LAYMAN´S REPORT

zero HYTECHPARK

FUNDACIÓN PARA EL DESARROLLO DE LAS NUEVAS TECNOLOGÍAS DEL HIDRÓGENO EN ARAGÓN

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ÍNDICE

ZERO-HYTECHPARK PROJECT

The Zero-Hytechpark Project, belonging to the European programme LIFE+, is the European Union's only financial instrument that is solely dedicated to the environment.

Its objective is to contribute to the application, updating and development of community policies and legislation in environmental matters and their integration into other policies.

The aim of the Zero-Hytechpark Project is to achieve Technological Parks that are more sustainable. It boasts a 1.4 million euro budget, 50 % of which is financed by the European Union over a period of four years.

FUNDACIÓN PARA EL DESARROLLO DE LAS NUEVAS TECNOLOGÍAS DEL HIDRÓGENO EN ARAGÓN

The Aragon Hydrogen Foundation coordinates this initiative with the participation of other members; the Andalusia Technology Park, the Bizkaia Science and Technology Park and the Walqa Technology Park.

The Zero-Hytechpark Project aims to put measures into place to achieve total sustainability in these areas through optimal energy management using systems based on hydrogen technology and renewable energy.

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OBJETIVES

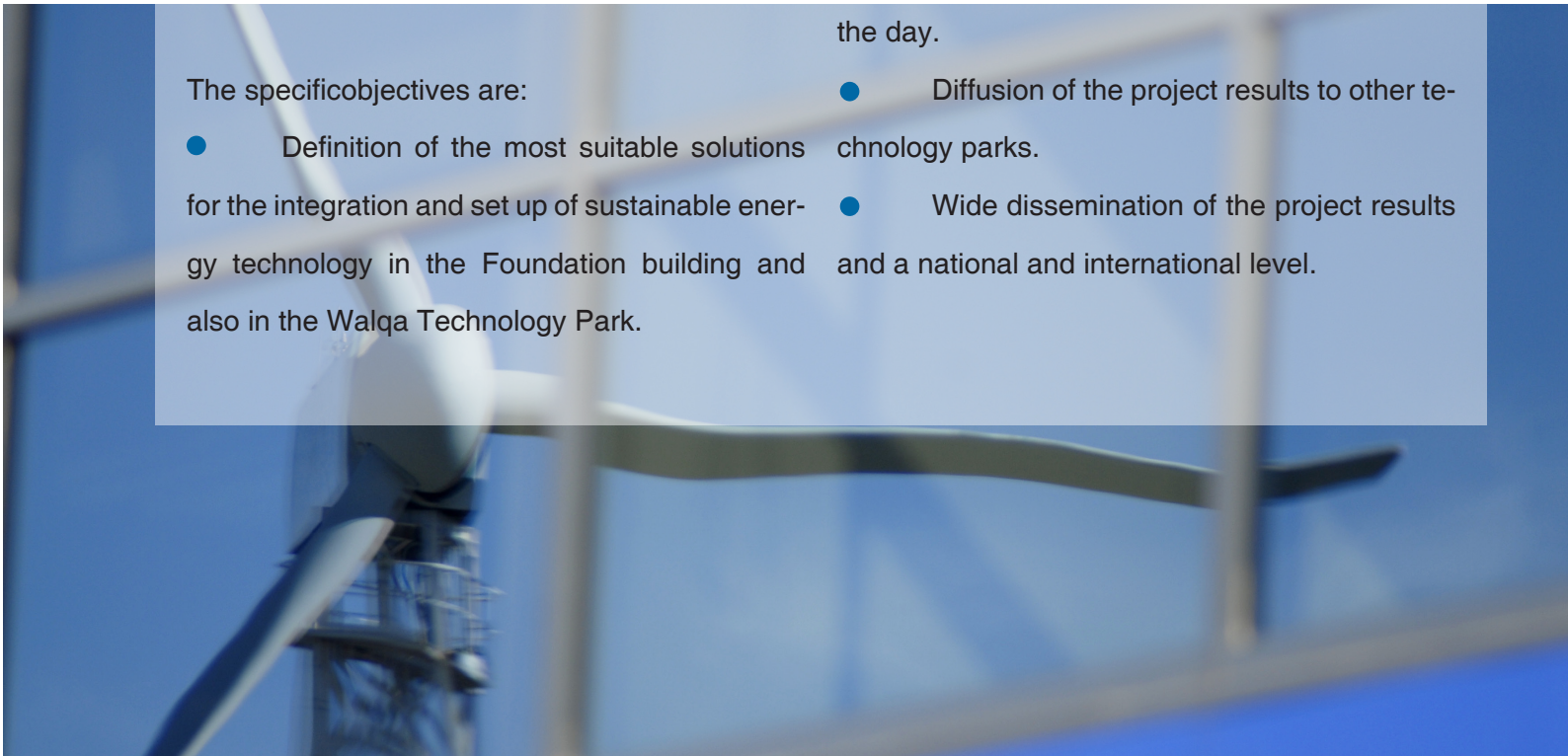
The main objectives of the programme are:

- Achieve a building with virtually zero CO2 emissions.
- Promotesustainablemobility.
- Raise awareness of the technology used with the general public and in particular within the industries of science and tech nology.

In order to achieve these objectives, energy solutions will be designed, simulated and put into motion in the headquarters of the Aragon Hydrogen Foundationwhich is located within the Walqa Technology Park near Huesca in Aragon. The results can then be extrapolated to other buildings within the technology complex as well as to other parks.

The specificobjectives are:

- Definition of the most suitable solutions for the integration and set up of sustainable energy technology in the Foundation building and also in the Walqa Technology Park.
- Design of a complete energy accumulation system using hydrogen generated from renewable energy.
- Integration of fuel cells in the Foundation building in order to decrease dependence on fossil fuels.
- Implementation of transportation in the Walqa Technology Park using vehicles with zero emissions powered by hydrogen.
- Cogeneration system based on hydrogen technology to be connected with the heating system of the Foundation building
- Set-up of an energy supply system using fuel cells able to meet the energy demands of the Foundation at night.
- Development of an optimal photovoltaic energy and hydrogen system capable of meeting the energy demands of the same building during the day.
- Diffusion of the project results to other technology parks.
- Wide dissemination of the project results and a national and international level.



ACTIONS

During the execution of the project the following actions will be carried out:

Action 1.Analysis and definition of technical establishment specifications.

Duration: January - September 2010 (9 months)

The analysis of the energy situation of the Aragon Hydrogen Foundation building, as well as other buildings within the Walqa Technology Park, is the initial phase in order to define the specific means of integrating and implanting sustainable technology, which will result in a 100% sustainable technology park in the future.

Action 2.Production of Renewable Energy.Authorisation and permission.

Duration: July 2010 – December 2011 (18 months)

The second phase involves the production of a detailed renewable energy installation project plan, with an infrastructure based on photovoltaic and solar thermal energy to meet the heat consumption needs of the Aragon Hydrogen Foundation building. In addition, the permission and relevant licenses necessary for this kind of installation will be obtained.

Action 3.The production of renewable hydrogen.Implantation of the technology.

Duration: January 2011 – September 2012 (21 months)

Includes the definition, design and implementation of an appropriate hydrogen production system capable of meeting the demands of all project installations, and achieving an improvement in hydrogen generation capacity.

Action 4.Hydrogen Infrastructure.

Duration: July 2011 – March 2013 (21 month)

This step consists of the evaluation, description and implementation of a hydrogen distribution system suitable for the Aragon Hydrogen Foundation building, by assessing the hydrogen supply capacity, amount and pressure of the for the different applications. This action will be carried out alongside actions 3, 5 and 6 due to the direct connection between production, distribution and the end use of the hydrogen.

Action 5.Sustainable mobility.

Duration: October 2011 – June 2013 (21 months)

At this point the development and trials of four sustainable mobility applications begins:

- The integration of two fuel cells with varying power levels in commercial electric vehicles.
- The maintenance of a fleet of 20 electric bicycles equipped with 250W fuel cells at the Aragon Hydrogen Foundation, which will be at the disposal of personnel within the Walqa Technology Park.
- The development of a Balance of Plant (BoP) of a hydrogen fuel cell stack for its integration into a fork lift truck.
- The development of a sustainable prototype for urban street cleaning (HyTow), using a fuel cell to propel the HyTow and to provide power to the water pressure cleaning system.

Action 6.Sustainable stationary application in the Aragon Hydrogen Foundation.

Duration: July 2010 – September 2013 (39 months)

The main objective of this action is to design and implement a back-up and cogeneration energy system based on hydrogen technology (fuel cell integration.) Cogeneration system: integration of a 5kW cell in the building with solar thermal panels. The installation comprises a 400W turbine, concentrated solar collectors, battery banks, polymer electrolyzer and storage in the form of hydrides. The system will produce electrical energy and heat derived can be used to heat water and even for heating. The objective is to avoid / reduce current propane consumption. Back-up system; the integration of a 5kW PEM fuel cell to guarantee enough reserve energy for the daily backups that are carried out in the Aragon Hydrogen Foundation building. The system will be connected to the hydrogen network at a pressure of 32 bars. (Action 4) The aim is to show the viability and advantages of this particular action so that other buildings can see the benefits of incorporating this type of technology.

Action 7.New areas and improvements.Awareness-raising plan and results.

Duration: October 2011 – September 2013 (24 months)

This action tests the installations in different situations and designs an improvement and expansion plan aimed at possible increases in demand. This affects the following aspects:

- The operation and maintenance of the renewable energy infrastructure and hydrogen storage.
- The operation and maintenance of the fleet of vehicles.
- The monitoring and analysis of results.
- The operation and maintenance of the integration of hydrogen technology in the Foundation building.

Action 8.Management and monitoring of the project.

Duration: January 2010 – December 2013 (48 months: the full duration of the project)

This action refers to the need to optimise project management by allocating resources and then monitoring, checking and validating the results obtained.

Action 9.Diffusion plan.

Duration: January 2010 – December 2013 (48 months: the full duration of the project)

Information regarding new hydrogen technology needs to be disseminated throughout society at large. Consequently, this action focuses on raising awareness, communication and training activities that are capable of reaching the general public and, more specifically, the scientific community, the industrial sector, technology parks and the main European agents.

RESULTS / PROTOTYPES

PRODUCTION OF RENEWABLE ENERGY:

DESCRIPTION:

The renewable energy sources installed in the Walqa Technology Park are those of wind power, solar photovoltaic energy and thermal solar energy. With this renewable energy production between 15% and 45% of electrical consumption in the park can be met. In addition the energy generated assists the heating system of the Aragon Hydrogen Foundation's building, resulting in a 20% saving in greenhouse gas emissions.

WIND POWER

Installed Power Capacity:	635 kW (3 wind turbines: Vestas V29, Lagerway L80 y Enercon E33).
Power Generation:	540 000 kWh/year
Avoided Emissions:	184 000 kgCO2/year

THERMAL ENERGY

Installed Power Capacity:	45 kW (Thermal solar panels IMS Calefacción).
Power Generation:	5 400 kWh/year, that is equivalent to 519 Nm3/year of natural gas consumption.
Avoided Emissions:	1 256 000 kgCO2/year

PHOTOVOLTAIC SOLAR ENERGY

Installed Power Capacity:	109 kW (40 kW with 4 solar trackers, 9 kW in Aragon Hydrogen Foundation flat roof and 60 kW in PT Walqa shelter).
Power Generation:	122 000 kWh/year
Avoided Emissions:	41 600 kgCO2/year

ISOLATED POWER ZERO EMISSIONS SYSTEM FOR REMOTE LOCATIONS

DESCRIPTION:

The installation of an isolated power generation system allows power to be supplied to areas off the electrical grid. This option represents an alternative to energy generated using diesel fuel contaminants.

The installation comprises a 2.7kW solar photovoltaic system, which is located on the roof of the Foundation building. Electrical energy is stored in a battery bank of 48V, 6.6 kWp and 1,990Ah, which gives our offices 4 to 5 days of independent energy. The system also has a 1.2kW fuel cell powered by hydrogen from our premises, which produces electricity and recharges the batteries.

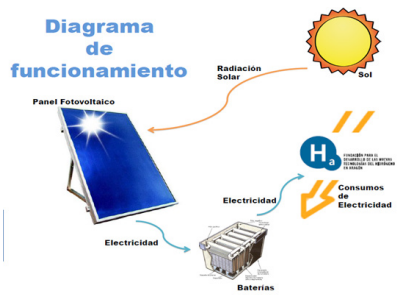
The installation of this system provides enough energy to run the Aragon Hydrogen Foundation's computer system in a totally green way with zero CO2 emissions. More than 11,000 kWh/year of electricity are produced, avoiding a total of 7,500 kgCO2/year in pollutant emissions.

RESULTS

Efficiency:	Diesel generator - off grid installation: 28 %. Zero emissions system: 90 %
Economical Ratio:	Diesel Generator cost: 3.000 € Fuel Cost: 4.200 €/year (price of June of 2013) Zero emissions system cost: 30.000 € Fuel cost: 0 €/year
Emissions:	Diesel generator: 0,27 kgCO2/kWh Zero emissions system: 0,0 kgCO2/kWh

COMPARISON WITH DIESEL GENERATOR

Elimination of pollutant emissions 10.500 kg de CO2 avoided per year.
Zero emission system doesn't need fuel so that emission is reduced, obtaining money savings.



STAND ALONE INSTALLATIONS

DESCRIPTION:
Through the installation of a stand-alone system, part of the energy consumed by the Foundation can be generated in situ. To achieve this, a stand-alone photovoltaic system with SANYO panels has been installed with a total of 7kW of power, which adheres to current legislation.

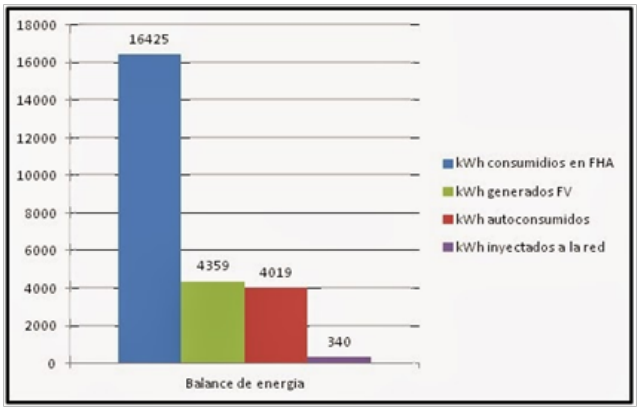
The photovoltaic panels are situated on the roof of the building and generate electricity which is later used by the Foundation. It should be highlighted that panels which had already been installed where used in order to reduce costs. In order to finish off the installation, a two-way metre was installed next to the connection centre, through which both the energy produced by the system and the energy consumed by the building can be measured.

In addition, an SMS inverter was installed to convert the energy produced by the photovoltaic panels from direct current to alternating current, ready for a variety of uses in the building. The unused energy, that is to say the energy that is not used by the building, can be sold to the grid, the quantity of which is also measured by the aforementioned metre.

A stand-alone system has a number of advantages, the main one being a saving in electricity costs as the energy is produced in situ. Another advantage is that energy losses are reduced as the distance the energy has to travel from production to consumption is minimal. Finally, using solar photovoltaic energy for own use ensures the reduction in fossil fuels and lowers energy dependence.

This particular installation generates 24% of annual consumption in the Aragon Hydrogen Foundation building in Walqa and as a direct result the electricity bill is reduced by 1,000 euros per year.

Inversor SMA



Balance energético

PEDAL-ASSIST BICYCLES:

DESCRIPTION:

The transformation of a fleet of twenty pedal-assist bicycles has been carried out. They have pedals and an auxiliary electrical motor but cannot be powered using the motor alone.
The bicycles have been equipped with an electrical motor, fed by an electrical battery, which drives the bicycle and reduces the effort needed to pedal. The motor works providing that the following conditions do not arise:

- The bicycle goes over a speed of 25km/h.
- The brakes are used.
- Pedaling stops.

These bicycles were given to Walqa as part of a collaboration agreement to facilitate the movement of workers around the technology park, thereby reducing the CO2 emissions of the area.

COMPARISON

Moto comparison:	- Reduction of CO 2 emissions -They are a much cheaper mean of transportation -It reduce the acoustic contamination till zero It is still a fast knid to transportation It facilitates the parking Means of transport much healthier
Convention al bicycle comparison:	-Reducing the effort till the minimum -Real alternative to the conventional mean of transportation -Healthy, safe and very pleasant to use. -Suitable for all ages.

CUANTIFICATION

Energy saving:	-Moto: 400 Wh/km -Conventional bicycle: 0Wh/km -Pedal assisted bicycle: 2,7 Wh/km
Economic rates:	-Moto: 2.500 € -Conventional bicycle: 400 € -Pedal assisted bicycle: 1.500 €
Emissions	-Moto: 0,17 kg/km -Conventional bicycle: 0,0 kg/km -Pedal assisted bicycle: 0,0 kg/km

COGENERATION SYSTEM:

DESCRIPTION:

A hydrogen fed fuel cell has been set up as a cogeneration system (combined heat and power use) in project prototype.

The system offers 4kW of electrical energy and 3.5kW of usable thermal energy which can be used to heat the water in an 150 litre tank from 20ºC to 60ºC over a period of 2 hours. The system yield is 70%; 40% electric, 30% thermal and 30% loss. Hot water can be used as Domestic Hot Water (DHW) or for heating.

The main advantage of this system is that it does not produce pollutant emissions.

CUANTIFICATION

Efficiency:	-Hydrogen Cogeneration Fuel Cell: Total efficiency is 70% (40% electrical and 30% thermal) -Natural Gas Cogeneration Fuel Cell: Total efficiency is 90% (35% electrical and 55% thermal) -Cogeneration Internal combustion engine: Total efficiency is 90% (27,5 % electrical and 62,5 % thermal)
Economical Ratio for one housing:	FCH2 cost: 26.000 € ; Fuel cost: 3.000 €/year FCGN cost: 35.000 €; Fuel cost: 320 €/year MCI cost: 18.000 €; Fuel cost: 400 €/year
In-situ emissions:	FCH2: 0,0 kgCO2/kWh FCGN: 0,2 kgCO2/kWh MCI: 0,2 kgCO2/kWh

COMPARISON

Comparative with Natural Gas Cogeneration Fuel Cell:	-Elimination of pollutants emissions. -Absence of hydrogen transport grid.

COMPARISON

Comparison with cogeneration internal combustion engine:	-Elimination of pollutant emissions. -Absence of hydrogen transport grid.

COMURO: METAL HYDRIDE HYDROGEN COMPRESSION SYSTEM

DESCRIPTION:

Current standards for the use of hydrogen involve high pressures which mean that it is necessary to compress the gas for transportation and use. The Comuro is a system that allows the compression of hydrogen through heat input, which differentiates it from other systems that use pistons and membranes.

The use of Comuro technology means that pressure of more than 200 bars can be reached. In order to achieve this, the system uses metal hydrides which have been used for hydrogen gas storage for many years. As a result the system is widely used and well known.

This new method of compressing the hydrogen takes advantage of the differences in temperature to carry out reactions that permit the pressure of the hydrogen to be increased.

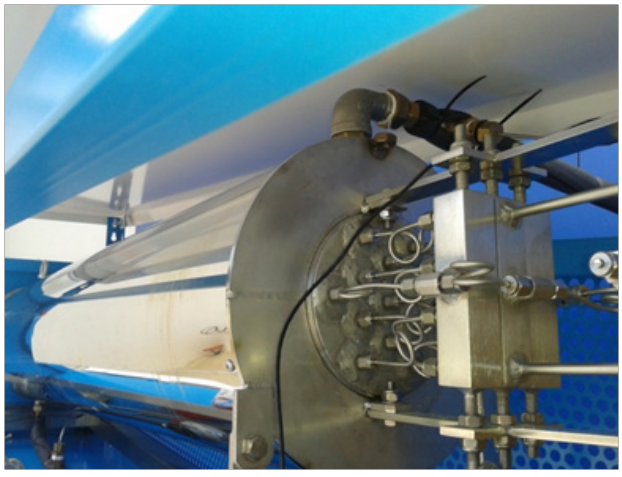
The compression system uses this technology and as a result is able to deliver much better compression pressures and gas quality than conventional systems.

RESULTS

Energy savings:	Usual system: 5 kWh/kgH2 Comuro system: 0 kWh/kgH2
Economical Ratio:	Usual system: 270.000 € Comuro system: 245.000 €
Emissions	Usual system: 1,5 kgCO2/kgH2 Comuro system: 0,0 kgCO2/kgH2

COMPARISON

Comuro	Without mobile parts. Take advantage of residual heat. It usesrenewableheatsources. It purifies hydrogen currents. High pressure. Minimum environmental impact.



HYDROGEN POWERED FORK LIFT TRUCK:

DESCRIPTION:

The transformation of a fork lift truck has been carried out by changing the traditional electric battery into a fuel cell battery.

The main problems that are presented by traditional battery powered fork lift trucks are the long charging times required by the batteries and the relative lack of autonomy.

During an 8 hour shift, an operator needs to stop at least once to replace the spent battery with a charged battery (a time loss of 15 – 30 minutes.) A hydrogen powered fork lift truck can be recharged immediately (2-3 minutes) and one charge allows the operator to work though the full 8 hour shift without stopping.

As part of this action, the Aragon Hydrogen Foundation has carried out a Balance of Plant (BoP) for the integration of a 21kw fuel cell battery into a fork lift truck.

RESULTS

Energy savings:	-Diesel forklift: 3,6 kWh/km -Electrical forklift: 0,55 kWh/km -Hydrogen forklift: 1,9 kWh/km
Economical Ratio:	-Diesel forklift: 15.000 € -Electrical forklift: 14.700 € -Hydrogen forklift: 28.000 €
Emissions	-Diesel forklift: 0,869 kgCO2/km -Electrical forklift: 0,0 kgCO2/km -Hydrogen forklift: 0,0 kgCO2/km

COMPARISON

Comparative with electrical forklift:	-In an electrical forklift the recharge time is 8 hours while in hydrogen forklift the recharge time is 2-3 minutes (Reduction of 99.4 %). -Double or Triple autonomy with each refueling. Increase productivity (highest number ofdisplacements / work shift). -Reduce lost time in refueling (reduction of 87 %). -Low investment in infrastructure, because it don't need auxiliary batteries to operate while principal batteries are recharging.
Comparative with diesel forklift:	-Elimination of pollutant emissions. -Reduction of mobile pieces so that the maintenance are reduced.

ELECTRIC GRID REINJECTION SYSTEM:

DESCRIPTION:

The Aragon Hydrogen Foundation has an electrical energy management system that uses hydrogen. Firstly hydrogen is produced with the surplus renewable energy generated and is stored in our facilities. When extra electricity is needed it is taken from the hydrogen fed fuel cell which re-injects the electricity into the grid.

The 10kW fuel cells are made up of stacks of 2kW and last for a total of 3,000 hours of use. The technology used is an open-air cathode PEM fuel cell, which is kept cool by air.

The fuel cells give out electricity produced from two 5kW single-phase inverters which transform the electrical energy into alternating current with suitable characteristics for use in the Foundation building.

The main advantage of this system is the instant response as it in constantly kept on stand-by.

RESULTS

Efficiency	-Diesel generator to off grid installation: 28% -Zero emissions system: > 50%
Economical Ratio:	-Diesel generator cost: 3.000 € Zero emissions system cost: 40.000 €
Emissions:	-Diesel generator: 0,27 kgCO2/kWh -Zero emissions system: 0,0 kgCO2/kWh

COMPARATIVE WITH DIESEL GENERATOR

Fuel cell working in extreme cold: -25 ºC
Elimination of pollutant emissions. It can integrate the fuel cell with renewable energies like solar photovoltaic energy.
High level of security of operation because system with diesel generator have a problems with Fueltheft.

HYTOW

DESCRIPTION:

The HyTow project consists of the development of a self-powered street cleaning system.

The prototype, a cart or trailer, contains a water tank of around 1,500 litre capacity with a pressure hose, which is used for cleaning the streets in urban areas of cities. The water is fired from the hose using pressure from a pump powered by a 4kW fuel cell.

The fuel cell is responsible for generating sufficient electrical energy to feed both the pump that provides the hose with pressure and the electric motors that power the trailer. A hydrogen fuel cell reduces both atmospheric and noise pollution.

The hydrogen is stored a steel tank which can store the gas at up to 200 bars. It can be recharged as it has a suitable receptacle, giving autonomy of around 4 hours.

The management and movement of the cleaner through the streets are very simple for the operator as it is equipped with a jockey wheel system which allows freedom of movement.

An equivalent traditional system would be made up of a tank and a pump fed by a diesel motor, which would be incorporated into a small van or pick-up in order to move it from place to place.

RESULTS

Energy savings:	-HyTow system: 37,5 kWh/day Pick-up system (diesel): 60 kWh/day
Economical Ratio:	-HyTow system : 21.000 € Pick-up system (diesel): 17.450 €
CO2 Emissions:	-HyTow system : 0kg CO2/ year Pick-up system (diesel): 3 750 kg CO2/year
Acoustics emissions:	-HyTow system : 70 dB (similar to the noise of an office) . -Pick-up system (diesel): 120 dB (similar to the take off an airplane).

COMPARATIVE WITH PICK- UP SYSTEM (DIESEL)

Fuel cell working in extreme cold: -25 ºC.
Elimination of pollutant emissions. It can integrate the fuel cell with renewable energies like solar photovoltaic energy.
High level of security of operation because system with diesel generator have a problems with Fueltheft.

PRODUCTION AND DISTRIBUTION OF RENEWABLE HYDROGEN:

DESCRIPTION:

Systems based on hydrogen as fuel have little impact on the environment as the only residue is water. However, generating hydrogen can cause greenhouse gas emissions.

Currently, the most commonly used method to obtain hydrogen is the reforming of natural gas, which results in a lot of pollutants. However, there are other processes through which hydrogen can be obtained which have less impact on the environment. The process that has been best developed to date is that of the electrolysis of water.

Electricity, together with water, is the most important element used to obtain the hydrogen and results in fewer pollutants. This can come from a variety of different sources, some of which can be renewable energy sources.

Independence from fossil fuels results in a system of generation and distribution of renewable hydrogen that can reach many areas.

RESULTS

Energy cost:	-Natural gas reformed system: 25,59 kWh/kgH2 -Renewable hydrogen system: 51,17 kWh/kgH2
Economical Ratio:	-Natural gas reformed system: 4,6 €/kgH2 -Natural gas reformed system: 2,7 €/kgH2
Emissions:	-Natural gas reformed system:: 18,0 kgCO2/kgH2 -Renewable hydrogen system: 1,2 kgCO2/kgH2

COMPARISON

With electrolysis system is obtained:	-Low pollutant emissions. -Independence of fossil fuels. -Economically competitive. -High flexibility of energy sources. -Developed technology. -It is possible installation gas generator off distribution grids.

FUEL CELL ELECTRIC VEHICLE (FCEV):

The conversion of a car has been carried out by changing the electric battery to a hydrogen fuel cell. This conversion affords greater autonomy to the vehicle (up to 50% more) as well as a reduction in the time needed to recharge the battery (for 8 hours of power the battery can be recharged in 3-4 minutes.)

The electric motor is supplied by electrical energy generated by the fuel cell, which in turn is fed by hydrogen at 350 bars. In addition, the vehicle has a system to recuperate heat generated by the fuel cell, which can then be used in the heating circuit of the car, therefore reducing the total energy consumption.

Following the conversion, the relevant permission was obtained meaning that this vehicle is totally operative and licensed to circulate on public roads.

RESULTS

Energy savings:	-Diesel/petrolvehicle: 0,68 kWh/km -Battery electric vehicle: 0,16 kWh/km -Fuel cell electric vehicle : 0,4 kWh/km
Economical Ratio:	-Diesel/petrol vehicle: 15.000 – 25.000 € -Battery electric vehicle: 30.000 – 40.000 € -Fuel cell electric vehicle: 125.000 €
CO2 Emissions:	-Diesel/petrolvehicle: 0,17 kgCO2/km -Battery electric vehicle: 0,0 kgCO2/km -Fuel cell electric vehicle: 0,0 kgCO2/km

COMPARISON

Comparative with diesel/petrol vehicle:	-Reduction of pollutant emissions. -Reduction of acoustic pollution. -Only produce heat and water as byproducts.
Comparative with battery electric vehicle:	-Increased autonomy. -Reduce of recharge time.

SAFETY SYSTEM FOR THE PROVISION OF ELECTRICITY. UPS FOR IT SERVERS IN BUILDINGS

DESCRIPTION:

An uninterruptible power supply (UPS) is a device that can supply short-term energy to all devices connected to it when a power cut occurs.

The inclusion of a hydrogen fuel cell in an UPS allows the duration of the provision of energy during a power cut to be increased exponentially. The duration can be days and even weeks compared to the few minutes or hours provided by a conventional system.

FEAUTURES	VALUE
Max. Output power	3 kVA (20 minutes)
Nominal output power	1,7 kVA
Battery nominal autonomy	15 minutes
Fuel cell autonomy (Volume of Hydrogen tank is 50 l at 200 Bar)	6 hours
Response time	Immediately

RESULTS

Autonomy:	Battery system: 15 min Hydrogen UPS: 6 h 15 min
Economical Ratio:	Battery system cost: 3.000 € Hydrogen UPS cost: 10.000 €
Emissions:	Battery system: 0 kgCO2/kWh Hydrogen UPS: 0 kgCO2/kWh

COMPARISON

Hydrogen UPS system is scalable.
Hydrogen system is more economically competitive how much more power and more autonomy are required.
Natural Gas UPS is main source of energy supply companies, leaving the grid as emergency system.
Durability.

MOST RELEVANT DISSEMINATION ACTIONS

Andalusia Technology Park Science Week, Malaga.

Over the period of a week in 2011, 2012 and 2013, a variety of activities related to science and technology were organized for school pupils of different ages in the Andalusia Technology Park. These activities reflected the needs of pupils from primary school through to university students and vocational learners. They included specific workshops related to science and technology, guided visits to the most emblematic companies within the park, and even conferences for future entrepreneurs. In order to present the project Zero-Hytechpark to pupils, a stand with banners was set up where they could pick up leaflets containing all the relevant information.

Green Cities & Sustainability Event, Trade Fair and Congress Centre, Malaga.

The project was presented at the Exhibition Centre in Malaga in October in 2011, 2012 and 2013. The Green Cities & Sustainability event is the setting for a forum of intelligence applied to urban sustainability. It is a unique professional showcase, highly specialized in energy efficiency in buildings and urban areas. It provides a participatory, flexible and practical environment centred on the three fundamental themes needed to turn a city into a Green City; Building, Energy Efficiency and Smart Cities.

The Malaga Technology Park participated in the presentation of the Zero-Hytechpark project and the Hydrogen Foundation provided a stand for the participants where relevant information about the project was available, including both informative material and sales material.

In addition, last year we provided the public with an opportunity to receive further Information and resolve any queries by receiving first-hand information from Ana Férriz, an Industrial Engineer from the Aragon Hydrogen Foundation. Ana Férriz was also in charge of presenting a talk in the ICT & Sustainability forum, in which several companies, institutions and Spanish cities dedicated to the concept of sustainable urban spaces took part. The speaker presented information regarding the application of hydrogen and the Zero-Hytechpark project, and was heard by a high number of people interested in the subject matter.

The forum was also an excellent tool for networking given that the latest edition coincided with a Sustainable Cities Forum and the Tikal Forum, which brought together municipal representatives from 21 Latin-American cities. As a result the event provided the ideal showcase to present the project to a highly specialized public.

Transfiere Forum 2014, Trade Fair and Congress Centre, Malaga.

The 3rd Edition of the Transfiere Forum took place on the 12th & 13th February 2014 in the Trade Fair and Congress Centre in Malaga. This European forum is dedicated to science, technology and innovation and the Andalusia Technology Park participated with the Zero- Hytechpark project.

On this occasion we provided a stand specifically for the project, where in addition to offering all relevant information to the visiting public, we also provided a range of promotional material and informative leaflets.

The Transfiere Forum actively encourages cooperation between the world of science and the business sector with the aim of transferring knowledge. Scientists from universities as well as public and private research centres were able to communicate the latest technologies and create business opportunities with companies and agents from the I+D+I sector.

The forum was also attended by two members of the Aragon Hydrogen Foundation; Maria Alaman and Joaquin Mora, who had a number of meetings and B2B engagements with business people interested in receiving further information about the project.

Numerous visits to the Andalusia Technology Park:

- Visit by the Association of Young Business People, Algarve, Portugal
- Commercial business relations between Cuba and Spain: possible investment opportunities and business with Cuba.
- Visit by the Itaipu Technology Park, PTA
- Visit by the Asunción National University, Paragua
- Visit by the University of Cape Coast School of Business, PTA.
- Panama Embassy.
- BelgianAmbassador to Spain.

Celebration of the 20th Anniversary of the LIFE+ programme

The board of the Aragon Hydrogen Foundation celebrated the 20th anniversary of the LIFE+ Programme on the 21st May 2012

The day began with a seminar focusing on the LIFE+ programme as it was responsible for financing one of the projects the foundation is currently carrying out in collaboration with the Andalusia Technology Park, the Bizkaia Technology Park, and the LIFE+ Zero-Hytechpark project.

After the seminar a presentation was given about the various applications, including; the system used to monitor the project's energy balance and CO2 emissions; an explanation of a stand-alone electrical system and with regards to sustainable mobility, information was given about a two-seater car powered by a fuel cell.

Presentation of the Project as scientific communication at the WHEC 2012

The Zero-Hytechpark Project was presented at the World Hydrogen Energy Conference 2012 in Toronto. The visual presentation of the project was made in the form of a poster with José Alfonso Arnedo Moncayo, one of the project technicians, on hand to explain the details of the Zero-Hytechpark Project to the congress attendees.

There were a total of 1,000 people from 55 different countries attending the congress, which was made up of 450 presentations, 20 key talks by invited specialists and 200 posters about various projects. In addition there was an exhibition area with 50 stands.

Tree planting initiative by the AHF and the WTP

On the 13th May, the Aragon Hydrogen Foundation and the Walqa Technology Park got together to plant a total of 70 olive trees. By planting these trees within the framework of the European LIFE+ Zero-Hytechpark project, around 860kg of yearly CO2 emissions from daily activities in the park will be offset.

Employees from both organisations were present to take part in the planting and were accompanied by the Director General of Industry and Small Businesses, the Vice-President of the Hydrogen Foundation, Javier Navarro Espada and the manager of the Walqa Technology Park, Miguel Ángel López.

Presentation of the Project at the Science Zone in 2011, 2012 and 2013.

In each of these years, the Zaragoza General Fair proposed the inclusion of scientific activities in the Science & Innovation Pavilion from 10th to 13th October. The displays were organized by the Aragon Government, more specifically, by the Department of Innovation and New Technology and the University of Zaragoza. The main objective was to integrate a specific zone for local investigation centres into the programme of the city's traditional annual fiestas with the aim of presenting and transmitting concepts of investigation and innovation to the general public in an easy-to-understand manner.

The Hydrogen Foundation had a stand in the Science Zone which was used to raise awareness of the day-to-day work carried out.

During the four days of the fair, around 500 people visited the Hydrogen Foundation stand in the Science Zone, most of who were families.

Visits to the BTEK Technology Interpretation Centre of the Bizkaia Science and Technology Park. Hydrogen Workshop and Permanent Display.

With the object of achieving greater dissemination of the Zero-Hytechpark Project, an interactive module and a practical workshop about hydrogen and renewable energy were set up in the BTEK Centre of the Bizkaia Science and Technology Park. The interactive module is located in one of the most visited areas of the centre and explains the role hydrogen technologies play in daily life through a number of different sets. This display was further enhanced by a practical workshop about hydrogen and renewable energy. Various kits were used to explain the different phases of hydrogen technology used for the transfer of energy. As a follow up to the workshop an informative leaflet was distributed to further highlight the uses of hydrogen and renewable energy.

Since the centre was established in 2010, around 4,000 visitors per year have had the opportunity to enjoy the display. The BTEK centre aims to raise awareness of science and technology amongst young people, to awaken science and technology vocations and, at the same time, promote science and technology culture in society.

Open Day workshop at the Bizkaia Science and Technology Park

The Bizkaia Science and Technology Park holds an open day workshop every year. This provides a unique opportunity for people to get to know technology parks and the companies installed within them first-hand and also brings new technologies closer to the general public. Thousands of people from all over Euskadi attend this event every year and are invited to get to know the park and the fifty different activities taking place within the individual companies located within. At the same time they have the opportunity to learn and experiment with science and technology.

At the latest edition of the event in 2013, the visit to the BTEK Technology Interpretation Centre was a highlight of the day. It was visited by approximately 700 people who took part in a variety of workshops sessions about hydrogen and renewable energy following the launch of the permanent module within the centre. All visitors were given material about the project in addition to a leaflet about hydrogen and renewable energy.

Technology Camps in the BTEK Centre of the Bizkaia Science and Technology Park

To coincide with the Easter and summer school holidays, the BTEK Technology Interpretation Centre organized a number of technology camps for children aged between 9 and 16 years old. The main objective was to awaken scientific vocations in young people and generate interest in science and technology.

Science and technology were the key focus of the technology camp's activity programmes and a total of 800 children have taken part in the camps over the last two years. They have had the opportunity to get to know the Zero-Hytechpark project through dynamic workshops about hydrogen and renewable energy within the permanent module installed in the BTEK Centre. As a follow up to the workshop an informative leaflet was distributed to all participants to further highlight the uses of hydrogen and renewable energy within the framework of the project.

Visits to the Bizkaia Science and Technology Park by International Delegations

The Bizkaia Science and Technology Park has received around 150 visits since the start of the project. Many of these were made by international delegations and others from within Spain. All visitors expressed an interest in getting to know the Bizkaia Science and Technology Park as a successful model and benchmark at an international level.

Of the many visits received over recent years, the following are worth highlighting; international delegations from Japan, Korea, Indonesia, the USA, Canada (Quebec), Mexico (Guanajuato), Ecuador (Azuey), Colombia (Bogotá, Antioquía), Brazil (Rio Grande do Sul), and Chile (Santiago, Coquimbo); the ambassadors of Chile and Peru and more recently the Governor of Panama; the ambassador of the Arab League; European delegations from Austria, the province of Lower Silesia in Poland, Normandy in France and finally at a national level visits from Madrid, Barcelona, Valencia and the Basque country.

Zero-Hytechpark Conclusions

The main objective of the Zero-HytechPark project is the reduction of CO2 emissions and to achieve this, a number of applications have been developed.

SOLAR THERMAL INSTALLATION;technology to feed the heating and air-conditioning system of the Aragon Hydrogen Foundation building. The use of this solar panel energy as a support to the existing heating system in the Foundation building ensures that the emission of a total of 4,500 kg of CO2 per year is avoided.ISOLATED PHOTOVOLTAIC SOLAR INSTALLATION; responsible for supplying the office IT equipment in the Aragon Foundation building which reduces the CO2 emissions by 7,500 kg per year.

HY TOW; a self-driven system used for cleaning the streets. The trailer has a water tank with a pressure hose that allows easy cleaning of streets in urban areas. The fuel cell installed is responsible for powering the water pump and the electric motors responsible for moving the unit.

The key advantages presented by this prototype are the following:-

- The fuel cells are capable of working well in extreme cold : -25ºC
- Pollutant emissions are eliminated and it is worth highlighting that noise pollution is significantly reduced.

FCEV; the conversion of a vehicle by changing the electric battery to a hydrogen fuel cell was carried out. This conversion affords the car greater autonomy (up to 50% more) and a reduction in the charging time (from periods of up to 8 hours to a charge time of just 3-4 minutes.)

The electric motor is powered by electrical energy from the fuel cell, which in turn is fed by compressed hydrogen at 350 bars. In addition, the car includes a system capable of holding the heat generated by the fuel cell, which can then be used to heat the interior of the car. This has the advantage of reducing the total energy consumption of the car.

The main advantages presented by this electrical vehicle powered by a hydrogen fuel cell are:

- A reduction in pollutant emissions and in noise pollution.
- The only byproducts are heat and steam.

FORKLIFT; the transformation of a forklift truck was carried out by replacing the electric battery with a hydrogen-fed fuel cell.

The main problems faced with a traditional electric battery are the long periods needed to recharge it and the lack of autonomy this produces.

In an 8 hour shift, an operator has to stop at least once to replace the spent battery with a charged battery, a process which can take between 15 and 30 minutes. With a hydrogen forklift the recharge is immediate, the whole process takes approximately 2-3 minutes, and one charge is sufficient to complete a full 8 hour shift.

The use of this type of forklift provides a number of benefits; productivity is increased as time spent recharging batteries decreases; CO2 emissions are reduced and there is less maintenance as the number of movable pieces is lower.

Installation of hydrogen fuel cells in the Foundation building to develop a cogeneration system and to be used as a back-up system.

COGENERATION BATTERY; a fuel cell powered by hydrogen has been set up as a cogeneration system (combined heat and power use) in a project prototype.

The system offers 4km of electrical power and 3.5 kW of thermal power which we use to heat the water in a 150l tank from 20ºC to 60ºC over a period of 2 hours. The system yield is 70%; 40% electric, 30% thermal and 30% loss. Hot water can be used as Domestic Hot Water (DHW) or for heating.

The main advantage of this system is that it does not produce pollutant emissions.

FUEL CELL CONNECTED TO THE POWER GRID; hydrogen cells which use the surplus hydrogen for the production of electrical energy and is later use.

Firstly, hydrogen is produced using the surplus of renewable energy generated. The hydrogen is stored in our facilities and whenever a boost of extra electricity is needed, the hydrogen fuel cell is used to reinject electricity into the grid.

The batteries give out the electricity produced using two inverters which transform the electrical

energy into alternating current with characteristics suitable for use where needed in the foundation building.

The main advantage of this system is the instant response as it in constantly kept on stand-by.

UPS; an uninterruptible power supply is a device that can supply short-term energy to all devices connected to it when a power cut occurs.

The inclusion of a hydrogen fuel cell in an UPS allows the duration of the provision of energy during a power cut to be increased exponentially. The duration can be days and even weeks compared to the few minutes or hours provided by a conventional system.

- Improvement in the current hydrogen station with the monitoring the main parameters and improvements in the communication system as well as the development of the system for compressing the gas produced in the foundation through the use of metal hydrides.

COMURO; this system for compressing gas takes advantage of thermal energy, or heat, in order to compress the hydrogen. This takes place thanks to a chemical reaction which is produced between the hydrogen and a metal alloy made up of iron, lanthanum and nickel amongst other elements.

In our facilities we have reached a pressure of 200 bars in a single stage. An increase in pressure can be achieved by increasing the number of stages; in fact experimental systems already exist that have manage to achieve pressure of up to 500 bars.

The main advantages of this system are that as there are no movable pieces within the system, maintenance work is practically zero and in addition, it is a way of taking advantage of residual heat that is produced by many applications.

SELF CONSUMPTION; as well as being the first legal institution in the province of Huesca with a photovoltaic system for self-consumption, the installation of a self-use system in the Aragon Hydrogen Foundation building means that approximately 25% of the annual energy consumption is covered.

With a larger and more powerful installation it would be possible to achieve total self-sufficiency in the foundation building; that is to say, the building would be able to produce all of the electricity it needed.

With this kind of installation, the following can be achieved:

- Generation of cleanenergy.
- Consumption of energy in the place it is produced.
- Reduction of energy loss from electricity transportation.

With all of these applications in place, a reduction of CO2 emissions will be achieved in the Walqa Technology Park and a number of key objectives of the project will be satisfied.

All of the applications that have been carried out have been done taking into account current legislation.

Firstly, It is important to highlight that thanks to the renewable energy installations currently in use in the Walqa Technology Park, a total of between 15% and 45% of electricity consumption of the whole park is met. The difference in the figures given is due to seasonal variations in consumption.

The second energy evaluation undertaken was related to heat consumption, in both the foundation building and the technology park as a whole. With regards to the foundation building, a detailed analysis of the energy balance of the solar thermal installation was included as a development of Action 2 of the Zero-Hytechpark project. The result was a reduction of 19% in propane emissions, the energy source of the current heating system.

Finally, the third energy evaluation carried out was a study of the CO2 emissions caused by transport used by employees between their homes and the technology park. This study was undertaken for the employees of the Hydrogen Foundation as well as the employees of the park as a whole. The study of the foundation also included emissions generated by work-related journeys undertaken by staff.

The results for both applications are summarised by stating that 885Nm3of hydrogen would be needed each year to meet the demands of a fleet of vehicles and that the surplus hydrogen could lead to the production of around 1060kWh of thermal energy, which could be used by the solar thermal system to further reduce the consumption of propane fuel used in the heating system of the foundation building.

However, taking into account that this data is not competitive from an economical-technical point of view, it is necessary to reiterate that the objective of the activities being developed in this project is purely to demonstrate how alternative technologies could be used in the future as efficient, reliable and profitable energy systems.

Finally, it should be pointed out that all of the actions that have been carried out share the common objective of a reduction in pollutant emissions as has been demonstrated in the report, and that a

project of this nature carried out in this technology park could be extrapolated to any technological park, logistics platform or industrial park.

H2 Technical barriers

Within the framework of the Zero-Hytechpark project, the Aragon Hydrogen Foundation has developed a series of applications in order to achieve the reduction of CO2 emissions in its buildings as well as in the Walqa Technology Park as a whole.

The majority of the applications that have been developed focus on hydrogen as the key element. As this is a relatively new technology that is currently being developed, we are faced with some barriers that currently impede the success of the technology.

Some of the barriers are as follows;

- As this is a technology currently under development, the price of components is high as they have to be tailor-made for each specific application. As a result, the investment is very high meaning that success is difficult to achieve with the current-day technology.
- Lack of governmental support, which would facilitate the development of the technology.
- Lack of a hydrogen network similar to the natural gas network already in our cities. With a network in place, the whole population would have access to hydrogen and it would be more accessible for use in the many different applications.
- Necessity of a change in mentality in the general public so that new technologies that are current being developed, such as hydrogen, form part of our everyday life.