr

IFP: www.ifp.fr

ANR: <http://www.agence-nationale-recherche.fr>

OTHER IMPORTANT WEBSITES

Pole de Bretagne: <http://erh2-bretagne.over-blog.com>

Pole de competitivité Rhône Alpes: www.tenerrdis.fr

Mission Hydrogène Pays de Loire: www.missionH2.org

Association Phyrenées: <http://blogs.enstimac.fr/phyrenees>

Polytechnique de Nantes: <http://web.polytech.univ-nantes.fr>

Pôle de compétitivité Cap Energies : www.capenergies.fr

COMPANIES

Mac Phy: www.mcphy.com

Raigi: www.raigi.com

CETH: www.ceth.fr

Axane: www.axane.fr

Hélion: www.helion-hydrogen.com

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Nass&Wind: www.nassetwind.com

ADVENTA: www.ad-venta.com

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PROJECTS

Project Althytude: www.althytude.info

Project Zero CO₂: www.zeroco2sailing.com