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SKILLS DEFICIENCIES IN THE AUSTRALIAN PLUMBING INDUSTRY

Green Plumbing Practices and Grey Water Recycling

Tony Darcy
Skills Victoria/ISS Institute TAFE Fellowship

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Department of Innovation,
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International Specialised Skills Institute

ISS Institute
Level 1
189 Faraday Street
Carlton Vic
AUSTRALIA 3053

T 03 9347 4583
F 03 9348 1474
E info@issinstitute.org.au
W www.issinstitute.org.au

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Executive Summary

The purpose of this Fellowship was to investigate the use of renewable energy heating systems and grey water recycling technology in the United Kingdom (UK) and Ireland, where long and cold winters, expensive natural resources and a heightened awareness of water consumption have driven rapid advancements in ‘green’ plumbing practices.

In Australia, large corporations, small industries, building practitioners and domestic dwellings are under increasing pressure to reduce their consumption of natural resources and carbon emissions. The country’s natural energy resources are being depleted at a greater rate than they are being regenerated. An increasing number of Australians are becoming conscious of this and are trying to use less energy and less resources. However, the population of Australia generally has a low awareness of the alternatives.

One way of reducing natural resource consumption is to install new technology into buildings and homes. Examples of this technology are geothermal heating systems, biomass boiler heating systems and grey water recycling. As this technology is still in its infancy in Australia, there are a limited number of tradespeople who are sufficiently skilled to provide advice and services.

There is, therefore, a need to increase and improve education in the use of renewable energy, and to develop training programs that incorporate sustainable trade practices. Vocational training institutions that provide the training in areas such as plumbing and fitting and turning are well positioned to deliver this type of training.

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Abbreviations/Acronyms

ALGA	Australian Local Government Association
AMCA	Air Conditioning and Mechanical Contractors' Association of Australia
BICCIAB	Building Industry Consultative Council Industry Advisory Board
GSHP	Ground Surface Heat Pump
CEPU	Communications Electrical Plumbing Union
COAG	Council of Australian Governments
kW	Kilowatt
MPMSAA	Master Plumbers' and Mechanical Services Association of Australia
Poly pipe	Polyethylene pipe
PTEU	Plumbing Trades Employees Union
PTMG	Plumbing Training Moderation Group of Victoria
RTO	Registered Training Organisation

Definitions

Auger

A spiral-shaped device for moving material or liquid.

Air Conditioning and Mechanical Contractors' Association of Australia

AMCA is and organisation representing air-conditioning and mechanical services employers.

Building Industry Consultative Council Industry Advisory Board

BICCIAB provides advice on vocational education and training issues to Victoria's building industry.

Biofuel

Fuels derived from biological sources such as wood and waste.

Biomass heating

A method that combusts plant- and animal-based organic materials to produce heat.

Communications Electrical Plumbing Union

CEPU is an Australian union that covers workers in electrical, communications and plumbing industries.

Council of Australian Governments

COAG is an intergovernmental forum that comprises the Prime Minister, State Premiers, Territory Chief Ministers and the President of the Australian Local Government Association (ALGA).

Coupled

Joined/attached

Design

Design is problem setting and problem solving. Design is a fundamental economic and business tool. It is embedded in every aspect of commerce and industry and adds high value to any service or product—in business, government, education and training, and the community in general.[1]

Energy Safe Victoria

A Statutory authority that regulates safety in electricity and gas in Victoria.

Flashback

Spontaneous combustion.

Flow and return manifolds

A junction of pipes or channels.

Fossil fuels

Fossil fuels are natural resources such as coal, oil and natural gas that contain hydrocarbons; these fuels produce carbon dioxide when burnt.

[1] 'Sustainable Policies for a Dynamic Future', Carolynne Bourne AM, ISS Institute 2007.

Geothermal heating

A method that uses warmth stored in the earth to produce heat.

Grey water

The wastewater generated from activities such as laundry, dishwashing, and bathing (excludes water containing human excrement).

Innovation

Creating and meeting new needs with new technical and design styles. (New realities of lifestyle).[2]

Master Plumbers' and Mechanical Services Association of Australia

MPMSAA is an organisation representing and providing services to registered employers in the Australian plumbing industry.

Plumbing Industry Commission (Victoria)

This is an authority of the Victorian Government that administers the licensing and registration system for plumbers and enforces plumbing standards in Victoria.

Plumbing Trades Employees Union

The PTEU is an Australian union for plumbers that is a division of the CEPU.

Plumbing Training Moderation Group of Victoria

PTMG is a training support network for plumbing teachers in Victoria.

Polyethylene pipe

Poly pipe is a flexible plastic material used to make irrigation pipe and other items.

Potable water

Water suitable for drinking.

Registered Training Organisation

An RTO is an organisation that provides students with nationally accredited vocational education and training.

Renewable

This term describes the organic properties of the energy source material.

Skill deficiency

A skill deficiency is where a demand for labour has not been recognised and training is unavailable in Australian education institutions. This arises where skills are acquired on-the-job, gleaned from published material or from working and/or studying overseas.[3]

There may be individuals or individual firms that have these capabilities. However, individuals in the main do not share their capabilities, but rather keep the intellectual property to themselves. Over time these individuals retire and pass away. Firms likewise come and go.

[2] 'Sustainable Policies for a Dynamic Future', Carolynne Bourne AM, ISS Institute 2007.

[3] 'Directory of Opportunities. Specialised Courses with Italy. Part 1: Veneto Region', ISS Institute, 1991.

Sustainable

This term describes how the original resource (used to supply the material) is utilised.

Sustainability

Sustainability when referring to the consumption of a resource is dependent on initial quality of the resource, its rate of generation and its rate of consumption.

Acknowledgements

Tony Darcy would like to thank the following individuals and organisations who gave generously of their time and their expertise to assist, advise and guide him throughout the Fellowship program.

Awarding Body – International Specialised Skills Institute (ISS Institute)

The International Specialised Skills Institute Inc is an independent, national organisation that for over two decades has worked with Australian governments, industry and education institutions to enable individuals to gain enhanced skills and experience in traditional trades, professions and leading-edge technologies.

At the heart of the ISS Institute are our Fellows. Under the **Overseas Applied Research Fellowship Program** the Fellows travel overseas. Upon their return, they are required to pass on what they have learnt by:

1. Preparing a detailed report for distribution to government departments, industry and educational institutions.
2. Recommending improvements to accredited educational courses.
3. Delivering training activities including workshops, conferences and forums.

Over 180 Australians have received Fellowships, across many industry sectors. In addition, recognised experts from overseas conduct training activities and events. To date, 22 leaders in their field have shared their expertise in Australia.

According to Skills Australia's 'Australian Workforce Futures: A National Workforce Development Strategy 2010':

> Australia requires a highly skilled population to maintain and improve our economic position in the face of increasing global competition, and to have the skills to adapt to the introduction of new technology and rapid change.
>
> International and Australian research indicates we need a deeper level of skills than currently exists in the Australian labour market to lift productivity. We need a workforce in which more people have skills, but also multiple and higher level skills and qualifications. Deepening skills across all occupations is crucial to achieving long-term productivity growth. It also reflects the recent trend for jobs to become more complex and the consequent increased demand for higher level skills. This trend is projected to continue regardless of whether we experience strong or weak economic growth in the future. Future environmental challenges will also create demand for more sustainability related skills across a range of industries and occupations.[4]

In this context, the ISS Institute works with Fellows, industry and government to identify specific skills in Australia that require enhancing, where accredited courses are not available through Australian higher education institutions or other Registered Training Organisations. The Fellows' overseas experience sees them broadening and deepening their own professional practice, which they then share with their peers, industry and government upon their return. This is the focus of the ISS Institute's work.

For further information on our Fellows and our work see www.issinstitute.org.au.

[4] Skills Australia's 'Australian Workforce Futures: A National Workforce Development Strategy 2010', pp. 1-2 http://www.skillsaustralia.gov.au/PDFs_RTFs/WWF_strategy.pdf

Fellowship Sponsor

The Victorian Government, Skills Victoria is responsible for the administration and coordination of programs for the provision of training and further education, adult community education and employment services in Victoria and is a valued sponsor of the ISS Institute. Darcy would like to thank them for providing funding support for this Fellowship.

Supporters

The Fellow would like to thanks the CEO and team at the ISS Institute for their support and assistance for the duration of the Fellowship.

Those Involved in the development of the overseas program:

- Carolynne Bourne AM, Former Chief Executive Officer, ISS Institute
- Building Industry Consultative Council Industry Advisory Board (BICCIAB)
- John Cook, Manager-Building Industries, South West Institute of TAFE
- Dr Timothy Hubbard, Director, Heritage Matters Pty Ltd
- Lyle Kelson, Chairman, Plumbing Training Moderation Group of Victoria
- Master Plumbers' and Mechanical Services Association of Australia (MPMSAA)
- Rachel Matthews, Staff Development Officer, South West Institute of TAFE
- Peter Mentha, Plumbing Team Leader, South West Institute of TAFE
- Karen O'Rilley, (Welding and Engineering Teacher), Swinburne Institute of TAFE
- Joe Piper, Chief Executive Officer, South West Institute of TAFE
- Plumbing Industry Commission (Victoria)
- Plumbing Training Moderation Group of Victoria
- Royal Automobile Club of Victoria
- Skills Victoria, Victorian Government
- South West Institute of TAFE
- Paul Sumner, Former Skills Victoria Fellowship Co-ordinator, ISS Institute

Those Involved in the Fellowship submission:

- Gary Bath, Practitioner Manager, Plumbing Industry Commission (Victoria)
- Rachel Matthews, Staff Development Officer, South West Institute of TAFE
- John McNally, Chief Executive Officer, BICCIAB
- Joe Piper, Chief Executive Officer, South West Institute of TAFE
- David Scannell, Curriculum Maintenance Manager, Skills Victoria
- Gary Workman, National Industry Development Manager, Master Plumbers' and Mechanical Services Association of Australia

Employer Support

The Fellow's employer, South West Institute of TAFE, has provided continuous support and encouragement throughout the Fellowship program. South West Institute of TAFE has provided in-kind contributions by assisting with travel arrangements and accommodating time spent on completing the program. The Fellow wishes to give special thanks to the Plumbing Department, Human Resources, and Executive for their invaluable advice and assistance.

Organisations Impacted by the Findings of the Fellowship

Government

- Department of Sustainability and Environment
- Energy Safe Victoria
- Environment Protection Authority (Victoria)
- Hospitals and aged care facilities
- Plumbing regulatory groups
- Sustainability Victoria

Industry

- Australian Institute of Architects
- Australian hospitals and aged care facilities
- Building construction industry
- Code of practice organisations e.g. Australian Building Codes Board
- Design Institute of Australia
- Industry Skills Councils
- Plumbing Industry Commission (Victoria)
- Utilities and infrastructure for water, gas, wastewater and sewerage

Professional Associations

- Air Conditioning and Mechanical Contractors' Association of Australia (AMCA)
- Building unions
- Construction, Forestry, Mining and Energy Union
- Master Builders Australia Limited
- Master Plumbers' and Mechanical Services Association of Australia
- Plumbing Trades Employees Union

Education and Training

- Australian industry trade colleges
- Australian Vocational Education and Training (VET) system
- National Information Training Service
- Registered Training Organisations (RTOs)
- Resource Generator
- Skills Victoria
- Technical and Further Education (TAFE) institutes

Community

The running costs to operate the average household are rising, especially for homes in rural and regional areas (i.e. outside the main cities) and those not connected to the main gas grid. In response to this, residents are now considering alternatives to the way they heat their homes and hot water. People also require access to clean and potable water and sanitary solutions. Efficient and effective water recycling systems will help address current water shortage issues.

Acknowledgements

Other

Manufacturing and construction organisations require plumbing industry consultation and input so they can operate effectively and efficiently using correct and safe practices to protect water and gas supplies, improve wastewater management and reduce energy consumption costs.

The industry also needs skilled workers to implement and install alternative technologies, and, thereby, give consumers some alternatives for heating and wastewater management.

About the Fellow

Name: Tony Darcy

Employment

- Plumbing Teacher and Training Coordinator, South West Institute of TAFE, Warrnambool

Qualifications

- Restricted Electrical Workers Licence (previously known as Disconnect/Reconnect Worker's Licence), Energy Safe Victoria Plumbing Licence/Registration, Plumbing Industry Commission (Victoria):
  - Main classes: drainage, gas fitting, irrigation, mechanical services, roofing, sanitary, water supply.
  - Restricted classes: fire hydrants and hose reels, Type A gas, gas mobile homes, solid fuel heating, duct fixing, refrigerant air conditioning, refrigeration split systems.
  - Specialised classes: gas servicing Type A, Type A gas conversion, refrigerant air conditioning, backflow prevention testingand repairs.
- Certificate II in Split Systems Air Conditioning, Bendigo Regional Institute of TAFE, 2008
- Certificate IV in Workplace Training and Assessment, South West Institute of TAFE, 2008
- Backflow Prevention Tester and Repair Certificate, Holmesglen Institute of TAFE, 1996
- Certificate of Competency as a Plumber and Gasfitter, Sanitary Plumbers Examination Board of Victoria, 1983

Memberships

- Plumbing Training Moderation Group of Victoria

Breif Biography

In a career spanning 26 years, Tony Darcy has worked as a qualified plumber and gas fitter in the construction and maintenance, and heating, ventilation and air-conditioning industries. This includes running a family operated plumbing service in Melbourne, where he employed apprentices.

Darcy has a logical approach to problem solving and a keen interest in acquiring new knowledge and skills. He has long been interested in alternative energy sources and biofuel. The knowledge, skills and insights gained during his career have served him well in his present position as Plumbing Teacher at South West Institute of TAFE, where he is able to pass on his experiences to plumbing apprentices and students.

Darcy is also part of the Plumbing Industry Training Moderation Group, responsible for developing and implementing plumbing resources and projects for apprentices using the Plumbing Industry Training Package.

His other interests include reading, electronics, tinkering with machines, archery, surf sports, clay target sports, walking, camping and playing the guitar.

Aims of the Fellowship Program

- Define present skills deficiencies in Australia in relation to renewable energy heating systems and grey water recycling.
- Investigate how these skills are implemented and achieved in Ireland and England.
- Research best practice in renewable energy heating systems and grey water recycling in Ireland and England.
- Help build knowledge and skills in renewable energy heating systems and grey water recycling within the Australian plumbing industry.
- Help build knowledge and skills in training, innovation and system designs for renewable energy heating systems and grey water recycling in Australia.
- Create and maintain international networks with heat pump and water recycling associations.
- Help create a better informed and efficient heating and plumbing industry where renewable energy heating systems and recycled grey water are available and where running costs can be reduced.
- Disseminate the acquired skills and knowledge gained from the Fellowship to industry via the BICCIAB, the MPMSAA, plumbing unions and the Plumbing Training Moderation Group of Victoria.

The Australian Context

Industry Description

Australia signed the Kyoto Protocol in 2007, making a declaration to join the majority of countries in the overseas community in endeavouring to address the impacts of climate change. As part of this agreement, the Federal Government has set a target to reduce carbon emissions by 60% in the 50-year period from 2000 to 2050. Australia also initially agreed to establish a national emissions trading scheme by 2010 and set a target to achieve 20% renewable energy production by 2020. Subsequent events have seen these targets modified, but the commitment to improve our sustainable performance has been re-confirmed by recent Federal Government announcements.

Another environmental issue currently faced by Australia is water shortage. This has forced the Federal and State Governments and related authorities to consider water saving measures.

These issues have driven the need for a new set of skills within the building industry, as plumbers and other tradespeople will need to know how to implement new technologies such as renewable energy heating systems and grey water recycling.

Increasingly since 2007, sustainable practices have started to infiltrate building designs, with water tanks and insulation ratings being mandatory in all new domestic dwellings in Victoria. Non-compulsory measures to save water include tap ware with Water Efficiency Labelling and Standards (WELS) ratings and dual flush toilet cisterns. Grey water use is only just starting to be considered.

These practices have directly impacted people working in the plumbing industry, as they have been asked to install alternative technologies that many are unfamiliar with. As technology improves, new systems will continue to emerge. Examples of technology not yet commonplace in Australia include geothermal heating, biomass boiler heating, and grey water recycling. Consumers and the plumbing industry require plumbing professionals to be highly trained in the installation of these types of technologies and systems, and to ensure that accurate advice and services are readily available as demand grows.

A coordinated approach to delivering training for Australian plumbers in these new skills areas has been identified as a key issue, and industry professionals have recognised the need to develop new training programs so they can assist the plumbing industry to build skills and knowledge in renewable energy heating systems and water recycling technology. An example of this is a joint venture between the Plumbing Trades Employees Union (PTEU) and the MPMSAA to build a green education centre for plumbers in Victoria. The aim of this education centre is to increase the number of tradespeople who are skilled in the installation of renewable energy heating technology and water recycling systems.

SWOT Analysis

Conducting a strengths, weakness, opportunities and threats (SWOT) analysis of renewable energy heating systems and grey water recycling has provided a clear picture of the current situation. For the purposes of this report, the analysis of renewable energy heating systems was confined to geothermal and biomass systems.

Geothermal Heating Systems

Geothermal heating systems are considered to be a type of renewable energy heating system as they collect heat from below the ground to use for heating and other applications.

Strengths

- Cheaper in the long-term than non-renewable resources.
- Wide spread availability of geothermal energy across Australia.
- Existing long-term examples in Australia can be quoted e.g. Portland (Victoria), until recently, used a geothermal bore to heat a number of council buildings.

- Existing long-term examples in overseas can be quoted e.g. USA, UK, Ireland.
- Applicable to a wide range of scale, and not limited to very large or small situations.
- Opportunities for new business specialisation in industry.
- Better utilisation of waste water.

Weaknesses

- Lack of public awareness.
- Few trained people, both trades and professional people, in the industry.
- Lack of government subsidies.
- Cost to go 'green' still not comparable with existing technologies.

Opportunities

- Low carbon footprint heating.
- Using low-impact renewable heat sources.
- Public education in a time of positive attitudes towards environmental issues.
- The Heat Pump Association already exists in South Australia, which could become national.
- PTEU and MPMSAA opening new 'green' training facility for plumbers.

Threats

- People anxious about perceived installation costs.
- Entrenched ideas on energy and predisposition to continue existing practices.
- Lack of public awareness regarding alternative technologies available.

Biomass Heating Systems

Biomass heating systems are another renewable heating source; these are high-efficiency boilers that have secondary gasifier chambers, which re-burn gas released from combusted materials. These materials can include reject mill logs, pellets made from timber mill waste or wood chips from tree maintenance.

Strengths

- Fuel can be derived from what would normally be either a waste product or material that is turned into garden mulch.

Weaknesses

- Requires substantial space to install systems and fuel storage.

Opportunities

- An emerging pellet manufacturing industry.
- The stockpiles of mulch chips generated every year.

Threats

- Early systems were unreliable causing poor confidence in product.
- People anxious about perceived installation costs.

Grey Water Recycling

Grey water recycling systems collect wastewater from domestic activities, such as laundry, dishwashing and bathing, and purify this water so it can be used again.

Strengths

- Reuse of otherwise wasted water.
- Reduction of demand on potable water supply systems.

Weaknesses

- Requires extra infrastructure and pipe work in addition to existing plumbing systems.
- Additional cost to install.

Opportunities

- Opportunities where plumbing companies are setting up specialised green areas of their business to promote and install grey water systems.

Threats

- Grey water can have an odour.
- Grey water if not treated correctly can contain bacteria and disease causing organisms.
- Long-term use can affect sensitive plants and soil.

Identifying the Skills Deficiencies

Definition of Skills Deficiencies

As already established, a skill deficiency is where a demand for labour has not been recognised and where accredited courses are not available through Australian higher education institutions. This demand is met where skills and knowledge are acquired on-the-job, gleaned from published material, or from working and/or study overseas.

Identifying and Defining the Deficiencies

As identified in 'The Australian Context' Chapter of this report, environmental issues have driven the need for a new set of skills within the plumbing industry as new technologies for heating and water saving emerge.

A large amount of installation work for heating systems and water recycling is performed by plumbers, so an evaluation of how it affects the skill sets of this trade must be performed. This report investigates the skill sets required for:

1. Geothermal Heating Systems, Focusing on Ground Surface Heat Pump (GSHP) Systems

These systems use renewable heat from the ground to heat buildings through a heat pump and ground collector system.

2. High Efficiency Biomass Boiler Heating Systems

These boilers can operate using a number of different materials e.g. recycled timber waste manufactured into pellets, chipped tree trimmings, crops, and the trimmings from purpose grown or renewable willow plantations, just to name a few. These boilers also use surprisingly small amounts of electricity for their size.

3. New Water Reclamation and Recycling Technologies

These new systems recycle water using no chemicals, and they also have systems to reclaim solvents from water containing paint.

Present Skills Deficiencies

There is currently limited training available in Australia for plumbing and heating/ventilation tradespeople to learn skills in geothermal systems, biomass boilers and grey water recycling. There is a need to develop and deliver further training in the following areas:

Geothermal GSHP systems:

- how geothermal GSHP heating systems operate
- applications where these systems can be used
- design practices
- installation practices
- safety requirements/procedures
- knowledge on energy requirements/savings
- type of pipe materials required
- reversing system to provide cooling instead of heating
- environmental conditions requirements.

Biomass boilers:

- biomass boiler types and operations/applications
- design and installation of systems
- different fuel types available
- specific requirements of fuel supply and storage systems
- drying requirements to receive optimum fuel performance
- growing of specific renewable resources
- procedures in place to recycle potash waste into fertiliser products
- biomass boiler maintenance systems/procedures.

Grey water recycling:

- grey water installations
- appropriate use of grey water applications
- grey water storage times and treatments
- environmental issues associated with grey water.

The plumbing, heating, ventilation and air-conditioning trades in Australia are deficient in all these skills. This Fellowship report attempts to address some of these deficiencies.

Specific Trade Skills Deficiencies

Geothermal GSHP Systems

Knowledge of installation practices:

- reading and deciphering plans and drawings on-site
- finding measurements at on-site locations
- excavating and installing pipe work to form collectors
- selecting correct pipe materials
- jointing and testing procedures for pipe work
- using specialised tools and equipment
- setting up heat exchange locations
- installing correct location and depth of collectors
- using correct backfill procedures and materials to achieve maximum heat transfer from the ground
- installing heat pumps
- handling glycol and other inhibitor/antifreeze products
- commissioning systems to ensure correct operation.

System design considerations:

- sizing heating load requirements—normally in kilowatts—of buildings to be heated
- sizing pipe work required to supply systems
- designing routes of pipe work
- best utilisation of space available on-site

- determining soil type and heat transfer properties
- using appropriate tables to calculate required ground areas and depth to install collectors.

Knowledge of repair and maintenance practices:

- problem solving skills
- tracing and analysing faults
- measuring flows
- repairing damaged pipe work
- occupational health and safety (OHS) practices
- sourcing correct trades and materials
- communicating information to customers.

Biomass Boiler Systems

Knowledge of installation practices:

- reading and deciphering plans and drawings on-site
- selecting correct location for boiler and associated pipe works
- selecting correct pipe materials
- jointing and testing procedures
- using specialised tools
- assembling and/or constructing fuel hopper feed systems
- on-site problem solving
- applying correct occupational health and safety (OHS) procedures
- commissioning systems to ensure correct operation.

System design considerations (biomass boiler systems):

- sizing heating load requirements—normally in kilowatts—of buildings to be heated
- sizing pipe work required to supply systems
- designing routes of pipe work
- best utilisation of space available on-site.
- delivery and storage
- mechanisms to feed fuel to boiler
- correctly selecting the type of fuel required for individual installations.

Knowledge of repair and maintenance practices:

- problem solving skills
- tracing and analysing faults
- measuring flows
- repairing damaged pipe work
- OHS practices
- sourcing correct trades and materials
- communicating information to customers.

Grey Water Recycling Systems

- Grey water education
- Design of grey water systems
- Health risks associated with using grey water
- Treatment of grey water
- Grey water types
- Effects of long-term grey water use on flora and fauna
- Maintaining grey water systems.

Nationally Accredited Courses

At the moment, there is no dedicated geothermal heating systems training available in Australia and it has been identified that there is great potential for a specialised trade in geothermal heating systems. There are only two nationally accredited qualifications that contain limited geothermal systems training that provide units of competency comparable to what is required. These are Certificate III in Plumbing (BCP30103) and Certificate III in Refrigeration and Air-conditioning (UEE31307).

Biomass boiler training is in its infancy at present. There are no dedicated training or study programs in plumbing for Biomass boiler systems at this time. The present available training is normally carried out on-site by only a few of the larger boiler companies that are starting to look at installing these systems.

Grey water recycling infrastructure is now being installed in some areas around Melbourne by the relevant water authorities. This involves having a separate water meter connected to the property, which is lilac in colour. This can be used for watering the garden, washing the car etc. At present there are no training units relating to grey water in the current CPC08 Plumbing training package, although the industry is looking to embed some sustainable units in the future.

The International Experience

Several sites were visited in Ireland and England in order to look at best practice in the following areas:

- geothermal heating systems
- biomass heating systems
- water recycling/recovery technology.

Through this study the Fellow was able to determine a benchmark and compare this to the Australian situation. Training centres, industrial sites, trade shows and display sustainable housing communities were visited with the aim of gaining knowledge of the trade, and in particular the methods used to install, maintain and service these systems. Monitoring processes to determine viability and sustainability values of these installations were also reviewed.

Destination: Údarás Industrial Park

Location

Bunbeg, County Donegal, Ireland

Contact

Gerard D'Arcy, Building Services Engineer

Objectives/Background

Údarás Industrial Park is owned by the Gaeltacht Authority. The Gaeltacht Authority is committed to sustainable practices, and the industrial park encompasses geothermal and biomass heating systems, as well as many more sustainable practices.

Údarás Industrial Park was initially an experiment to investigate the most cost effective and environmentally sustainable methods of heating small- to medium-sized office spaces. The research has been used to build additional factory or office spaces to meet the needs of the Galetacht business community, utilising cost effective energy solutions.

According to D'Arcy, Ireland has been the largest consumer of fossil fuels in Europe. The country had spent approximately €5 billion (approximately A$7 billion) on energy every year with oil consumption accounting for about half of this, and coal being another major expense.[5] Economically speaking, Ireland had much to gain by developing new strategies and systems to better manage energy consumption and reduce carbon dioxide emissions.

Although Ireland has developed a small natural gas field off the west coast and is starting to install an associated pipe network, it is likely to take some time to develop due to the installation costs involved. Once installed, this will help reduce some of the country's external fuel costs.

Outcomes

There were several new businesses setting up in this industrial park. The first business occupied 1,400 square metres, with an office and substantial factory floor area attached. The building housed a toolmaking/component manufacturing business. The owner of this business was very conscious of energy use and costs. Because the winters in Northern Ireland are very cold and long, the business was faced with the challenge of keeping the office and workshop area a comfortable temperature all year round.

Working with D'Arcy, this business developed an alternative heating system to replace the previous system that relied on oil, a very expensive one that was diminishing natural resources.

[5] Dubuisson Xavier, 2004, *Ground Source Heat Pumps – A Crash Course for Project Development.*

Gasfication-type Biomass Boiler Heating Systems

All the biomass heating systems at Údarás Industrial Park use gasification-type boilers. These boilers use a downdraft gasification system in a two-stage process. Wood or pellets are placed into the chamber and the materials begin to burn and release heat. As the chamber begins to heat up, volatile gases are emitted and the downdraft forces the gas products into another chamber where they are combusted. Here the gases are mixed with super pre-heated secondary air, and the combustion of the gases takes place through a long, super-heated after-burn chamber. Because of the high temperatures inside the combustion chambers, it is far too hot to allow deposits of tar and other substances to form. Boilers this efficient produce less than one per cent of the total mass of the combusted material into ash.

At Údarás Industrial Park, a Herlt[6] 150 kilowatt (kW) gasifying biomass log fed boiler was coupled to a large buffer storage tank. This unit supplied heating and hot water requirements. The heating uses central heating hydronic radiators in the offices and an air convector heating system in the workshop. It also supplies hot water through a heat exchange system.

The boiler takes logs about one metre in length. These logs are typically sub-grade forestry seconds, or logs rotted from extended storage time. The business can purchase these at a very reasonable price. They also collect and store wood transport pallets and break these up for fuel, recycling something that most businesses would incur costs to dispose of. The boiler only requires feeding about every second day in peak load times; hot water is stored in an insulated buffer tank.

The company has a reasonably large workforce, so obtaining labour for these processes was not an issue—the apprentices normally performed these duties and learned to be boiler attendants as part of their skills training in toolmaking and fitter and turner trades.

Figure 1: Herlt gasifying boiler and buffer storage tank at Údarás Industrial Park

[6] Herlt is a European manufacturer of biomass heating systems.

The Office Block Building

This building had been converted from an old factory to a new and modern office complex. There is also a substantial existing factory floor area at the rear of the building.

At the time of visiting, several tenants had already signed contracts to move into new office spaces. One of these was a leading Irish transport authority (Ireland's equivalent of VicRoads). The new building also incorporates children's day care facilities.

The building has several energy saving and efficient design features: double and triple glazed windows (the standard for Europe), insulated blocks and insulated floor sections. By insulating concrete floor areas, heat loss from slab heating systems is reduced and this helps the building meet air loss standards. However, air still has to be turned over from outside to ensure the healthy operation of the building and this is achieved through a ventilation system that preheats incoming air using air leaving the building. This method ensures there is little or no effect on ambient temperatures inside the building; thereby, reducing energy heating cycles.

There are a number of systems in place to produce heating for the building. One of these is a set of two 150 kW KWBPowerfire[7] biomass boilers, which run on willow tree chips. These are connected to two large insulated buffer storage tanks.

The building also has a large geothermal collection system in the front lawn area, which collects heat through a geothermal GSHP system and transfers this to the buffer tank system through a heat exchange system.

Finally, on top of the rear building above the boiler room there are several rows of solar panels facing to the south. These are used to harness solar energy in warmer weather and on sunny winter days, and serve to heat the buffer tank, which reduces reliance on the biomass heating system.

Figure 2: Newly renovated office block building in Údarás Industrial Park (note the childcare enclosure at the front is yet to be fitted out)

The biomass boilers were installed by an Irish company called Rural Generation Ltd. This company specialises in wood energy, organic waste recycling, and installing and commissioning wood-fired boilers.

[7] KWB is a European manufacturer of biomass heating systems and Powerfire is a model name.

Figure 3: Rural Generation Ltd service van on-site at Údarás Industrial Park

Figure 4: One of the two 150 kW KWB Powerfire willow chip boilers

Generally, one biomass boiler is able to meet the building's heating requirements, but both can run if required. A computerised management system alternates the hours each boiler operates, ensuring that the buffer storage tanks remains heated. Having two boilers also provides the capacity to heat the factory floor area.

These biomass boilers were very unlike the old-fashioned boilers. They are modern, clean, computer-controlled units and automatically begin operating when the computerised management system determines that heat is required. Fuel is fed in from a storage unit at the rear of the boilers, via an auger system. Sensors in the flue pipe system constantly measure oxygen levels in the flues. The boiler controller then makes the necessary adjustments to power fan air levels, and feeds in fuel to create the most efficient burn rate and emissions.

These two boilers are to be managed for approximately five years by the installation company Rural Generation Ltd, who will provide fuel and maintenance for the boiler system. The system was fitted with a heat meter, enabling the installation company to charge the Údarás Industrial Park for the amount of heat used and generated by system.

Figure 5: Second of the two KWB Powerfire boilers, with well insulated buffer storage tanks

Figure 5 shows the second boiler in the plant room at Údarás Industrial Park. Also pictured is the well-insulated pair of water storage tanks, where heated water is sent and then stored until required for use in the building. To the rear of the boiler there is a small duct penetrating the wall. This is the fuel feed auger, which is connected to the fuel storage unit.

Biomass Boilers by Fuel Type

Biomass boilers are classified according to the type of fuel used. There are three main types:

1. Wood Pellet Boilers

   Wood pellets are usually derived as a by-product of sawmilling and other wood product manufacturing processes, and from compacted sawdust. The pellets are extremely dense and have low moisture content (below 10 per cent). This allows them to burn with very high combustion efficiency. Because of the uniform shape and small size, they are used for automatic feeding with very fine calibration. They would normally be fed to a boiler by an auger from a storage unit or bunker. On smaller appliances this storage unit could be attached to the top of the boiler.

   The high-density pellets are capable of compact storage and can be purchased in small bag lots. The pellets can be deposited from a delivery truck directly into a bunker or storage unit and are capable of being transported over substantial distances with ease.

2. Wood Chip Boilers

   Wood chips are regarded as having a smaller carbon footprint than wood pellets because they require less energy in the manufacturing process. They can be generated from waste wood and residuals from construction, agriculture, landscaping, logging, and sawmills, or can be locally grown and harvested. Fuel crops such as willow crop trees are used (note: willow needs to dry to a minimum of 25 per cent moisture content to facilitate efficient burning). Wood chips are also less expensive than other fuels because the harvesting is faster; all parts of a tree can be chipped including small limbs and branches. They look similar to the garden mulch used in Australia.

   Wood chip boilers have a modern design and function, and can operate using a highly automated management system. They are generally used for higher output demands in larger buildings.

   Wood chip boilers require substantial room for fuel storage and handling. Fuel is normally stored in a room or bunker attached to the plant room where the boiler is located. Storage units are usually accessible from outside, to allow fuel stores to be easily replenished. They have a small channel in the floor that incorporates an auger. When the boiler needs to generate more heat it activates the auger and fuel travels along the channel though the wall and into boiler feed ducts, where a second auger lifts the material up and deposits it into the burn chamber. This duct also incorporates a heat sensor that injects water into the duct in the event of a flashback from the boiler along the fuel channel.

   These fuel stores can have a sloping floor and a scraper mechanism that periodically travels across the floor to move the chips or pellets to the auger channel. Fuel is then replenished by a small truck with a conveyer that pulls up adjacent to the outside access door, and deposits the chips into the storage. In some instances, the fuel supplier checks and clears ash deposits while the storage unit was being filled.

3. Solid Biomass Boilers

   Solid biomass boilers are capable of taking small logs and other solid materials, which consist of 'seconds' from the forestry industry, timber that is partially rotten, or used timber pallets. Some of these boilers have a store attached to them where small logs can be stacked and then automatically fed into the boiler by chain drive. Domestic versions of these boiler heating systems are also available.

Other Fuel Sources

Rapeseed or Canola cake—the residual of pressed oil—is another source of fuel for biomass heating systems. Grain and similar crops can also be used as fuel, and conveniently stored in a silo near the boiler location.

Geothermal GSHP System

Geothermal heating systems are widely used in Europe. This technology requires only a small amount of electricity to power circulating pumps. It involves collecting heat from below the ground to use for heating and other applications. The principle is simple: the ground temperature approximately one and a half metres below the surface does not fluctuate, in fact, it becomes warmer further down. To collect this heat a wide trench is dug to at least one and a half metres, and coiled lengths of polyethylene pipe (poly pipe) are installed over a distance. Water circulates through the pipe and picks up the heat as it travels through the pipe. This water can then be used to preheat hot water or to heat homes. In areas where space is a premium and trenches are impracticable, a similar result can be achieved by drilling boreholes straight into the ground to a depth of 30 metres.

The heating system at Údarás Industrial Park also uses a geothermal GSHP system. The front lawn area is also designed to collect solar energy: a series of pipes are laid in a wide, shallow trench over a substantial distance, these are then connected to flow and return manifolds. The amount of pipe required is calculated according to the required output of the heat pump unit. The fluid used in the pipes is generally 100% water, but in colder areas it may contain glycol to prevent freezing. As this fluid moves through the pipe it absorbs heat from the ground, and is transferred through the return line to a heat pump heat exchange unit, which raises the temperature to approximately 45 degrees Celsius above its original temperature—ideal for slab-type heating.

Ground conditions affect how efficiently these systems operate; damp and moist soil conditions transfer heat far better than dry and rocky ground.

Figure 6: Flow and return collector poly pipe lines from lawn area (note: the lines are not yet connected to the manifolds).

This GSHP system operates on the basic principle that fluid absorbs heat when it evaporates, and it gives off heat when it is condensed back into a liquid. This is called a vapour compression cycle. One of the main advantages of these systems is their high efficiency rate; for example, one unit of energy input will produce between two and a half and four times this in energy output. This is called the coefficient of performance (COP). Some manufacturers using alternative gases claim theoretical COPs of up to seven times the original energy input.

GSHPs have been used for some time, in most cases employing a vapour compression cycle. The main components of the unit include an evaporator and condenser, a compressor and its drive, an expansion valve and a working fluid (refrigerant).

A closed loop GSHP, of the type installed at Údarás Industrial Park, starts with a pipe buried approximately one metre below the ground. This pipe contains a mixture of water and glycol. The cold fluid absorbs heat from the ground when the earth reaches approximately 12 degrees Celsius, and this heat is delivered to the heat pump where it passes through a heat exchanger, acting as an evaporator, and transfers heat to the refrigerant. The refrigerant boils and, when vaporised, travels to the compressor where its pressure and temperature are increased. The high-pressure refrigerant gas is moved to a second heat exchanger acting as a condenser, and the heating circuit absorbs heat from the exchanger and transfers it to either subfloor heating circuits or radiator/fan coil circuits. The condenser supplies heat to the building by condensing the working fluid (refrigerant) at a higher temperature. The flow of fluid through the throttling valve or expansion valve reduces the pressure to the level required by the evaporator. The working fluid continues its cycle, as the flow is continuous once heat is required.

The net output at the condenser is effectively the sum of heat absorbed by the evaporator plus the heat equivalent of the input to the compressor. The energy gain sets the GSHP system apart from other heating methods as the heat delivered is far greater than that which can result from the effective use of primary energy alone.

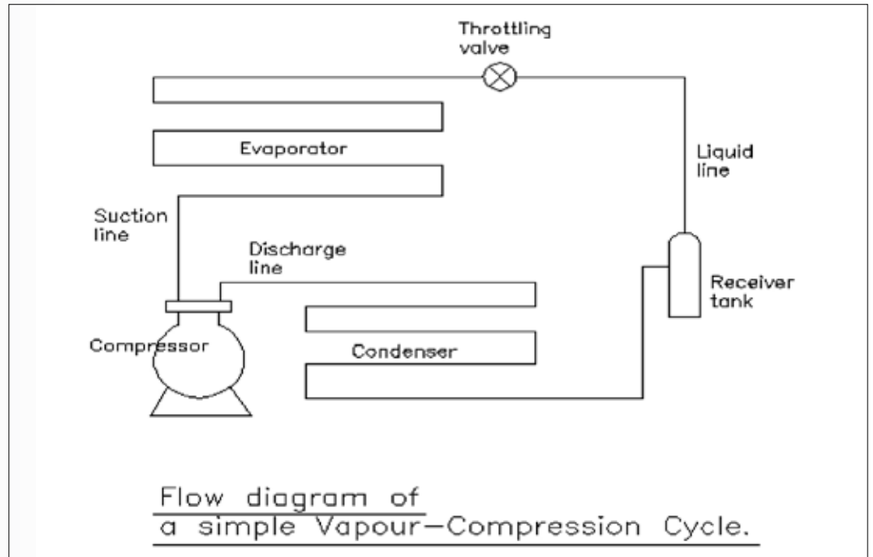

Figure 7: Flow diagram of a simple vapour compression cycle

Geothermal energy is generally considered to be renewable and sustainable. Renewable describes the organic properties of the energy source whereas sustainable describes how the resource is utilised. The sustainability in consumption of a resource is dependent on its initial quality, its rate of generation and its rate of consumption.

The earth's surface acts as a large solar collector and the earth itself stores heat energy in a large capacity 'thermal store'. This 'thermal store' is referring to the fact that the Earth absorbs the sun's energy every day, this is stored in the very ground we walk on, at night when the surface temperature cools this heat can be given up back into atmosphere. Low temperature energy is available in large quantities from renewable sources such as the ground, outdoor air and surface water (rivers, lakes and dams). A GSHP system extracts heat from that low temperature heat source and increases it to a higher temperature for use in air and water heating. In Europe houses built on concrete slab installations are using solar water systems to heat the ground under the building during the warmer weather, the stored heat is only released when the area above it becomes cooler, otherwise the heat energy remains where it is stored.

The term GSHP is applied to a number of systems that use the ground, ground water or surface water as a heat source. They can also be called ground water heat pump (GWHP) and surface water heat pump (SWHP) systems, depending on where the heat is being obtained.

Substantial improvements to energy efficiency and environmental problems can be made where heat pump systems are installed in applications that use electricity or oil as a primary energy source. Heat pump systems are considered to have a large potential in many parts of the world because they can provide air heating as well as air cooling to a large range of domestic, industrial and commercial buildings.

In 1997 when the Kyoto Protocol was initiated, the world's carbon dioxide (CO_2) emissions were 22 billion tonnes. Of this, 30% (6.6 billion tonnes) was generated from heating domestic and commercial buildings, and 35% was generated by industrial activity. By 2008 the world's CO_2 emissions had increased to 31.5 billion tonnes.[8] Based on these figures, if heat pumps could supply 30% of heating in buildings with emission reductions of around 50%, CO_2 emissions could potentially be reduced by 1.0 billion tonnes.[9]

GSHP installations could cost, on average 35–50% more than conventional forms of heating. Without some form of rebate or incentive there would be a general unwillingness by builders and developers to incur the extra costs involved. At present, there is also a lack of knowledge and training available with regards to servicing and installing these systems. The general public also has a low awareness of the technology.

Solar Panels Heating System

Figure 8: Solar panels on the roof at Údarás Industrial Park (the two flues in rear of picture were connected to the biomass boilers in the plant room)

[8] Howley M., Ó Gallachóir B, O'Loughlin B, 2002, Energy in Ireland 2002 – Trends, Issues and Indicators, Sustainable Energy Ireland – Energy Policy Statistical Support Unit.

[9] http://www.heatpumpcentre.org/intro.htm.

The building at Údarás Industrial Park also has several solar panels used for heating water and these are installed on a south-facing roof. These are also connected to the heating management system, the idea being that solar radiation could be harvested in the warmer summer months to complement the biomass boiler system by preheating the water and, thereby, reducing the amount of time the boilers need to operate.

Air Handle Units

The cold climate in Europe has necessitated strict regulations regarding how buildings are constructed to ensure they are virtually airtight. Buildings have to be tested to make sure that all surrounds of windows and doors are sealed and that there are no great areas of air leakage. In cold climates air leakage is equivalent to heat loss.

This testing involves checking the air pressure in the building over a certain time period. If a building fails the air pressure test, the source of the leak has to be identified and eliminated. This testing requirement aims to ensure that heat loss in all new buildings is kept to a minimum, thereby, minimising the energy required for heating.

Although it is important to make sure that buildings are as airtight as possible, it is also recognised that a healthy environment requires fresh air, and that regular turnover of air in the building is also needed. This has to be done without compromising the ambient temperature inside the building. Air handle units manage the flow of air going out and preheat the fresh air coming in, thereby, minimising any changes to ambient temperatures inside the building.

Figure 9: The air handle unit in the ceiling area of a crèche on the ground floor building of Údarás Industrial Park

Destination: Chem-Regen

Location

Portarlington, County Laois, Ireland

Contact

Angelo O'Connor, Company Director, Chem-Regen

Objectives/Background

Chem-Regen is an Irish government-approved organisation for water recycling and waste removal. It uses state-of-the-art German-made water recycling technologies that are chemical free. These systems are capable of treating small or large amounts of water for commercial enterprises, and can easily be adapted to Australian conditions. Darcy was fortunate to be able to inspect some of the company's installations.

European countries have conducted much research into grey water use and have been implementing these findings for some time. The Fellow was informed that a certain amount of their water supply actually has a recycled component. The fact that some European countries have recently experienced very hot summers did not appear to be an impetus for their advanced practices; rather, an increasing population seems to have driven the innovation in grey water technology. European countries are also incorporating grey water technology into new building designs.

Ireland was no exception, where a strong awareness of water use exists and the government is soon to launch a 'user pays' system. This could encourage large businesses to change their water consumption habits and to consider the installation of water recycling technology.

To protect water reserves, Ireland also has strict regulations surrounding industrial waste disposal and collection. Waste that is not suitable for landfill is often sent to other parts of Europe and converted to fuel. Household organic waste is collected and used to create fertilisers. Another measure used to protect water reserves is treating industrial and commercial wastewater on-site.

Outcomes

Case study: Bearna Golf Club

Bearna Golf Club in Ireland's west is not unlike other golf clubs in that it uses a substantial amount of equipment on the golf course every day. This equipment has to be maintained and kept clean and presentable. The golf club is situated in close proximity to a lake-like water reserve, used as a potable water supply for nearby villages.

Chem-Regen was asked to come up with a solution for cleaning the equipment and treating the water used on-site. Their solution was to install an aqua-detox system. This system is not only able to supply water pressure to hoses used for cleaning the equipment, but also to treat the run-off water so it meets the required standards. This is a chemical-free treatment capable of cleaning fuel and oil from the equipment. Up to the time of the Fellow's visit, no mains water had been required, even though equipment is washed almost daily. This will help create a substantial cost saving for the golf club when the 'user pays' system for water consumption is introduced by the government.

The equipment is rinsed in an oversized wash bay designed to also act as a catchment area during rainfall. It works by draining rinsing water into large storage tanks where it is treated. If the storage unit overflows (after rainfall, for example), it releases treated water to an overflow pipe where it enters the nearest watercourse. This is known as the wash bay apron catchment area.

Figure 10

Figure 11

Figure 12

Figure 10 shows the below ground component interceptor and water collection pits, where water is stored for use in the system (the water is collected by the apron and channelled into the pits). Figure 11 shows above ground equipment building, and Figure 12 shows near completion of the wash down bay.

This site was once a quarry and the below ground pits had to be excavated through sheer rock. This demonstrates that the system can be installed just about anywhere.

At the time of the Fellow's visit, Chem-Regen was also working on a new water storage and treatment solution for a fresh vegetable processing plant, which would save up to one million litres of water each week. This system could be used in both small and large commercial enterprises.

Destination: Foras Aiseanna Saothair Training & Employment Authority

Location

Galway Training Facility, Dublin, Ireland

Contacts

- Jerry Mahon, Assistant Manager
- Brendan O'Reilly and Seamus Keane, Plumbing Teachers

Objectives/Background

Being a teacher in plumbing studies at a TAFE institute, the Fellow took the opportunity to visit local plumbing training facilities while overseas. Foras Aiseanna Saothair Training & Employment Authority (FAS) is Ireland's national training and employment authority. The FAS training centre in Galway teaches plumbing and electrical trades skills. By visiting this centre the Fellow aimed to experience first hand some of the training practices delivered.

Outcomes

During the Fellow's visit Mahon, O'Reilly and Keane gave their time generously. The Fellow appraised the plumbing training practices and resources and concluded that the training was very similar to that used in Australia.

At the time of the Fellow's visit the plumbing training department was in the process of implementing solar hot water systems training, which was a relatively new concept in Ireland. The plumbing teachers were writing resources to facilitate training in these areas and were also building operational workstations. Both were of a very high standard.

As evidenced by a strong ethos to provide apprentices with a solid education upon which to build their plumbing skills, the plumbing training department is extremely committed to the craft of plumbing. FAS also delivers electrical training, which includes installations of photoelectric generation panels.

Figure 13: FAS plumbing teacher Brendan O'Reilly teaches apprentices copper brazing techniques, to help with their solar hot water installation skills

Figure 14: Mobile solar hot water training workstations at FAS

Figure 15: Solar heat exchange cylinder

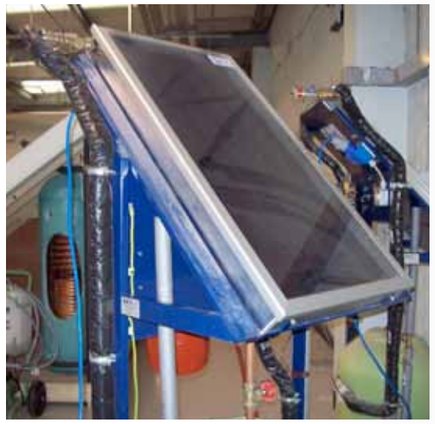

Figure 16: Solar heat exchange front panel

Figure 17: Typical slate roof installation

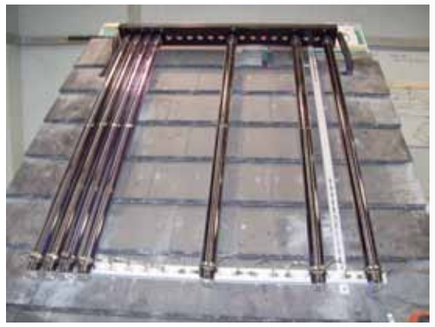

Figure 18: Evacuated tube solar system installation process

Figure 19: Internal cylinder operation having two heat exchange coils (the inside one is for a closed glycol system from rooftop solar panels, the other is for a sealed domestic hot water exchange coil)

Figure 20: A large working model complete with electric boost and heating option

Figure 21: The large, fully functional solar unit installed in the FAS plumbing workshop (this unit had solar panels fitted on the roof and monitoring gauges so apprentices could see the heat process in operation)

Figure 22: Photoelectric panel system workstation used in electrical training

Destination: BRE Innovation Park

Location

Watford, England

Objectives/Background

BRE Innovation Park (BRE) is a display centre for sustainable building construction and sustainable housing communities. It was developed as a collaborative project involving industry, manufacturers and the government. It showcases the latest sustainable technologies, building designs and products in a simulated village environment.

For more information see: http://www.bre.co.uk/page.jsp?id=634. The aim of visiting BRE was to investigate and document these new innovations in a working situation.

BRE's industry partners and contributors included:

- DuPont: showcases products throughout the site.
- Pilkington: provided window glazing for the new pavilion.

- Mitsubishi Electric: showcases technologies that provide and monitor low energy heating.
- Open Hub: provides a Community Digital Management Centre (CDMC) and associated services, connected via a fibre-optic broadband network to all buildings at BRE. For more information see: http://www.openhub.co.uk/projects.htm
- Hanson UK: constructed the original building.

Figure 23: Front entrance to BRE Innovation Park.

Outcomes

At the time of the Fellow's visit, seven houses built to the Code for Sustainable Homes and one health centre had been completed. There were also over 300 displays of emerging technology and construction systems. Some of these were experimental facilities constructed by partners and contributors to the park. The development also had a state-of-the-art community landscape design.

Some of the buildings had been designed in a way that enabled them to be manufactured in bulk quantities; they were not just 'one offs'.

The Visitor Information Centre (VIC) at BRE uses browser portal networks to provide information about the technologies and products on display, this includes suppliers, contactors and knowledge transfer networks. When exploring the park, visitors have the option of using a portable hearing device that gives commentary on each display at the push of a button.

Figure 24: The Hanson EcoHouse

Figure 25: Diagram showing the theory supporting the thermal mass concept.

Built in 2007 the 'Hanson EcoHouse' was the first masonry house to achieve Code Level 4 under the Code for Sustainable Homes. It brought together the latest developments in off-site construction, thermal mass heating and natural ventilation.

Examples of Homes Built at the BRE Innovation Park

Sigma Home

The 'Sigma home' was designed to address high-density living. Its height is approximately the same as a three-storey dwelling but it has four levels. This design minimises the building's carbon footprint and construction costs. The primary design objective was to reduce CO_2 emissions by 100% and reduce the energy required for heating of water and space; the building also generates electricity through wind turbines and photovoltaic cells on the rooftop.

Figure 26: Stewart Milne Group's[10] Sigma home

The house achieves this by being airtight, having high levels of thermal performance, and by using renewable energy technologies such as micro-wind and photovoltaic. Several different styles of exterior finishes can be selected, including a range of rendering products and timber.

Approximately 45 of these houses could be constructed on two and half acres of land.

Kingspan Lighthouse

The 'Kingspan lighthouse' design has achieved Level 6 of the Code for Sustainable Homes. It is a net zero carbon home, meaning that it does not use any power from the grid. The environmental features of this home are capable of delivering all the building's energy needs water heating, space heating and appliances.

The building has a generous open plan living space, a top-lit, double height living area and ground floor sleeping accommodation. The insulated and airtight building fabric is designed to provide daytime light levels and has solar control. Renewable energy features include biomass boiler technology, photovoltaic electricity connected to the grid, evacuated tube solar water heating system, a wind turbine and mechanical ventilation with a heat recovery system. The building also has water saving sanitary ware and appliances. Approximately 30% of water used in the building is sourced from rainwater and grey water.

[10] Stewart Milne Group is a UK home building, construction and development company in the UK

Figure 27: Kingspan lighthouse

Insulation Examples

Figure 28: Insulation used to reduce heat loss between floors

Figure 29: Insulation used as part of concrete raft slab construction (note the insulation is part of the slab)

Destination: Asgard Biomass Systems

Location

Biggleswade, Bedfordshire, United Kingdom

Contact

Ross Donovan, Company Director, Asgard Biomass Systems

Objectives/Background

Asgard Biomass Systems are manufacturers of biomass boiler systems. The visit to Asgard was aimed at learning about these systems through hands-on experience in design, operating and maintenance procedures for biomass boiler installations.

Outcomes

The Fellow gained knowledge of biomass systems and their operation through hands-on work experience, which involved assisting with the servicing, maintenance and repair of equipment at a number of commercial installations. The opportunity to learn about these systems via hands-on work gave considerable insight into how the machines operated. One biomass boiler installation that was visited had been damaged by a tractor and some of the operating components that were exposed provided insight as to how an auto-feed system worked in a wood chip biomass boiler.

According to Ross Donovan, Company Director, Asgard Biomass Systems, the emergence of biomass technology has been driven by the desire of private companies to obtain energy inputs from internal sources, rather than having to important fuel from external sources.

Biomass Boiler Installation: Ashley Church of England Primary School

The Ashley Church of England Primary School has developed a slogan 'The little green school with the big green attitude'. The sustainability project began because the school was not very energy efficient, being an old Victorian building with a maze of corridors and high-ceilinged classrooms. They have installed photovoltaic power generating panels, solar panels for hot water and pool heating, and a KSM[11] wood pellet biomass boiler to heat buildings.

Figure 30: Feed auger for pellets from old coal store in basement of school (also pictured are some spare bags of pellets)

Figure 31: The 38 kW KSM 'Stoker' biomass boiler installed in the basement of the school (note the old gas unit in the background)

[11] KSM is a European brand name for biomass boilers

The biomass boiler was installed by Asgard Biomass Systems and is located in the basement bunker, which originally housed a coal-fired boiler and featured an old coal store, which was converted into a wood pellet storage unit for the biomass boiler. The wood pellets are delivered by a small truck and are fed into the storage unit via a chute. The school also keeps spare bags of wood pellets in the basement.

Biomass Boiler Installation: Moorhead Presbyterian Home

Moorhead Presbyterian Home is a retirement home for retired Vickers and their wives. It features a new building added to an existing complex. As part of planning requirements for the new building, management wanted to achieve 60–70% renewable energy.

Asgard were contracted to install a 50 kW wood pellet biomass boiler. The boiler became the primary source of energy for heating water and air, and is supported by two gas heating units that can be used if required.

Figure 32: Moorhead Presbyterian Home building

The fuel (i.e. wood pellets) for this boiler is deposited into a storage unit adjacent to the boiler room. These wood pellets are manufactured from materials that might otherwise have gone to landfill.

Figure 33

Figure 34

Figure 33 shows Ross Donovan, Company Director of Asgard Biomass Solutions, in the plant room at Moorhead Presbyterian Home with the 50 kW KSM boiler. The auger feed system automatically brought pellets from the storage unit located behind Donovan to the boiler when the unit needed to generate heat, this created minimal mess and was very heat efficient.

Figure 34 shows the location where the pellets are blown into the storage unit adjacent to boiler room. The delivery truck delivered pellets to the storage unit by attaching to the first connection. The other connection was for a return air line. The truck had an earth strap, which connected to the fill pipes to reduce the chance of sparks being generated from static electricity.

Biomass Boiler Installation: Wasing Estate

Wasing Estate covers several thousand acres of land in Berkshire, UK. It has belonged to the same family for over 250 years, and contains rivers, woodland, wetlands, lakes, flora and fauna. Aside from farming and recreational industries, the estate also has corporate and events facilities.

As many of the buildings on the estate are very old and are constructed from brick and slate, the challenge was to create a sustainable means to supply heat to all buildings. Traditionally, oil, liquefied petroleum gas (LPG) and timber fires would normally be used. The LPG and heating oil are becoming very expensive methods due to the costs associated with inputs and maintenance.

Wasing Estate has a substantial area of well-managed woodlands and they engaged Asgard to develop a biomass heating solution that could utilise these resources and heat all buildings effectively and efficiently. As a result, a 240 kW KSM Stoker wood chip biomass boiler has been installed. The boiler was placed in an existing shed, located centrally on the property. A wood chip store was then constructed from concrete blocks and positioned inside the shed with an external access point. Approximately 700 metres of Calpex[12] insulated poly pipe was installed in a flow and return configuration from/to the boiler. This system connects to a heat exchanger in each building, from which radiator panel heating, floor heating and water heating is supplied. This system replaced all existing methods of heating previously in use.

Fuel for the boiler is sourced from the estate via routine tree and garden maintenance. This material was previously turned into garden mulch, but is now 'chipped' and placed in the storage unit to dry out to between 20–25% moisture content to optimise burning efficiency.

The chipping process is now the only cost involved in sourcing fuel, and the estate has achieved substantial cost savings in fuel inputs for heating requirements. According to management, the boiler installation costs will be recovered from these savings in just a few years.

Figure 35: 240 kW KSM wood chip boiler installed at Wasing Estate

Figure 36

Figure 37

Figure 38

[12] Calpex is a pre-insulated, flexible piping system suitable for transporting high and low temperature water from underground heat sources, losing minimal heat

Figure 36 shows the rear of the wood chip boiler is, showing the auger riser for fuel chips. The blue pressure vessel in the foreground is connected to the water supply. This vessel has a water storage unit that is connected to the auger riser via the silver insulated riser pipe. In the event that heat is detected in the auger feed, which may arise due to a burn back along fuel suppl, the storage from the vessel would released into the supply auger to prevent the fuel train burning and/or a fire in the fuel storage supply. This is a common requirement for biomass boilers.

Figure 37 shows the channel in floor behind the boiler containing the ground auger. This channel is placed outside the rear of the fuel store, in the bottom of which are a set of rails that drag chips forward from the bottom of the fuel store as required. This area would have restricted access due to hazards caused by moving augers and rams.

Figure 38 shows the rail assembly on the floor of the chip store. The rails move backwards and forwards, bringing chips to the front of the store and into the auger bay so they can be transported to the boiler. This set was additional to the other set, and was built for use in a second fuel bay if required.

Figure 39: The outside view of the wood chip storage bay (note the accessibility for tractors or loaders to deliver chips into the storage unit)

Figure 40: The typical soft wood chips used in the biomass system from local woodland material

Destination: Glassex International Trade Show

Location

National Exhibition Centre, Birmingham, England

Objectives/Background

The Glassex International Trade show was an annual exhibition of emerging construction methods and materials in the construction industry, aimed at tradespeople such as builders, plumbers, and electricians. The objective of visiting the trade show was to investigate the new and emerging technologies in sustainability in one large area, to interact with manufacturers and suppliers in order to learn about these systems, and to collect written material and specifications regarding these systems.

Outcome

The show floor was divided into sections that covered new building products, tools, and equipment. This included exhibits highlighting scaffolding, access equipment, earthmoving equipment, waste and recycling equipment, and painting and decorating.

A floor area dedicated to environmental building and heating practices called Sustainability Street housed the latest innovations in sustainable design and materials for plumbing, heating and building systems.

SummitSkills—the peak skills council for plumbing in the UK—also had an exhibit, and this showcased the work of a selection of award winning apprentices, as well as training advice for plumbing industry practitioners.

Figure 41: Some of the products on show at the Glassex International Trade Show

Figure 42: Locally made biomass chips and wood pellet central heating boiler

Figure 43: Soft wood fuel samples and tree species that are conducive to renewable cropping.

Figure 44: Innovative electricity generation

Figure 45: Innovative electricity generation

Figure 46: Modular environmentally friendly homes

Figure 47: Modular environmentally friendly homes

Figure 48: SummitSkills plumbing awards at the Glassex International Trade Show

Figure 49: SummitSkills plumbing awards at the Glassex International Trade Show

Figure 50: Some of the work done by the award winning plumbing apprentices

Figure 51: Some of the work done by the award winning plumbing apprentices

Destination: Thames Valley University

Location

Reading campus, Trade Training Department, Reading, Berkshire, England

Contact

Chris Mullard, Plumbing Teacher, Thames Valley University, Reading campus

Objectives/Background

Thames Valley University is the largest university by student population in the UK, and has campuses in several locations. The Reading campus specialises in vocational training and has a dedicated plumbing department. The visit to Thames Valley University's Reading campus was aimed at interacting with the plumbing training department to investigate how training is approached and carried out in England, and to form network connections for the future.

Outcome

Plumbing training at the Reading campus is focused on heating systems, sanitary and water installations. Discussions revealed that their training uses competency-based principles similar to Australia, but their delivery methods are different. The training uses a combination of on-site assessment and classroom training.

The student is given a portfolio of work to be performed at trade school as well as on-the-job. The work that is completed on-site is required to be photographed and documented by the employer. The work done at trade school is similar to the work on-site to ensure that the apprentices are able to reproduce the work to the required standard.

Plumbing training in the UK is overseen by the national qualifications authority known as SummitSkills. Plumbers in the UK are not responsible for roofing or drainage and, as such, the training for plumbers focuses on water installations, sanitary installations, floor heating, and hydronic radiator central heating systems across a range of domestic situations. Roof work is a separate trade and is carried out by specialised roofing contractors. Drainage is also a separate skill set.

The materials being used are very similar to Australia with PVC pipe for waste and drainage, the use of copper and steel pipe is still in use for water and gas. However, they have not yet embraced the wide use of composite materials for water and gas as in mainland Europe and in Australia.

Training is mostly carried out by product manufacturers and installations are designed by engineers with the relevant experience.

Figure 52: Front entrance to the Thames Valley University's Reading campus

Figure 53: Theory computer assessments at the Thames Valley University's Reading campus.

Figure 54: Workshop at the Thames Valley University's Reading campus

Knowledge Transfer: Applying the Outcomes

Through travelling and networking with relevant people and organisations overseas, ongoing professional working relationships have been established to help local training organisations and relevant industries access to best practice trade skills knowledge.

At present, the number of training programs available in Australia for geothermal and biomass heating systems is minimal. There are no financial incentives available to install these systems, and because the technology is relatively new, they are expensive to install.

Australia is so rich in natural resources that it has relied on these commodities not only for energy but also as an export product. Most major cities are connected to reticulated natural gas, which has been a very economical energy source compared to electricity. However, population growth and development has placed considerable demand on our natural resources and Australia must now consider new ways of producing energy. Indeed, communities that are not connected to energy infrastructure, such as those in remote and rural areas, have already implemented small-scale renewable energy systems.

Not only is the amount of landfill space running out, but Australia's natural energy resources are also being depleted. An increasing number of Australians are becoming conscious of this and are trying to use less energy, but the country generally has a low awareness of the alternatives.

These systems have the potential to reduce both heating operating costs and electricity consumption, leading to reduced carbon outputs.

Europe does not have an abundance of natural resources and has had to import these commodities at great expense. The desire to save costs has driven the rapid advancements in renewable energy and energy-efficient technologies. As an example, waste that once went to landfill is now used as a renewable fuel source. Waste products from the spray painting industry are another example, as these are converted into fuel blocks to feed large incinerators on mainland Europe.

There is ample opportunity to begin using similar practices in Australia, as every day tonnes of materials that could be recycled and used as fuel are sent to landfill. Pine trees are also an excellent source of fuel for renewable energy systems and these trees grow in abundance in Australia. Instead of chopping them down and burning them, the timber could be converted into wood chips for biomass heating systems such as those used in Europe. It is apparent that hundreds of tonnes of potentially low-cost and energy efficient fuel is being wasted every year.

With Australia's capacity for adequate ground temperatures, an emerging pellet manufacturing industry, stockpiles of mulch chips generated every year, and commitment to climate change practices, there is huge potential for sustainable heating businesses and associated employment.

Recommendations

There is definitely a need to increase and improve education in the use of renewable energy, and develop training programs that incorporate sustainable training practices. Vocational training institutions that provide training in areas such as plumbing and fitting and turning are well positioned to deliver this type of training. As Australia increases its use of renewable energy, new business opportunities will also emerge.

Australian Government

Financial Support

At present, there are no financial rebates or assistance in Australia for GSHP or biomass heating systems, as there is with solar electricity and hot water installations. This is despite recent industry representations to government regarding the potential energy savings associated with the use of GSHP heat pump systems.

Recognition of GSHP Technology

As the population of Australia continues to grow, it will be necessary to continue to invest in energy-saving industries and renewable fuel sources. GSHP technology has proven to be capable of saving large amounts of electricity by delivering up to four times the amount of energy than was input, thus producing heat using only one quarter of the energy that would normally be required by electricity.

Biomass Heating Systems

Biomass boilers need to be recognised as a viable, efficient form of heating, as they are able to run on a number of different mediums, some of these being waste products from industry and renewable sources such as tree clippings. Support must be given to industry to establish infrastructure to collect and process waste and renewable timber materials so biomass boilers can become more mainstream. Hundreds of tonnes of timber industry waste is sent to landfill each year from industries such as construction and manufacturing, and land owners burn off large stocks of pine trees regularly. All of these materials are capable of being converted to fuel for use in biomass boiler systems.

Australian Skills

Australia's trade and building sectors are highly regulated and therefore we have a highly skilled workforce in these sectors. With this skill base, people in these industries are capable of readily adapting to new technologies. The Australian Government needs to continue to fund new training programs, so that industry can diversify and help tradespeople develop the skills required to implement sustainable technologies. This will create further employment and help the Government achieve its environmental targets.

Industry and Business

Australia's population has an increased knowledge of sustainable technologies and environmental issues compared to 20 years ago. With this knowledge is an awareness of how to reduce carbon emissions and waste outputs. This provides industry with the potential to develop and encourage businesses that specialise in renewable energy and sustainable building design, especially in the areas of plumbing, electrical and refrigeration. If action is taken, this has the potential to increase employment in these industries and create more sustainable building practices.

In view of this, Australian industry and businesses are encouraged to:

- Continue lobbying the Australian Government to offer rebates and incentives for alternative energy systems, which will make different forms of heating and cooling more affordable for consumers.
- Advise the Council of Australian Governments (COAG) to continue to fund the education and training of tradespeople, to meet the growing demand for energy saving technologies.

- Advise COAG to support initiatives such as the Green Plumbing Centre in Victoria, an initiative of MPMSAA and the PECU.
- Work and consult with educational organisations such as Skills Victoria and TAFE institutes, to help develop best practice methods and training programs for alternative heating and cooling systems.

Education and Training Organisations

It is recommended that Skills Victoria and other state training authorities work with industry and consult with groups such as the Plumbing Training Moderation Group of Victoria (PTMG) to develop best practice in training and education for new and emerging technologies in order to meet the needs of industry and consumers. Part of this may involve the development of new units of competency and nationally accredited qualifications.

In view of the findings in this report, Australian education and training organisations are encouraged to:

- Continue to consult with industry about their requirements for training in new and emerging technologies.
- Continue to fund training programs that up-skill trade teachers.
- Enable trade teachers to participate in training so they can gain competence in GSHP and biomass boiler heating systems.
- Fund further teacher exchange programs and networking opportunities in areas such as Europe, where these technologies are widely used.

ISS Institute

It would be valuable if the ISS Institute participated alongside government, educational bodies and industry in the:

- Support of tradespeople to undertake professional development activities such as Fellowship programs.
- Provision of incentives for tradespeople to further investigate emerging plumbing and heating technologies.
- Development and implementation of accredited training in biomass boiler and geothermal heating systems.
- Support of tradespeople in the development of new ideas.
- Support of tradespeople to build international networks that will facilitate the exchange of skills and technology.

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