Eco-efficiency in Australian food processing
– an update on implementation, drivers and barriers.

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Abstract

In 2002, the Working Group for Cleaner Production undertook the first eco-efficiency project for the Queensland food processing sector, in partnership with the Queensland State Government and industry groups. This initial project aimed to increase awareness by providing sector-specific technical resources and engaging industry through workshops. A follow-up eco-efficiency project for food processors took place in 2007, which continued the awareness process by updating resources and developing eco-efficiency assessment skills in the industry. The follow-up project provided the opportunity to evaluate the implementation of eco-efficiency by this sector over the intervening five years, and examine the changing drivers and barriers to eco-efficiency uptake. This paper reports on this evaluation.

Keywords

Eco-efficiency, cleaner production, Australia, food processing, environmental impacts, water, wastewater, energy, solid waste.

1. Introduction

In 2002, an eco-efficiency project for the Queensland food processing sector was undertaken through a partnership between food processors, government agencies, industry groups and the Working Group for Cleaner Production at the University of Queensland. Its aim was to increase awareness and uptake of eco-efficiency, and the outputs were workshops and information resources, including an Eco-efficiency Toolkit (Pagan et al, 2004). In 2007, a follow up project updated resources, making
them more accessible on a customised website (www.ecoefficiency.com.au), and further promoted eco-efficiency via targeted workshops and site visits.

The follow-up project gave an opportunity to evaluate eco-efficiency implementation by this sector over the preceding five years. The aim of this paper is to review the progress made in eco-efficiency by food processors between 2002 and 2007, and examine if and how the drivers and barriers for eco-efficiency have changed. The eco-efficiency projects engaged Queensland food processors, however this paper will look at eco-efficiency implementation for the Australian industry more broadly.

2. Background

Based on 2008/9 data, food and beverage processing is Australia’s largest manufacturing industry; contributing 19% of added value and 2.3% to Australia’s gross domestic product (ABS, 2009a, p.26). The largest sectors (by employment) are meat processors (14.4%), bakeries (13.8%), wineries (10%), dairy processors (9%) and fruit and vegetable processors (7.5%) (DAFF 2009). The food processing sector is principally concerned with the processing of food for domestic consumption. Only 27% of product is exported (ABS, 2007), compared with 60% for primary agricultural products (ABARE, 2009). The industry is comprised of around 7,200 businesses (AFGC, 2009b) and accounts for 23% of manufacturing sector employment; around 206,000 people (DAFF, 2009). Employment occurs in major cities (52.8%), inner regional areas (30.7%) and outer regional areas (15%) (DAFF 2009).

Food processing makes an important economic and social contribution. Its role is central to the provision of nutrition for people, and so will always be a key sector of any society. It is a major employer across most parts of the country, and contributes to economies at local, regional and national levels. Food processors are significant consumers of resources (water and energy), and, as they are commonly located in densely populated urban regions, can face competition with other interests for ongoing access to resources. The authors believe eco-efficiency is significant for this industry for three reasons. Firstly, it helps ensure the continued success of this important sector in an increasingly resource-strapped world. Secondly, the accumulative gains in resource efficiency from this large and influential industry can be very significant. Thirdly, having a central role in the wider food supply chain, it can influence the uptake of eco-efficiency downstream and upstream.
A reference case for the uptake of eco-efficiency is provided by Pagan and Prasad (2007), who describe the drivers for, and barriers to eco-efficiency implementation at the time of the original eco-efficiency project (2002). The drivers were:

- the promotion of eco-efficiency by regulators, who encouraged businesses to adopt eco-efficiency voluntarily, generally via government partnerships;
- individual leadership by visionary managers and employees who understood a need for resource efficiency;
- concerns about the environmental impacts of packaging, which drove industry involvement in initiatives such as the National Packaging Covenant.

The identified barriers to eco-efficiency were:

- the low cost of resources and waste disposal, such that the return on investment was not often sufficient to encourage implementation;
- lack of funds, technical knowledge and support; and
- low public awareness and pressure coupled with minimal regulatory pressure.

3. Methodology

The significance of the sector’s environmental impacts was first examined by gathering statistics and information for key indicators, to provide background for the discussion. Eco-efficiency initiatives undertaken by the food processing sector since 2002 were then reviewed, using information from industry publications, conference and workshop proceedings, consultation with industry and the personal knowledge of the researchers. The changing drivers and barriers for eco-efficiency were evaluated based on the researchers’ interpretation of the reasons behind the efforts to date.

4. Results

4.1 Environmental impacts of food processing in Australia

4.1.1 Water use and wastewater

In the Australian context, food processing is a relatively low user of water, responsible for only 1% of national water used, compared with 66% for agriculture (DAFF, 2007). Primary production places a much greater drain on water resources, (600-50,000 L/kg product), compared with processing (1-9L/kg) and packaging (2.5L/kg) (AFGC, 2003, cited in DAFF, 2007). However, water availability has been a
significant issue for Australian food processors since intense drought conditions over the last 5-10 years has limited fresh water supplies in many regions. Processors rely on municipal water supplies (63.7%) and self extracted sources (river and bore; 35.6%), and less than 1% is reused (DAFF, 2007). In small country towns food processors can account for a very high proportion of total town water use, putting pressure on supplies. In larger towns and cities, processors compete with other industry and domestic users to guarantee continued supply. From 2000/01 to 2004/05, water use by the sector increased from 202 to 215GL/yr, an increase of 6% (ABS, 2005), while industry value added increased by 23% (DAFF, 2004), indicating an overall reduction in water use intensity. Water use presents one of the more significant environmental issues for food processing in Australia at present.

Of the 215GL/yr of water used in food processing, around 40% is estimated to be discharged to municipal sewerage systems (internal unpublished data), 40% (89GL/yr) discharged under licence to waterways or irrigation (ABS, 2006), and the remaining 20% incorporated into product or lost through evaporation. This means that as much as 80% of becomes wastewater. Wastewaters can carry significant loads of organic matter (COD/BOD). They can also contain salts, such as sodium hydroxide, from salt-based cleaning chemicals. Salt levels in wastewater discharged to sewer can be an issue in some regions, as it inhibits the ability to treat and recycle water. Therefore food processors are being encouraged to investigate the use of alternate cleaning chemicals (Palmowski et al, 2005).

Trade waste charges are usually calculated on levels of organic matter, oil and grease, nitrogen and phosphorus. Trade waste acceptance limits are now negotiated based on the potential for beneficial reuse of the wastewater and may vary depending on the system for municipal treatment. For example, a food processor discharging wastewater to a treatment plant which includes biological nutrient removal (BNR) can potentially negotiate a higher level of organic load than a processor that does not have this option. In some instances a higher organic load can be beneficial to the operation of the treatment plant and may be welcomed (pers.com. Gary Dean (Australian Water Association) 2010).

Regulated discharges of wastewater from food processing are reported to have increased from no recorded discharge to 89GL/yr over the study period (ABS, 2004,
Some may be due to changes in reporting practices. However, increasing sewer discharge costs due to greater cost recovery by municipal governments are thought to have prompted in-house water treatment and discharge (ABS 2004). Food processors are therefore taking on greater responsibility for the quality of the water discharged and for the environmental protection of the receiving environment.

4.1.2 Energy and greenhouse gas emissions

Australian food processors account for 1% of total national energy use and 7% of total manufacturing use (ABS, 2007b). Energy intensity relative to manufacturing as a whole is relatively low (7% of energy use for 19% of industry value added (DAFF, 2009)). From 2004/05 to 2006/07, energy use increased by 9% (ABS, 2007b), while industry value added increased by around 9% (DAFF, 2009, 2007) indicating that energy use intensity is relatively stable. The sector is reliant on fossil-fuel energy; the main sources being natural gas, electricity from coal, oil and thermal coal (ABS, 2007b), except for sugar milling where all energy is self-generated from bagasse. However the industry reports to be diversifying its energy supply, with some companies purchasing some of their energy from renewable sources (AFGC 2009). Fossil energy use is the main source of greenhouse gas (GHG) emissions. Total GHG emissions for the sector are around 4,500 MT CO$_2$eq/yr, which is less than 1% of national, and 6.4% of manufacturing emissions (DCC, 2009), reflecting the relatively low significance of this industry in relation to global warming potential.

4.1.3 Solid waste and packaging

Solid waste from food processing includes packaging, food ingredients, food product, and office waste. Data for total volumes of solid waste from the industry is not available, a deficiency identified in the National Waste Overview (EPHC, 2009). However, AFGC (2009a) reports quantities sent to landfill per unit of product ranging from 2.5 kg/t (oils and fats) up to 89.6 kg/t (meat). In the absence of total quantities, it is difficult to discuss the scale and significance of solid waste generation by the sector. What is known however, is that recycling and waste utilization rates for this industry are high. Where possible, processors recycle packaging waste and pass on food waste for beneficial reuse. A survey of 35 processors reported recycling rates of 33% for meat, 69% for dairy, 78% for fruit and vegetables, and 90% for oil and fat processors, with the overall average being 74% (AFGC, 2009).
4.2 Review of eco-efficiency initiatives since 2002

This section reviews trends in eco-efficiency implementation in Australian food processing since the initial eco-efficiency project in 2002. It describes initiatives that demonstrate the trends, supported by some case studies. More specific details and case studies can be found at www.ecoefficiency.com.au.

4.2.1 Water and wastewater

Most water used is for processing operations (washing, conveying, cooking, etc.) and for cleaning, and these are the areas with greatest water saving potential (Pagan et al, 2004; WGCP, 2008a,b,c). Early initiatives commonly targeted water use not directly contacting product (leak prevention, housekeeping, recycling final rinse waters, amenities, etc.). Water feeds to utilities (boilers, cooling towers, pumps) were also targeted as technical support is widely available from service providers.

Severe drought conditions between 2003 and 2009 lead to water restrictions, particularly in central and southern parts of Australia, and government programs to promote water efficiency in industry (see 4.3.1). Consequently food processors have been forced to move on to more challenging water saving initiatives.

For demand-side management, operators initially looked to technical resources for ideas, such as those prepared for the initial project (Pagan et al, 2004). However, it is now more common to see companies take a more systematic approach of ‘mapping’ water flows to highlight where savings can be achieved, and to develop site-specific water management plans. Water meters are an important tool for this. Whereas once a single meter was in place to measure total use only, multiple meters are commonly installed to allow constant monitoring of important unit operations.

Alternative water sources are being sought by Australian communities generally, especially rainwater collection. Though there are examples of rainwater use by food processors, it is not a significant source and is limited to external applications.

Increasing numbers of food companies are employing advanced wastewater treatment systems (with combinations of aerobic, anaerobic and membrane treatment) to treat wastewater to qualities that can be better than potable water. As a result, greater consideration is being given to onsite wastewater reuse. There are examples of treated water being used in applications that do not involve contact with
food or food surfaces where there are reduced risks. For example, a brewery uses treated clean-in-place rinse water for cleaning, boiler feed and cooling tower make-up. (Gold Coast Water, 2010). There are far fewer examples of treated water applied direct to food product, as processors are nervous about compromising food quality and hygiene standards, and of possible negative customer perceptions. A snackfood manufacturer has proposed the reuse of potato wash water (after treatment using membrane filtration and an anti-microbial biocide), which is expected to reduce water use by 70% (DECC, 2010). A chicken processor is using water from an advanced wastewater treatment plant for an application involving direct food contact (AWA, 2010). Reuse of water only increased from 0.4% to 0.6% of total consumption between 2000/01 and 2004/05 indicating there is still significant opportunity in this area. The low price of fresh water compared with the cost of water treatment is noted as being the greatest impediment (AFGC, 2009a).

4.2.2 Energy and greenhouse gas emissions

The reliance on carbon-intensive energy (natural gas and coal-derived electricity) means there’s an imperative to improve energy efficiencies for greenhouse gas mitigation as well as resource conservation. The energy reporting and resource efficiency programs introduced by government agencies (see 4.3.1) have heightened industry’s awareness of energy issues and driven initiatives in this area.

Since the initial project in 2002, efforts in demand-side management have been towards improving fuel and electrical efficiencies in equipment. Refrigeration, chilling and air conditioning are the main users of electricity (WGCP 2008d), and so this has been a particular focus. Efforts are being aided by improved process control and real time measurement of electricity use through greater sub-metering.

A noteworthy change has been the utilization of renewable energy in recent years. However the high capital cost means it is still too expensive for most food processors. A few examples include a Victorian winery that installed a 150kW wind turbine which supplies enough energy for the estate and an additional 34 households (WGCP, 2008f); and a Victorian meat company which uses local geothermal energy (45°C bore water) for plant washdown or pre-heating hot water (WGCP, 2008f). The use of cleaner fuels is also being investigated. A Victorian dairy processor uses
liquefied natural gas (LNG) to fuel 54 of its 150 fleet vehicles, reducing greenhouse gas emissions and other air and noise emissions (Dairy Australia, 2008).

The anaerobic digestion of organic waste streams to produce biogas has not been embraced by Australian industry compared with other parts of the world. However, interest is increasing and there are now at least ten examples1 of Australian food processors supplementing energy supplies with biogas (GCPP, nd) as well as one centralised plant accepting wastes from many food plants (Waste Solutions, 2008).

4.2.3 Solid waste and packaging

Solid waste initiatives fall into two categories – those related to direct waste generation at processing plants (WGCP, 2008i,j), and those related to food packaging (WGCP, 2008 k,l). For the former, initiatives have focused on beneficial reuse of food waste, and source reduction and recycling of packaging waste. At the time of the initial eco-efficiency project, packaging waste was regarded as the most significant environmental issue (Pagan and Prasad, 2007, citing AFGC, 2003). Since then food processors have played a major part in packaging initiatives reported via the National Packaging Covenant (NPC), a voluntary program promoting product stewardship (DEWHA, 2009), and targeting increases in the recycling of post consumer packaging (DEWHA, 2008). Examples of efforts by food processors can be found at www.packagingcovenant.org.au or www.ecoefficiency.com.au. Packaging and solid waste are still an issue, but efforts in this area have taken a lower priority to the more pressing issues of water and energy management. However, companies can be required to incorporate waste minimization into resource efficiency plans required by government programs (see 4.3.1).

4.2.4 Public reporting and benchmarking

There has been a major increase in public reporting with most large food companies now producing environment or sustainability reports (60% of AFGC member companies in 2008 (AFGC, 2009)). The Global Reporting Initiative (GRI) and Triple Bottom Line Reporting are the most common frameworks used (AFGC, 2009), and

reported themes typically include sustainable sourcing and supply chains, transportation, packaging, environmental performance, advertising and marketing.

The requirements for reporting resource efficiency programs (see 4.3.1) means there is now a mass of data that could be utilised to generate resource efficiency benchmarks for Australian food processors. However it is mostly not published due to confidentiality issues and difficulties in presenting data so that processes can be compared on a ‘like for like’ basis. One of the few examples is the City West Water Benchmarking Fact Sheet (2007) which presents water efficiency benchmark data for a range of industries, including food processing. Some benchmarking data has been published by industry groups, such as the Australian Food and Grocery Council (AFGC, 2005, 2009a), Dairy Australia (2006; 2009) and the Australian Wine Industry (SAWIA, 2003) in various public reports.

4.2.5 Life cycle approaches to support eco-efficiency

Interest in environmental life cycle assessment (LCA) is growing, driven by increasing community awareness of the environmental impacts of food supply. Most work to date has focused on agricultural products up to the farm gate, including dairy, meat, sugar, grains, and eggs. A few studies have examined the wider life cycles of food products through to the consumer. Greenhouse gas emissions (GHG) has been the key indicator reported and water use is being considered more frequently. The aim of past work has been to better understand the impacts of Australian food production (mostly agricultural), to identify ‘hot spots’, or to generate data for marketing or customer reporting. For the latter, GHG reporting (carbon footprinting) has been the focus, with the establishment of the PAS2050 standard for carbon footprinting in 2009 (BSI, 2009) prompting considerable interest. The concept of food miles has occasioned industry reaction and the realisation their business is not universally seen as “friendly”. There is expected to be greater pressure on food manufacturers to label their products with carbon footprint information and the like.

The processing, distribution, retail and home consumption phases of food life cycles have received far less attention. The processing phase has been included in the scope of a number of Australian food product LCAs. However the significance of food processing across the broader spectrum of food products is not well understood. This is an area that warrants further investigation to identify where and how eco-efficiency
efforts in processing should be directed. European studies are increasingly recognising the importance of the distribution and retail aspects, and these phases also need to be investigated further in the Australian context.

4.3 Analysis of how drivers and barriers have changed
The following section discusses factors believed to have driven the eco-efficiency efforts, and how the drivers and barriers have changed.

4.3.1 Government programs
The most significant direct driver for the adoption of eco-efficiency over the study period has been the introduction of government programs that have shifted the impetus for action from voluntary to compulsory. These require industry to identify resource efficiency measures, and produce action plans declaring timelines for implementation. Previously, eco-efficiency was promoted from within motivated companies or through industry-government partnerships where involvement was voluntary. Now, the compulsory programs have forced industry to adopt eco-efficiency or risk legal action. The programs typically include energy, water and waste which may be treated together or individually. Examples include National Energy Efficiency Opportunity Program (EEO) (2006), National Greenhouse Emissions Reporting Scheme (NGERS) (2007), Victorian Environment and Resource Efficiency (EREP) Program (2007) and WaterMap Program (2007), New South Wales Energy and Water Saving Action Plans (2005) and Queensland Water Efficiency Management Plans (WEMP) (2008). Voluntary schemes, such as the Victorian Sustainability Partnership Program and the NSW Sustainability Compacts, still exist, however much of the eco-efficiency activity over the study period is thought to have been driven by the mandatory programs in response to resource scarcity.

4.3.2 Resource scarcity
At the time of the first eco-efficiency project, resource scarcity was not identified as a direct driver for eco-efficiency. However, water availability has become a significant issue for Australian food processors over the study period, due to the severe drought in many regions. This is evidenced by the numerous government programs requiring demonstration of water efficiency (see 4.3.1). Projections for further reduced or variable rainfall along with population increases, suggest that water efficiency will remain significant a issue.
Despite recognition of impending scarcity of fossil-energy resource, it has not developed as a direct driver for energy efficiency by Australian food processors. The climate change implications have been more influential (discussed in 4.3.3).

4.3.3 Climate change
Probably the most significant driver for energy efficiency and associated greenhouse gas mitigation has been the increased political focus on climate change and consequential interest from the community at large. At the time of the first project, climate change was not considered an issue for most food processors. Since then, it has moved into the public arena with wide media coverage. Several government programs targeting energy efficiency (see 4.3.1) have since been instigated. In particular, the NGERS program was designed to underpin Australia’s Carbon Pollution Reduction Scheme (CPRS) by providing the emissions data on which obligations under the trading scheme would be based. The introduction of a CPRS is now debated and only a small number of the larger processors are likely to have direct obligations under the CPRS. However all companies will feel the effects of resulting increases in energy costs. The interest in reducing national output of GHG has resulted in most companies taking steps to manage the associated risk and introduce measures to reduce and continuously manage their carbon footprint.

4.3.4 Community awareness of the environmental impacts of food
At the time of the original eco-efficiency project, public awareness was considered to be low and flagged as a barrier to eco-efficiency uptake. There has since been a complete turn around in this respect. Community interest has grown, along with an increasing recognition by business of the need for a ‘social licence to operate’. This has lead to public reporting by some food processors (see 4.2.4), a greater interest in carbon footprinting and labeling (see 4.2.5). The direct influence of community expectations on the eco-efficiency efforts of the industry is yet to be seen.

4.3.5 Cost of resources and waste management
At the time of the first eco-efficiency project, the low cost of resources and waste disposal was considered a key barrier to eco-efficiency. Since then costs have increased, most by levels well above the consumer price index. The price industry pays for electricity and natural gas has increased by 40.4% and 24.9% respectively between 2002 and 2009 (ABARE, 2009). Even more considerable cost increases are
expected if a CPRS is introduced. The cost of water has increased by as much as 100% between 2004 and 2009 (unpublished review by the authors). Further substantial increases are expected with the supplementation of water supplies using costly technologies (such as desalination), and the trend toward full cost recovery. There have been similar substantive increases in costs for wastewater disposal to sewer. For example, Gold Coast Water’s volumetric charges have increased over 300% from $1/kL to $3.37/kL from 2004 to 2010. The cost of solid waste is also known to have increased (although data is not readily available), but landfill disposal in Australia is cheaper than resource recovery of most materials (Hyder Consulting, 2008). However, costs are still a small proportion of overall operating costs and remain an impediment to eco-efficiency. For instance, the cost of utilities (electricity, gas, water) is less than 2% of total input costs for food processors (ABARE, 2006, p.54).

4.3.6 Company funds and technical knowledge

At the time of the initial project, lack of funds and technical knowledge was identified as barriers to eco-efficiency. For the former, the situation has not changed. Food processing remains a competitive sector and financial investment can be difficult to justify, particularly given the continuing low cost of resources and waste disposal. It is not uncommon for food processors to require payback periods of as low as two years, which is often difficult. Food processors take advantage of government funding for eco-efficiency projects (for example, the 2007 Queensland Business Water Efficiency Program), without which many projects may not have been implemented. The shift in impetus from voluntary to mandatory however may have changed investment criteria. The availability of technical resources is believed to have increased substantially. Information is more readily available and accessible, and processors can call on the technical support of a growing number of service providers. This is therefore no longer thought to be a barrier.

5. Conclusion

The drivers and incentives to adopt eco-efficiency have increased in the intervening five year between eco-efficiency projects, resulting mostly from government intervention. This has lead to an attempt to implement resource conservation and waste mitigation in a more structured approach to than previously seen. At the time
of the initial eco-efficiency project, businesses were encouraged to adopt eco-efficiency practices via voluntary approaches, generally through government partnerships. Since then, the impact of water shortages, climate change and increasing community awareness have resulted in political processes to mandate the adoption of eco-efficiency measures. This has had the affect of entrenching eco-efficiency activities in some businesses to various degrees. Though these programs may not be specifically labelled as ‘eco-efficiency’, they still have similar intents which is to encourage a structured approach to resource conservation through the use of management or action plans. Many of the plans are required to be publicly reported with specific timelines for implementation. Coupled with this has been an emerging interest in life cycle assessment and whole of supply-chain considerations, lead mainly by the agricultural sector. This has pushed the processing industry to evaluate its environmental impact across the supply chain, identifying those areas where significant improvements can be made.

To date, eco-efficiency efforts have been most concerted in the food processing sector. There has been very little consideration of eco-efficiency uptake in downstream distribution, retail and home consumption. Future eco-efficiency efforts need to be driven by an understanding of the life cycle of food products, and the relative importance of the different phases. It is anticipated that eco-efficiency attention to distribution, retail and home consumption will become priority in the future.

Generally with the more structured approach to addressing eco-efficiency as a result of compulsory government programs, it is considered that the ‘low hanging’ eco-efficiency initiatives have been tackled. It is envisaged that the next generation of initiatives will stem from advances in technology such as renewable energy sources (solar, wind). It is also expected that there will be increasing examples of water recycling and reuse, including direct product contact, as the industry (and consumers) gain confidence in available technology and the ability to continue to produce safe food products.

References


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