



## H2SEED

### Comhairle Nan Eilean Siar (CNES), Scotland

#### Summary

The islands of the Outer Hebrides make up the administrative area of the Western Isles, and are located off the North West coast of Scotland. Their land extension is of the order of 3.100 km<sup>2</sup>, with a population of near 27.000 inhabitants; Stornoway is home to about 9.000 inhabitants. Over 97% of the energy consumed is imported, while the average energy cost is over 13% higher than in the main island (UK).

The local authority Comhairle nan Eilean Siar (CnES) initiated a series of hydrogen projects, of which H2 SEED will be the 1st project covering the whole value chain of hydrogen technologies: H<sub>2</sub> production from biogas, H<sub>2</sub> storage, H<sub>2</sub> filling station and H<sub>2</sub> use in both stationary and transport applications.

H2 SEED aims at giving an innovative solution to an electricity excess produced by a biogas engine in the Creed Waste Treatment Plant while being the starting point for the creation of a H<sub>2</sub> infrastructure in the island.

#### End-user area

- New buildings
- Refurbishment of buildings
- Transport and mobility
- Financial instruments
- Industry
- Legal initiatives (regulations, directives, etc)
- Planning issues
- Sustainable communities
- User behaviour
- Education
- Other

#### Target Audience

- Citizens
- Households
- Property owners
- Schools and universities
- Decision makers
- Local and regional authorities
- Transport companies
- Utilities
- ESCOs
- Architects and engineers
- Financial institutions
- Other

#### Technical

- Energy efficiency
- Heating
- Cooling
- Appliances
- Lighting
- CHP
- District Heating
- Solar energy
- Biomass
- Wind
- Geothermal
- Hydro power
- Other

#### Context

The local authority Comhairle nan Eilean Siar (CnES) has been working for some years to deliver a high-quality strategy on hydrogen and related technologies. The Hebridean Hydrogen Park identifies three phases of activity, i.e. Phase 1: Capacity building and skills development, Phase 2: Infrastructure and demonstration projects, Phase 3: Development of hydrogen markets. H2 SEED project belongs to Phase 2 of the Business Plan. Only one 32 kV line connect the island with mainland Scotland, causing a significant instability and a lack of reliability of electrical supply. With the biogas of a waste management facility an engine produces electricity which is used for the electrolysis of water to produce hydrogen. The hydrogen produced (around 35.000 Nm<sup>3</sup>/year) will be stored compressed at 200 bars, with a storage capacity around 700 Nm<sup>3</sup> of hydrogen, allowing the storage of one week of hydrogen production.

The vehicles to be used in this first stage of the project are two hybrid Toyota Prius, working with hydrogen ICE engines. They will require around 12.000 Nm<sup>3</sup> of hydrogen per year, saving the emission of 6.5 Ton of CO<sub>2</sub> per year. For supplying the hydrogen to the fuel cell vehicles, a fuelling station will also be installed in the plant. The excess of hydrogen will be exported to the University Hydrogen Laboratory (15.000 Nm<sup>3</sup>/year), and other applications using hydrogen (broadband repeater).

In addition, an important quantity of exceeded hydrogen will be left for future applications. The idea of H2 SEED is to create a basic infrastructure to be expanded in a sustainable way once more financing is secured. Therefore, further applications are expected to be used in the Outer Hebrides at a later stage (e.g. public buses, forklifts, golf carts, etc).



## Objectives

H2 SEED will be the 1st project delivered in the Isle of Lewis covering the whole value chain of hydrogen technologies: H<sub>2</sub> production from biogas, H<sub>2</sub> storage, H<sub>2</sub> filling station and H<sub>2</sub> use in both stationary and transport applications. H2 SEED aims at giving an innovative solution to an electricity excess produced by a biogas engine in the Creed Waste Treatment Plant while being the starting point for the creation of a H<sub>2</sub> infrastructure in the island.

Key objectives:

- Provide an innovative end use solution to the currently grid constrained Creed Waste Management Facility's anaerobic biodigester
- Continue the groundbreaking achievement epitomised by the establishment of Scotland's first purpose built hydrogen teaching lab in 2006
- Contribute (as the first phase) to the implementation of the Hebridean Hydrogen Park Business Plan 2006-2008 launched the Comhairle nan Eilean Siar.

## Process

With the biogas of a waste management facility an engine produces electricity which is used for the electrolysis of water to produce hydrogen. The Hydrogen Supply is assured via Alkaline Electrolyse (capacity of around 20 Nm<sup>3</sup>/h), electricity from a biogas engine and high pressure Hydrogen storage is envisaged. The filling station is supposed to serve at least two fuel cell vehicles for the use of Comhairle Nan Eilean Siar. The proposed vehicles are hydrogen ICE/battery Toyota Prius.

The project is structured into a set of Work Packages (WP) and Work Tasks (WT), covering above mentioned objectives and coordinated by Comhairle nan Eilean Siar.

**WP1 (Detailed Engineering Design, including Technological Development)** is aiming at the Development of an elaborated engineering study. This study will be based on a feasibility study commissioned by CnES and carried out by a Consortium led by NTDA Energía including PURE Energy, Air Products & Norsk Hydro.

**Task 1.1 Hydrogen Production & Storage:** Definition of all systems, including electrolyser, water deioniser, hydrogen compressor and purifier, hydrogen deposits and all piping, valves and safety systems needed.

**Task 1.2 Filling Station:** Definition of station including hydrogen compressor, buffer storage systems, nozzles, safety and control systems.

**Task 1.3 Development of the control system,** which is required to manage all the new elements (electrolyser, stationary fuel cell, and all the safety and measurements devices), as well as the biogas engine, and their interaction with the plant.

**Task 1.4 Development of monitoring systems** including data recording, remote connection and analysis tools.

**WP2 (Project Execution)** aims at installing all devices and components and starts the operation of systems. Implementation of the engineering project, including the acquisition and installation of all elements forming part of the project

**Task 2.1 Licensing & certification issues.** Specific tailored made certifications should be started.

**Task 2.2 Installation of components** Acquisition of all needed devices and systems, and installation

**Task 2.3 Operation tests & commissioning** Testing of subsystem in real operating conditions

**WP3 (Operation & Maintenance and monitoring of the Plant)** is aiming at the Operation of the Plant once the execution of the project is finalised and provide all needed O&M activities in order to maximise plant efficiency. This WP will last for the whole lifetime of the plant.

**Task 3.1 Execution of O&M activities:** Normal plant operation, the predictive maintenance, the corrective maintenance.

**Task 3.2 – Monitoring** in which all relevant parameters describing the operation of the plant will be recorded and analysed.



**WP4 (Training & Public Awareness)** aims at increasing public awareness, creating new market opportunities, contributing to creating an attractive image of the Island (innovative, environmentally friendly, dynamic), thus attracting investments and increasing possibilities for EU, national and regional funding. Also includes human resources training on hydrogen and fuel cell technologies & development of new knowledge in the island, avoiding emigration of people looking for technological educational programs.

**Task 4.1 - Plant operators training** in which the operators working with the new systems to be installed in the plant will be trained to operate properly all systems. Safety issues will be a crucial topic.

**Task 4.2 - Workshop on hydrogen and related technologies:** University workshop providing basic knowledge about hydrogen production, storage and use, including safety and standards requirements.

**Task 4.3 - Other dissemination activities:** Technical conferences, papers, press articles / local TV announcements, banners etc.

## Financial resources and partners

The H2SEED project is being delivered by the Comhairle nan Eilean Siar in conjunction with the following project partners:

- HIE – Innse Gall
- Lewis Castle College
- The Stornoway Trust
- NTDA Energía
- Pure Energy Centre

£ 500,000 has been invested by the Comhairle Nan Eilean Siar and further £ 250,000 has been received in the form of a grant from the Scottish Executive. The project partners anticipate accessing more financing sources in order to pursue this project.

## Results

The Hebridean Hydrogen Park projects will ensure that the Outer Hebrides are well positioned to take advantage of the future commercial opportunities in the emerging hydrogen markets. This will have impacts on the economic development of the islands in terms of skills and diversity in the economy. It will seek to attract research and development activity to the area and will promote the Outer Hebrides as a “centre of excellence” for renewable energy innovation.

### What are the benefits of H2 SEED?

- Increase the lifetime of the biogas engine currently installed in the Creed Waste Treatment Plant.
- Produce a new, renewable, autochthonous and clean fuel (hydrogen) that will be used in vehicles, therefore substituting oil, which is not renewable, not autochthonous and pollutant.
- Creation of a basic hydrogen infrastructure in the island that could grow in the near future with other renewable energy sources, such as wind energy.
- Public awareness, especially owing to the high visibility of the hydrogen public vehicle fleet.
- Human resources training on new technologies & development of new knowledge in the Isle (it should be taken into account the high rate of young emigrants from the Isle of Lewis to the mainland looking for better education/ job opportunities).
- Creation of an attractive (innovative, environmentally friendly, dynamic) image of the Island that could be beneficial in terms of tourism, attraction of industry / investments, etc.

## Lessons learned and repeatability

H2SEED is the seed-project for further Hydrogen Activities in the Western Isles. The Hebridean Hydrogen Park 2006- 2008 Business Plan details a suite of strategically and geographically inter-related hydrogen projects. The suite of incubator projects identified in the business plan is anticipated to cost the region of £2.5M. The Comhairle has allocated a capital funding package of £500K, with the remaining £2M to be secured. Due to the funding constraints and timescales the full suite of projects may not be deliverable under the current capital



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programme which ends on 31st March 2008. The key project priorities are the production and refuelling facilities, the council pool vehicles and emergency services training. The additional project objectives are designed to enable greater community participation and inclusion in the Hebridean Hydrogen Park, with the inclusion of elements accessible to communities and tourists and to add diversity to the project as a whole. The project has been developed in partnership with Lews Castle College University of the Highlands and Islands to maximise opportunities for research, development and training.

The Creed Waste Processing Plant is the first plant in the United Kingdom combining an anaerobic digestion technology and in-vessel composting to process biodegradable wastes. This biogas is used to feed an engine producing electricity and heat. The plant is not authorised to export electricity to the grid due to technical constraints, forcing the engine to operate at partial load (because electricity demands at the plant are lower than engine nominal capacity). Operating at partial load, the engine temperature is reduced and the sulphur contained in the biogas corrodes the engine reducing considerably its lifetime.

**Contact for more information:**

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Printed reports or other literature available:

Title	Author	Date
Invitation to Tender	CNES	18/10/2006
Methodology for the supply of Consultancy Services	NTDA	03/11/2006
Progress Reports	NTDA	12/06 – 04/07
Western Isles Assessment	NTDA	22/03/2007
Business Plan Review Del 1.1	NTDA	23/04/2007
Funding Opportunities Overview	NTDA	23/04/2007
H2 Seed Background Document	NTDA	23/04/2007
H2 Seed Application Form	NTDA	23/04/2007
Financing Strategy	NTDA	24/04/2007
Engineering Project Del. 1.2	NTDA	24/04/2007
Engineering Project Annex Del. 1.2	NTDA	24/04/2007
Preliminary Suppliers Contact List	NTDA	11/05/2007

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