“The renewable energy croft and Hydrogen facility”

1 - Project Aims

The Renewable Energy Croft and Hydrogen facility is a showcase project that has been set up to increase knowledge on renewable energy sources and hydrogen technologies and to improve their penetration in the Outer Hebrides Community. The facility provides working laboratory for students and the basis for delivering the Hydrogen economy to which the Outer Hebrides Community Planning Partnership is committed. These technologies represent a key point to supporting the transition to a low carbon economy supported by renewable energy and provide a real-life example that will inspire people and promote new opportunity on the Island.

2 - Project Summary

Project title: The Renewable Energy Croft and Hydrogen facility.

Lead organisation: Lews Castle College

Key words: Renewable Energy, hydrogen, technology transfer, education

Country: Scotland, United Kingdom

Town: Stornoway, Outer Hebrides

Project website: http://www.lews.uhi.ac.uk/

Project time span: 5 year

Project budget: £1,000,000

Funding sources: EU, Scottish Government, Comhairle nan Eilean Siar

There is an increasing demand for the development of renewable energy schemes in Europe and the United Kingdom (UK) to help cut the 20% of CO2 emissions and meet renewables targets set-out by the European Union (EU) for 2020 [1]. The Western Isles of Scotland have an abundance of renewable energy resource which could be used to meet the renewable energy targets both the UK Government and Scottish Executive have set for the future. In addition the Outer Hebrides has shown the highest level of Fuel Poverty and Extreme Fuel Poverty in Great Britain, current estimates are that around 50% of all households experience fuel poverty. In this scenario the development of a renewable energy croft and hydrogen facility in Stornoway create a unique opportunity for an early deployment of a low carbon economy supported by renewable energy and hydrogen infrastructure.

The Renewable Energy Croft and Hydrogen facility project has been developed by the Lews Castle College. The college is part of the University of the Highlands and Islands (UHI) Millennium Institute and it is specialised in providing a broad range of undergraduate and postgraduate courses for the achievement of academic qualifications and professional development.

The Renewable Energy Croft includes a combined mixture of renewable energy sources generating the electricity required for heating and lighting system of a cluster of poly-tunnels and greenhouses and to extend the growing season.

The intermittence nature of the renewable sources has been proved to be efficiently balanced by the integration with hydrogen storage technologies. This combination has provided a real-life example of reliable energy system completely off-grid and with zero carbon emission.

Figure 1. The Renewable Energy Croft

3 - The project

The project has created the basis for the development of a demonstrative energy generation system with latest advanced technologies available for off-grid energy system. It has been nominated and shortlisted as a finalist for the prestigious Scottish Green Energy Awards 2009, as the most innovative project in Scotland. The project development includes a Renewable Energy Croft and a Hydrogen facility installed within the Lewis Castle College, UHI Institute facilities.

The Renewable Energy Croft shows latest renewable technologies available for the production of electricity and heat, such as solar photovoltaics and collectors panels, wind turbines, a ground source heat pump and a micro hydro system.

There are six wind turbines, three of which were fabricated during the college workshops by members of the public attending evening classes. The wind turbines can produce up to 5 kW.

As the intermittence of the wind source is highly unpredictable a diversification of the energy source is required to improve the stability and reliability of the energy generation. For this reason the wind energy is combined with solar panels for a further utilisation of the renewable sources available on site. The system includes four PV arrays that can produce 5 kW.

In addition a micro-hydro scheme is currently under construction on the stream running through the facility and it is predicted to be able to provide 2 kW

The electricity produced from these renewable sources is feed into the Renewable Energy Croft energy system and provides the required electricity for the lighting system of the poly-tunnels and greenhouse.

Complementary to the electricity production the Renewable Energy Croft includes a heating system powered from renewables sources. Therefore a ground source heat pump together with a range of solar collectors on flat, tiles and slated roofs have been included into the project.

The intermittency of the load is balanced by a large battery bank and as a last resort, a backup biodiesel generator which uses fuel processed on site. The project has demonstrated it is possible to deliver a reliable supply from what are fundamentally unreliable sources of energy. Figure 1 provides a schematic diagram of the Renewable Energy Croft.

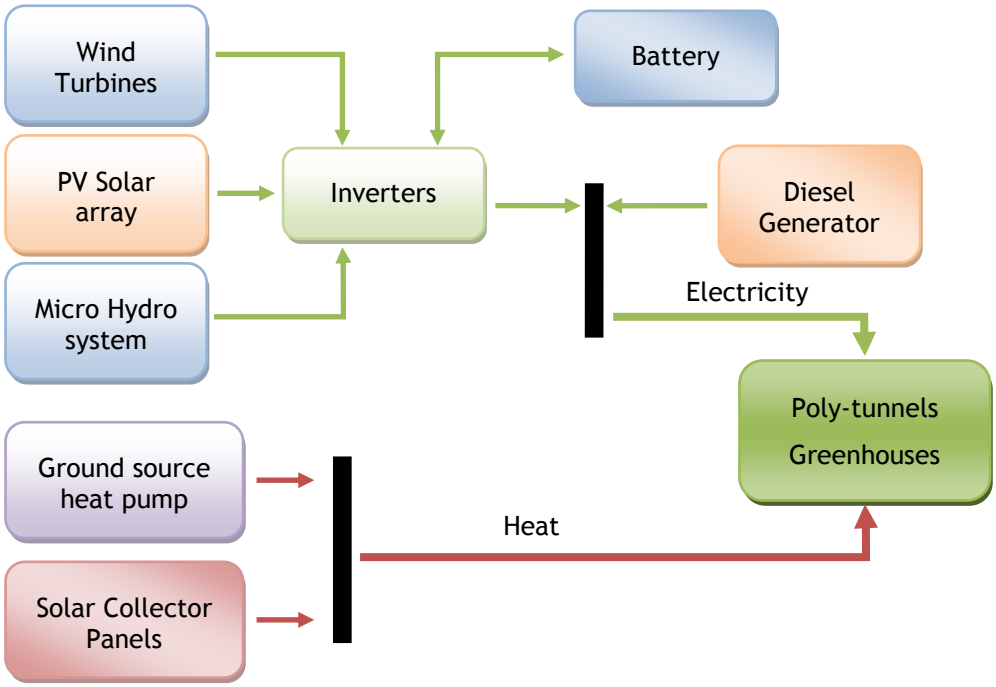

Figure 1. Schematic diagram of the Renewable Energy Croft

The Hydrogen facility is a demonstrative project and provides an advanced research centre for hydrogen applications. It includes latest technologies available on hydrogen production and a hydrogen laboratory where to conduct research and teaching activities for the Lews Castle College.

Hydrogen is produced with electrolysis of water. The electrolyser is a 5 Nm3/hour system (or 5000 litres of hydrogen per hour), which uses the electricity supplied from the grid to split pure water into hydrogen and oxygen gas. Despite the energy used for this process in derived from the public grid, the presence of the Renewable Energy Croft within the Lewis Castle facility containing renewable energy sources could theoretically supply the excess energy produced locally to the electrolyser.

The unique characteristic of hydrogen is that it is the only carbon-free or zero-emission chemical energy carrier when produced from renewable sources. It is one of the most promising alternative fuels for future transport applications, stationary and portable electrical power generation. As an energy storage system, Hydrogen acts as a bridge between all major sectors of an energy system: the electricity, heat, cooling and transport sectors. It is the only energy storage system that allows this level of interaction between these sectors and hence it is becoming a very attractive option for integrating large quantities of intermittent renewable energy such as wind and solar [2].

The H2 produced is stored on pressurised tanks and used for the development of new applications and research activity within the hydrogen laboratory. Among the research activities there is a project intended to reduce fuel cost on fishing vessels using hydrogen. The aim of this research activity is to develop a system that will inject small amounts of hydrogen along with the normal fuel to aid combustion in large diesel engines with a prevision of saving of 10%-20% on fuel costs. Another significant application is the use of hydrogen as fuel for Fuel Cell in order to produce electricity, heat and cooling. The applications for this new technology can cover several fields from automotive transportation to power supply for portable and stationary applications.

Figure 2. Pure® Hydrogen production system

One of the great successes of the Renewable Energy Croft and Hydrogen facility is that the public have had access to the facility to learn firsthand how these devices work and encourage them to consider installing similar devices on their own buildings or land. The choice of technologies is coherent and complementary, and presents all the choices available to the householder or community group on a fair basis. The output from the generation devices is continuously monitored and the data are available into the worldwide network.

The hydrogen and micro-generation facilities have been used for teaching and supporting the development of new courses on renewable energy technologies, including a unique online professional development award (PDA) in Renewable Energy accredited by the Scottish Qualifications Authority and accessible by everyone remotely. The presence of the Renewable Energy Croft on the Island has made the Lews Castle College a centre of community focus with a growing interest in renewable technologies. The number of Student is increased rapidly, recording now 67 students on the PDA course, most of them from remote rural areas. The facility is daily used for training students and public members to develop skills in renewable energy systems and principles to a level appropriate to the industry.

Lews Castle College UHI principal David Green said: "Our current and future engineering students will be well-trained in renewable technologies and in the safe use and applications of hydrogen, and this is an important contribution to a low carbon future for us all."

Figure 3. Students at the Renewable Energy Croft

The Renewable Energy Croft and the Hydrogen facility have highly benefited the Outer Hebrides communities. It has provided the opportunity:

- to develop knowledge and understanding of the broad issues impacting on energy production and use at present and in the future,
- to develop knowledge and understanding of the science and engineering of a wide range of energy extraction systems used in the renewable energy sector
- to demonstrate an accurate comparisons between renewable technologies for solving energy problems.

- of specialising people in the areas of Renewable Energy Systems with improvement of the academic qualifications and professional developments.
- Enhancing employment prospects
- Allowing the community to see what renewable energy technologies can be used today.
- Raise public awareness, and interest in renewable technologies.

Reference:

[1] “A European strategic energy technology plan”, COMMISSION OF THE EUROPEAN COMMUNITIES, Brussels, 22.11.2007.

[2] V. Ortisi, D. Aklil, R. Gazey, A. MacLeod, E. Johnson, “BENEFITS OF HYDROGEN ENERGY STORAGE”, IC-SES 2011