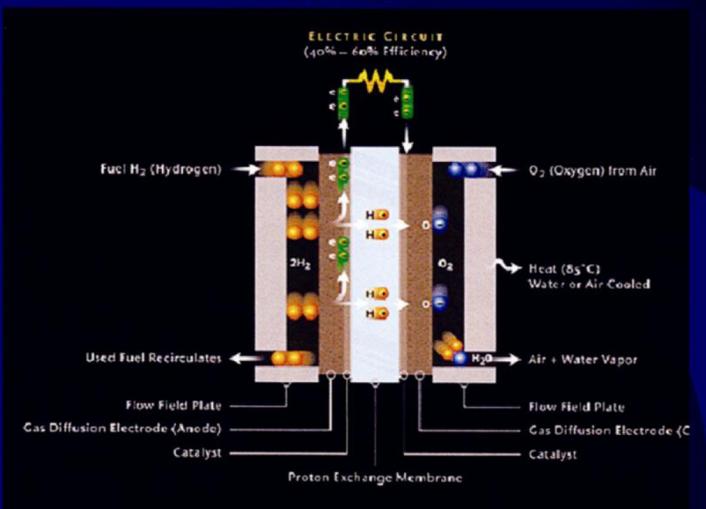


# HYDROGEN FUEL CELL TECHNOLOGY

## Fuel Cell



## John Van Cleef

ISS Institute/TAFE Fellowship

Fellowship funded by OTTE, Victorian Government

# Table of Contents:

<b>TABLE OF CONTENTS:</b> .....	<b>2</b>
<b>INTERNATIONAL SPECIALIST SKILLS INSTITUTE – TAFE FELLOWSHIP</b> .....	<b>3</b>
<b>1 SUMMARY</b> .....	<b>4</b>
<b>2 ACKNOWLEDGEMENTS</b> .....	<b>5</b>
<b>3 INTRODUCTION</b> .....	<b>6</b>
3.1 INTERNATIONAL SPECIALISED SKILLS INSTITUTE INC .....	6
3.2 SPONSORS .....	7
3.3 THE AUSTRALIAN CONTEXT – NATURE AND CURRENT SITUATIONS OF THE INDUSTRY/ OCCUPATION .....	8
3.4 ORGANISATIONS WHICH HAVE AN IMPACT ON INDUSTRY/ OCCUPATION .....	9
3.5 AIM OF THE FELLOWSHIP.....	10
3.6 THE SKILLS/KNOWLEDGE GAPS .....	11
<b>4 THE FELLOWSHIP PROGRAM</b> .....	<b>12</b>
4.1 INTRODUCTION .....	12
<b>KEY CONTACTS</b> .....	<b>13</b>
<b>REPORT</b> .....	<b>15</b>
<b>INTRODUCTION</b> .....	<b>15</b>
<b>THE CANADIAN/CALIFORNIAN EXPERIENCE</b> .....	<b>15</b>
KEY ACTIVITIES UNDERTAKEN BY NRC .....	16
BALLARD POWER SYSTEMS .....	17
THE CALIFORNIAN EXPERIENCE .....	18
LOPEZ CANYON LANDFILL .....	19
CALIFORNIAN FUEL CELL PARTNERSHIP (CAFP) – WEST SACRAMENTO .....	22
OBSERVATION .....	22
OUTCOMES .....	25
<b>CONCLUSION</b> .....	<b>26</b>
HYDROGEN SAFETY.....	26
<b>CODES, STANDARDS AND GUIDELINES</b> .....	<b>27</b>
<b>SAFE DESIGN, OPERATING PRACTICES AND SAFETY SYSTEMS</b> .....	<b>27</b>
<b>RECOMMENDATIONS AND ACTIONS TAKEN (BENEFITING VICTORIA AND AUSTRALIA)</b> .....	<b>28</b>

# **International Specialist Skills Institute – TAFE Fellowship**

**John Van Cleef  
Gordon Institute of TAFE**

# 1 Summary

The adoption of low-emission energy technologies is now essential to reduce greenhouse gas emission across the globe. Global warming and localised effects such as air quality and acid rain are linked to the burning of fossil fuels. The demand for electrical energy (generally obtained from coal, oil or natural gas) will continue to grow and the use of LPG/petrol/diesel as fuel for motor vehicles will further compound the problem.

Most experts believe that the world has 30 – 50 years supply of oil in the ground. Given that it takes time to develop and prove any new technology, many government agencies and private companies are now seeking alternative, more sustainable energy sources.

To overcome some of the above problems, the use of renewable energy resources, such as hydroelectricity, wind power and solar thermal and photovoltaic power generation are now emerging in a small way as a replacement of the traditional fossil fuel as the energy source for the generation of electricity.

A common inherent problem with these technologies is that at night the sun does not shine and sometimes the wind just doesn't blow.

So any base load electrical power supply system that utilises these technologies needs to have backup storage devices such as batteries or hybridised systems, typically with fossil fuel driven generation equipment. Utilising a Hydrogen Fuel Cell (H<sub>2</sub>FC) can eliminate the need for a fossil fuel driven backup system.

More significantly, the adoption of a H<sub>2</sub>FC in the transport system will essentially eliminate tail pipe emissions of greenhouse gases to zero.

At present, Victoria has very little training or development in place for H<sub>2</sub>FC technology, both at the TAFE level and within small and medium businesses.

This Fellowship looks at all aspects of H<sub>2</sub>FC technology in New Zealand, USA and Canada at -Government, Training Organisation and Industry levels.

## **2 Acknowledgements**

The awarding of my International Specialist Skills Institute Fellowship in 2005 to study Hydrogen Fuel Cells in New Zealand, USA and Canada was due to a number of organisations and individuals.

### **Awarding Bodies**

#### **Major Sponsor**

The Office of Employment, Training and Tertiary Education (OTTE) for their financial sponsorship

#### **Sponsor**

Gordon Institute of TAFE management team for endorsing my Application

The ISSI Board of Management for their generous support and guidance

ISSI selection committee for selecting me.

- Ms Marlene Johnson – OTTE
- Ms Carolynne Bourne – ISSI -
- Mr David Wittner – ISSI

#### **Other Individuals/Organisations**

- Mr Rob Gullan – Executive Officer – ITB
- Mr George Adda – Electrical/Electronics – CMM Box Hill TAFE
- Mr Geoff Griffiths – Business Development Officer – ETTA
- Mr Phil Hapgood – Manager – Victorian Greenhouse Strategy – Radiant Energy Systems
- Mr Graeme Hall – Manager – New and Emerging Skills Grant – OTTE
- The Royal Australian Chemical Institute

## 3 Introduction

### 3.1 *International Specialised Skills Institute Inc*

The International Specialised Skills Institute Inc (ISS Institute) fills gaps in industries and enterprises where the means of doing so are not available through government programs or Australian TAFE institutes and universities.

#### **ISS Institute:**

Explores opportunities in 'design' and skills (traditional and leading-edge) and identifies knowledge gaps towards establishing a range of collaborative projects with industry, professional associations, firms education and training institutions and government.

Identifies experts in diverse areas of design, master level trades and professional occupations in established and emerging industry sectors with the intent to effect their services to visit Victoria to conduct a range of education and training activities such as workshops, lectures and exhibitions.

The way in which this is achieved is by building global partnerships through the Fellowship program, then the fellow sharing what he/she has learnt overseas through education and training activities – one fellowship; many benefits.

ISS Institute's operations are directed towards bringing knowledge and leading-edge technologies to Australian industry, business and education/training institutes, rebuilding specialised skills and knowledge which are disappearing or have been lost in order to build the capabilities of industry and business and to maximise opportunities in the global and local marketplace.

The result of their work has been highly effective in the creation of new business enterprises, the development of existing business and the return of lost skills and knowledge to the workforce thus creating jobs. Enormous benefits can be gained from working with ISS Institute through their overseas Fellowship program, education and training activities.

Since 1999 the Victorian government, through OTTE, has financially supported ISS Institute as its major sponsor.

## 3.2 Sponsors

### Office of Employment, Training and Tertiary Education (OTTE) Victoria

The Office of Employment, Training and Tertiary Education (OTTE) is a long time valued sponsor of the ISS Institute fellowship. OTTE is responsible for overseeing the administration and coordination of programs for the provision of training and further education, adult community education and employment services in Victoria.

### Gordon Institute of TAFE

Gordon Institute of TAFE is a leading provider of Education and Training within the Victorian Education system. The Institute was a very generous sponsor of this fellowship, both financially and by allowing me to complete the overseas study tour. Both Management and staff within the Institute were very supportive.

### Industry Providers

There are several Industry organisations that assisted me with this Fellowship program and whilst not necessarily contributing financially, their very generous assistance and support has also made this Fellowship possible.

These organisations assisted with arranging Industry visits and meetings, letters of introduction and support.

Jason Smolensky	Business Development Manager	Heliocentris Energy Systems CANADA
Phil Hapgood	Manager	Radiant Energy Systems GEELONG
Michael Callander	Fuel Cell Technology Manager	Industrial Research Ltd NEW ZEALAND

### **3.3 The Australian Context – Nature and Current Situations of the Industry/ Occupation**

The Australian Government is providing a major boost to renewable energy as a key part of its overall strategy for reducing Australia's greenhouse gas emissions.

In Victoria, the State Government through the 'Victorian Greenhouse Strategy (VGS)' has committed a number of actions, including a reduction of 10% in greenhouse gas emissions from the government's vehicle fleet, support of Victorian businesses to pursue greenhouse best practices and to take advantage of business opportunities in greenhouse gas mitigation. It is also committed to reducing and determining the most appropriate role for the Victorian Government in promoting preferred transport fuels and technologies.

Overseas studies have shown that the Hydrogen Fuel Cell (H<sub>2</sub>FC) is the most likely candidate to replace the Internal Combustion engine. Extensive Bus and motor vehicle trials are in progress to test this new technology in Europe, Japan, China, USA and Australia (Perth).

Attendance at the 'Hydrogen and Fuel Cell Futures conference and Exhibition' held on 12-15 September 2004 in Perth (WA), convinced me that the 'Hydrogen-Age' looks more and more appealing.

Currently, CSIRO and several Universities are actively involved in H<sub>2</sub>FC research but there is little evidence of extensive training and development across TAFE and Industry.

In Victoria, the Industry Training Board (ITB) for Electronics/Electrical and the Curriculum Maintenance Manager (CMM) in Electrical/ Electronics have identified that the lack of H<sub>2</sub>FC training and resources is a serious impediment to the introduction of this new technology.

With significant support from OTTE the Gordon Institute of TAFE has established a Renewable Energy Demonstration Unit (REDU) as part of the Environmental Management Specialist Centre.

The REDU is an integrated system that generates green power from a combination of wind, photovoltaic and Hydrogen Fuel Cells.

This facility will provide extensive training and education on Renewable Energy devices, for both students, electrical contractors and Industry, which is not available in Victoria.

### **3.4 Organisations which have an impact on Industry/ Occupation**

- Office of Training and Tertiary Education
- Gordon Institute of TAFE
- Industry Training Board –
- Registered Contractor authorised to install Renewable Energy equipment (eg voltaic cells, wind turbines)
- Industry reference group on Renewable Energy
- Other TAFE Institutes and Providers involved in Education and Training across Renewable Energy/Sustainability
- Deakin University
- CSIRO
- Ballard Fuel Cell Company (Canada)
- Australian Greenhouse Offices
- Victorian Department of Sustainability and Environment
- California Fuel Cell Partnership
- Royal Australian Chemical Institute
- Ford Motor Company - Geelong

### **3.5 *Aim of the Fellowship***

The major aim of the Fellowship was to undertake an overseas study program to gain a comprehensive understanding in the field of Renewable Energy specifically related to Hydrogen Fuel Cell Technology.

Countries chosen with a track record on H<sub>2</sub>FC training and education were New Zealand, USA and Canada.

### **3.6 The Skills/Knowledge Gaps**

The skills/knowledge gaps identified in relation to Hydrogen Fuel Cells included

- The need to gain a comprehensive understanding in the field of Renewable Energy specifically related to Hydrogen Fuel Cell Technology.

Areas of investigation to include:

- (a) Hydrogen production, separation and storage
  - Fuel Cell Technology
  - Optimising Fuel Cell performance
  - Installation, Maintenance and Repair
  - Safety, Codes and Standards
- (b) Fuel Cell Education Programs

## **4 The Fellowship Program**

### **4.1 Introduction**

The purpose of this Fellowship program was to visit Key organisations connected with Hydrogen Fuel Cell technology and Training providers involved in H<sub>2</sub>FC courses.

Contacts were sourced from the

- Internet
- Hydrogen Fuel Cell Conference (Perth – September 2004)
- Direct contact with the Ballard Fuel Cell Company in Canada
- E-mail communications with Institutes in the USA involved in H<sub>2</sub>FC programs.
- OTTE - Office of Training and Tertiary Education
- EPA - Environmental Protection Agency
- AGO - Australian Greenhouse Office

## Key Contacts

- A) Mr Cal Macy  
Project Director - Advanced Transportation Centre  
Long Beach City College  
1305E Pacific Coast Highway  
Long Beach CA 90806
- Telephone : 526/938 3067  
Facsimile: 526/938 3161
- E-mail: [cmacy@lbcc.eu](mailto:cmacy@lbcc.eu)
- B) Visitor Program Coordinator  
California Fuel Cell Partnership (CaFcp)  
Suite 1000, 3300 Industrial Boulevard  
West Sacramento CA 95691
- Telephone: 916/371 2870  
Facsimile: 916/375 2008
- E-mail: [info@cafcp.org](mailto:info@cafcp.org)
- C) Professor Jan Dekker  
Reedley College  
995 N. Reed Road  
Reedley CA 93654
- Telephone: 559/638 3641
- E-Mail: [jan.dekker@scccd.cc.ca.us](mailto:jan.dekker@scccd.cc.ca.us)
- D) Mr Jason Smolensky  
Business Development Manager - Heliocentris Energy Systems  
3250 East Mall  
Vancouver BC V6T 1W5
- Telephone: 604 - 827 - 5066  
Facsimile: 604 - 827 - 5069
- E-mail: [j.smolensky@heliocentris.com](mailto:j.smolensky@heliocentris.com)
- E) Mr Michael Callander  
Fuel Cell Technology Manager - Industries Research Limited (IRL)  
PO Box 31-310 Lower Hutt  
New Zealand
- Telephone: +64 - 4 - 931 - 3000  
Facsimile: +64 - 4 - 931 - 3142
- E-mail: [m.callander@irl.cri.nz](mailto:m.callander@irl.cri.nz)

# Study Tour

-

## Overseas Trends in Renewable Energy (Training and Education)

8 May 2005 – 10 June 2005



Prepared by John Van Cleef

4 July 2005

# REPORT

## Overseas Study Tour on Renewable Energy with an emphasis on Hydrogen Fuel Cells

**Countries visited: Vancouver (Canada), California (USA)  
and New Zealand**

**John Van Cleef**

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### **Introduction**

The purpose of this report is to summarise current and future developments in Renewable Energy (namely Hydrogen Fuel Cell technologies) in Canada, USA and NZ. The motivation of this study tour is based on the fact that climatic change is now linked to the enhanced greenhouse effect and its serious environmental, social and economic threat to the world community.

In addition, the long-term vision accepted by many governments around the world is that we need to transition to a low carbon economy, involving significant reduction in global greenhouse gas emissions by the middle of this century.

Renewable sources of energy such as, wind, solar, (photovoltaic cells), hydropower, geothermal and even wave power are technologies available today and are increasingly being used to produce ‘green’ electricity.

In addition Hydrogen Fuel Cell devices are now available as a stationary source of electrical power and also as a “possible” replacement of the internal combustion engine in the automotive industry.

### **The Canadian/Californian Experience**

“Fuel Cell Canada” is a national non-profit industry association whose mission is to accelerate Canada’s world leading hydrogen and fuel cell industry.

It is the collective voice for the industry and works to raise awareness of the environmental, economic and social benefits of hydrogen and fuel cell technologies. It is the prime source of services and support to Canadian corporations, governments and educational institutions promoting, developing, demonstrating and deploying fuel cells and hydrogen products and services in Canada.

Fuel Cell Canada is located at the National Research Council’s Institute for Fuel Cell and Innovation in Vancouver.



*National Research Council Canada*

The NRC Institute has nine hydrogen-ready laboratories and a hydrogen-ready environmental chamber controlled for temperature, humidity and climate. These facilities provide the infrastructure to industry and educational bodies for testing, training and fabrication expertise to assist in the manufacturers of fuel cell components.

A major focus of the NRC is related to the production, storage and safe handling of hydrogen gas at high pressure.

***Key activities undertaken by NRC***

- a) Training programs on H<sub>2</sub>FC.
- b) Production of H<sub>2</sub> using a Hydrogen Electrolyser and different compression plants for storage of hydrogen gas at different pressures (5000 psig and 10,000 psig)
- c) Safety practices and storage of hydrogen.
- d) Opportunity to drive a Ford Focus Fuel Cell vehicle on a public road near the Uni of BC.

Website at: <http://ifci-iipc.nrc.cnre.gc.ca>

Email: [j.smolenski@heliocentris.com](mailto:j.smolenski@heliocentris.com)

## ***Ballard Power Systems***

*Burnaby – British Columbia, Canada*

Ballard is a major developer and manufacturer of proton exchange membranes (PEM), fuel cells for automotive, stationary and portable applications.

It is currently an industry leader in developing and manufacturing fuel cell engines and fuel cell systems and carbon fibre products to ten of the top fifteen automakers.

Its strategic partners/investors are Daimler Chrysler AG and Ford Motor Company.

The Gordon Institute purchased a Ballard Nexa 1.2KW fuel cell power unit in April 2005 and both Kevin and I attended a 1 day training session on this unit on 13 May 2005 at the Ballard Manufacturing facility.

The training program was intensive and the company provided adequate course notes and manuals to support the Gordon to install and commission the 1.2 KW power unit.

Also in attendance was Mr. Lee Richardson – Coordinator of the Fuel Cell - Power Engineering Program from the Northern Alberta Institute of Technology (NAIT) Canada.

This Institute purchased a heavily subsidised 200KW Phosphoric Acid Fuel Cell from the USA as part of an educational program to provide an opportunity for the public to learn more about fuel cells. This project is partnered with the US Department of Energy, Alto Gas, Alberta Energy Research Institute and Climate Change Control (refer to brochure).

In addition, NAIT also acquired the Nexa – H<sub>2</sub>FC for training and education programs. It is interesting to observe that OTTE (VIC) and the Gordon Institute in particular are at the forefront of this new technology for education and training.

Website at: <http://www.ballard.com>



*Ballard Power Systems - Canada*

## ***The Californian Experience***

Mr Cal Macy is Program Director for Advanced Transportation Technology Centre – Long Beach, City College (LBCC).

This training facility focused heavily on technician training on alternative fuels namely gaseous fuels such as CNC, LNG, LPC and Hydrogen.

LBCC also acquired the Nexa 1.2KW H2FC for future training, but admitted that existing demand for this training has not yet materialised (due to the fact that wide spread application of H2FC technology is still limited at this point in time to privately funded organisations. However, OEM's (original equipment manufacturers) are adopting and adapting fuel cells for both stationary and mobile applications eg: motorbikes etc), and future demand for fuel cells will increase.

Cal Macy provided us with significant teaching resources on fuel cells and several valuable contacts at the higher education level.

Local councils (Longbeach) have adopted alternative fuels for their car fleet and officials drive so called "green cars" powered by LPG (cleaner than petrol) as part of their "clean city" program.



*Longbeach City College*

## ***Lopez Canyon Landfill***

Methane gas production from decaying landfill refuse is an example of energy derived from a Biomass system. This source of fuel is used to generate electricity using micro turbine generators. This facility produces 1.5 megawatt of electricity.



*Lopez Canyon Micro-turbo Generators*

## ***Lawrence Livermore National Laboratory, (LLNL) California***

We were fortunate to visit this facility at a time when it was celebrating the world “Year of Physics” 2005 - Albert Einstein Miraculous Year.

Although LLNL’s scope of research is broad and overwhelming, it is also involved in developing alternative energy technologies for transportation, including hydrogen fuel. The on-board storage of hydrogen fuel in vehicles is under intensive research by LLNL and their current research on a flexibly fuelled storage system brings hydrogen powered cars closer to reality.

(Ref – Science and Technology Review. June 2005 edition, pages 24 – 26).



*Lawrence Livermore National Laboratory*

**ANUVU Incorporated**

A small independent manufacturer of Hydrogen Fuel Cells and associated electronic systems is located in the Industrial Park – Sacramento. The company is managed by a team of young engineers and technologists trying to enter the market with their own H2FC products.

Website at: <http://www.anuvu.com>

Email: [info@anuvu.com](mailto:info@anuvu.com)



*H2 Fuel Cell Stack*

## ***Reedley College – California***

Professor Jan Dekker visited the Gordon Institute (Applied Science Dept) on sabbatical leave during 2003. Our hospitality was returned by Jan during our visit in May 2005.

The Community College is located on expansive grounds with different departments strategically located around the campus. However, very little renewable energy programs were delivered and introductory programs on H2FC were non-existent.

The Chemistry dept of Reedley College has established excellent transfer rates (articulation) with several Universities such as the California State University (Fresno).

We were given the opportunity to visit the University and met two graduates of Reedley College who were undertaking their MSc/PhD in the University's Pollution Research Centre.

Website at: <http://www.reedleycollege.com>



*Reedley College*

## **Californian Fuel Cell Partnership (CaFP) – West Sacramento**

Since 1999, the CaFP has conducted numerous public open days and community workshops to demonstrate the potential for fuel cell powered vehicles as a safe, practical clean and efficient alternative to vehicles powered by internal combustion engines.

We were invited to participate in their public open day and experienced and learnt from a wide range of activities.

- A ride in several fuel cell vehicles (VW, Ford, Hyundai and Toyota).
- Viewed a typical Hydrogen refuelling station.
- Spoke to a number of enterprising individuals who were interested in present and future business opportunities associated with H2FC applications.
- Noted that there are 43 fuel cell cars and buses on the road in California right now.
- Significant investment by major automakers, US Dept of Energy, Transport US, EPA, Exxon-Mobil, Shell Hydrogen Transit Agencies (Bus lines) plus many others.
- CaFP is involved in the distribution of Fuel Cell teacher-learning kits to high schools.

In working in this field so far CaFP has managed:

- The establishment up to 40-50 Hydrogen refuelling stations planned along Californian highways and completed the Emergency Response Guide for light duty fuel cell vehicles.
- Significant Public Outreach program have brought more than 700,000 people face to face with fuel cell vehicles over the past 4 years.
- Demystified the technology and is involved with the appropriate authorities in reclassifying Hydrogen as fuel. (currently rated as an industrial gas)

## **Observation**

The commitment to commercialise and introduce H2FC as a replacement of the internal combustion engine was evident from discussions with key industry and State government (California) officials.

Website at: <http://www.cafcp.org>

Email: [info@cafcp.org](mailto:info@cafcp.org)

University of California, Davis. (specific research programs on Transportation and the Hydrogen Economy – Pathways and Strategies).



*California Fuel Cell Partnership*



*Hydrogen Fuel Cell Vehicle*

## The New Zealand Experience

Michael Callander is Fuel Cell Technology Manager – Electronics at the Industrial Research Ltd – Wellington.

NZ Future Hydrogen energy is linked to:

- Coal gasification to produce Hydrogen gas.
- Determine the performance/reliability of Alkaline Fuel Cells.
- Underground storage of CO<sub>2</sub> (cost \$130 per ton to sequester CO<sub>2</sub>)
- Research on electrolysis of water by renewable resources (solar and wind)
- Storage of Hydrogen fuel for electricity generation for use at small sites close to demand. Metal Hydride studies undertaken by NZ.
- NZ current power generation is under pressure (particularly hydro-power and thermal plants) and new energy sources are required to meet demand.
- Wind Turbines are planned for the North Island.
- NZ is a signed up member of the International Partnership for the Hydrogen Economy Group (IPHEG) – as is Australia.
- Research is underway to utilise waste products from dairy farms (eg fermentation of whey to produce ethanol which in turn can be used as a fuel (reformer) for fuel cells). A typical dairy farm's power consumption is around 1 megawatt of electrical energy per annum.



*Industrial Research Limited*

Ben McQueen is Fuel Cell Systems Engineer and Alistair Gardener (Research Manager) – Electro technology at the Industrial Research LTD (IRL) located in Christchurch.

This facility is involved in R and D on small scale applications of Alkaline Fuel Cell in the field. The cell was purchased from Europe. It is also responsible for the installation and maintenance of a large Polymer Membrane Cell (PEM) to support the US Antarctic Centre.

Additional research is undertaken to test several 2KW PEM cells for use in homes and in traffic/road lights.

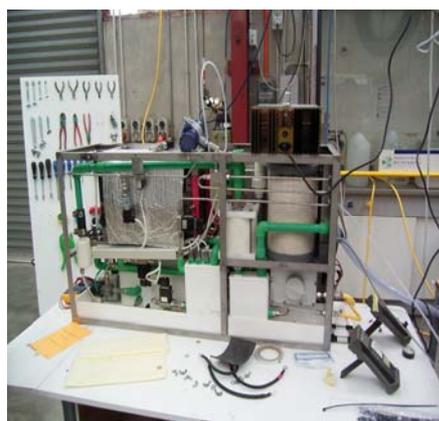
Solid oxide fuel cells (SOFC) are also in use in NZ.

## Outcomes

- IRL is keen to form a linkage with the Gordon Institute of TAFE (OTTE)
- Joint promotion of H2FC and information sharing.
- Participate in the development of Renewable Energy Training programs.

It became apparent that whilst “Renewable Energy” (RE) and the application of “sustainability” is viewed as important in NZ, California and Canada (Vancouver) by industry, government and the community, the potential integration of various RE devices to harness renewable energy was not seriously considered.

Individual RE devices such as Photovoltaic Panels and Wind Turbines were common, whilst H2FC remained in the background - due mainly to the cost of H2FC and safety concerns related to the use of Hydrogen Gas. However, the Gordon Institute’s Renewable Energy Demonstration Unit was viewed as highly innovative and useful as a training model for industry and the community.



*Alkaline Fuel Cell*



*H2 Fuel Cell Demo Project*

On 8/9 June several hydro electric and thermal electric power plants in the South Island were visited between Queenstown and Christchurch. Both power plants utilise renewable energy (non-carbon based) which can be used to provide clean energy for the electrolysis of water to produce Hydrogen and Oxygen gases. The Hydrogen gas is compressed and utilised as the fuel for the H2FC.

## Conclusion

Renewable Energy/Fuel Cell Outcomes:

- a) The integration of alternative electrical supply technologies (namely wind, solar and H<sub>2</sub>FC) was not considered as a training model by Canada, USA and NZ.
- b) Fuel cell technology and its applications are beginning to reach the market. Applications with power demands below 1KW constitute a potential market for fuel cells. Examples include electronics, sensors for remote locations and a large number of recreational appliances. Promotion and delivery of H<sub>2</sub>FC training programs is essential to implement the introduction of Fuel Cells in industry and the community.

### **Hydrogen Safety**

All fuels burn and pose fire and explosive risks if their combustion is not controlled, so safety is always a issue with fuels. Most people are familiar with hydrocarbon fuels such as petrol, propane and natural gas. Tens of millions of people pump petrol into their cars everyday. It is common place for natural gas or propane to be pumped into homes for use in appliances such as heaters, stoves etc.

The risk associated with the use of these fuels is accepted because systems that use them achieve sufficient levels of safety.

Hydrogen as a fuel is a new idea to most people. However, hydrogen systems can be and are being designed so they are safe.

The introduction of hydrogen gas in stationary fuel cells applications or in motor vehicles is well understood and years of experience by NASA have led to systems in place that can handle and deliver hydrogen gas safely.



*Hydrogen Storage Cage*



*Hydrogen Refuelling Station*

## **Codes, Standards and Guidelines**

Available on request.

## **Safe Design, Operating Practices and Safety Systems**

Available on request.

## **Recommendations and Actions Taken (benefiting Victoria and Australia)**

1. John Van Cleef, via the Gordon Institute of TAFE, to provide to the 'New and Emerging Skills Unit' at OTTE a draft report on the overseas study tour on Hydrogen Fuel Cells. This was part of the funding agreement connected with the 'Innovation Project' which the Gordon Institute of TAFE was committed to.

**Action: completed December 2005**

2. Develop a set of competency standards for TAFE (Victoria) on the 'Introduction to Hydrogen Fuel Cells'. This unit will be placed on the national register for the benefit of Institutes across Australia.

**Action: in progress, completion due June 2006**

3. Meet with the Australian Business Council for Sustainable Energy/Renewable Energy teachers (Victoria) to integrate Hydrogen Fuel Cells into existing training programs.

**Action: in progress, meeting with Council held 22/02/06**

4. Promote Hydrogen Fuel Cells and the study tour in the press (namely Geelong Advertiser and other daily papers). Refer to copy of article, page 30.

**Action: completed September 2005**

5. Participate and promote Hydrogen Fuel Cells and Renewable Energy devices at regional seminars and expos.

John Van Cleef to attend the Surfcoast Living Green Expo and conduct a PowerPoint presentation on Hydrogen Fuel Cells.

**Action: completed 23 October 2006 (to an audience in excess of 40 people)**

6. Promote and operate a Hydrogen Fuel Cell to selected target audiences.

John Van Cleef and Kevin Leach (Gordon Institute of TAFE staff) to conduct a 'live' presentation on the operation of a Hydrogen Fuel Cell for the general public (Open Day) and industry representatives involved in Renewable Energy Technologies. Further demonstrations planned throughout remainder of 2006, and beyond.

**Action: completed 21 August (Open Day) and 23 October 2006**

7. John Van Cleef to promote 'Hydrogen Fuel Cells' and the 'Hydrogen Economy' to key stake holders, such as the City of Greater Geelong, State Government departments and Industry.

John Van Cleef to meet with key City officers to discuss and promote Hydrogen Fuel Cells and Renewable Energy at the G21 Government Environmental Pillar meeting (City of Greater Geelong). Further discussions are planned with City mayor, Cr. P McMullin, later in 2006.

**Action: meeting with G21 Pillar group completed 21 August 2005.**

8. Complement other Renewable Energy Centres across TAFE Victoria individually.

John Van Cleef to attend VISTA conference to promote Hydrogen Fuel Cells with Victorian TAFE colleagues.

**Action: completed 23 February 2006**

9. Promote Renewable Energy (emphasis on Hydrogen Fuel Cells) nationally and internationally.

The Gordon Institute of TAFE is establishing a dedicated Renewable Energy Demonstration Unit. This facility will integrate wind, solar and Hydrogen Fuel Cell devices as a model to demonstrate various options for the generation of 'green energy'. This facility will be promoted nationally and internationally.

**Action: in progress, completion due November/December 2006**

10. Promote Hydrogen Fuel Cells within motor vehicle organisations and industry. Meet with bodies such as the VACC (Victorian Automobile Chamber of Commerce) and raise the profile of Hydrogen Fuel Cell education and training within the motoring community.

John Van Cleef to:

- contact Mr M Liston, Marketing Manager at VACC
- meet with major car manufacturers
- discuss production, storage and safe handling of Hydrogen with Shell, Work Safe Victoria and BOC.

**Action: in progress**

# Fuel cell could fix the fuel cost

PETER BEGG

THE Gordon Institute has brought the first hydrogen powered fuel cell to Geelong as the school positions itself at the forefront of the green energy push.

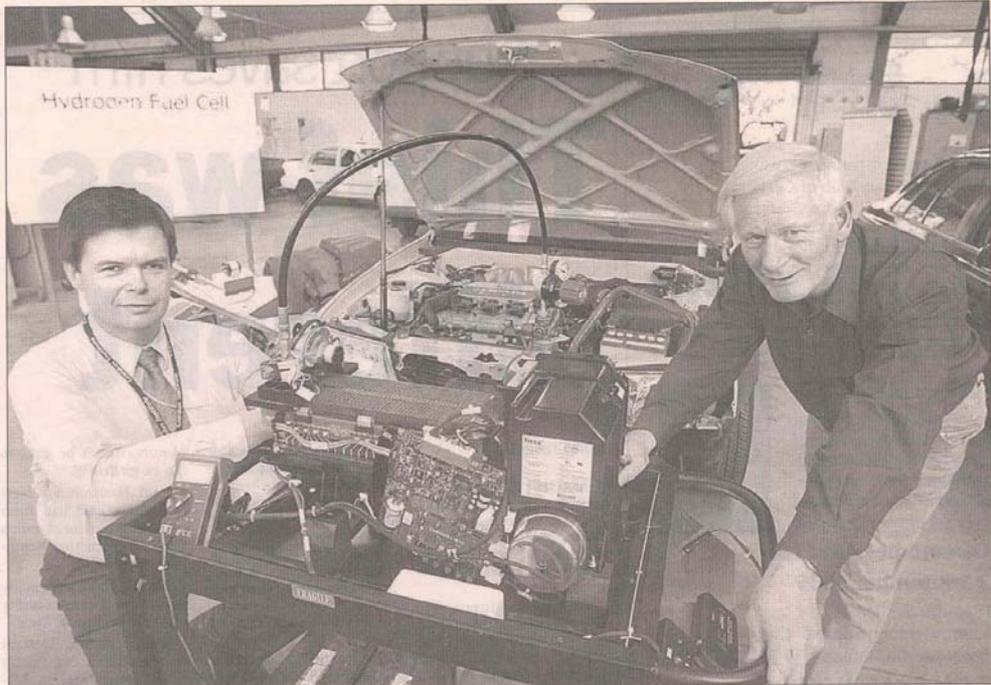
The Gordon Institute has bought a \$15,000 Ballard hydrogen fuel cell unit which runs on hydrogen. Its only emission is water in the form of steam.

The fuel cell will be on permanent display at the Gordon's East Geelong campus to provide demonstrations of its uses.

Two Gordon staff members, John Van Cleef and Kevin Leach, recently returned from a study tour of Canada, the US and New Zealand to look at renewable energy, with an emphasis on hydrogen fuel cells.

Mr Van Cleef said yesterday that if people don't want to be paying \$5 a litre for their fuel in coming years, they will soon take an interest in renewable energy.

He said people have to realise that there must be a shift from a high carbon



CELL OUT: Kevin Leach and John Van Cleef from the Gordon TAFE's East Geelong campus with the Ballard hydrogen fuel cell unit. Photo: DANIEL LAST

economy to a low carbon economy.

"Human behaviour is contributing to some extent to climate change and we believe that looking at different forms of energy is one way to reduce carbon energy," he said.

"We are now going to establish a Renewable Energy Demonstration Unit which will integrate wind

power and also solar voltaic panels and hydrogen fuel as devices to produce green energy."

Mr Van Cleef said the Canadians had developed the Ballard fuel cell, while in California transit authorities were trialing hydrogen powered buses.

He said there were already three fuel cell

buses operating in Perth on a trial basis.

The recent study tour was funded by the Gordon and the State Government, which he said was showing some leadership in the area of green energy.

Mr Leach, who accompanied Mr Van Cleef on the study trip, is currently working on an elec-

tric powered motorcycle at the Gordon's automotive workshop.

The motorcycle's electric motor will run on 48 volts and produce 20 horsepower, but its real advantage will be in its torque.

Combustion engines produce their maximum torque at high revs while electric motors have their

highest torque at no revs, Mr Leach said.

He said once the motorbike was complete he would look at building an electric car.

The Gordon's marketing manager Colin Frisch said yesterday the school would be buying two Toyota Prius hybrid cars next year to further push the green energy message around Geelong.

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