

WATER TRANSFORMED:

SUSTAINABLE WATER SOLUTIONS FOR CLIMATE CHANGE ADAPTATION

MODULE B: ADAPTING TO CHANGES IN WATER AVAILABILITY - INDUSTRIAL & COMMERCIAL SECTORS

This online textbook provides free access to a comprehensive education and training package that brings together the knowledge of how countries, specifically Australia, can adapt to climate change. This resource has been developed formally as part of the Federal Government's Department of Climate Change's Climate Change Adaptation Professional Skills program.

CHAPTER 3: IDENTIFYING & IMPLEMENTING WATER EFFICIENCY & RECYCLING OPPORTUNITIES BY INDUSTRY SECTOR

LECTURE 3.1: THE MANUFACTURING SECTOR - NON-FOOD INDUSTRIES

© The Natural Edge Project ('TNEP'), 2009

Copyright of this material (Work) is owned by the members of the research team from The Natural Edge Project, based at Griffith University and the Australian National University. The material contained in this document is released under a Creative Commons Attribution 3.0 License. According to the License, this document may be copied, distributed, transmitted and adapted by others, providing the work is properly attributed as: 'Smith, M., Hargroves, K., Desha, C. and Stasinopoulos, P. (2009) *Water Transformed - Australia: Sustainable Water Solutions for Climate Change Adaptation*, The Natural Edge Project (TNEP), Australia.'

Document is available electronically at http://www.naturaledgeproject.net/Sustainable_Water_Solutions_Portfolio.aspx.

Disclaimer: While reasonable efforts have been made to ensure that the contents of this publication are factually correct, the parties involved in the development of this document do not accept responsibility for the accuracy or completeness of the contents. Information, recommendations and opinions expressed herein are not intended to address the specific circumstances of any particular individual or entity and should not be relied upon for personal, legal, financial or other decisions. The user must make its own assessment of the suitability of the information or material contained herein for its use. To the extent permitted by law, the parties involved in the development of this document exclude all liability to any other party for expenses, losses, damages and costs (whether losses were foreseen, foreseeable, known or otherwise) arising directly or indirectly from using this document. This document is produced for general information only and does not represent a statement of the policy of the Commonwealth of Australia. The Commonwealth of Australia and all persons acting for the Commonwealth preparing this report accept no liability for the accuracy of or inferences from the material contained in this publication, or for any action as a result of any person's or group's interpretations, deductions, conclusions or actions in relying on this material.

Acknowledgements

The Work was produced by The Natural Edge Project supported by funding from the Australian Government Department of Climate Change under its '*Climate Change Adaptation Skills for Professionals Program*'. The development of this publication has been supported by the contribution of non-salary on-costs and administrative support by the Griffith University Urban Research Program, under the supervision of Professor Brendan Gleeson, and the Australian National University Fenner School of Environment and Society and Engineering Department, under the supervision of Professor Stephen Dovers.

Chief Investigator and Project Manager: Karlson 'Charlie' Hargroves, Research Fellow, Griffith University.

Principle Researchers: Dr Michael Smith, Research Fellow, ANU; Cheryl Desha, Research Intensive Lecturer, Griffith University, and Peter Stasinopoulos, Research Officer Griffith University.

Research Support: Angie Reeves, Research Officer Griffith University, and Stacey Hargroves, Professional Editor, Griffith University.

Peer Review

Claire Hammond, Water Efficiency Specialist, Every Drop Counts Business Program, Sydney Water Corporation. Dennis Lee, Water Efficiency Specialist, Every Drop Counts Business Program, Sydney Water Corporation. Anntonette Joseph, Director, Urban Water Efficiency Initiatives, Commonwealth Department of Environment, Water, Heritage and The Arts.

Review for this program was also received from: Alex Fearnside, Leader of the Sustainability Team, Melbourne City Council; Alison Scotland, Sydney Water Corporation; Anna MacKenzie, ACT representative, Australian Association of Environmental Education and Deputy Principal Campbell Primary School; Anntonette Joseph, Director, Urban Water Efficiency Initiatives, Commonwealth Department of Environment, Water, Heritage and The Arts; Barry Coker and Jeffrey Briggs, St Andrews Hospital, Brisbane; Dr Barry Newell, ANU Fenner School of Environment and Society, Facilitator of ANU Fenner School of Environment and Society's Climate and Water Integration Group; Caleb Furner, Sydney Water Corporation; Carl Binns, Sydney Water Corporation; Cheryl Davis, International Water Association; David Dumaresq, ANU Fenner School of Environment and Society, Senior Lecturer Human Ecology, Agro-ecology, and Sustainable Systems; Glenn MacMillan, Genesis Now Pty Ltd; Jill Grant, Director Sustainable Development, Commonwealth Department of Resources, Energy and Tourism; Karen Jacobson, Commonwealth Department of Resources, Energy and Tourism; Kevin Moon, Institute of Hospital Engineering Australia; Kieran Coupe, Manager, MeterMate, Water and Energy Managers; Nick Edgerton, AMP Capital Sustainable Share Fund (formerly the Institute for Sustainable Futures, University of Technology Sydney, Australia); Para K Parameshwaran, Sydney Water Corporation; Adj. Prof Paul Perkins, Australian National University, Chair, Environment Industry Action Agenda and Barton Group; Dr Marguerite Renouf, Director UNEP Working Group for Cleaner Production, University of Queensland; Phil Smith, President of the Australian Association of Environmental Education; Rob McKenna, Energy Saving Specialist, Water & Energy Programs, NSW Department of Environment and Climate Change; Sally Armstrong, Sydney Water Corporation; Stan Scahill, The Institution of Engineers Australia (Biomedical Engineering College); Stephen Fahey, Environment Officer (Energy & Water), ANU Green; Victoria Hart, Facilitator and Program Director, Sustainability Victoria; and Vivian Filling, Australia Industry Group.

Enquires should be directed to: Karlson 'Charlie' Hargroves (www.naturaledgeproject.net/contact.aspx)

Adapting to Changes in Water Availability - Industrial & Commercial Sectors

Lecture 3.1: The Manufacturing Sector – Non-Food Industries

Educational Aim

This lecture provides an overview of water saving opportunities available in the manufacturing sector, focusing on possibilities for factory operations. The lecture also includes examples of water saving achievements in paper, chemicals and plastics, automotive, carpet, glass, pharmaceuticals, aluminium, steel and cement manufacturing industries.

Learning Points

1. Manufacturing is a vital part of the Australian economy, averaging 1.5 per cent growth per year over the last 30 years and contributing an estimated \$96 billion dollars to the Australian economy in the 2005-2006 financial year.¹ However, the last three decades of significant regulatory and market changes have forced large parts of the sector to change, including the need to become more outwardly focussed, manufacture higher value goods, and to develop niche products for global markets or mass-produced goods for global supply chains. Today the Australian manufacturing sector comprises a diverse mix of industries engaged in transforming materials, substances or components into consumer or industrial goods. This includes chemically, mechanically, or physically processing anything from fabricated metals, food and beverages, wood, wood products and furniture, clothing and footwear, to paper, printing and publishing, and basic metal products.
2. In 2004-2005, the Australian manufacturing industry used an estimated 7 per cent (589 GL) of Australia's total water consumption, which was 9 per cent higher than in 2001-2002² and which is expected to continue climbing.³ Over the same period, the sector increased its water reuse to just 2 per cent of its total consumption, from 7 GL to 13 GL.⁴ However, a 2007 Australian Industry Group survey of its manufacturing members found close to 45 per cent of respondents considered reduction of water use as a major priority, after cutting carbon dioxide emissions, and more than three quarters of respondents predicted price rises of up to 30 per cent over the next 5 years.⁵ There is clearly a growing understanding within the sector that water saving opportunities need to be addressed as part of business planning and risk management. Leadership examples are provided in the Brief Background Information.
3. Within the manufacturing sector, a wide variety of opportunities exist to achieve water savings, as highlighted in the following learning points for factory operations. This includes identifying end-user opportunities (for example expectations regarding whether the product is washed), checking the functionality of water handling equipment in the factory (i.e. for leaks and

¹ Australian Chamber of Commerce and Industry (2007) *The Future of Australia's Manufacturing Sector: A Blueprint for Success*, Issues Paper, March 2007, p1.

² Trewin, D. (2006) '4610.0 – Water Account Australia, 2004-2005', Commonwealth of Australia, p80.

³ SaveWater! (undated) 'Manufacturing', www.savewater.com.au/how-to-save-water/in-business/manufacturing, accessed 21 August 2009.

⁴ Trewin, D. (2006) '4610.0 – Water Account Australia, 2004-2005', Commonwealth of Australia, p80.

⁵ Australia Industry Group 2007 Industrial Water survey, cited in Collins, R. (2007) 'Talking Water', *Industrial Water Supplement*, Waste Management and Environment (WME), pp32-33.

efficiency), and in considering the potential for using alternatives to mains water supply (for example rainwater, stormwater and recycled water). The process may be undertaken informally in various parts of the manufacturing plant, or alternatively there may be a formal 'water audit' with an appointed coordinator responsible for presenting the results to senior management, and future reviews.

4. *End-User Considerations (Manufacturer/Consumer)*: Taking a systems approach to water management can be a valuable tool in identifying opportunities to save water usage whilst meeting the needs of the manufacturer and the consumer (i.e. their clients/ supply chain).⁶ A useful sequence to use here is to first try to avoid and reduce water usage before then investigating opportunities to save water through reuse and recycling. Water usage can be avoided. Client requirements for the finished product may not require a final wash-down of the product at the point of manufacture, or may not require a particular type of water-intensive finish. reduce water usage. Avoiding water usage and improving water efficiency are the most profitable ways to save water and hence should be focused on first. For example, reducing water use not only saves on water costs for the manufacturer, but can also reduce the costs and environmental impact of heating water (such as energy demand), reduce the demand for water pumping, reduce the use of chemicals (for manufacturing processes or water treatment), reduce hydraulic loading for wastewater treatment and reduce the environmental risks and costs involved in dealing with potential wastewater spills, overflows and leaks.⁷.
5. *Identifying and Repairing Leaks*: Water leaks ranging from dripping taps to ruptured underground pipes, which often go undetected, can cost a several thousands of dollars per year.⁸ Hence, identifying and repairing water leaks is often the most cost effective of all water efficiency measures and is best done first in order to ensure that any measure of baseline water consumption is accurate. Leaks can be identified by metering and monitoring (see below), where if there is a base flow (i.e. a constant flow of water when nothing is on in the factory), then it is likely that there is a leak.
6. *Metering and Monitoring*: Properly maintaining water-using equipment and appliances will help manage water use and prevent wasting water, including the identification of any leaks, enhancing the effectiveness of a plant maintenance plan. Metering involves ensuring that there is an operational water meter at the entry point to the factory which records how much water is being consumed. It may also involve installing additional meters along the manufacturing process. Monitoring may be visual (i.e through inspections), or alternatively automated monitoring systems can regularly log water use at one or more points in the system.⁹ Automated systems typically use sub-meters to measure water use at key component junctions in a building's plumbing.
7. *Redesigning Manufacturing Processes*: For some manufacturing processes, there may be opportunities to take advantage of technology substitutions that reduce or eliminate water demand. This might range from simple substitutions such as sweeping rather than hosing, to investing in hybrid wet/dry cooling systems and dry lubricant systems, and redesigning products and processes to be zero discharge or totally effluent free. In a typical manufacturing plant,

⁶ Stasinopoulos, P., Smith, M., Hargroves, K. and Desha, C. (2008) Whole System Design: An Integrated Approach to Sustainable Engineering, Earthscan, London, and The Natural Edge Project, Australia.

⁷ SaveWater! (undated) 'Manufacturing', www.savewater.com.au/how-to-save-water/in-business/manufacturing, accessed 21 August 2009; Sydney Water (2005) 'Solutions: Leaks Waste More than Water', *The Conserver*, no 8, p15.

⁸ Sydney Water (2005) 'Solutions: Leaks Waste More than Water', *The Conserver*, no 8, p15.

⁹ Sydney Water (undated) 'Factsheet: Monitoring and Maintenance',

<http://www.sydneywater.com.au/Publications/FactSheets/SavingWaterMonitoringAndMaintenance.pdf>, accessed 2 September 2009.

cleaning might use around 35-44 per cent of all water consumed, so reducing water consumption for cleaning can considerably reduce total water usage, through dry cleaning and other such emerging technologies.¹⁰ For example, as water is often delivered as a spray or jet, various technologies, such as spray nozzles¹¹ and spray guns¹² enable less water to deliver better spray characteristics. Waterless (dry) conveyor lubricants¹³ can also eliminate water demand and help to create a safe working environment.

8. *Optimising Cooling for Products, Equipment and the Plant:* Cooling in factories is most often undertaken through directly spraying or rinsing with cool water, or through a heat exchange process with air, as in an air conditioning unit. In cooling towers which are associated with large-scale air conditioning, the water is cooled via an evaporation process, which uses a significant amount of water.¹⁴ The most cost effective way to reduce cooling tower water usage is to reduce the demand for air-conditioning, for example through passive thermal insulation, outside shading, low radiant heat lighting. and window glass tinting. These measures will also save energy. The water efficiency of cooling towers can also be improved through, reducing overflow (the source of up to 40 per cent of water used), and reducing the need to bleed off part of the coolers reservoir due to the build up of particulates and minerals (the source of up to 25 per cent of water used).¹⁵ There are also newly developed hybrid wet/dry cooling systems¹⁶ which use 4-5 times less water and only 5 per cent more energy than water cooled systems. Sydney Water's Every Drop Counts Business Program conducted a small study of cooling towers in April 2009.¹⁷ From the study, three main recommendations were common to almost all sites to ensure efficiently running cooling towers. These were: routine maintenance of the cooling tower and automated control systems; monitor water use and conductivity; and optimise cycles of concentration.
9. *Optimising Steam Systems:* Steam systems are used to produce and deliver steam for climate control, process heating, cooking and turbines. The largest opportunities for water efficiency improvements are in installing steam traps and condensate return systems.¹⁸ Steam traps remove condensate and incondensable gases (such as air), from the distribution system while allowing dry steam to pass. The condensate and gases are then returned through the condensate return system to the boiler for reuse. This setup not only saves water, but also saves water softeners and chemicals that are used to pre-treat the water; and saves energy since condensate contains up to 12 percent of the steam's initial heat. Every 5°C increase in the temperature of the water into the boiler will reduce the boiler's fuel consumption by 0.7 percent.¹⁹

¹⁰ Sydney Water (undated) 'Factsheet: Spray Guns', <http://www.sydneywater.com.au/Publications/Factsheets/SprayGuns.pdf>, accessed 1 June 2009.

¹¹ Sydney Water (undated) 'Factsheet: Spray Nozzles', <http://www.sydneywater.com.au/Publications/Factsheets/SprayNozzles.pdf>, accessed 1 June 2009.

¹² Sydney Water (undated) 'Factsheet: Spray Guns', <http://www.sydneywater.com.au/Publications/Factsheets/SprayGuns.pdf>, accessed 1 June 2009.

¹³ Sydney Water (2007), 'Solutions: Dry Lubes Smooth the Way to Water Saving', *The Conserver*, no 12, pp18-19.

¹⁴ Alliance for Water Efficiency (undated) Introduction to Cooling Towers, www.allianceforwaterefficiency.org/cooling_tower_intro.aspx, accessed 18 August 2009.

¹⁵ Australian Institute of Refrigeration Air Conditioning and Heating (AIRAH) (2009) 'DA17 Application Manual: Cooling Towers', AIRAH; Sydney Water (2007) 'Best Practice Guidelines for Water Conservation in Commercial Office Buildings and Shopping Centres', Sydney Water Corporation, Sydney South, New South Wales, Australia, pp66-71; Quinn, R., Bannister, P., Munzinger, M. and Bloomfield, C. (2006) 'Water Efficiency Guidelines: Office and Public Buildings', Commonwealth of Australia, Canberra, Australia, pp 12-18; Sydney Water (2007) Water Conservation: Best Practice Guidelines for Cooling Towers in Commercial Office Buildings, Sydney Water Corporation, Sydney South, New South Wales, Australia, pp6,10.

¹⁶ Sydney Water (2006), 'Solutions: Hybrid Cooling Towers', *The Conserver*, no 10, p16; Sydney Water (2007) Water Conservation: Best Practice Guidelines for Cooling Towers in Commercial Office Buildings, Sydney Water Corporation, Sydney South, New South Wales, Australia, pp14,19-20.

¹⁷ Sydney Water (2009), 'Tower of water loss', *The Conserver*, No 19, pg 14)

¹⁸ Sustainability Victoria (2006) 'Fact Sheets and Calculation Fact Sheets: Boiler Optimisation', Victorian State Government, Australia; Sydney Water (2004), 'Solutions: Steam Systems – Recycle and Save', *The Conserver*, no 6, pp15-16.

¹⁹ Australian Greenhouse Office (2005) 'Energy Audit Tool: Boilers', AGO, Australia,.

10. *Alternatives to Using Mains Water:* Demand and hence cost for mains water supply can be reduced by capturing rain water. Water can be recycled in cooling towers, vacuum pumps, evaporative coolers, sanitation and wash down bays, and for washing trucks, potentially requiring treatment and some heating or cooling prior to use. For example, textile mills can reuse bleaching rinse water for initial textile washing. One of the most common opportunities to reuse water is in manufacturing processes where products are rinsed several times. In these situations it may be suitable to reuse final rinse water (i.e. the cleanest), for earlier rinsing steps. For example, beverage manufacturers can reuse rinse water from bottle washers for washing crates washing or washing the floor.²⁰

Brief Background Information

In recent years, the manufacturing industry has increased activity in water efficiency, largely driven by the expectation of 30-40 per cent higher water costs.²¹ Figure 3.1.1 shows the results of a survey by The Australian Industry Group on the types of water efficiency measures implemented by manufacturers.

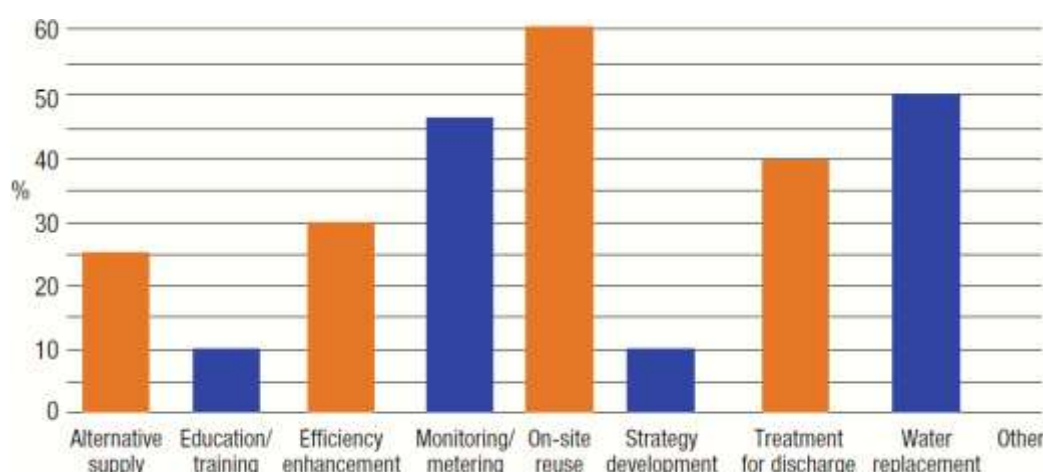


Figure 3.1.1 Major project types for water saving in Australian manufacturing

Source: Australia Industry Group²²

Further to the Learning Points, the following paragraphs provide evidence to support a systematic approach to water management.

Metering and Monitoring: The simplest form of monitoring is to take daily water meter readings. If there is a large and unexpected change, then some equipment or appliances may require attention. This simple form of monitoring does not indicate which components are faulty nor whether there is any unnecessary base load water usage. A more sophisticated form of monitoring is to install an automatic monitoring system,²³ which automatically logs the water usage of various components at regular intervals. These systems typically use sub-meters to measure water usage at key locations in the facilities plumbing network. Automatic monitoring systems can sound alarms to alert managers

²⁰ Alliance for Water Efficiency (undated) 'Manufacturing Introduction', www.allianceforwaterefficiency.org/Manufacturing_Introduction.aspx, accessed 18 August 2009.

²¹ Australia Industry Group cited in Collins, R. (2007) 'Talking Water', *Industrial Water Supplement*, Waste Management and Environment (WME), pp32-33.

²² Australia Industry Group cited in Collins, R. (2007) 'Talking Water', *Industrial Water Supplement*, Waste Management and Environment (WME), p33.

²³ Sydney Water (undated) 'Factsheet: Monitoring and Maintenance', <http://www.sydneywater.com.au/Publications/FactSheets/SavingWaterMonitoringAndMaintenance.pdf>, accessed 2 September 2009.

of unusual water usage. These systems can also help identify water efficiency opportunities as part of a water audit. For example, Bonds Industries, at its Wentworthville site, conducted a water audit and identified that its fabric dyeing process used 70 per cent of the nearly 880kL of potable water used per day on the site, and this led to the identification of six water efficiency opportunities that would reduce the site's water consumption by 214kL.²⁴ *Identifying and Repairing Leaks*: Water leaks can range from a dripping tap or a poorly fitting seal, to a ruptured underground or in wall pipe.²⁵ These, leaks, which often go undetected, can cost a several thousands of dollars per year in water cost, as well as causing water damage to buildings and equipment. Leaks can be identified on the site scale by looking at demand when the site is inactive, and can be located within a site by monitoring readings from a system of meters that can create zones to narrow down the source of the unwanted demand.

Optimising Product Cleaning and Preparation, and Plant Cleaning: Cleaning uses about 35-44 per cent of all water used on a typical manufacturing plant, thus reducing water consumption in cleaning tasks can considerably reduce total water usage.²⁶ Water is often delivered to the end use as a spray or jet. There are various technologies, some simple, some highly engineered, that enable less water to deliver better spray characteristics.

- *Water efficient spray nozzles*: Spray nozzles are precision components that can play critical roles in many manufacturing processes and site sanitation.²⁷ When appropriately selected, these components have many benefits, including reducing water consumption and hence chemical consumption and cost, improving cleaning efficiency and enabling accurate control of fluid flow rates. For example, Coca-Cola Amatil, at its Northmead site, replaced a number of spray nozzles on two bottling lines with water efficient nozzles that performed better and reduced water usage by 46 per cent, saving 37,400 kL and AU\$78,500 per year. Spray nozzles are typically used for tasks such as cleaning, coating, cooling, spray drying, humidifying and air and gas scrubbing. Water usage can be further reduced by setting spray nozzles to activate only when needed, such as via a sensor trigger, pedal trigger or timer.²⁸ Despite their critical role, spray nozzles do not usually feature in a plant's maintenance schedule, resulting in the use of damaged nozzles that produce spray with less pressure, at narrower angles and with less coverage, and hence can waste as much as 30 per cent of the water. Nozzle damage can occur due to wear, corrosion by chemicals, breakdown by high temperature fluids, caking and clogging of solids, and accidental damage.
- *Water efficient spray guns*: The simplest way to reduce cleaning and wash-down water consumption is to install and maintain spray nozzles and spray guns on open hoses and cleaning equipment.²⁹ These components deliver a better cleaning jet while providing many benefits, including reducing water consumption and hence chemical consumption and cost, improving cleaning efficiency, enabling variable control of fluid flow rates and being manoeuvrable. Water usage is reduced mainly from reducing the water flow rate from 30 L/min to 20 L/min and from avoiding having the water flowing while turning the hose on and off from the tap. For example,

²⁴ Sydney Water (2005), 'Chesty Bonds Gets Water Smart', *The Conserver*, no 12, pp14-15.

²⁵ Sydney Water (2005) 'Solutions: Leaks Waste More than Water', *The Conserver*, no 8, p15.

²⁶ Sydney Water (undated) 'Factsheet: Spray Guns', <http://www.sydneywater.com.au/Publications/Factsheets/SprayGuns.pdf>, accessed 1 June 2009.

²⁷ Sydney Water (undated) 'Factsheet: Spray Nozzles', <http://www.sydneywater.com.au/Publications/Factsheets/SprayNozzles.pdf>, accessed 1 June 2009.

²⁸ SaveWater! (undated) 'Industry Advice for Saving Water', www.savewater.com.au/how-to-save-water/in-business/manufacturing/industry-advice, accessed 17 August 2009.

²⁹ Sydney Water (undated) 'Factsheet: Spray Guns', <http://www.sydneywater.com.au/Publications/Factsheets/SprayGuns.pdf>, accessed 1 June 2009.

Arnott's SnackFoods, at its Smithfield site, improved cleaning practices and equipped hoses with spray guns and reduced water usage by 10 kL/day, saving AU\$25,000 per year on water costs, sewerage charges and heating costs – a simple payback of less than three months.

- *Waterless conveyor lubricants*: Bottling lines are usually lubricated by being sprayed by water, a practice that not only consumes large amounts of water but also creates a damp, slippery and potentially unsafe working environment. Comprehensive maintenance of these lubrication systems – such as ensuring that spray nozzles are correctly directed, provide water at the correct rate and stop when the line is idle – can reduce water usage by up to 45 per cent. However, greater reductions in water usage can be achieved through the use of dry lubricants, such as Teflon or a silicone formulation (90 per cent silicone, 10 per cent water), which are applied through drip nozzles. Several companies have reaped the benefits of switching to dry lubricants. For example, Cadbury Schweppes is using dry lubricants in 12 bottling lines across Australia, saving about 42 ML per year. In another example, in 2005-2006, Coca-Cola Amatil used dry lubricants in nine bottling lines across Australia, saving about 20 ML per year and, once all lines are converted, expects to save about 75 ML per year.³⁰

Installing a Rain Water Harvesting System: Demand for mains water supply can be reduced by capturing rain water from rooftops then storing it in tanks for use throughout the site. Depending on the application, the water may require treatment, although it is usually quite 'clean' to begin with. While the potential to use rain water depends on the rainfall pattern of the local area, rain water harvesting systems are often cost effective due to their low operating costs. Nestlé Foods, at its Pakenham site in Melbourne, installed a rain water harvesting system that captures rain water from the rooftops of three factory buildings and stores it in two treatment tanks with a combined capacity of 1.2ML, saving and expected 5ML per year.³¹

Reusing and Recycling Water: Recycled water can be used in cooling towers, vacuum pumps, evaporative coolers, sanitation and wash down bays, and for washing trucks. Compared to rain water harvesting, reusing recycled water has the advantage of supplying water year round and is often well matched with demand. Between 2003 and 2007, Bonds Industries, at its Wentworthville site, has reduced water usage per kilogram of fabric bleached from 43L to 12L by reusing process water. Bonds will also reuse the process water from its textile bleaching and dyeing processes, saving 50ML per year.³²

Water Saving Examples by Industry

Companies across the manufacturing industry are achieving considerable water savings as highlighted in the following examples for a number of large water consumers:

Paper Manufacturing

In 2003-2004, the Australian paper manufacturing industry used an average of 26.7 tonnes of water (kL) per tonne of production, a 65 per cent reduction in water usage per tonne since 1990.³³ This reduction was achieved by major developments in many Australian paper mills. For example, Visy Tumut Paper and Pulp mill achieved an 80 per cent reduction in average water consumed by pulp and paper mills compared to elsewhere in the world. No water is now discharged off the site, and

³⁰ Sydney Water (2007), 'Solutions: Dry Lubes Smooth the Way to Water Saving', *The Conserver*, no 12, pp18-19.

³¹ Waste Management and Environment (WME) (2008) *Industrial Water Supplement*. WME: Collins, R. and Lamb, G. (2008) 'Rainwater gets the treatment', *Industrial Water Supplement*, Waste Management and Environment (WME), pp30-31

³² Sydney Water (2005), 'Chesty Bonds Gets Water Smart', *The Conserver*, no 12, pp14-15.

³³ Prosser, M., Smith, M., Hargroves, K. and Toyne, P. (2006) 'A3P Sustainability Action Plan: Performance, People and Prosperity', www.a3p.asn.au/admin/assets/pdf/A3P_SAP_2008_5.pdf, accessed 1 June 2009.

treated waste water is used for the irrigation of pastures.³⁴ Norske Skog Paper Mills at the Boyer mill in Tasmania has reduced water usage by 40 per cent since 1988. At its Albury plant, water is reused up to 20 times before it is thoroughly treated to a standard suitable for use in a 310 hectare irrigated forest and dam complex adjacent to the Mill.³⁵ In Gippsland, Victoria, the Maryvale pulp and paper mill was designed to maximise the amount of water recycled and reused during production.³⁶ To reduce freshwater usage the mill treats and reuses around 6 ML/day and also incorporates 8 ML/day of recycled 'A-Grade' water that has been treated at the nearby Gippsland water treatment plants.³⁷

Chemicals and Plastics Manufacturing

Water is used by chemical and plastic companies directly in the manufacture of many materials and products – plastics, paints, fertilizers, inks, adhesives – and is critical for many process stages such as cooling, heating (steam), separating, and cleaning. Water savings are possible through each of these stages either through efficiency improvements or reuse, recycling and treatment. Qenos provides an example of possibilities. As the sole manufacturer of ethylene and polyethylene in Australia, Qenos' Victoria plant is one of the largest manufacturing plants in the state and has some of the highest water consumption and wastewater disposal levels. In 2002 the company embarked on a water efficiency programme, to reduce water consumption by 30 per cent and trade waste by 46 per cent over the following four years. Qenos has subsequently achieved this, reducing its potable water usage and trade waste disposals by 400 ML of water per year through installing new pipes and pumps, changing the treatment processes for some of the water uses at the plant and upgrading the biological treatment plant, at a cost of AUD\$5 million. In addition to these improvements, Qenos will receive 6 ML of recycled water per day from the Altona Treatment Plant of Melbourne water retailer, City West Water, further reducing their potable water consumption by 2 GL a year.³⁸ Furthermore, Australian Vinyls, the sole manufacturer of polyvinyl chloride (PVC) resin in Australia, operates out of Laverton, in Melbourne's west with a wide range of applications, from making pipes, to flooring, cable, hoses, window frames and packaging. The company has already implemented many water efficiency measures and improved aspects of the plant, which have reduced water consumption from 6.7 kL per tonne of PVC in 2001 to 4.5 kL per tonne in 2006-07. To achieve further reductions the company developed a filtration system over 18 months for PVC production effluent to remove adhesive suspended solids. The final design was chosen not just for water recovery efficiency, but also for its energy efficiency and minimal need for manual operation. As of late 2009, the full scale recycling plant is able to recover 326 ML per year, equivalent to a water recovery efficiency of 73 per cent and reducing consumption of mains water to 2.2 kL per tonne of PVC – a 67 per cent efficiency improvement from its initial 2001 consumption rates.³⁹

Automotive Manufacturing

³⁴ Toyne, P., Tate, A., Hargroves, K. and Smith, M. (2003) 'Sustainability Framework for the Future of Australia's Infrastructure Handbook', Australian Council for Infrastructure and Development.

³⁵ The Newsprint Producer/Publisher Group (2005) 'National Environmental Sustainability Plan (Newspapers) 2006-2010', The Newsprint Producer/Publisher Group.

³⁶ Australian Paper (undated) MaryVale Pulp Mill. Australian Paper, http://www.australianpaper.com.au/mills_mvale.htm accessed 1 October 2009

³⁷ Australian Paper (undated) MaryVale Pulp Mill. Australian Paper, http://www.australianpaper.com.au/mills_mvale.htm accessed 1 October 2009

³⁸ Plastics and Chemicals Industries Association (2009) 'PACIA REWARDS Company Project – Qenos Sour Water Reuse 2008', PACIA, Abbotsford, Victoria, Australia; South East Water – Industry Innovators.

³⁹ Plastics and Chemicals Industries Association (2009) 'PACIA REWARDS Company Project – AV Water Reuse Feasibility Project 2009', PACIA, Abbotsford, Victoria, Australia.

Significant water saving are achievable in the automotive sector.⁴⁰ For example, Holden has worked in collaboration with the water utility South East Water to monitor, analyse and reduce its water consumption, and has had water saving initiatives in place for over 8 years. Through operational efficiency, wastewater management and culture and education initiatives, the total water Holden consumed per engine produced between 2002 and 2005 dropped 25 per cent.⁴¹ Toyota, Australia also has made a strong public commitment to reducing water waste by 25 per cent reduction that will save 42 ML per year through 12 key water saving projects. For instance, one of the projects is reducing seal flush water for the pumps on the 'unit parts' paint line. As the Australian Industry Group describes, *'The pumps' seals for this area currently require high quality water (generated using reverse osmosis) to ensure operation. By implementing a recovery system to recirculate the high quality water, Toyota plans to save over 3 ML of precious drinking water each year'*.⁴²

Carpet Manufacturing

Godfrey Hirst Australia, Geelong-based carpet and floor covering manufacturer, reduced water consumption by 32.5 per cent (85 ML per year) in its carpet dyeing operations by recycling the water used in the process. An audit identified the carpet dyeing process as the process with the greatest potential for water savings. The company uses large liquid ring vacuum pumps to extract the excess water from dyed carpet. The pumping action is achieved by a rotating ring of potable water, called 'seal water', inside a cylindrical housing. Prior to the audit, the seal water was continuously discharged from the vacuum pumps. The company developed a closed loop system to capture and treat the seal water and then reuse it in the pumps. The new system introduced several new components, including fibre removal systems, a heat exchanger/cooling tower system, continual monitoring equipment, extensive piping and plumbing networks, and electrical control systems that ensure that the vacuum pumps never run without seal water. Nonetheless, the company is confident that costs of the setting up the new system will be recovered by the water saving.⁴³

Glass Manufacturing

Pilkington (Australia) Limited, specialist manufacturers of automotive glass, reduced water consumption in their Geelong factories by 61 per cent (70,000 kL per year) between 1999 and 2003, including a reduction of 25 per cent in 2003 alone. The reduction was the result of four major projects: recycling rinse water in glass washing machines, using recycled cooling water for the glass toughening furnace, recycling grinding fluids in new glass grinding machines, and linking the old machine to a recirculation system.⁴⁴

Pharmaceuticals Manufacturing

AstraZeneca is a global pharmaceutical company with operations in over 100 countries, and 24 manufacturing facilities in 19 countries. All of these facilities use water and subsequently discharge wastewater, which then requires treating either onsite or by the local municipality. Nine of the facilities are located in countries which are under either 'high' or 'medium' water stress according to the United Nations' Environment Programme (UNEP), and as a result AstraZeneca is undertaking

⁴⁰ Parsons Brinckerhoff (2008) 'Water Efficiency in Automotive and Metal Manufacturing', The Australian Industry Group, Australia.

⁴¹ South East Water (undated) 'Water Innovators: Holden', www.sewl.com.au/personal/community/IndustryInnovators/Pages/default.aspx, accessed 1 October 2009

⁴² Australia Industry Group (AIG) (undated) Case Study - Toyota Motor Company Australia. AIG http://pdf.aigroup.asn.au/environment/TOYOTA_case_study.pdf accessed 1 October 2009

⁴³ SaveWater! (undated) 'Godfrey Hirst Australia Pty Ltd', www.savewater.com.au/programs-and-events/savewater-awards/past-winners-finalists/2005-winners/godfrey-hirst, accessed 2 September 2009.

⁴⁴ SaveWater! (undated) '(2004) Savewater! Award Winners', www.savewater.com.au/programs-and-events/savewater-awards/past-winners-finalists/2004-winners, accessed 2 September 2009.

efforts globally to reduce the water intensity of their operations and has reduced its water consumption intensity decreased by 43 per cent, from 300 kL/US\$million sales in 2003, to 170 kL/US\$million sales in 2007.⁴⁵

Country-based achievements include:

- In Australia, Sydney Water's 'Every Drop Counts' programme has identified water saving opportunities, with the results now being tracked. The company has also implemented a Water Reclaim System and has rationalised production to a single water efficient plant.
- In China, efficiency measures have reduced the amount of water used for cooling, while an active water minimisation programme has also been introduced to limit overall consumption.
- In India, a water treatment plant has been constructed at the AstraZeneca research and development site, through which 90 per cent of the process water is recycled and being used for garden irrigation.
- In Brazil, water used for process-cooling is recycled and used for site maintenance. The site runs an Annual Water Week event to remind all employees of the need to be water efficient and a committee has been formed to identify ways of reducing water consumption.
- In France, a softened water treatment system has been optimised in order to limit water consumption and wastewater release.
- In Mexico, a reverse osmosis plant has enabled fresh water consumption and wastewater release to be reduced.

Aluminium Manufacturing

Alcoa, a global aluminium production company, has reduced the water usage and discharge at its Saint Cosme facility in France by 85 per cent through making changes to their manufacturing processes. The facility specialises in the manufacture of aluminium nuts where newly manufactured parts are sat in a salt bath to harden and are then rinsed with water to remove the salt. Previously, the rinse water was discharged into a nearby creek, however the installation of a closed-loop rinsing and cooling circuit, has enabled the facility to reuse this water. The water is sent to an evaporator, where the salt is removed and recovered for reuse in the salt bath, while the remaining salt-free water is returned to the system to be reused as rinse water. The company has also implemented processes that recirculate the water used for cooling the furnaces, which involves passing the water through a refrigeration unit to chill it before returning it to the furnace for reuse. These two measures have reduced the facility's water consumption by 180,000 kL per year and also save around 13 tonnes of salt per year.⁴⁶

Steel Manufacturing

CST a subsidiary of Arcelor in Brazil uses sea water for 96 per cent of the total water used for steel manufacturing in their plant, all but eliminating the use of freshwater.⁴⁷ Furthermore, through an investigation of process improvement opportunities the BlueScope Steel's Port Kembla Steelworks (90 km south of Sydney) has shown that 80 per cent improvements in water productivity can be

⁴⁵ AstraZeneca (undated) 'Biodiversity, Land and Water Use', www.astrazeneca.com/responsibility/sustainable-production/?itemId=3887857, accessed 27 August 2009.

⁴⁶ Alcoa (2005) 'Process Changes Result in 85% Reduction in Water Usage, Discharge', Alcoa..

⁴⁷ International Iron and Steel Institute (2005) *Steel: The Foundation of a Sustainable Future*, Sustainability Report of the World Steel Industry 2005.

achieved in oxygen blast furnace steel making, reducing from 55 ML to 9 ML per day of freshwater in 2005.⁴⁸ The large potable water savings were achieved by both using treated sewerage water in the cooling towers and for dust suppression and through increasing re-use and recycling of water between different parts of the plant. Furthermore, as outlined in detail in the 2009 book *'Factor Five'*,⁴⁹ steel manufacturers can achieve significant improvements in water productivity improvements by switching from oxygen blast furnace steel making to electric arc furnaces. For example, a 1994 study found that, *'electric arc steel furnaces (EAF) use ... one-eighth of the water... compared with traditional basic-oxygen blast furnace (BOF) steel plants.'*⁵⁰ In electric arc furnaces water is mainly used for cooling and most modern furnaces are equipped with water-cooled panels in the upper half of the sidewall where water is also used to cool the lance, a key part of the electric arc furnace and allowing recirculating of cooling water.⁵¹

Cement Manufacturing

Portland Cement production technologies involve two basic processes, 'dry' and 'wet', where the wet process was developed to improve chemical uniformity of the raw materials, a deficiency in original dry kilns. However, wet production technologies use high-moisture raw limestone feed to allow for better control of the chemistry and texture of the cement, and require around 34 per cent more energy due to the need to evaporate the water. Technological improvements in grinding raw materials gradually improved the chemical uniformity of the clinker, enabling producers to return to the dry process and benefit from its lower energy and water consumption. Research now shows that both the energy-related and process related carbon dioxide emissions from 'wet' methods of Portland cement manufacture can also be reduced by at least 30 per cent globally through utilising 'dry' Portland cement processes and other measures,⁵² highlighting a strong energy/water nexus for this sector.

Further Reading

Best Practice Case Studies

Australia Industry Group (undated) *'Water – Case Studies'*,
<http://www.aigroup.com.au/environment/managingwater>, accessed 1 October 2009.

SaveWater! (undated) *'Manufacturing Case Studies'*,
www.wme.com.au/categories/water/index.php, accessed 2 September 2009.

Sydney Water (undated) *'Business Case Studies - Manufacturing'*,
<http://www.sydneywater.com.au/Water4Life/InYourBusiness/EDCPublications/CaseStudies.cfm>,
accessed 1 June 2009.

⁴⁸ Hird, W. (2005) 'Recycled water - case study: BlueScope Steel, Port Kembla Steelworks', Presented at the International Conference on Integrated Concepts on Water Recycling, Wollongong, NSW, Australia, 14–17 February 2005.

⁴⁹ von Weizsäcker, E., Hargroves, K., Smith, M., Desha, C. and Stasinopoulos, P. (2009) *Factor 5: Transforming the Global Economy through 80% Increase in Resource Productivity*, Earthscan, London.

⁵⁰ Liedtke, C. and Merten, T. (1994) 'MIPS: Resource Management and Sustainable Development', pp 163-173, *Proceedings of the Second International Conference on 'The Recycling of Metal'*, Amsterdam

⁵¹ EPRI Centre for Materials Production (2009) Understanding Electric Arc Operations. Carnegie Mellon Research Institute at <http://www.p2pays.org/ref/10/09047.pdf> accessed 1 October 2009

⁵² Humphreys, K. and M. Mahasenan, (2002) *Towards a sustainable cement industry - Substudy 8: Climate Change*. World Business Council for Sustainable Development (WBCSD), Geneva, Switzerland. Kim, Y. and E. Worrell (2002) CO₂ emission trends in the cement industry: An international comparison. *Mitigation and Adaptation Strategies for Global Change*, 7, pp. 115-33.

General Electric (2007) '*Solutions for Sustainable Water Savings – A Guide to Water Efficiency*'
http://www.gewater.com/pdf/events/2007/georgia_water/A_Guide_to_Water_Efficiency.pdf,
 accessed 1 June 2009.

Checklists

Australia Industry Group (AIG) (2009) *Water Saving Factsheet: Automotive Industry*, AIG,
http://pdf.aigroup.asn.au/environment/7082_WPA_fact_sheet_AUTO.pdf, accessed 1 June 2009.

Australia Industry Group (AIG) (2009) *Water Saving Factsheet: Metal Products: Manufacturing Industry*. AIG. http://pdf.aigroup.asn.au/environment/7082_WPA_fact_sheet_METAL.pdf, accessed 1 October 2009.

Australia Industry Group (AIG) (2009) *Water Saving Factsheet: The Printing Industry*, AIG,
http://pdf.aigroup.asn.au/environment/7082_WPA_fact_sheet_PRINTING.pdf, accessed 1 October 2009.

Parsons Brinckerhoff (2008) '*Water Saving Tips for Metal Manufacturing*', The Australian Industry Group, Australia, pdf.aigroup.asn.au/environment/water_saving_metal_mfg.pdf, accessed 17 June 2009.

Parsons Brinckerhoff (2008) '*Water Efficiency in Industry*', The Australian Industry Group, Australia, pdf.aigroup.asn.au/environment/Water_Efficiency_in_Industry_Seminar_short.pdf, accessed 17 June 2009.

SaveWater! (undated) '*Manufacturing*', www.savewater.com.au/how-to-save-water/in-business/manufacturing, accessed 21 August 2009.

Other Reading

Australia Industry Group and Sustainability Victoria (2007) '*Environmental Sustainability and Industry – Road to a Sustainable Future: Findings of the National Survey on Environmental Sustainable Practices*', Australia Industry Group, North Sydney, New South Wales, Australia, pp12,52, pdf.aigroup.asn.au/environment/enviro_sustain_indust_report.pdf, accessed 19 June 2009.

CEDA and Serco (2007) '*Water that Works: Sustainable Water Management in the Commercial sector*', CEDA, ceda.com.au/member/nxx/publications/other/docs/water_that_works.pdf, accessed 2 September 2009.

Parsons Brinckerhoff (2008) '*Water Efficiency in Automotive and Metal Manufacturing*', The Australian Industry Group, Australia, http://pdf.aigroup.asn.au/environment/WaterEfficiency_in_Industry_automotive.pdf, accessed 17 June 2009.

Sydney Water, *The Conserver*, <http://www.sydneywater.com.au/Water4Life/InYourBusiness/EDCPublications/TheConserver.cfm>, accessed 2 September 2009.

US Alliance for Water Efficiency (undated) '*Manufacturing*', http://www.allianceforwaterefficiency.org/Manufacturing_Introduction.aspx accessed 17 October 2009.