CSIRO

30 May 2008

Our Ref: 08/287

Committee Secretary
Senate Standing Committee on Environment, Communications and the Arts
Department of the Senate
PO Box 6100
Parliament House
CANBERRA ACT 2600

Dear Committee Secretary,

Re: CSIRO's Submission to the Inquiry into the Management of Australia's Waste Streams

We thank you for the opportunity to provide a submission to the Inquiry into the Management of Australia's Waste Steams by the Senate Standing Committee on Environment, Communications and the Arts. Our attached comments are written with an understanding that CSIRO is actively undertaking research of particular relevance to waste minimisation practices across a broad range of industries.

Due to the breadth CSIRO's scientific activities, we have the capabilities to undertake research and apply technological solutions across a wide range of waste minimisation strategies including reduction, recovery and reuse. CSIRO is also in a position to conduct considerable research into Life Cycle Analysis, including the broader socio-environmental aspects, as well as undertake economic evaluations of proposed waste solutions for the domestic, commercial, industrial and construction sectors.

Please do not hesitate to contact me or should you require any further information.

Sincerely

Stephen Morton

Dr Steve Morton
Group Executive, CSIRO Manufacturing, Materials & Minerals

CSIRO

CSIRO Submission 08/287

Inquiry into the Management of Australia's waste streams and the Drink Container Recycling Bill 20

Senate Standing Committee on the Environment, Communications and the Arts

May 2008

Enquiries should be addressed to:

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Introduction

CSIRO welcomes the opportunity to contribute to this inquiry and we would also welcome any further opportunities to discuss the breadth of our ongoing research activities in relation to waste reduction and recycling in different streams.

Terms of reference

Management of Australia's waste streams, with particular reference to:

a. trends in waste production in Australia across household, consumer, commercial and industrial waste streams;
b. effectiveness of existing strategies to reduce, recover or reuse waste from different waste streams;
c. potential new strategies to reduce, recover or reuse waste from different waste streams;
d. the economic, environmental and social benefits and costs of such strategies;
e. policy priorities to maximise the efficiency and efficacy of efforts to reduce, recover or reuse waste from different waste streams; and
f. consideration of the Drink Container Recycling Bill 2008.

Scope of this submission

The content of our submission is pertinent to terms of reference a, c and d only (see above), for which we have expertise and ongoing research activities that enable us to provide comment. We do not comment upon term of reference b, and e and f are outside the scope of our remit.

In addressing the specific terms of reference mentioned above, we outline in how CSIRO is making critical contributions to future waste reduction, reuse and recycling strategies through the application of our cutting edge science. The ability to reuse wastes in a safe and economical way requires extensive research and a thorough evaluation of risks and benefits. Objective scientific evaluation is also frequently required for community acceptance of proposed strategies.

CSIRO's research capacity in waste stream management

CSIRO has the research capability to provide objective scientific data and evaluation for the management of Australia's waste streams. Our research into waste management is ongoing, and because of our broad research capacity, has the benefits of enabling innovative cross-fertilisation between research areas (e.g. environment, engineering, materials and socio-economic sciences). Furthermore, our research involves close partnerships with public agencies and industry, enabling us to readily identify and address current and future national challenges in this domain.

Trends in waste production in Australia across household, consumer, commercial and industrial waste streams.

The Australian Waste Database (AWD) http://awd.csiro.au/default.aspx was a joint effort between CSIRO and the Department of Environment and Heritage in the 1990's. The AWD was developed in response to the need to provide a monitoring mechanism for Commonwealth and State waste minimisation policies as well as addressing next generation waste management strategies.

AWD provides a historical overview of the waste management scenario in various regions of Australia. Specifically, it:

- provides a national Solid Waste and Hazardous Waste Classification System;
- provides a Guidance Manual for Solid Waste Composition Studies;
- provides data on Waste generation and Disposal in Australia for both Urban Solid Waste and Manifested Hazardous Waste.

The AWD was developed under the auspices of the CRC for Waste Management & Pollution Control Ltd for the Department of the Environment (then known as Environment Australia). The AWD was last updated in 2004 with publications of relevance, and serves as a bank of considerable historical data.

Potential new strategies to reduce, recover or reuse waste from different waste streams

Reduce

Bio-degradable plastics

CSIRO has made concerted efforts to develop next generation bioderived and biodegradable plastics. Life cycle analysis suggests that such technologies provide benefits in terms of green house gas emission and energy savings.

CSIRO is also taking a leading role in addressing the issue of packaging sustainability. Members of our Materials Science and Engineering Division are involved with the Standards Committee for Biodegradable Plastics and are active in coordinating industry seminars, for example "Selling Green Plastics". We are also active in the biodegradable plastic bag space having provided briefing documents to Minister Kim Carr on this issue and are currently in discussions with the Department of Environment, Water, Heritage and the Arts on new strategies to address the impact of bag litter through biodegradable bag technology. A feasibility study for developing the next generation plastic bag that overcomes the current biodegradable bag limitations of degradability under different environments, shelf life, cost and performance is currently being scoped and is expected to begin in the next few months.

CSIRO continues to invest in the development of “green materials” capability in response to industry road maps focused on carbohydrate (starch), protein, cellulose and bio-derived polyester platforms across all three technology horizons.

A particular focus for CSIRO is to address industry concerns pertaining to cost (through investigating new “zero toxicity” bio-derived polymer blends that allow cheap feed stocks to be employed without sacrificing performance, and one step processing strategies to reduce manufacturing costs), performance (particularly strength, water resistance and gas barriers through investigating the use of nanotechnology, low toxicity modifiers and the impact of plant source) and processability (through the use/development of new processing technologies or, additives to improve melt strength and hence the range of manufacturing processes suitable for these materials; specifically film formation and foamed products).

Our recently commissioned biodegradation facility (as it is understood by CSIRO) now represents the only operational equipment in Australia capable of certifying materials for biodegradation and composting to AS46736 and EN13432 standards. This facility provides an important service to industry and assists CSIRO in our new materials development effort.

Research on the mechanisms of biodegradability with a view to controlling these processes (triggered biodegradability) requires the development of new techniques to investigate and characterize the micro-organisms involved and is fundamental to achieving success for developing new biodegradable plastics for use by industry.

Technology developed by CSIRO in partnership with the International Food Manufacture and Packaging Science CRC has lead to the founding of a spin off company, Plantic, which internationally markets a range of biodegradable starch-based materials for dry food packaging. CSIRO continues to work across industry in the area of biodegradable plastics from the use of wheat proteins as binders in the paper making industry and investigating environmentally responsible alternatives to polystyrene beads (R-Max), to the exploitation of the degradation process for specific purposes such as the controlled deactivation of detonators (ORICA) and the controlled release of anti-microbial agents (Novapharm).

Zero waste powder coatings

Most products, regardless of the “input material”, require surface finishing for desirable decorative and/or functional surface attributes such as colour, texture, long-term durability and others. Typically, industrial wet paints or wet coatings containing up to 70% of solvents are used for this purpose. All non-aqueous solvents (generally 30% to 70% in all wet paints) become airborne Volatile Organic Compounds (VOCs) during the application and drying process, whilst approximately 70% of the solids component becomes landfill due to a generally low transfer efficiency of wet paint (i.e. the percentage paint deposition on the painted item).

The above problems (low transfer efficiency, VOC emissions and solid waste) are totally eliminated by powder coatings. As explained below, the products destined for powder coating have to be electro-conductive. This pre-requisite effectively prevents powder coating of plastics, wood composites and other electrically insulating materials. Another limitation is the high curing temperature of standard powder coatings designed for metals: 180 to 220°C. This powder coating cure temperature is above the melting point of most engineering plastics and above the onset point of thermal decomposition of wood-based products and constituents.

A new generation of environmentally friendly powder-coatings suitable for coating engineering plastics and both bio- or wood-based materials and composites has been developed by CSIRO and combined with the breakthrough surface treatment technology. The combination of these two novel technologies totally eliminates VOCs from coating plastics, MDF and other wood –based composites due to the fact that powder coatings are 100% free of solvents.

A set of comprehensive and unbiased analytical data concerning life cycle analysis of Dulux/Orica powder coatings applied to bio-sustainable and synthetic polymeric substrates clearly demonstrates a significant reduction in the environmental impact of breakthrough technologies developed with our partner organisation Dulux Powdercoatings. This project was undertaken with the financial support of Sustainability Victoria and won the Victorian Premier's Sustainability Award "Products or Services" in 2008.

Cold Spray Technology for Advanced Coatings and Direct Fabrication

By utilising interactions between supersonic particles, adhesions under ultra high pressure and given our understanding of atomic scale interactions both particle/substrate and particle/particle, CSIRO has developed a Cold Spray technology for advanced coatings and direct fabrication.

Cold Spray is changing some areas of the Australian manufacturing sector to provide leading edge, cost effective and environmentally friendly (less water, less energy, and no harmful chemicals) technology for coatings and direct fabrication.

Replacing conventional coating technologies such as electroplating, sputtering and thermal spraying with novel, cost effective and environmentally friendly alternatives is an ongoing area of investigation. Developing direct fabrication technologies for oxygen sensitive materials such as titanium and tantalum is also a CSIRO research priority. This has the potential to replace some conventional manufacturing techniques which require vacuum and protective atmospheres.

New manufacturing processes such as the direct fabrication of seamless titanium pipes using Cold Spray are being developed. Changing existing industry practices such as electroplating copper coatings for printing rollers with Cold Spray coatings has been a further outcome. This technology has been developed, patented and licensed to Kirk Group. The first Cold Spray printing roller plant has now been established in Melbourne.

Treating contaminated soils with high power ultrasound

CSIRO has been investigating micro-reactors in cavitation bubbles associated with high density ultrasonic fields for the purpose of treating contaminated soils/sediments with high power ultrasound.

The aim of perfecting this technology is the reduction in a range of contaminants in soils and sediments at significant cost reduction over existing technologies. Other possible applications of the technology are envisaged including the general destruction of organic molecules in solid/liquid mixtures. Should this technology prove to meet current expectations this could be a new paradigm in soil remediation.

Recovery

Composites from waste wood

CSIRO is actively investigating the use of waste wood in the formation of wood-plastic composite materials both using recycled conventional plastics (eg milk bottles etc) and bioderived plastic materials (polyester-based). In the latter case, cellulose reinforced semi-structural bioderived materials are being developed for potential use in the automotive and aerospace industries. Designing this material to achieve the required mechanical performance as well achieving a balance of degradability and durability are key scientific challenges being addressed.

CSIRO has also had significant commercial interest in wood fibre reinforced (conventional) plastic materials particularly from industries which have traditionally used wood for their particular applications (eg logistics industries, construction) and have waste wood stockpiles for use as a feedstock.

The key to utilizing waste wood fibre in plastic applications is to develop technology which enables the wood fibre to be mixed with the plastic and to tailor the interface between them so that the woods engineering characteristics can be exploited as low density reinforcement. This facilitates potential high end applications for structural and automotive purposes. Other scientific challenges include processability as the wood feedstock is not thermally stable at the temperatures required to process plastics, fire performance etc. CSIRO has on-going research programs to tackle these challenges.

Fuel from Wood Waste

CSIRO is undertaking research, as part of the broader biofuels program, into fuel generation from waste timber specifically, but also through the use of general organic wastes i.e. second generation technology. The uses of timber waste from construction, industry and furniture manufacturing are all being investigated in our bioenergy research. Up to 70% of the end product is currently predicted to be usable fuel, with the remaining 30% end product primarily comprising char (soil conditioner), activated carbon, resins and plastics. As with many by–products, those such as activated carbon, resins and plastics are more likely to be of a higher economic value than the major fuel end product. In addition, although significant gains from reducing the timber waste stream by utilising the waste as feedstock are obvious, the additional gains from reducing the emphasis on agriculturally based feedstocks should not be overlooked.

Recycling of rubber tyres

CSIRO's work on recycling rubber tyres (rubber crumb) generated significant media interest in the late 1990s early 2000s and we had a number of projects with the Victorian government and plastics producers in this area.

The key objective of CSIRO research was to value add to this rubber crumb resource so that it could be used for higher end applications and not just as a cheap filler material for roads, flower pots, garbage bins etc. The concept was to make use of the crumb rubbers excellent physical properties to toughen plastics, or to better utilize it as a valuable feedstock in the production of tyres - which is currently only possible for a very small percentage of these materials.

The primary scientific challenge is to tailor the interface between the crumb rubber particle (which is essentially inert and does not readily mix with other plastics or rubbers) and the plastic or rubber matrix. CSIRO has developed considerable expertise to modify the surface characteristics of crumb rubber through cost effective and environmentally acceptable means. The derived materials show a far better mechanical performance than was previously achieved and hence the potential range of applications is greatly increased. CSIRO is in the process of negotiating a new joint development agreement with an Australian company that will focus on the recycling of rubber products from vehicles.

Geopolymer binder technology

CSIRO is developing a new generation of binders based on aluminium/silicon chemistry as opposed to calcium/silicon systems which characterizes the ordinary Portland cement binders used currently by the concrete construction sector. The reactive alumino-silicate materials used in geopolymer manufacturing are, by contrast, derived from industrial waste resources such as ash that comes from coal-fired power stations and by-products from the manufacturing of iron.

Production of traditional calcium-based cements is responsible for over 5% of the world's CO_2 emissions. The development of geopolymer binder aims to reduce the amount of CO_2 ordinarily emitted in the manufacture of conventional ordinary Portland cement by more than 70%.

Geopolymer binders also have applications in fire resistant industrial coatings and refractory products. CSIRO is currently partnering several Australian and multinational companies to develop new products and applications based on geopolymer binder technology.

Water re-use for potable purposes.

CSIRO (through the Water for a Healthy Country Flagship), together with the Queensland Water Commission, Griffith University and the University of Queensland, is actively involved in evaluation of the performance and risk associated with re-use of wastewater for drinking purposes, after appropriate treatment, in South East Queensland.

Resource Recovery from water treatment

Currently the discharges from water treatment and wastewater are treated as wastes rather than a valuable resource. CSIRO is investigating options for reclaiming valuable salts from water desalination as well as opportunities to reclaim energy and nutrients from wastewater streams.

Low Energy Desalination

Desalination is currently still a very energy intensive process. CSIRO is currently working on the development of a new class of high flux, low pressure desalination and microfiltration membrane for low energy but efficient separation.

Advanced Membrane Technologies for Water Treatment Research Cluster

The Water for a Healthy Country National Research Flagship has established the Advanced Membrane Technologies for Water Treatment Research Cluster with the support of the National Research Flagship Collaboration Fund, through partnerships with:

- Victoria University, Victoria, Australia
- Curtin University of Technology, Perth, Australia
- Monash University, Melbourne, Australia
- Murdoch University, Perth, Australia
- Royal Melbourne Institute of Technology (RMIT), Melbourne, Australia
- The University of Queensland, Australia
- University of Melbourne, Victoria, Australia
- The University of New South Wales (UNSW), Sydney, NSW, Australia
- Deakin University, Victoria, Australia.

The collaborative nature of the Cluster means Australia’s leading scientists in membrane research and development can work together to improve the fundamental understanding of membrane materials at both a microscopic and atomic level to better understand the way they interact with liquids and solids.

The Cluster will be utilising nanotechnology, biomimetics and functional materials to deliver new innovations in membrane technology and cost-effective and highly efficient water recovery systems.

Industrial steam separation and recovery

Steam is the most universal energy carrier. Its application is wide spread and can be found in all aspect of industrial process. Industry converts more than 70% of the fuel it purchases for energy into steam.

CSIRO is currently working on its patented membrane materials and process for steam separation and recovery. The newly developed membrane appears to provide very high steam recovery rate and stable performance at temperatures applicable for most industry.

Biosolids reuse

CSIRO coordinates the National Biosolids Research Program, which is a consortium of research and regulatory agencies around Australia, to assess the benefits and risk from re-use of wastewater biosolids on agricultural land. To date, this research has examined nutrients and heavy metals, and in a smaller more focused program is now examining pathogen risks and risks from emerging organic contaminants (e.g. endocrine disruptors).

Reuse

Industrial Water Reuse

Managing human impact on the environment is now recognised as being essential to healthy economies and for local and global sustainability. With this recognition, regulatory restrictions on industrial waste are becoming more restrictive. With industrial wastewater being a significant component of industrial waste, great attention is now focussed on technologies that will more efficiently satisfy regulatory requirements and promote effective recovery of industrial water. CSIRO is currently working with Australian industry to demonstrate a possible application of membrane distillation technology for industrial wastewater treatment and reuse.

Re-use of mine wastes.

In a project sponsored by the Premier's Water Foundation of Western Australia, CSIRO is investigating the potential for use of mineral by-products from mining and mineral processing in water treatment technologies including the treatment of domestic, agricultural and industrial effluents or as soil amendments for agriculture.

CSIRO is also in the process of negotiating a new joint development agreement with an Australian company that will focus on the separation of waste streams from mineral dressing, facilitating recovery and re-use of water and reduced waste footprint.

Re-use of aluminium from beverage containers

The recycling of aluminium beverage cans results in a large mass of aluminium that is alloyed with further scrap and virgin raw materials to produce a lower value secondary alloy product. CSIRO, through the Light Metals Flagship, has developed new alloys that accommodate large percentages of can scrap for use in the manufacture of components for automotive and building products applications.

Reduce, Recover & Reuse

Industrial ecology

In an efficient industrial precinct, the wastes of one industry may be valued as a reagent for another industry. Examples of this already exist for water re-use in Western Australia, with the Kwinana Water Reclamation Project that was developed by the Water Corporation of Western Australia. CSIRO will embark on an examination of other potential synergies between material use synergies between industries, with an early target being sustainable industrial development in the south east of Melbourne.

The economic, environmental and social benefits and costs of such strategies

Reduce

Bio-degradable plastics

- Approximately 3.93 billion plastic bags were used in Australia in 2007
- Approximately 40 million plastic bags enter the litter stream each year.
- In June 2006 and 2007 the EPHC resolved to phase out plastic bags by the end of 2008, following the failure of the voluntary Retailer Code of Practice to deliver a 50% reduction in plastic bag use. However the EPHC meeting on 17 April 2008 did not agree to national ban charge on plastic bags. Amongst other initiatives, the EPHC mandated an intensification of research work on biodegradable plastic bags and other alternative products.

Zero waste powder coatings

A set of comprehensive and unbiased analytical data concerning Life Cycle Analysis of Dulux/Orica powdercoatings applied to bio-sustainable and synthetic polymeric substrates clearly demonstrates a significant reduction of negative environmental impact of the breakthrough technologies developed by partner organisations, Dulux Powdercoatings and CSIRO[1].

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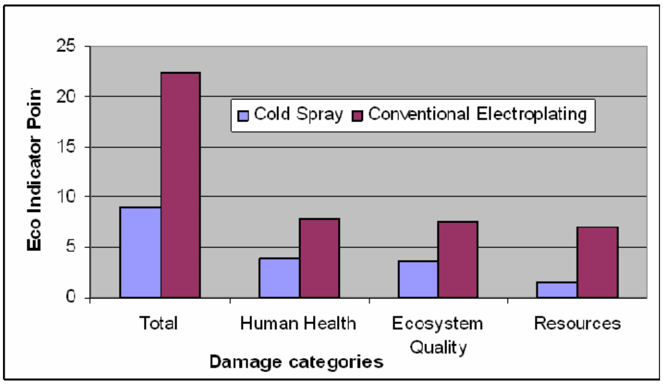
[1] Reference - Powder coatings: environmentally sustainable, zero-emission & zero-waste technology for decorative finishing of products made of natural, bio-based and synthetic polymers' CSIRO/DULUX submission for Premier's Sustainability Award 2008

- Orica Confidential Report *(by A. Carre, RMIT)*, Life Cycle Assessment of Trimatrx® Powder Coating System, Dec 2006.
- Orica Confidential Report, Streamlined Life Cycle Assessment of Powder Coating.
- Orica Confidential Report, Life Cycle Assessment – Dulux Alphatec – Special White, 2007.

Cold Spray Technology for Advanced Coatings and Direct Fabrication

The economic assessment of the Cold Spray technology was carried out by Kirk Group before establishing the Cold Spray printing rollers plant in Melbourne. The assessment of environmental advantage of the Cold Spray also has been carried out and is shown in the following diagram.



Comparison of environmental damage assessment of Conventional Electroplating vs. Cold Spray used in printing rollers

Treating contaminated soils with high power ultrasound

The aim of perfecting this technology is the reduction in a range of contaminants in soils and sediments at significant cost reduction over existing technologies. The soil remediation market is seen as growing with the estimated annual global value put at up to $17 Billion and growing (2001-Industry Canada). The markets exists predominantly in the developed world but there are perceived requirements arising from the emerging markets of eastern Europe etc.

Recovery

Fuel from Wood Waste

Over 40% (or 8.4 million tonnes) of the solid waste that goes into landfill each year (21 million tonnes total) is putrescible organic material. Organic waste tends to be low density and to take up to double the volume (space) of other wastes. Organic waste decomposes in landfill, producing greenhouse gases. It is estimated that if organics were removed from the waste stream, the resulting reduction in Australia's greenhouse gas emissions would be about 3%.

Geopolymer binder technology

Published preliminary environmental impact analysis of the production Geopolymer binder systems discloses a greater than 70% reduction in CO_2 emissions compared with traditional

Ordinary Portland cements. The unit cost of geopolymer binders is also very competitive by comparison.

Industrial steam separation and recovery

With the high energy and water consumption required for industrial steam generation and a growing concern regarding environmental effects, this technology is expected to result in a great impact on not only industrial water but also energy and environment. Water vapour is the major driver of greenhouse gas-induced climate change.