HYLINK: Distributed Hydrogen Energy System for Remote Areas

Wairarapa, New Zealand

The HyLink project, run by Industrial Research Limited (IRL), demonstrates a remote area hydrogen energy application well suited to rugged terrain and a plentiful supply of distributed energy resources, both of which are found in New Zealand. In this project, hydrogen was produced by wind electrolysis at an exposed hilltop and piped 2 kilometers (km) to a farming community where it was used to provide power and hot water. The project has shown that its concept is feasible using existing technologies and that there is a possibility for commercial opportunities through further technology development and cost reductions.

Objectives

The New Zealand Government is the sole shareholder in IRL, which seeks to discover whether community micro-generation could significantly improve options for providing energy services in remote areas—benefiting both utility companies and their rural customers—by providing a less costly alternative to running power lines.

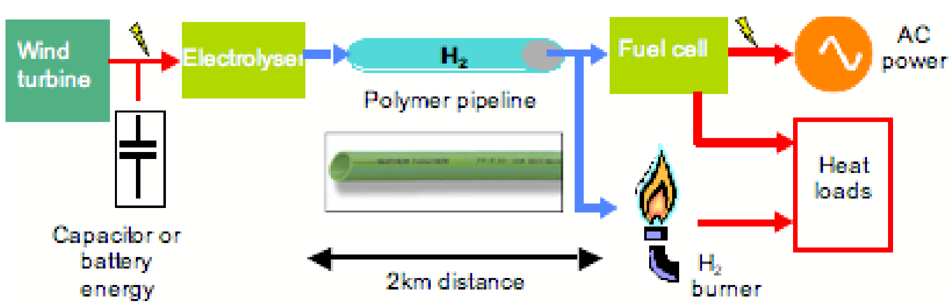
In remote communities, delivery of local renewable energy is often not economical due to the cost of running overhead power lines for long distances over rough terrain and dealing with intermittency of the power delivered. These issues led IRL to investigate the potential for hydrogen to contribute to the delivery of remote renewable energy. The project aimed to demonstrate that hydrogen conveyed in a pipeline can be used to both transmit and store intermittently produced energy at high power. Another objective was to reduce the cost of the hydrogen technologies used in the project, while maintaining safety and reliability.

Approach

This project was conducted in the small, remote farming community of Totara Valley, Wairarapa, where the load consisted of three farmhouses and a collection of farm buildings. The community was grid-connected throughout the project but had a strong desire to use as much local renewable energy as possible.

The proof-of-concept HyLink system consists of an 18-millimeter polymer hydrogen pipeline connected at the supply end to a 400-watt proton exchange membrane (PEM) electrolyser, and at the demand end to a one-kilowatt PEM fuel cell and a one-kilowatt hydrogen combustor located in a woolshed.

Power to the electrolyser is provided by a 300-watt wind turbine. Hydrogen produced via electrolysis directly pressurizes the pipeline, which both stores the hydrogen and conveys it at high efficiency (greater than 99%) over relatively long distances. The pipeline provides a storage volume of 400 liters, equivalent to about 5 kWh of energy at 4 bar pressure.



Schematic of the HyLink system

Project Overview

What

HYLINK

Who

Industrial Research Limited

When

Started: March 2001
Completed: August 2005

Participants

New Zealand

Renewable Technology

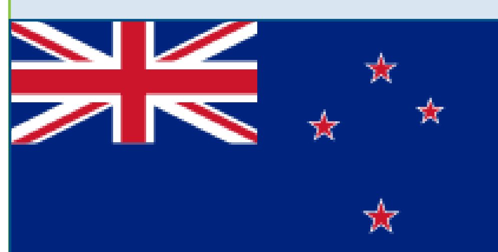
Wind power

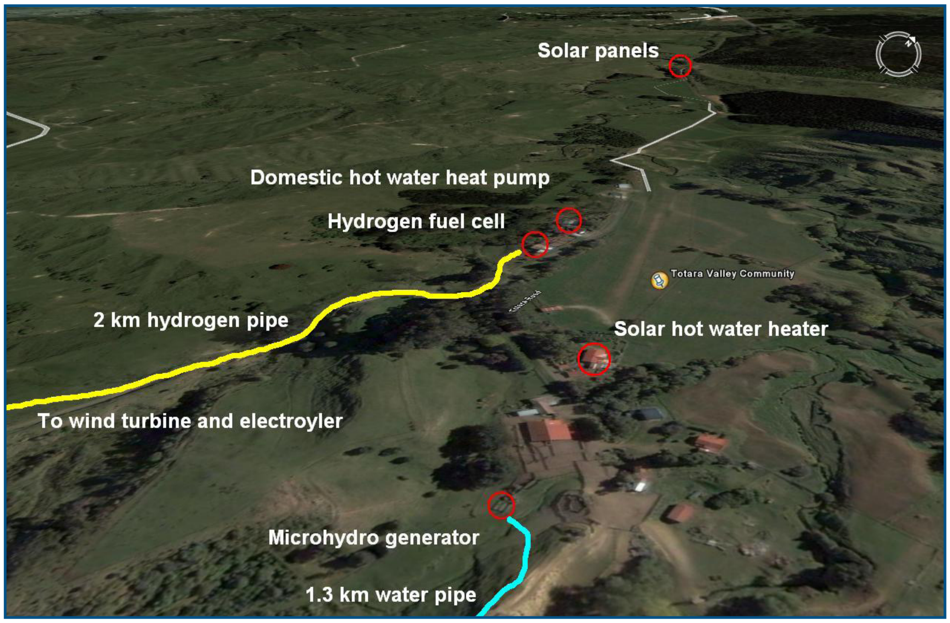
Application

Remote community power

Website

http://www.irl.cri.nz





Geographical layout of the HyLink system including other renewable technologies at the site.

The control systems at each end operate independently. The hilltop controller runs the electrolyser whenever the battery is fully charged and the pipeline pressure is below 4 barg (gauge pressure). The woolshed controller starts the fuel cell when the pipeline pressure reaches a high set point and delivers power to the electrical network (which is "net-billed" by the energy retailer) until the pipeline pressure drops to a lower set point. The fuel cell then goes back into standby mode until the upper threshold is again reached.

Monitoring systems at both the hilltop site and at the woolshed log and report basic system operating parameters, such as wind speed, power flows, battery status, hydrogen production, and pressure, electrolyser temperatures, water level, etc. The data is telemetered from the hilltop via the cellular General Packet Radio Service network and automatically sent to an Internet mailbox.

Accomplishments and Lessons Learned

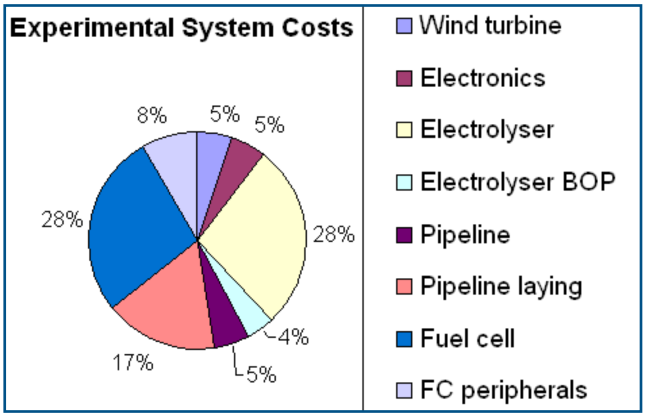
The project successfully demonstrated the feasibility of producing and using hydrogen from wind remotely using existing technology. It is anticipated that as hydrogen conversion technologies mature and become proven, larger community scale hydrogen network systems that take advantage of the economies of scale for wind turbines will be the most cost effective.

The system performed well, although less wind energy was collected than anticipated due to the small size of the 300W wind turbine and the turbulent and gusty wind conditions. At high wind and turbulent sites, wind turbine generators with power-limiting settings should be used under high wind conditions rather than going to power-shutdown mode.

Hydrogen storage within a low pressure pipeline is useful as a low cost, supply-demand power matching buffer that becomes more substantial the further away the wind generator is located. The storage capacity is easily increased by using a larger pipe. At practical power flow rates, pipeline hydrogen diffusion losses are negligible.

Cost analysis of the project showed that the fuel cell and the electrolyser represent significant portions of the cost and are good opportunities for cost reduction (see below). Pipeline laying represented a significant cost to the project, because regulations required the pipeline to be buried. However, this was much lower than the cost of a medium voltage electrical circuit, which in New Zealand in this terrain costs about $30,000/km.

Demonstration system hardware cost breakdown



International Partnership for Hydrogen and Fuel Cells in the Economy

Future Plans

Having successfully developed the concepts, IRL's objective is to reduce the cost of the hydrogen technologies at each end, while maintaining the safety and the inherent reliability. In particular, the electrolyser and gas management have been identified as areas for further development.

IRL is planning to use the HyLink technology demonstrated in this project on Matiu/Somes Island in Wellington Harbour as part of a project to use renewable energy to replace diesel generation, and are also investigating the possibility of using such systems to power remote villages in India.