

Burning waste for energy

It doesn't stack- up

Exposing the push towards unsustainable waste to energy technology in Australia.



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Executive Summary

The National Toxics Network of Australia has prepared this report to contribute to the debate as to how Australia should manage its growing waste streams without further compromising the environment, public health or the needs of future generations through waste incineration.

Whether it be municipal waste (MSW), industrial waste, electronic waste or biomass, the way in which we, as a society, deal with discarded materials represents an important material and symbolic intersection between the environmental, economic and social aspects of our society. Waste is currently at the heart of many of our environmental problems but when addressed through ecologically sustainable practices can dramatically reduce resource consumption, energy use, and carbon pollution while becoming a valuable economic and agricultural resource.

Volumes of waste continue to grow at a rate that far outstrips our current recycling rates while environmentally damaging landfills become scarce and are now considered a last resort for dealing with waste. Local, regional and state governments have introduced levies on landfill dumping in an attempt to divert waste away from landfill and drive the waste producers and managers toward alternative waste treatment and recycling technologies.

At the same time climate change is driving domestic demand for renewable energy generation to displace fossil fuel based carbon emissions. State and Federal governments have introduced various schemes involving subsidies and tax breaks for renewable energy generators in an attempt to grow the renewable energy sector and thereby meet national greenhouse gas abatement targets under our international obligations.

These two key factors are driving waste incinerator operators to establish in Australia as renewable energy subsidies offered under such schemes provide enough financial incentive to make incinerators financially viable. Only a small fraction of the waste burnt by incinerators is considered of biogenic origin (the rest being petrochemical based plastics or metals) and the energy generated by burning it 'renewable' under regulatory criteria - and even that is subject to considerable controversy. Waste incinerators are extremely expensive to build and operate which is why it is critical for their financial viability to have access to 'green energy' subsidies and to have the electricity they sell labeled as 'renewable'.

In recent years there has been strong lobbying by some industry sectors to ensure that Australia adopts waste incineration as a means to reduce the waste directed to landfill while generating 'renewable' electricity.

However, burning biogenic material such as agricultural biomass or the organic fraction of municipal waste still releases large volumes of CO² to the atmosphere. The atmosphere does not distinguish between fossil fuel based CO² and biogenic CO². Despite the hype from the waste incineration industry there is no scientific basis to suggest that we can burn our way out of climate change.

The incinerator industry is now compelled to make claims that the electricity it produces is renewable and green to attract subsidies and credits for 'green' energy. It is unlikely that the industry would be able to remain financially viable in any sense unless they can access these funds. However, regulators and legislators are taking a closer look at these claims in some countries and exposing the false nature of these arguments.

The debate over waste in Australia has also been distorted by elements of the energy sector who have dominated the debate over 'renewable' energy that may be derived from waste without full consideration of the social impacts and broader sustainability problems arising from burning resources that may be put to better uses. The connection between biomass energy, biofuels, syngas, and other alternative "green fuels" and their role in supporting the continuation of our unsustainable fossil fuel based economy, needs urgent consideration. Decoupling carbon from our energy production systems is paramount if we are to address climate change and waste incineration fails this test.

It is also impossible to ignore the fact that while a fraction of waste burned in incinerators is from biogenic origin, the majority consists of plastics and other materials that form highly toxic compounds such as mercury and dioxin, that are either released to atmosphere as emissions or to soil through ash dumping contaminating the environment and causing serious health impacts in many communities.

The growing debate in Australia over which direction communities should take to deal with waste is at risk of being hijacked by the waste incinerator industry. For decades this industry was infamous as the highest known source of global dioxin pollution – one of the most toxic compounds ever studied. It was considered a dirty industry with a poor track record of air pollution and incidents. More recently the industry has rebranded itself to shake the 'dioxin factory' label and present itself as the 'waste to energy' solution which makes waste disappear and landfills obsolete while fighting climate change by generating 'green power'. This report demonstrates that incinerators remain a dirty industry beleaguered with pollution problems.

Even the term 'incinerator' is rarely discussed in industry publications and proposals with the technology re-named as gasification, pyrolysis, plasma arc and mass

combustion. However all of these technology variants are defined as waste incineration by the US Environmental Protection Authority and The European Union.

This report argues there have been no *fundamental* changes to thermal technologies ('hot' technologies) since the 1960's, only incremental improvements to air pollution control and other operating parameters. Industrial combustion of waste has been conducted since the late 19th century while gasification and pyrolysis technologies are not new, as claimed by proponents, but have been in use since the 1850's and 1950's respectively. This report provides examples that demonstrate the current waste burning technology is an expensive, carbon intensive, unreliable, polluting, unsustainable and inflexible basis on which to recover resources and generate electricity.

The global experience with incinerators for many decades has been serious incidences of air pollution and growing evidence of impacts on human health. Disposing of incinerator residues (ash and char) has also been problematic due to the large volumes and toxicity of the material. Australia would do well to avoid introducing these environmental problems as part of its waste management system. Incinerators have also been demonstrated to be extremely expensive to build and operate often leaving communities with a legacy of debt and pollution while locking out alternate, superior methods of dealing with MSW.

How to address the problems presented by waste while achieving the best social, environmental and economic outcomes is the challenge ahead for government and society. At the same time the increasing need for social investments such as job creation can benefit through more efficient recovery of resources currently destroyed by landfilling our waste. In attempting to meet this challenge, is it rational to say that we will divert waste from landfill only to have it "treated" in expensive, risky and dirty incineration technologies that employ few people, create little energy and impose a range of new public and environmental adverse impacts?

This report concludes that it is not rational to burn our waste and forego opportunities for simpler solutions that are rich in social investment and provide for longer term ecological benefits such as recycling and composting. These are options that generate much higher employment, save energy, water, boost agriculture and maximize resource recovery. A key strategy that achieves all of these goals is the Zero Waste model.

Zero waste models invest in 'cool' technologies and green jobs, maximizing resource recovery through enhanced recycling and composting schemes and can deliver sustainable resource recovery with maximum landfill diversion rates and provide for longer term public health and environmental benefits.

This report also outlines Zero Waste strategies as a mode of recovering high levels of resources from our waste stream while generating major environmental, economic and social benefits for Australia without polluting our communities.

This report **recommends** that Australian state and federal governments reject waste incineration and adopt a national policy for enhanced waste avoidance and resource recovery that includes;

1. Support and incentives for 'cool' technologies such as composting and anaerobic digestion.
2. The adoption of zero waste principles in legislation.
3. Increased support for an expanded recycling and composting sector.
4. National Container Deposit and Extended Producer Responsibility legislation that mandates product recycling.
5. Promotion of better industrial design to drive elimination of non-recyclable 'residuals' from the waste stream.
6. A review and removal of clauses in the ***Renewable Energy (Electricity) Act 2000*** that deem any aspect of waste burning for electricity generation 'renewable energy' which allows municipal waste burners to access credits, subsidies or certificates for renewable energy generation depriving genuine renewable energy projects of much needed resources.
7. Amendment of any other legislation, regulations or schemes to remove subsidies, benefits and incentives for waste incineration that would otherwise be directed to carbon-free renewable energy sources.

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Introduction

Incineration of household or municipal solid waste (MSW) is currently being considered by a range of state and local governments in Australia as an alternative to landfill. For example the NSW and WA Environmental Protection Authorities have both recently prepared Energy from Waste policies to guide regulatory assessors and project proponents.

This report exposes the environmental, economic, social and health impacts associated with burning waste. It also argues that waste incineration under the guise of *waste to energy, gasification, pyrolysis and plasma arc technology* can never be ecologically sustainable and produce little if any renewable energy. The main focus of this report is on the issue of incineration of MSW while issues of incineration of hazardous waste, medical waste and biomass are largely outside the scope of this study. There is some discussion of biomass incinerator residue from gasification and pyrolysis processes (also known as biochar) which shares similar properties to char from processing MSW in the same technologies.

Australians have fought for decades to keep incinerators out of their communities because of their long history of pollution, poor performance and financial failures. Most waste incinerators operating in proximity to communities in democratic countries around the world have been the subject of great controversy and public protests. The fact that they operate does not mean they are socially acceptable or result in any environmental or social benefits. However, they can make proponents very wealthy.

As concerns over sustainability and climate change permeate through society and challenge our policy makers to make increasingly complex decisions, certain activities of our society have been subject to increasing scrutiny. In particular the issues of energy generation, production, consumption and employment and their interrelation with national economy have been central to public policy debate and a daily feature of the media and political campaigns.

However, one critical aspect of public policy in the debate around economic growth and ecological sustainability that has been given little attention is the enormous opportunity for win-win outcomes in the area of *waste*.

Every person in our country has a daily relationship with waste that begins when they purchase products and then usually ends on their front road verges when the remnants of their consumption are discarded as waste.

How we as a society resolve the issue of waste is deeply interlinked with the much higher profile issues of sustainability, energy generation, production, consumption and employment. Yet, the issue of how we resolve our waste dilemma and its role in sustainability rarely makes headlines. When waste is in the news it is usually around issues of recycling, litter and political debate over Container Deposit Legislation (CDL). While this debate is important it overshadows the serious problems in Australia from the growing mountain of waste generated by our society which has been filling landfills almost as quickly as they can be excavated. The problem is getting worse and is in lock step with our growing patterns of consumption.

Australia is at a crucial turning point as local and regional governments run out of options to landfill waste. Decisions are now being made throughout Australia about infrastructure investment in waste management and resource recovery which will set the trajectory for the waste sector for decades to come. Billions of dollars in public and private funds are set to be invested as State, local and regional governments seek alternatives to landfill and more sustainable outcomes for community waste streams.

The term 'resource recovery' features prominently in the emerging policy debate on waste and refers to the principle of extracting higher value in the form of resources and energy from waste instead of just sending it to landfill. As Australian government agencies and the waste management sector started to adopt sustainability principles in the 1990's it became clear that there needed to be a transition away from landfill to higher levels of recycling and resource recovery.

Large-scale resource recovery technology proposals began to emerge and were collectively termed Alternative Waste Treatment (AWT). The AWT technologies can be divided into two categories – 'cool' technologies and 'hot' technologies. Both of these categories can include resource recovery technologies including those that generate some form of energy from waste. 'Hot' technologies are incinerators or thermal treatment (gasification, pyrolysis, plasma arc and combustion) while 'cool' technologies include large scale composting, recycling and anaerobic digestion (AD).

The range of terminology around these technologies can be confusing and a part of the problem is the cooption of the term 'waste to energy' (WtE) as a marketing tool by incinerator companies to make their technologies appear greener than they actually are. Waste to Energy processes can include non-incineration technologies such as Anaerobic Digestion of waste and flaring of landfill methane to generate electricity. Resource recovery technologies can refer to a large range of technologies including incinerators.

For the purposes of this report the European Union and US Environmental Protection Authority definition of incineration technologies is used. They define gasification, pyrolysis, combustion and plasma arc as incinerators. Despite claims by the incinerator industry that these are 'new' technologies, they are, in reality, based on decades-old technology with incorporated incremental changes.

Resource recovery can take the form of various processes, practices and technology including recycling, re-use, materials recovery, composting and energy generation from waste. Some forms of resource recovery contribute greatly the triple bottom line

outcomes of social, economic and environmental sustainability while others clearly do not. Among the poorest performers in this regard are MSW incinerators who burn waste to generate small amounts of electricity.

In the rush to access funding available to renewable energy generators many claims are made that burning waste is a form of renewable energy. This is a controversial issue and there are arguments to suggest that waste burning is not renewable energy and actually contributes to climate change through significant carbon dioxide releases and other impacts. While some arguments suggest that all biogenic material that is burnt to produce electricity is renewable (because it can be regrown) other approaches incorporating life-cycle analysis of this material stress that better climate change outcomes may be achieved by assessing the *best and highest value use* of biogenic resources and redirecting these materials to other processes such as composting and AD.

Using biogenic material as a 'fuel' source can have unintended consequences that also accelerate climate change and create social impacts. The example of large percentages of the corn crops in North and South America being diverted to ethanol production for automotive biofuels is one such case. The unintended consequences included sudden rises in food costs and clearing of forests (carbon sinks) to plant biofuel crops.

There is increasing concern that there is an orchestrated campaign by overseas corporations to flood the resource recovery sector in Australia and the Asia Pacific with waste incinerators. For example there are four waste incineration projects currently being considered in WA and a number of biomass and pyrolysis plants in regional NSW and Victoria are also currently being considered. Fiji and other Pacific islands also face the prospect of waste incinerator technologies establishing.

Proponents of incineration are exploiting concerns over climate change and landfill capacity by claiming that they are a source of renewable 'green' energy that can 'fix' our waste problems which doesn't stack up.

Some decision makers have been persuaded by this apparent fix with the result that the first Waste to Energy (WtE) plant has been approved in Port Hedland Western Australia. Incinerator proponents claim that this is just Australia 'catching up' with the rest of the world where waste incinerators 'operate successfully'.

A recent study published in American Economic Review found that solid waste combustion has the highest ratio of negative environmental and economic impacts (gross external damage) to benefits, among U.S. industries.

Muller, N., et al . 2011. "Environmental Accounting for Pollution in the United States Economy." American Economic Review, 101(5): 1649-75.

The National Toxics Network believes that there are alternative waste treatment technologies and practices that can deliver ecologically sustainable development including maximum resource recovery, higher comparative employment and other economic benefits without resorting to waste incineration.

This report provides an overview of those alternatives while presenting the case that waste incinerators undermine recycling, create a heavy economic burden on communities while converting valuable resources into dirty energy and pollution while generating hazardous waste.

The increasing array of toxic chemicals being used in products means that incinerators burning these products in their disposal phase will be emitting many combinations of chemicals that can change form during combustion and, which are rarely if ever monitored.

In addition to Polychlorinated Biphenyls (PCB's) dioxins and furans, new persistent organic pollutants are regularly being identified by the international scientific community. These are the most hazardous chemicals due to their toxicity and persistence in the environment. Many, but not all are listed for elimination under the Stockholm Convention on Persistent Organic Pollutants. These include brominated flame retardants in common use in household products like computers and electronics with plastic casings.

There is also the increasing use of nano-material components in household goods which also raises the risk of nano-particle emissions from incinerators when these goods are discarded into the municipal waste stream. Nano particles penetrate deep into human tissue with unknown health implications and are not monitored or regulated.

If an incinerator plant is established today the chemicals in the waste it burns for the next 25 years cannot be accurately predicted and neither can the nature of the emissions. Establishing waste incinerators in Australia will lead us down an expensive and difficult path wasting scarce resources trying to control novel and toxic emissions that may take decades to identify.

As decision-makers struggle with the task of managing the issues of increased consumption and waste in Australia, NTN believes that our community will need to engage with a range of problems whichever technological path is chosen to address waste. If we are to be successful in the long term in achieving ecologically sustainable resource recovery then the dilemma is in choosing the right set of problems and solving them. Incinerating our waste will result in our society spending vast amounts of resources trying to make incinerators safe but even if they can be made safe (and that is unlikely) we will never be able to make them sustainable.

The option that brings us closest to ecologically sustainable resource recovery is the process and practice of 'zero waste'. This means that we need as a community to continue to reduce consumption, re-use and recycle wherever possible and at every level of society. Where recovery must take place it should have the highest environmental and social outcomes with acceptable economic performance. In practice this should involve adoption of 'cool' technologies such as composting and anaerobic

digestion which are climate friendly and generate benefits for agriculture and energy production.

Adopting 'hot' technologies such as waste incineration undermines ecologically sustainable resource recovery and has poor environmental and social outcomes. In this sense it will become an incredibly expensive exercise in trying to solve the wrong set of problems, a billion dollar road to nowhere.

This report examines these matters in detail and concludes that Australia will not solve its consumption and waste issues with incineration and that we cannot burn our way out of climate change. By adopting 'cool' technologies for resource recovery we can minimise our carbon footprint, generate green jobs and boost agriculture.

Chapter 1 Drivers and Barriers for Sustainable Resource Recovery

At national, state and local level Australian governments have become more progressive on issues of waste in the last decade when council-run landfills were the only option for managing waste. National and state governments have developed waste policies and strategies that are based on the waste hierarchy, enshrine resource recovery and promote avoidance, reuse and recycling of our waste stream with disposal as the last option.

Incineration of waste has always been unpopular in Australia due to public health and environmental impacts and proponents have found it difficult to establish their technology in the past. Public opposition, cheap landfill and the enormous capital required to establish incinerators have proved major obstacles to the entry into the Australian market.

However, policies in the energy sector to address climate change combined with recent policy shifts driven by waste regulators in some states such as WA, to redefine the waste hierarchy so that waste burning is equivalent to recycling, have opened the door to incinerators.

Most jurisdictions are now working on diverting waste from landfill to recover resources, increase recycling and composting rates as well as implementing alternative waste treatment for residual waste.

While many of these policies, legislation and frameworks have been adopted for better environmental outcomes some have been unintentionally attracting a flood of proposals to burn municipal waste to generate energy.

This section describes some of the overarching regulatory and economic framework in the waste and energy sectors that act as drivers and enablers of waste incineration in Australia.

National Policy Frameworks

In terms of environment the regulatory framework is headed by the Standing Council on Environment and Water (SCEW) operating under the overarching Council of Australian Governments (COAG). SCEW incorporates the National Environmental Protection Council (NEPC). The law making powers of NEPC are defined under the National Environment Protection Council Act 1994 (Commonwealth). NEPC makes laws in a number of areas that are applicable in all states.

These laws are called National Environmental Protection Measures (NEPM's). NEPC and COAG have agreed upon a range of Issues of National Significance which relate to waste, water, air quality, and conservation of biodiversity and habitats and harmonised environmental regulation. In response to the NEPC priorities, the Federal Department of Sustainability, Environment, Water, Population and Communities developed The National Waste Policy which the department describes as a,

“...new, coherent, efficient and environmentally responsible approach to waste management in Australia. The policy, agreed by all Australian environment ministers in November 2009, sets Australia's waste management and resource recovery direction to 2020¹.

The development of the *National Waste Policy: Less Waste, More Resources, Implementation Plan 2010*, provides the overall direction to state governments to minimise waste for disposal and maximise recycling and recovery to the year 2020. It provides directions and strategies as well as roles and responsibilities for state and territory governments which were outlined in the earlier document *National Waste Policy: Less Waste, More Resources 2009*.

The National Waste Policy Implementation Plan addresses the issue of recovering energy from waste and other modes of organic resource recovery as a means of reducing greenhouse gas emissions from landfill. It also suggests that state governments need to expand their existing waste programmes and assess the potential for alternative waste treatment technologies such as anaerobic, composting and thermal technologies².

Product Stewardship³

The Product Stewardship Act 2011 allows for certain classes of products to be regulated for the purposes of product stewardship and more classes of product can be added to the regulations on the recommendation of The Product Stewardship Advisory Group. Currently some of the classes of products regulated include televisions and computers, refrigerators, air conditioners and certain batteries, paint and packaging.

¹ Australian Government (2010) *National Waste Policy: Less Waste, More Resources Implementation Plan* July 2010

² Many technologies lay claim to some form of 'resource recovery'. For the purposes of this report municipal waste resource recovery technologies are notionally separated into 'cool' technologies such as composting and anaerobic digestion and 'hot' incineration technologies such as combustion, gasification, pyrolysis and plasma arc.

³ Product stewardship is an approach to managing the impacts of different products and materials. It acknowledges that those involved in producing, selling, using and disposing of products have a shared responsibility to ensure that those products or materials are managed in a way that reduces their impact, throughout their lifecycle, on the environment and on human health and safety.

These products can pose significant risks because of their toxic components such as Brominated Flame Retardants (BFR's) and Lead which need to be quarantined out of any recycling programme.

While product stewardship is an essential step toward increasing industry responsibility for the products they manufacture the process in Australia has been very slow and the items listed under the Act are currently quite limited although there is provision to expand the products subject to the Act. There are also significant concerns as to how these products will be handled when they are managed under this legislation. Many forms of waste such as electronic waste contain persistent organic pollutants in the form of flame retardants and other additives. There is a significant risk that these toxic materials will be redistributed back into the community in a form which increases human exposure and health risks. Some plastics from e-waste in Australia are being recycled into kits for plastic raised garden beds which could potentially lead to food contamination issues.

In this respect federal policy makers need to ensure that recycling of products under stewardship schemes does not result in ongoing environmental impacts and increased human exposure to toxic substances.

National Fiscal Drivers

One of the key issues affecting resource recovery operations that generate electricity has been fiscal benefits associated with renewable energy production and pricing and trade mechanisms for carbon whether it be in the form of credits, taxes or tradable options.

For 'hot' resource recovery facilities such as incinerators the massive capital investment in construction (usually in excess of AU \$150 million based on many industry estimates) and high operational costs mean that some form of subsidy or tax break is needed to maintain financial viability. National energy policies developed to mitigate the threat of climate change have created incentives for waste incineration that allow proponents to develop plausible business plans for potential public and private investors..

The Carbon Tax

Australia introduced a carbon tax in July 2012 which would require around 500 large CO² polluters to pay for their carbon emissions at a price of Aus\$24.15 per tonne of CO². The scheme was designed so that by year of operation the price of carbon would revert back to a price determined by the market. However, the government recently announced it would scrap the current Carbon Tax scheme and accelerate the start date of a floating market based pricing mechanism of between Aus\$6 and Aus\$10 per tonne from July 1, 2014. This may be subject to further change depending on which political party is elected in the forthcoming Federal election.

Most landfills will be subject to the carbon tax (if they emit more than 25,000 tonnes of greenhouse gases a year) and this will cause the cost of disposing of waste to landfill to rise.

In addition, most State and Territory authorities have adopted some form of levy on landfill per tonne of waste disposed. This has driven up landfill disposal costs to higher levels. In some states a portion of the levy is paid back to waste managers on the basis of every tonne of waste diverted from landfill to recovery and recycling operations.

Diversion of waste from landfill may not always result in superior environmental outcomes and this report argues that waste diversion to incinerators is a poor outcome compared to diversion to recycling, composting and anaerobic digestion.

Renewable Energy (Electricity) Act 2000

The Renewable Energy (Electricity) Act 2000 establishes the legal framework for the generation and sale of renewable energy in Australia. It defines what constitutes renewable energy and creates a system of redeemable renewable energy certificates which can provide a revenue stream for renewable energy providers.

Renewable energy producers can be accredited under the Act and are then able to access and transfer small-scale technology certificates (STCs) or large-scale generation certificates (LGCs) depending on their total output. The Act also provides for the creation of 'liable entities' who have excessive carbon emissions and can buy renewable energy certificates to offset their carbon liabilities.

Section 17 of the Act defines what is an eligible renewable energy source and specifically excludes fossil fuel based materials such as plastics – a major fraction of high calorific value municipal waste. Most of the eligible materials are biogenic in nature – that is they have been produced by living organisms or biological processes - and energy can be recovered from them through either cool technologies (anaerobic digestion) or 'hot' technologies such as incineration.

- energy crops;
- wood waste;
- agricultural waste;
- waste from processing of agricultural products;
- food waste;
- food processing waste;
- bagasse;
- biomass-based components of municipal solid waste; and
- biomass-based components of sewage;

If the biogenic component of municipal waste was not eligible for renewable energy credits it would be unlikely that incineration would be financially viable in Australia, especially given the fact that they emit more CO² than coal fired power stations per unit of energy produced.

Currently waste incinerators can claim the renewable energy credits for that fraction of MSW which is biogenic in origin (food, wood, paper etc). MSW is mixed waste from household bins that includes plastics, paper, metal, food scraps and a wide range of other materials. A large portion of the waste may be fossil fuel based such as plastics and cannot be claimed as biogenic. Incinerators are required to demonstrate the average level of biogenic materials in the waste they burn which may be between 30-60% of the total waste volume they burn. In principle, if an incinerator reports that 40% of the waste they burn is of biogenic they are eligible for Renewable Energy Credits for 40% of the electricity they generate.

Renewable Energy Target Scheme

The Renewable Energy Target (RET) Scheme is a federal government commitment that by 2020, 20% of Australia's electricity supply will be sourced from renewable sources. The RET expands on the previous Mandatory Renewable Energy Target (MRET), which began in 2001. From 1 January 2011 the RET has operated as two parts:

1. Large-scale Renewable Energy Target (LRET)
2. Small-scale Renewable Energy Scheme (SRES).

The LRET encourages the deployment of large-scale renewable energy projects such as wind farms, while the SRES supports the installation of small-scale systems, including solar panels and solar water heaters⁴.

Renewable Energy Generation Financial Incentives

The Federal government has also made available over Aus\$13 billion to invest in new renewable energy sources via a range of entities. The Clean Energy Finance Corporation (CEFC) has funds of Aus\$10 billion to invest in the commercialisation and deployment of renewable energy.

The Australian Renewable Energy Agency (ARENA) to streamline and coordinate the administration of \$3.2 billion in existing support for research and development, demonstration and commercialisation of renewable energy technologies. In addition the Clean Technology Innovation Programme has \$200 million over five years to support

⁴ Department of Industry, innovation, Climate Change, Science, Research and Tertiary Education. (2013) access online at <http://www.climatechange.gov.au/reducing-carbon/renewable-energy/renewable-energy-target>

innovation through grants for business investment in renewable energy, low emissions technology and energy efficiency⁵.

The Carbon Farming Initiative

The Carbon Farming Initiative introduced by the Federal government, allows farmers and other land use managers *to generate carbon credits by storing carbon or reducing greenhouse gas emissions on the land. Participants can earn carbon credits by setting up a project under an approved CFI methodology, which sets out the rules for the activity*⁶. An accurate methodology has now been determined to allow composting operators who divert waste from landfill to generate carbon credits from this scheme. Australian carbon credit units (ACCUs) can be bought and sold in the Australian market.

State Drivers and Barriers to large scale resource recovery technologies

Rising landfill costs, rising recycled commodity prices and renewable energy creation incentives are clearly driving the resource recovery sector, which for recycling and 'cool' technologies are positive trends.

The principle driver at state level for increased resource recovery from MSW is the application of the Landfill Levy. Most states now have some form of landfill levy which applies to each tonne of waste deposited in landfill. The levy makes it more expensive to dispose of waste to landfill and creates a financially competitive opportunity for alternative waste technologies to process waste. A secondary driver is the depletion of available landfill space and increase in waste volumes generated. It is very difficult to establish new landfills due to community opposition and existing landfills may only have a lifespan of years to decades. The combination of landfill price increases and limited options to expand the landfill network work in favor of the establishment of resource recovery technologies.

There are also some barriers to establishment due to the scale of many of the operations. Incinerators have a more difficult task to overcome these barriers in the sense that they are both unpopular with the public and far more expensive to establish and operate than cool technologies. Zero Waste South Australia⁷ have accurately summarised the primary barriers to establishment of resource recovery operations based on municipal waste in Australia.

⁵ Ibid

⁶ Australian Government (2013) *CFI Methodologies: Diverting Legacy Waste to Alternative Waste Treatment. Fact Sheet.*

⁷ Zero Waste South Australia (2006) *Alternative Waste Technologies. A Position Paper.* January 2006.p.8

- cost
- unknown nature of 'new technologies'
- long-term contracts required to make them viable
- community concerns and uncertainty
- financing
- competing methods of managing waste streams
- vulnerable markets for end-products
- concerns over end-product quality
- the need for large volumes of material.

The greatest barrier to establishing resource recovery facilities is cost with many operations costing more than \$100 million to establish⁸. The most expensive to establish are waste incinerators with or without electricity production due to the high expense of the air pollution control (APC) systems (often costing 3 times as much as the rest of the facility).

APC investment is a key expense that is avoided when organics from the waste stream are diverted to compost and anaerobic digesters instead of incinerators. All large scale waste handling facilities will incur some expense in controlling odour and dust nuisance but this is an almost insignificant compared to the high standard scrubbers and filters that must be installed in incinerators to prevent uncontrolled emissions. As pointed out elsewhere in this report, updating APC to meet stricter air quality standards over time can be prohibitively expensive to the point that incinerators may not be able to meet the upgrade costs and will close.

Most states are in the process of finalising inquiries, studies and policies to guide their jurisdiction on the assessment and cost/benefits of resource recovery (including energy from waste).

Most are taking the view that only the residual fraction of MSW that cannot be recycled or recovered through 'cool' processes should be available to waste burners. That small fraction may dwindle over time as recycling, substitution of toxics and product design improve. This is a key risk to the financial viability of incinerators. In the absence of residuals to burn the expectation is that they will demand more and more recyclable material as fuel.

⁸ Nolan ITU (2004) Alternative Waste Treatment in Australia: Stakeholder Survey. Nolan ITU, Sydney. www.nolanitu.com.au/__data/page/10/NolanITU_AWT_Stakeholder_Survey_Summary.pdf

Chapter 2 Incinerators in Disguise

For the last decade the waste incineration industry has spent a great deal of time and energy looking for ways to shake off its negative public perception and expand into new markets around the globe. Traditional incinerator markets in the US and Japan are stagnant and locations such as Australia are looking more attractive.

Australians have always been wary of waste incineration and communities have been opposed to any proposals that have arisen. Public resistance to incineration is also growing in many other countries. In the UK alone, over 80 groups have been established to oppose plans to build new waste incinerators⁹. On a global scale there are many more individuals and organizations who oppose waste incineration with the Global Alliance for Incinerator Alternatives claiming 500 grassroots organizations and individual members world-wide¹⁰.

This has forced the incinerator industry into a public relations make-over where the word 'incinerator' is rarely mentioned and has been replaced by terms such as 'gasification, pyrolysis, plasma arc and waste to energy (WtE)'.

These technologies are all waste incinerator technologies according to the European Union¹¹ and the US Environmental Protection Authority¹². The configuration of each technology varies but they are all designed around single stage or dual stage burning of waste. They all produce a similar profile of pollutants (although the concentrations may vary) and all have similar negative effects on communities and alternative resource recovery practices such as recycling and composting.

Incinerator proponents have attempted to make a distinction between 'old' incinerators and 'new' technologies. This is part of promoting the argument that environmentalists and communities are objecting to the old polluting technology which has now been replaced by 'new clean' technology. However, all of the 'new' technologies are basic incineration variants that have been subject to incremental changes over time and most continue to suffer from a poor environmental track record.

While tighter air quality standards have forced waste incinerators to increase pollution controls (especially for dioxins) they continue to be responsible for discharges of a large range of atmospheric pollutants and dioxin release incidents. The improvements to air emissions have also led to a much higher level of contamination of incinerator residues such as ash which must still be sent to landfill.

⁹ see the United Kingdom Without Incineration Network accessed online at <http://ukwin.org.uk/thenetwork/>

¹⁰ see Global Alliance for Incinerator Alternatives at <http://www.no-burn.org>

¹¹ European Union (EU) Directive 2000/76/EC on the incineration of waste (the WI Directive)

¹² U.S. Environmental Protection Agency, Title 40: Protection of Environment, Hazardous Waste Management System: General, subpart B-definitions, 260.10, current as of February 5, 2008.

Incineration – an outdated industry

The incinerator industry has rebuilt its image around the generation of electricity from burning waste. They claim that this is a renewable and ‘green’ form of energy generation which is climate friendly and can replace landfill emissions of methane.

These claims are critical to the establishment of the incinerator industry in Australia because of the government subsidies and credits available to renewable energy generators. Because a percentage of the municipal waste they will burn is organic in origin or biogenic they claim this constitutes renewable energy and have been aggressively lobbying state and federal government to accept this logic. These claims are built on a number of false assumptions which are examined in Chapter 3 of this report.

The incinerator industry is desperate to establish a foothold and capture a share of the waste stream before more ‘cool’ technologies can establish throughout Australia. This section of the report examines the global trend of incinerator oversupply and market sector stagnation before briefly describing the so-called ‘new’ incinerator technologies of gasification, pyrolysis and plasma arc.

In the US, growing concerns over identifiable health risks, high costs and environmental justice issues (the siting of high risk and polluting facilities in low income communities with high populations of Afro-Americans and Latinos) stymied the incinerator market. These elements combined with a movement in the US toward recycling and composting meant that no new incinerators have been added to the 113 existing incinerators in the US in the last decade¹³.

According to the USEPA¹⁴ waste incineration has stagnated as more cities embrace composting and recycling,

“The waste-to-energy industry has been outpaced by the growth of recycling and composting. In 1990, recycling and composting accounted for 33.2 million tons of waste; that rose to 81.8 million tons in 2006, an increase of 146 percent. The amount of waste burned for energy recovery in 2006 (31.4 million tons) is only slightly larger than that in 1990, 29.7 million tons – a 0.3 percent average growth.”

The U.S. Department of Energy¹⁵ detailed some of the reasons for the decline of the market and pointed out the vital role that tax subsidies, energy credits and regulations play in the financial viability of incinerators,

¹³ Texas Comptroller of Public Accounts (2013) *Energy* Chapter 18

¹⁴ U.S. Environmental Protection Agency, Office of Solid Waste, *Municipal Solid Waste Generation, Recycling and Disposal in the United States: Facts and Figures for 2006*, (Washington, D.C., November 2007), pp. 1-2.

¹⁵ U.S. Department of Energy, 1997. cited in GAIA (2003) *Waste Incineration: A Dying Technology*

The WTE market has been steadily shrinking in the USA, due to the following reasons:

- 1. The Federal Tax Policy no longer favors investment in the capital-intensive (because of expensive pollution control and monitoring equipment) WTE technologies. (WTE companies previously had tax-credit benefits.)*
- 2. Energy regulations, which once required utilities to buy WTE energy at favourable rates, have been revamped.*
- 3. There have been increasing challenges to interstate waste movement.*
- 4. With increasing awareness and protest by communities, the governments have been forced to involve them in the decision-making process. This sometimes means having to leave the waste management option to the communities themselves. People are increasingly opting for recycling and composting of waste, and out of WTE.”*

In the UK, Germany, Japan, Sweden, Denmark and the Netherlands new incinerators face public opposition for similar reasons to the US and there is currently an oversupply of incineration (down from 430 incinerators in 2005 to 406 in 2013) which looks set to decline further in the decades ahead.¹⁶ In some European jurisdictions there are more incinerators than waste available to burn leading to waste exports between countries in the EU.

Facing stagnant markets in the US, Europe and Japan for new incinerators and a surge in composting and recycling across the globe, the incinerator industry has been forced to ‘rebrand’ itself and look for new markets. Many countries with economies in transition or developing countries cannot afford the high costs associated with establishing and running incinerators with expensive APC technology. As a result countries like Australia become attractive because of their relative economic prosperity, high consumption, high volumes of waste and an immature resource recovery market.

European incinerator oversupply; impacting recycling and driving waste shipments

“...There are two major objectives we need to pursue. Obviously, landfill rates must go down as quickly as possible, but it is also important to switch from energy recovery to increased recycling. Plastic recycling rates are far too low across Europe with an average of just 24 per cent. Today, even in countries with high recovery rates, there is simply not enough plastic available for recycling because most of it goes to energy recovery. A dominance of energy recovery over recycling is not acceptable in the medium-term...”

-Janez Potočnik European Commissioner for the Environment 2012

¹⁶ Sora, J., (2013) *Incineration overcapacity and waste shipping in Europe: the end of the proximity principle?* Fundacio Ent January 7th, 2013

The waste incineration market in Europe has moved past saturation point and has now entered a period where there is an oversupply of incineration capacity. The incinerator industry underestimated forward projections for recycling leaving existing incinerators with excess capacity. This unregulated market based approach has seen incinerator companies competing for limited supplies of waste as recycling has reached unexpectedly high levels in many European nations. Germany, Sweden, Denmark, the Netherlands and the United Kingdom all have far more incineration capacity than there is waste to burn. This has caused a significant distortion in the waste market that has led to most of these countries importing municipal waste as a fuel for the incinerators or accessing waste within their country far from the point of generation. Transporting waste long distances generates large quantities of GHG which are not factored into the overall contribution of waste incinerators to climate change.

As this activity increases it has become clear to authorities that it is undermining the objectives set out in the Waste Framework Directive (WFD 2008/98/EC) and the Roadmap to a Resource Efficient Europe¹⁷ which prioritise waste prevention, re-use and recycling. In particular, the revision of the Waste Framework Directive¹⁸ has made it possible to ship waste across internal EU borders and creating a direct conflict with the 'proximity principle' touted as one of the EU 'firm principles' for managing waste.

The proximity principle (art16 WFD 2008/98/EC) advocates that waste should be treated close to the point at which is generated and that *"the network shall be designed to enable the Community as a whole to become self-sufficient in waste disposal and recovery operations."*¹⁹

Those countries with a significant incinerator industry are now looking to increase incineration capacity to take advantage of being able to access MSW from any EU member countries without cross boundary notification. Overall this trend oppresses recycling rates and increases demand for waste that could be recycled or recovered in more beneficial ways.

The Roadmap to a Resource Efficient Europe was agreed on by a resolution of the European Parliament in May 2012 and states that by 2020 incineration with energy recovery should be limited to *non-recyclable materials*. However, estimates of residuals in the waste stream are currently at 20% of total volumes yet existing incinerators which are not operating at capacity are burning 22% of the total waste generated in the EU. In

¹⁷ European Commission (2011) COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS, *Roadmap to a Resource Efficient Europe*.

¹⁸ Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste.

¹⁹ European Commission (1999) *EU focus on waste management*, Directorate-General Environment, Nuclear Safety and Civil Protection.

other words, recyclable material is currently being burned and more will be burned with additional incineration capacity.

Denmark has four times as much incineration capacity as it does waste to burn. This has resulted in two incinerators importing waste to burn from London and another importing its waste from Germany. Some European countries are now imposing taxes on waste incineration in an attempt to curb the flow of waste into their country. Austria, Spain, Denmark, Belgium, France and Italy all have incineration taxes ranging from 1.03 Euro/tonne to 44 Euro/tonne²⁰. The European incinerator industry is fighting against any form of taxation because it affects profitability and in some cases can cause them to become financially unviable²¹.

Manipulating the Waste Hierarchy

Since the incinerator industry in Australia has reframed the justification for its technology away from waste disposal to 'green energy' generation to combat climate change, they have also pushed for greater incorporation in government waste and energy policies.

The problem for proponents with incinerators being identified with waste *disposal* was that it effectively placed the technology at the bottom of the sustainable waste management hierarchy alongside landfills. Identification of incineration with dirty and unsustainable practices redirected market investment toward more sustainable waste management practices such as recycling, reuse and 'cool' resource recovery techniques. The identification of incineration as a disposal technology also minimised the industry's opportunity to receive public funds, subsidies, grants and tax incentives which now flowed toward ecologically sustainable alternatives and genuine renewable energy such as wind, wave and solar power.

In an era of dangerous climate change induced by anthropogenic CO₂ emissions, the public relations 'makeover' of waste incinerators as green energy producers was intended to improve political, public and regulatory attitudes to waste burners.

²⁰ Jofra Sora, M., (2012) *Zero Waste. Handbook on Alternative Waste Management Streams*. Project co-financed by the European Regional Development Fund.p.18

²¹ Afvalforum (2010) *Incineration Tax unpopular with European Waste Industry. Reward good behaviour, punish bad behaviour*. September 2010

Incinerator proponents also lobbied for the waste management hierarchy to be revised to boost waste burners up the hierarchy from *disposal* to *resource recovery*. This category was considered more sustainable and publicly palatable than *disposal*.

In some Australian jurisdictions such as Western Australia the incinerator industry has convinced authorities that incinerators should be given equivalent status to *recycling*²². This is achieved by creating a three level hierarchy with 'Avoid' as the most preferred, 'Recovery' (which includes reuse, reprocessing, recycling and energy recovery in one group) and the second preference and 'Disposal' as the lowest preference. In this way energy recovery becomes an equivalent option to reuse, reprocessing and recycling rather than a lower preference.

The WA Waste Authority recently issued this 'interpretation' of the waste hierarchy as a result of pressure from the incineration lobby. This is made clear in the Foreword of the document by the Waste Authority Chairman,

*"Together, the work of the Strategic Waste Infrastructure Planning Working Group and the recent arrival in WA of proponents for thermal waste to energy technologies have prompted discussions about the need for resource recovery to be implemented at the highest point possible in the hierarchy for any given material."*²³

While many of the waste hierarchy structures in Australia have evolved over the last decade to incorporate a 'resource recovery' level (to acknowledge the role of composting and energy recovery from landfills and waste) this is the first instance where incineration has been given an equal status to recycling. The two waste hierarchies below show this development with the most common version (the current South Australian EPA version) and the WA waste hierarchy.

²² Waste Authority of Western Australia (2013) Waste Authority Communication on the Waste Hierarchy.p.4

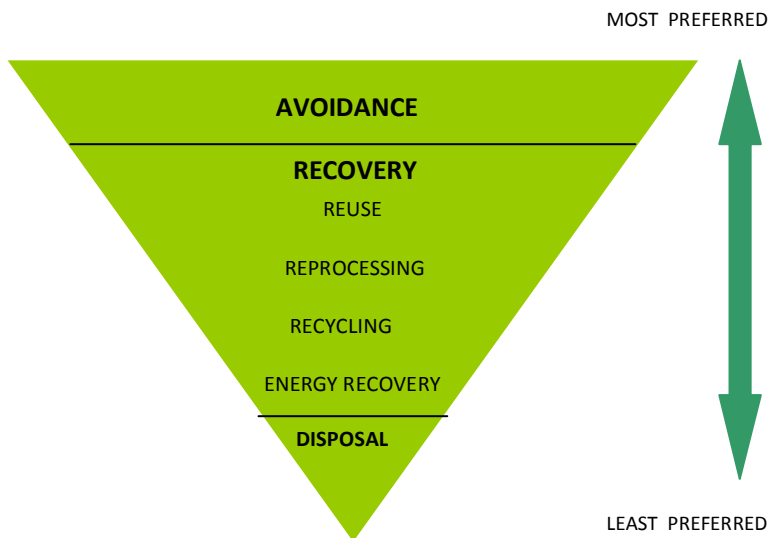
²³ Waste Authority of Western Australia (2013) Waste Authority Communication on the Waste Hierarchy. Chairman's Foreword.



Fig 1. Waste Hierarchy South Australian EPA

The new Western Australian Waste Hierarchy interpretation has a subtle difference that ranks all recovery technologies as optional alternatives.

Fig 2. Waste Authority WA Waste Hierarchy Interpretation 2013



In Europe, the Waste Framework Directive has a strict preferential hierarchy in which incineration of waste is classified as 'Disposal' the least preferred option unless they are

able to meet energy efficiency levels.²⁴ Disposal of waste is ranked as the least preferred option for waste management and attracts no subsidies or credits.

'New' Incinerators

The push to establish incinerators in Australia has been driven by industry claims that they now generate climate friendly energy using 'new' safe technologies which operate successfully overseas. This section examines these technologies and the industry claims that they are safe and reliable.

Gasification and pyrolysis use thermal treatment to break down waste at high temperatures. The major difference between these incinerators and 'old' incinerators (sometimes referred to as 'combustors') is that these technologies break down the waste in a low oxygen environment. These technologies are not new as gasification systems have been in use since the mid 19th century and pyrolysis since the 1950's. While these processes have been subject to incremental changes over time, there have been no fundamental process changes for decades. Both of these technologies have the same pollution control devices available to the as combustion incinerators and experience similar problems in controlling their emissions.

The high temperature, low-oxygen process breaks the waste down into solid, liquid and gas residues. The gas component is a combination of hydrogen (around 85%) carbon monoxide, and low levels of carbon dioxide, nitrogen, methane and some hydrocarbon gases. The combination of gas is referred to as 'syngas' which is combusted in a secondary process to generate electricity.

In order to generate syngas the waste used in these processes must be rich in carbon and includes paper, plastics and organic matter such as kitchen and garden waste. The syngas can be used to generate energy or as a feedstock in the petrochemical industry.

Gasification allows the use of low levels of oxygen but not enough to cause combustion of the waste. Pyrolysis heats and degrades the waste in the absence of oxygen. Both processes usually operate at or above 750° C. Some pyrolysis units may also engage a secondary gasification system to extract higher levels of syngas.

Virtually all gasifiers and pyrolysis plants have four stages of operation:

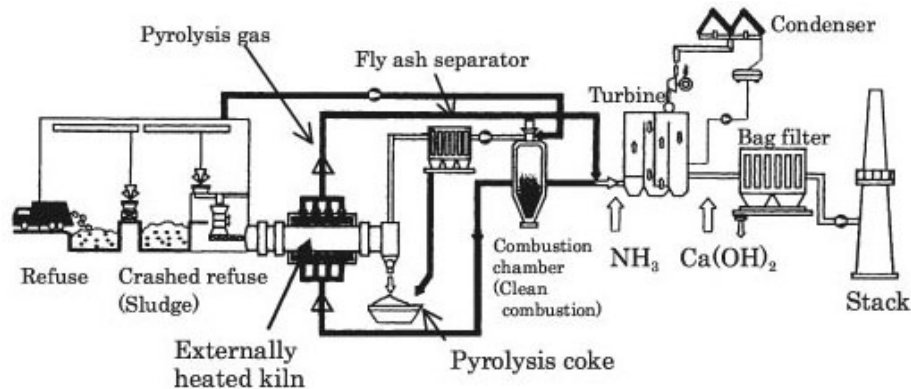
1. **Waste Feedstock preparation:** The plant may take mixed waste that has had low calorific value materials removed (sand and concrete) and some recyclables such as glass extracted by a Materials Recovery Facility (MRF). Alternately the

²⁴ 'Waste to Energy incinerators must meet the R1 formula in Annex II of the Directive to demonstrate they are net energy exporters or they are classified as waste *disposal* not resource recovery.

feedstock may be a form of Refuse Derived Fuel (RdF) from a Mechanical and Biological Treatment (MBT) plant.²⁵

2. **Heating the waste:** Thermal treatment of the waste in a low oxygen (gasification) or nil oxygen (pyrolysis) environment to generate syngas, oils and char or ash.
3. **Gas filtering:** to remove some (but not all) of the hydrocarbons, dioxin and particulate.
4. **Use syngas for energy generation:** Electricity can be generated via a steam turbine or gas engine or potentially used for combined heat and power (CHP).

Fig 3. Flow sheet for typical pyrolysis system for MSW



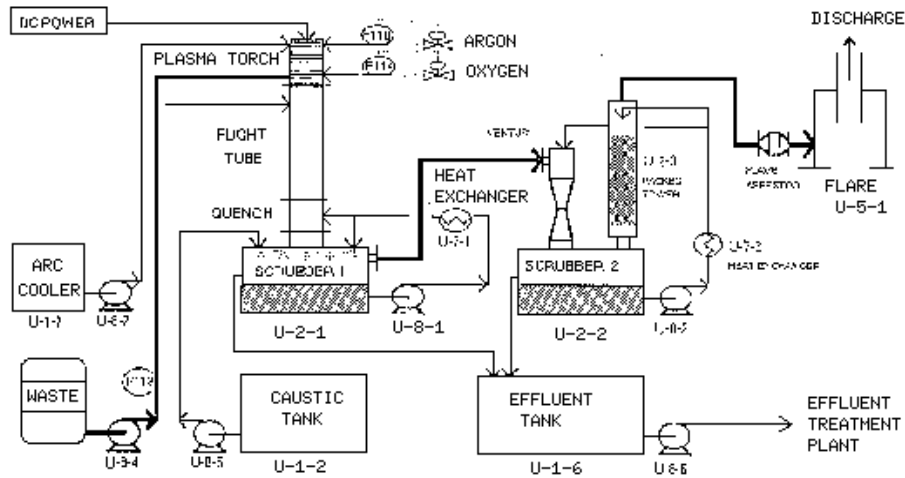
Plasma Arc operates at a much higher temperature (between 3000°C and 15000 °C) creating a thermal plasma field by directing an electric current through a low pressure gas stream²⁶. The intense high temperature zone can be used to dissociate the waste into its atomic elements by injecting the waste into the plasma, or by using the plasma arc as a heat source for combustion or pyrolysis.

Typically plasma arc has been proposed in Australia for the destruction of hazardous waste rather than the generation of energy from municipal waste. However, Nufarm Australia has been operating a Plascon plasma arc unit at Laverton in Victoria to destroy chlorinated pesticide waste since 1992 while generating electricity. Dioxin emissions have been detected in the emissions.

²⁵ The MBT plants normally employ a combination of mechanical shredders, separators, magnets and trommels etc with a biological treatment process such as anaerobic digestion. These processes use a significant amount of energy to produce a 'fuel' for gasification and pyrolysis.

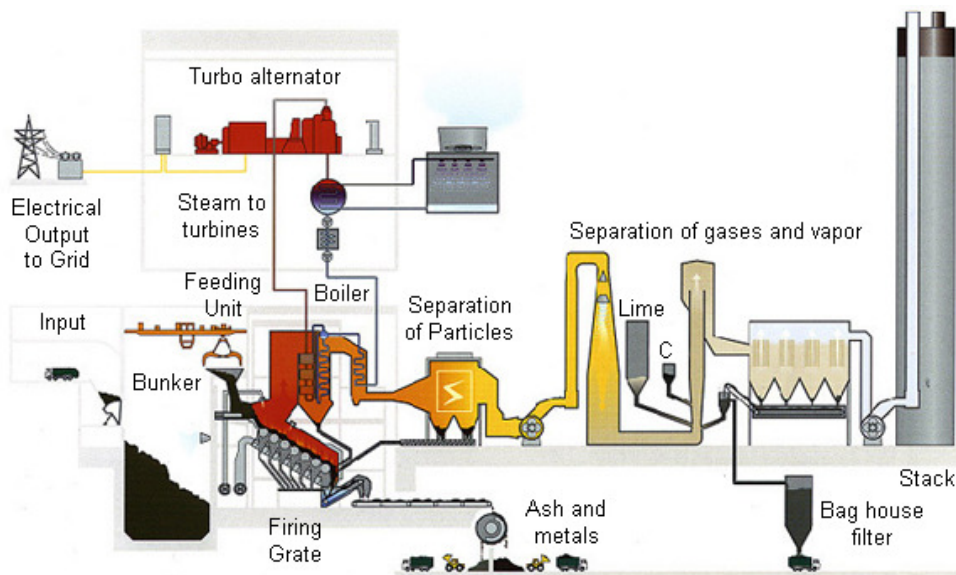
²⁶ CMPS&F- Environment Australia (1997) Appropriate technologies for the treatment of scheduled wastes. Review Report Number 4 - November 1997

Fig 4. Flow sheet for PLASCON plasma arc system.



Traditional mass combustion incinerators tend to operate at much lower temperatures (typically 750°C -1000°C) and burn waste in the presence of uncontrolled levels of oxygen with no pre-treatment of municipal waste (although some facilities remove a percentage of the recyclables from the waste stream). Those incinerators that generate energy use the heat from combusting waste to generate steam for turbines to generate power.

Fig 5. Flow sheet for mass combustion waste incinerator.



Track record of gasification, pyrolysis and plasma arc.

Despite the claim that these technologies are proven and reliable, they are not widely used in the waste management industry and have experienced serious problems with pyrolysis in particular, found to create considerable amounts of dioxin and furans when burning waste.²⁷

A 2008 US study surveyed a large range of gasification and pyrolysis technologies and reported that:

- they are unproven on a commercial scale for treating MSW in the United States,²⁸
- the residuals from the process can be hazardous,
- they require pre-treatment of waste, and
- are more expensive than other technologies.

Of the few facilities that have been operational in the US and Europe, many have been plagued with operational problems, serious emissions breaches or financial failures.

The US experience

While combustion of waste in incinerators has been undertaken in the US since the early 20th century gasification and pyrolysis have not played any significant role in managing waste and is considered an unproven technology. These forms of incineration often need specialized preparation of waste to ensure a consistent feedstock can be fed into the unit. MSW is highly differentiated and these technologies have difficulty accepting the high diversity of materials into their feedstock systems. There is some evidence that these systems perform better when burning a single type of waste with consistent characteristics.

Neoteric plasma arc/pyrolysis facility

Neoteric Environmental Technologies and International Environmental Solutions built a plasma arc/pyrolysis facility in Romoland, located in Riverside County, California. The company failed in test burns on sewage sludge and fireworks. When the company trialled municipal waste, the South Coast Air Quality Management District determined that the pyrolysis facility emits more dioxins, NO_x, volatile organic compounds and

²⁷ Weber, R., and Sakurai, T.,(2001) Formation characteristics of PCDD and PCDF during pyrolysis processes. *Chemosphere* [Volume 45, Issue 8](#), December 2001, Pages 1111–1117

²⁸ Foth Infrastructure & Environment, LLC (2008) *Updated Research Study Gasification, Plasma Ethanol and Anaerobic Digestion Waste Processing Technologies*. Prepared for Ramsey/Washington County Resource Recovery Project. p. viii

particulate matter than the two existing large municipal solid waste incinerators in the Los Angeles area²⁹.

The Hawaii Medical Vitrification plant

The Hawaii Medical Vitrification plant operated by Asian Pacific Environmental Technologies near Honolulu operated a plasma arc for medical waste but encountered serious operational problems and licence breaches and was closed for an eight month period due to refractory chamber damage. The technology used was Integrated Environmental Technologies' (IET) "Plasma Enhanced Melter" which was also used by Allied Technology Group in Richland, Washington to treat radioactive and hazardous wastes. This facility was forced to close due to operational and financial problems.

The Australian experience

The Solid Waste and Energy Recycling Facility (SWERF)

The only gasifier to treat municipal waste in Australia was established in Wollongong, New South Wales in 2001. Proponents Brightstar Environmental and Energy Developments Ltd named the technology the Solid Waste and Energy Recycling Facility or SWERF. An identical plant was proposed to be established Maddington, Western Australia at the same time but community opposition saw more than a 1000 residents turn out on the streets to protest against the facility. The Maddington SWERF was withdrawn shortly after.

Fig 6. The defunct SWERF gasifier Wollongong NSW



The Wollongong SWERF was plagued by operational problems and emissions breaches during its three year 'test period'. Emissions breaches³⁰ included major

²⁹ Presentation by South Coast Air Quality Management District to California Integrated Waste Management Board, 20 Sept. 2005

³⁰ Brightstar Environmental. "Emissions Data from Solid Waste and Energy Recycling Facility (SWERF)," 1-2 Mar. 2001.

exceedences of arsenic and SO_x, carbon monoxide over 13 times the German limit (50 mg/Nm³). The gasifier also produced significant emissions of dioxins, hydrogen chloride, hydrogen fluoride, polyaromatic hydrocarbons, hexachlorobenzene and heavy metals.

In 2004, the SWERF facility was abruptly closed by its parent company EDL³¹ following withdrawal of funding for the project in mid-2003. Brightstar Environmental was also negotiating contracts to establish waste gasifiers in India, the UK, US and other Australian cities. These contracts were cancelled following the failure of the Wollongong SWERF and Brightstar Environmental no longer operates.

The Pacific Experience

In May 2011, IPEN in the U.S. forwarded a call for assistance to GAIA-Phillipines and Island Sustainability Alliance in the Cook Islands. Members of the "AKTIV" organization in Vanuatu were objecting to the proposed installation of a rotary kiln incinerator. The plan was to put in an "Intherma" unit near a sub-division on two commercial plots, close to residential plots. No consultations took place with the local communities, residents, land owners and businesses. An EIA report dated April 2011 appeared to be in favour of such an incinerator. GAIA-Phillipines provided good technical support, which enabled residents to challenge and prevent this project from going ahead.

During July 2012, a Feasibility Study was prepared for installation of an IST GEM Waste-to-Energy system in Rarotonga, Cook Islands, with the proposed site being the utility which generates power for Rarotonga. There was no consultation with environmental and community groups; in fact there was so little transparency in the preparation of this feasibility study that the Cook Islands Commissioner for Energy was unaware of it. After some difficulty, ISACI obtained a copy of this report, and subsequently a letter of protest was published in the local newspaper. There is increasing resistance to incinerators by communities affected by incineration of quarantine waste from airplanes, and at another site where residents complain that they are forced to leave their houses to escape the impact of incineration fumes. No further steps have been taken publicly to progress the incinerator.

The UK and European experience

Energos Gasifier

The modern MSW gasifier established on the Isle of Wight in 2008 by Waste Gas Technology³² has breached its dioxin limits on numerous occasions since April 2010.

³¹ Energy Developments Limited, "ENE to cease SWERF development expenditure and focus on traditional energy business," press release, 21 July 2003.

³² Waste Gas Technology is the sister company to Energos who have recently received approval for the first waste incinerator in Australia using the same technology as the Isle of Wight gasifier (the facility is planned for Port Hedland, Western Australia).

Dioxin emissions at 0.86 ITEQ ng/m³ were over 8 times the regulatory limit during the April sampling. The plant restarted in June 2010 and independent tests confirmed that dioxin levels were still 3-4 times higher than permitted³³.

A report by The Isle of Wight Council *"Energos' efforts to solve the problem have not reduced the level of dioxin emissions sufficiently and the Environment Agency has directed that the plant remains closed."* In 2011, the incinerator re-opened but was again continued to have problems with mercury emissions which the Environment Agency tests demonstrated were over 5 times the legal limit.

Scotgen Gasifier

Scotland's newest incinerator, the Scotgen Dumfries gasifier plant was commissioned in 2009 to gasify more than 20,000 tonnes of municipal waste. It has had 200 breaches of emissions limits, two of which involved dioxins, and also had 100 "short-term" exceedences. It was shut down in April 2011 and is now operating on a restricted basis. In 2013, the plant experienced more exceedences of emission limits and a major explosion without having produced a fraction of the electricity initially claimed.³⁴

Thermoselect gasification incinerator

Thermoselect's Karlsruhe facility in Germany was once one of the world's largest municipal solid waste (MSW) gasification incinerators, designed to process 225,000 tons of municipal wastes per year. Recurring operational problems that led local press to rename it "Thermodfect" prevented the facility from reaching full operating capacity.

During its operations the facility was only able to dispose of one fifth of the total quantity of contracted waste, forcing cities that had contracted with the facility to find new disposal options. It also breached its permissible emission limits for dioxins³⁵ and for hydrogen chloride, particulates, nitrogen oxides and total organic carbon³⁶. By the time facility-owner EnBW decided to close Thermoselect Karlsruhe in 2004, it had lost at least 400 million Euros (approximately \$500 million) on MSW gasification.

³³ US Environment Agency data cited by Gala, M., (2010) Gasification plant remains closed after re-testing. (Letsrecycle.com)

³⁴ Staff reporter (2013) *The Herald Scotland*. Pioneering waste plant faces legal action after pollution leaks and an explosion.

³⁵ District Administration of Karlsruhe(1999) (Regierungspräsidium Karlsruhe), press release, 5 Nov. 1999.

³⁶ Trade Control Office Karlsruhe, (2002) Thermoselect emissions data, 2002; Stuttgarter Zeitung, "Lawsuit Against Thermoselect [Anzeigegegen Thermoselect]," 5 July 2000; District Administration of Karlsruhe (Regierungspräsidium Karlsruhe), press release, 5 Nov. 1999.

Fig 7. Thermoselect's Karlsruhe gasification facility (Germany)



Chapter 3 Waste to Energy Incinerators –not climate friendly

Waste is a significant contributor to greenhouse gas (GHG) emissions releases and climate change, mainly due to methane gas emissions from landfill³⁷ which total around 15 million tonnes of carbon pollution in Australia each year³⁸. Waste incinerators also contribute directly to climate change due to their high level of GHG emissions per unit of electricity generated even when compared to electricity from coal and oil fired power stations. Waste incineration and landfill represent the worst outcomes in terms of climate change and how, as a society, we deal with our resources. If we are to divert waste away from landfill and incineration into alternate forms of resource recovery (recycling, reuse, composting and anaerobic digestion) the climate change benefits increase significantly.

While incinerators emit more CO₂ pollution than coal or oil power plants³⁹ promoters of waste incinerators continue to claim that the energy they generate is 'climate friendly'.

Despite their poor performance, incinerator proponents maintain that they are generating renewable energy and are more climate friendly than landfill. These claims are examined in more detail below. However, the real issue for climate change is how well incinerators compare to *other energy generation sources* - not other waste management practices. When this comparison is examined, GHG emissions from waste incinerators generating electricity, is revealed to be the highest of all technologies.

Incinerator proponents also assume that any electricity they generate will replace demand for electricity that is currently generated by fossil fuel power plants and that this will deliver a net benefit for the climate. In a limited electricity supply market place any subsidies supplied to waste incinerators would be taking resources from the genuine renewable energy providers they compete with such as wind, solar, and wave energy.

The USEPA have undertaken comparative studies of modern MSW incinerators and other forms of electricity generation which revealed that incinerators are the dirtiest electricity production option releasing more CO₂ than coal fired power stations per unit of energy generated.

³⁷ USEPA (2013) *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2011*

³⁸ Australian Government (2012) Emissions from landfill facilities. Fact Sheet.

³⁹ U.S. EPA, eGRID 2000

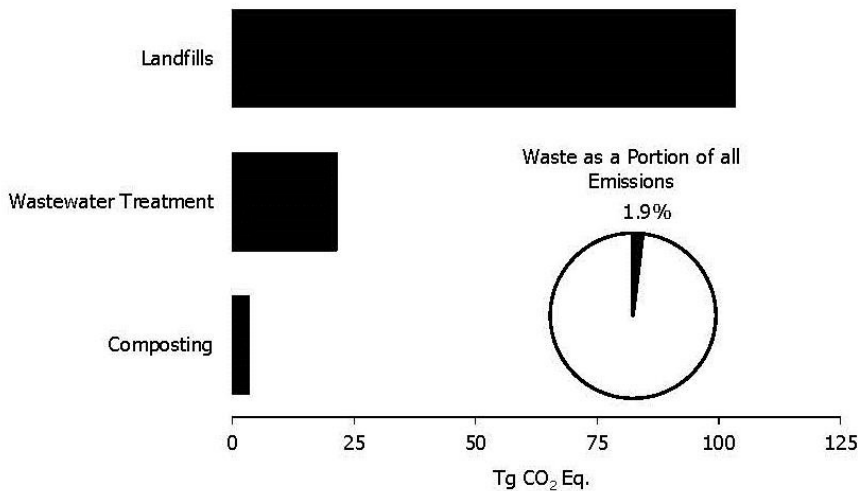
Table 1. Air Pollutants by Electricity Generation Source (US)

	CO ₂ (lbs/MWh)	SO _x (lbs/MWh)	NO _x (lbs/MWh)
MSW Incinerators	2988	0.8	5.4
Coal	2249	13	6
Oil	1672	12	4
Natural Gas	1135	0.1	1.7
Wind	0	0	0
Geothermal	0	0	0
Solar	0	0	0

Source: U.S. EPA, eGRID 2000.U.S. EPA, Compilation of Air Pollutant Emission Factors (AP-42).

While it is widely known that landfills create groundwater contamination their contribution to climate change is less obvious. Landfill generates significant greenhouse gases to atmosphere through emissions of methane (CH₄) which according to the USEPA has 21 times the global warming potential of CO₂ over a 100 year period⁴⁰.

Fig 8. Greenhouse gas emissions from waste (USEPA 2011)



⁴⁰ Op Cit at 37

In the US landfill contributes 17.5 percent of total methane emissions whereas composting only accounted for 1 percent⁴¹. Even with the most efficient forms of landfill gas extraction (LFG) the highest levels of methane recovery achieved is around 75 percent while the rest escapes as fugitive emissions. Despite this poor record Australian landfills have increased LFG extraction and are converting it to electricity.

According to the Australian Bureau of Statistics net emissions of GHG from waste have declined due to a significant rise in methane extraction from existing landfills,

*In 1990, less than one percent of all landfill emissions were recovered. By 2008, this figure had increased to 28%. During this same period, the total volume of emissions being generated at Australian landfills only experienced a moderate increase (8%). Consequently, net emissions from Australian landfills has fallen by 22% between 1990 and 2008 (from 14.2 million tonnes of carbon dioxide equivalent emissions to 11.1 million tonnes).*⁴²

While the incinerator industry chooses to ignore comparisons with alternative resource recovery technologies like composting and anaerobic digestion, it does not always compare that well to landfill with methane gas extraction either.

In a UK government study⁴³ comparisons between landfill with gas extraction and waste incinerators generating electricity found that the climate change impacts of incineration were clearly worse.⁴⁴ While this is not an argument to suggest that landfill is environmentally acceptable it does cast serious doubts on claims that incineration of waste is anything other than an expensive and polluting waste disposal technology.

When waste is burned to generate energy the process is not only incredibly expensive in capital terms, but is also a highly inefficient process in its own right. Researchers have found that *because of high corrosion in the boilers, the steam temperature in WTE plants is less than 400 degrees Celsius. As a result, total system efficiency of WTE plants is only between 12%–24%*⁴⁵.

Mixed municipal waste is a dirty, highly heterogeneous fuel with low calorific value when compared to standard fossil fuels used to generate electricity. In other studies, UK researchers have demonstrated that incineration of waste emits up to **twice** the amount of CO₂ of coal-fired power plants per kilowatt-hour of electricity.⁴⁶

While incinerators emit more CO₂ pollution than coal or oil power plants promoters of waste incinerators continue to claim that the energy they generate is climate friendly.

⁴¹ Ibid

⁴² Department of Climate Change and Energy Efficiency (2010) *National Greenhouse Gas Inventory*.

⁴³ HM Customs & Excise (2004) Combining the Government's Two Health and Environment Studies to Calculate Estimates for the External Costs of Landfill and Incineration, December 2004.

⁴⁴ Hogg, D., (2006) "A Changing Climate for Energy from Waste?" Eunomia Research and Consulting. May 2006.p 21.

⁴⁵ Faaij *et al.*, 1998; US EPA, 1998; Swithenbank and Nasserzadeh, 1997 cited in IPCC (2003) at 6.

⁴⁶ Op Cit at 44

They base this claim on three discredited arguments⁴⁷;

- only incineration of waste can displace landfill methane releases
- the biogenic fraction of incinerator CO₂ emissions are climate neutral
- lifecycle GHG emissions from waste are somehow inevitable

Claim: Only waste incineration can displace landfill emissions

Incorrect. The argument that only incineration can displace landfill emissions ignores other technologies and practices while using the worst case scenario (landfill without methane gas extraction) as the baseline for comparison. By using this comparison electricity generated by incinerators may appear marginally more 'climate friendly'.

This illusion is quickly dispelled when waste incineration is compared to other resource recovery alternatives such as composting. While some studies have ranked incineration in terms of GHG emissions as marginally better than landfill (without LFG extraction) and some rank incineration as marginally worse (when compared to landfill with LFG extraction), composting the organic fraction of municipal waste has negligible GHG emissions when compared to landfill (and therefore to incineration).

When organic material is source separated and diverted away from landfills to composting most methane generation is avoided and a useful product is generated that aids with soil structure and fertility while conserving water. Other GHG emissions, such as CO₂, are greatly reduced when compared to incinerators⁴⁸ and Australian agriculture could benefit significantly from composts and soil stabilisers generated through these alternative technologies.

When the organic fraction of the waste stream is converted to compost and applied to soils the release of CO₂ occurs over an extended period, increases soil carbon retention and CO₂ uptake of the crops that it is applied to. Incinerating the organic fraction of the waste stream releases the carbon to atmosphere immediately.

The incinerator industry is now compelled to make claims that the electricity it produces is renewable and green to attract subsidies and credits for 'green' energy. It is unlikely that the industry would be able to remain financially viable in any sense unless they can access these funds. However, regulators and legislators are taking a closer look at these claims in some countries and exposing the false nature of these arguments.

⁴⁷ **Global Anti Incineration Alliance** (2008) *Zero Waste for Zero Warming: GAIA's Statement of Concern on Waste and Climate Change*. December 2008

⁴⁸ Ayalon et al., "Solid waste treatment as a high-priority and low-cost alternative for greenhouse gas mitigation." *Environmental Management* 27(5) pp. 697-704. 2001.

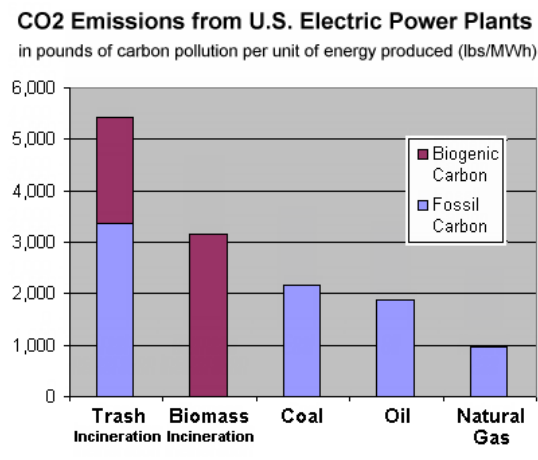
Claim: The biogenic fraction of incinerator CO₂ emissions are climate neutral

Incorrect. Incinerator proponents often point to the IPCC ruling excluding biogenic CO₂ emissions from 'waste' in its protocol for calculating national inventories. However, because the IPCC national inventory calculation guidelines are intended to address every sector in a nation's emissions the biogenic emissions are accounted for in other sectors. When addressing a countries energy sources the IPCC specifically states that the biogenic fraction must be taken into account when comparing energy sources.

"The CO₂ emissions from combustion of biomass materials (e.g., paper, food, and wood waste) contained in the waste are biogenic emissions and should not be included in national total emission estimates. However, if incineration of waste is used for energy purposes, both fossil and biogenic CO₂ emissions should be estimated.... Moreover, if combustion, or any other factor, is causing long term decline in the total carbon embodied in living biomass (e.g., forests), this net release should be evident in the calculation of CO₂ emissions described in the Agriculture, Forestry and Other Land Use (AFOLU) Volume of the 2006 Guidelines."⁴⁹

The total CO₂ emitted from incinerators impacts on the atmosphere which makes no distinction between biogenic and non-biogenic emissions. It is disingenuous to deliberately misinterpret the greenhouse gas accounting protocols to claim that they are producing 'renewable energy' that mitigates climate change. The US comparison of energy sources in the graph below demonstrates the high levels of GHG emissions from modern waste incinerators.

Figure 9.



Source: U.S. EPA eGRID 2012 Database
Analysis by Energy Justice Network, www.EnergyJustice.net

⁴⁹ Sabin Guendeh ou., et al., "2006 IPCC Guidelines for National Greenhouse Gas Inventories; Chapter 5: Incineration and Open Burning of Waste," Intergovernmental Panel on Climate Change National Greenhouse Gas Inventories Programme, p. 5.5, 2006.

In the US the incinerator ‘renewable energy’ argument is unravelling. Maricopa County Superior Court Judge Crane McClennen has recently ruled that incinerators don’t meet ‘renewable energy’ requirements despite claims that the waste they will burn has a 75-90% biogenic content. The incinerator proponent Mohave Electric Cooperative cannot charge a premium for its electricity unless it is certified renewable. Without that premium the proponent will not be able to meet the capital costs for the incinerator.⁵⁰

Claim: Lifecycle GHG emissions from waste are inevitable

Incorrect. This claim relies on an assumption that ‘business as usual’ will prevail in the waste sector and that landfill will continue unabated unless incineration replaces it. If communities adopt different resource recovery practices then the current regime, greenhouse gas releases can be avoided, mitigated or slowed down to the extent that it becomes a climate friendly alternative. In assessing the true impacts of incineration and landfill it is important to recognise both the direct emissions from the smokestack and through landfill methane but also to be aware that financial resources directed to these polluting technologies could be much better spent on alternative resource recovery practices that are economically and environmentally beneficial.

The embedded energy in a plastic bottle comprises the calorific value as well as all the energy that was used to extract, process, manufacture and transport that article before it was discarded. When that plastic bottle is burned in an incinerator only a quarter of the calorific value is converted to electricity while the embedded energy is lost forever.

By destroying valuable materials that can be used in products or by agriculture, incineration forces industry to return to the cycle of virgin material extraction, processing, manufacture and transport. This creates an incredibly inefficient material flow through the production system and denies many benefits to other sectors of the economy. The greenhouse gases generated through the need to replace virgin materials, clearly diminishes any claimed benefits of displacing a small amount of coal fired electricity with waste fired electricity.

The benefits of avoiding landfill and incineration in resource recovery are recognised by the IPCC

“Waste management policies can reduce industrial sector GHG emissions by reducing energy use through the re-use of products (e.g., of refillable bottles) and the use of recycled materials in industrial production processes. Recycled materials significantly reduce the specific energy consumption of the production of paper, glass, steel, aluminum and magnesium.”⁵¹

⁵⁰ Accessed online: <http://verdenews.com/main.asp?SectionID=1&SubSectionID=1&ArticleID=55241> and AAP <http://www.chron.com/business/energy/article/Judge-rules-burning-trash-isn-t-renewable-energy-4671188.php>

⁵¹ Bogner, et al., “Waste Management,” In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Chapter 7.9.9 p. 483.

Composting returns organic matter to an agricultural setting displacing expensive synthetic fertilisers and soil amendments. It has the added benefit of increasing crop yields, building on soil structure, carbon retention and ecology (which chemical cropping methods destroy), as well as retaining moisture in a warming climate. In the Australian context, farmers clearly need any assistance in water retention for crops that is available. In a drying climate with water scarcity it makes no sense to burn organic matter that could be much more efficiently employed in agriculture.

Wood and paper products that are recycled, reused or converted to compost have an especially beneficial role in that they provide all the benefits of 'embedded energy' and composting described above as well as an important additional factor. If wood and paper are burned in an incinerator more demand is generated for virgin timber supplies. Not only is the embedded energy lost, the benefits of composting foregone and more virgin materials extracted to replace them, but it also diminishes the role of forests and their soils as a major carbon sink as more trees are felled and land cleared.

The findings of a major analysis by the European Union into this issue conclude;

"Source-segregation of various waste components from MSW [municipal solid waste], followed by recycling or composting or anaerobic digestion of putrescibles offers the lowest net flux of greenhouse gases under assumed baseline conditions."⁵²

Clearly Australia should strive to turn around its poor waste management record and invest intensively in technologies that maximise avoidance, re-use and recycling while opting for climate friendly resource recovery in the form of industrial and small scale composting and anaerobic digestion with energy recovery. Existing landfills should maximise methane extraction until they are no longer biologically active and waste incinerators should not be subsidised as a form of climate friendly energy.

⁵² Smith, Brown, et al., "Waste Management Options and Climate Change: Final report to the European Commission, DG Environment: Executive Summary," July 2001.

Chapter 4 Incineration and Air Toxics

Waste incinerators are widely documented as a source of air pollutants including acid gases, nitrogen oxides (NO_x), sulphur oxides (SO_x), heavy metals, particulates and persistent organic pollutants (POPs) such as dioxins and furans. Incinerator proponents claim to have reduced air emissions to acceptable levels over recent decades by installing very expensive pollution filters and scrubbers which are collectively known as APC (Air Pollution Control).

When working, the filters capture a lot (but not all) of the pollutants that would otherwise escape to atmosphere. The highly toxic compounds are then transferred to 'fly ash' which is so contaminated that it must be dumped at special hazardous waste landfills⁵³.

Nevertheless, significant air pollution escapes the APC process, which can break down, lose efficiency or be bypassed during plant failures or emergencies. More information on the contamination of fly ash and bottom ash with POPs, heavy metals and other chemicals can be found in Chapter 5 of this report.

Municipal waste is a highly diverse mix of materials with varying calorific value. The high variability of municipal waste makes it easier for hazardous materials to slip through the separation processes that may be in place prior to waste entering the incinerator where they can be converted into toxic gases and particles.

However, even non-hazardous materials in MSW such as fabrics and furnishings can be converted into hazardous emissions as they may contain or be treated with chemicals for fire retardation (polybrominated diphenyl ethers), stain resistance (perfluorochemicals) or with nanoparticles to reduce UV penetration or to prevent bacteria. Other materials may be non-hazardous in the MSW stream but are converted into hazardous emissions when burned such as poly vinyl chloride (PVC).

Potentially hazardous wastes that might be found in municipal solid waste

Items in the municipal waste stream that exhibit characteristics that could, under some circumstances, be described as hazardous include:

- **lead acid batteries, mobile phones, televisions and computers that can contain toxic and ecotoxic heavy metals, such as lead, nickel, copper and cadmium, chromium and mercury;**
- **pesticide, paint and household chemical containers, which can contain toxic, ecotoxic and poisonous materials;**
- **car parts, which can contain toxic, ecotoxic and poisonous components;**
- **tyres, which can catch fire thus leading to toxic emissions;**
- **domestic smoke detectors, which contain small amounts of radioactive material;**
- **copper chrome arsenate treated timber.**

(Source: Productivity Commission (2006), Waste Management, Report no. 38, Canberra.p.6)

⁵³ In some European countries the fly ash must be disposed of in deep unused salt mines because of the risk of it leaking from hazardous waste landfills.

The result is that most modern waste incinerators are still significant sources of hazardous air toxics emissions that are difficult to control. Some of the pollutants such as mercury, dioxins and polycyclic aromatic hydrocarbons (PAHs) can travel great distances and contribute to contamination on a global level as well as contaminating local soil and produce. Less persistent pollutants such as acid gases, nitrogen oxides (NO_x), sulphur oxides (SO_x) can still be highly toxic and impact on public health at a local and regional level around individual incinerators.

Mercury (Hg) is a toxic heavy metal that will soon be restricted by an international legal convention (The Minamata Treaty⁵⁴). Modern waste incineration is the fifth highest source of mercury pollution from anthropogenic sources in the world today⁵⁵.

Dioxins (polychlorinated dibenzo-p-dioxins) are persistent organic pollutants (POPs) restricted under the *Stockholm Convention on Persistent Organic Pollutants* and one of the most toxic chemicals ever evaluated by science. Waste incineration has been estimated as the highest⁵⁶ source of dioxin air emissions in the US (1000 Grams ITEQ_{DF}^a/year) followed by secondary metal smelting (600 Grams ITEQ_{DF}^a/year) and medical waste incineration (500 Grams ITEQ_{DF}^a/year). Claims by waste incinerator proponents that they produce 'acceptable' air emissions are seriously undermined by the facts.

Nano-particles

Australia currently has no regulatory framework for nano-materials and therefore cannot control the types or amounts entering our municipal waste streams. There have been significant public health concerns related to the effects of nano-materials in the human body.⁵⁷

As these particles bypass the normal defence mechanisms of the body and enter the blood stream and organs directly, the failure of waste incinerators to be able to control nano-pollution may represent a significant threat to human health. There are significant scientific data gaps on the health impacts of nano-materials yet current research is uncovering serious adverse health impacts⁵⁸. There are no air quality standards or stack emission limits for nano-particles in Australia hence the use of the precautionary principle should be applied in relation to all nano-pollution releases.

⁵⁴ See UNEP website for details accessed at

<http://www.unep.org/newscentre/default.aspx?DocumentID=2702&ArticleID=9373>

⁵⁵ Pirrone et al (2010) Global mercury emissions to the atmosphere from anthropogenic and natural sources. *Atmos. Chem. Phys.*, 10, 5951–5964, 2010 p.

⁵⁶ Cleverly et al (1995) Inventory of sources and releases of dioxin-like compounds in the United States. *Organohalogen Compounds* 41: 467-472 (1995). cited in *California Department of Health Services Environmental Health Investigations Branch (2003) Dioxin Technical Information for California Health Officials*

⁵⁷ Tetley, T., Health effects of nanomaterials. *Biochem Soc Trans.* 2007 Jun;35(Pt 3):527-31,

⁵⁸ Helland, A., et al (2007) *Environmental Health Perspectives* 115:1125–1131 (2007). doi:10.1289/ehp.9652

Ultrafine particles

There is overwhelming evidence of the harm to human health caused by ultrafine particulates⁵⁹ which are known to be emitted in high amounts from all forms of incinerator technologies. These small particles can lodge deep in the lungs and cause respiratory and cardiac diseases. There are currently no state or national air quality standards, license conditions or other regulatory measures to protect the Australian community from ultrafine particulates (those less than 0.1 microns in size).

Public Health Impacts of Incinerator Technologies

The release of toxic air emissions from incinerators can have a significant impact on human health. Because toxic emissions can have a significant lag time or latency period before their human health impacts become obvious scientific studies have only recently emerged that acknowledge the scale of public health impacts from waste incinerators.

A range of public health studies and contamination investigations related to waste incineration are outlined below. The public health impacts associated with incinerator technologies have been documented by internationally recognised scientists in the fields of respiratory and cardiac medicine and epidemiology.⁶⁰

Waste incinerators release a diverse range of toxic substances to the atmosphere. Some toxic compounds are short-lived and some are persistent and all have varying degrees of toxicity. Once released from an incinerator toxic materials may be carried long distances or deposited in nearby soil and surface water. How these toxic releases affect human health is difficult to assess as people may be exposed to multiple toxic compounds at one time and exposures may vary between individuals even in the same location.

Some groups of people, such as young children, the elderly and immune compromised individuals may be more susceptible to health effects than others. There is also the issue of latency of onset of symptoms after exposure which can take decades. All of these issues make it difficult to predict health impacts of incinerator emissions and to attribute causality between an individual's sickness and a specific source of emissions. This can be complicated further by the presence of other polluting facilities or sources of pollutant exposure.

Assessing the health impacts of emissions usually falls into the two categories of predictive assessment (health risk assessment) or epidemiological studies examining current or past population group exposures. Health risk assessment is a form of modeling often criticized for its high levels of uncertainty and inability to consider the impacts of chemical mixtures and cumulative impacts over time. Epidemiological studies are considered more reliable but usually identify population health impacts only after

⁵⁹ Ibalid-Mulli A, Wichmann HE, Kreyling W, Peters A. (2002) Epidemiological evidence on health effects of ultrafine particles. *J Aerosol Med.* 2002 Summer;15(2):189-201.

⁶⁰ British Society for Ecological Medicine (2008) *The Health Effects of Waste Incinerators*. 4th Report of the British Society for Ecological Medicine.

they have occurred. The result is that it can be very difficult to assess the impacts of waste incineration until after they have occurred. Incineration proponents rely almost exclusively on health risk assessment when seeking regulatory approvals and this has been criticized by some health professionals.

The British Society for Ecological Medicine in their 4th report (2008) concluded the following in relation to determination of the health impact of MSW incineration:

'Typically this decision is based on an inexact method called risk assessment. They tend to rely almost exclusively on this type of assessment and often have little understanding of its limitations. Risk assessment is a method developed for engineering but is very poor for assessing the complexities of human health. Typically it involves estimating the risk to health of just 20 out of the hundreds of different pollutants emitted by incinerators.'

A number of waste incinerator proponents in Australia have pointed out that Japan, as an advanced industrialised economy, has numerous incinerators operating 'successfully'.

Japan has very limited space available for landfill and in the 1970's adopted waste incineration to manage its waste streams. Now Japan has the dubious honour of being the largest waste burner of any country in the world with nearly 70% of the world's waste incinerators burning 70% of Japan's MSW.

The price of this commitment to incineration has been high in terms of public health risk. Japan now has dioxin contamination levels *ten times higher* than any other industrialised country and is now struggling to reduce dioxin emissions.⁶¹

A large cohort study in Japan has identified increased symptoms associated with proximity to waste incinerators, particularly in children.

*"The findings suggest that proximity of schools to municipal waste incineration plants may be associated with an increased prevalence of wheeze, headache, stomach ache, and fatigue in Japanese children"*⁶²

Another study investigated an area in Japan near a MSW incinerator that had high levels of dioxin contamination in soil and an unusually high rate of cancer in residents.

The study tested blood samples from 13 women and 5 men living within 2 km of the incinerator. Levels of dioxins were raised considerably in the residents compared to background levels found in the general population. For instance, women had an average blood level of 149 pg TEQ/g lipid and men 81 pg TEQ/g lipid, whereas the background level for the general population is in the range of 15 to 29 pg TEQ/g lipid. The authors commented that increased exposure in the residents was considered to be due to direct inhalation of dioxins from the stack

⁶¹ Corliss, M., (1999) Dioxin: Levels high in incinerator-happy Japan. *Japan Times* May 7

⁶² Miyake, Y., et al (2005) Relationship between distance of schools from the nearest municipal waste incineration plant and child health in Japan. *European Journal of Epidemiology* 20 1023-1029

gas of the incinerator and by intake of local vegetables contaminated by stack gas⁶³.

A 2013 study investigating health impacts from MSW incineration and hazardous waste treatment plants in Spain concluded,

“Our results support the hypothesis of a statistically significant increase in the risk of dying from cancer in towns near incinerators and installations for the recovery or disposal of hazardous waste”⁶⁴.

Those townships in the proximity of MSW incinerators had the highest excess cancer mortality for populations of all the towns studied.

France also has a high proportion of waste incinerators compared to most other countries. Researchers conducted a study in the area of Doubs, eastern France, to investigate clustering of two types of cancer, soft tissue sarcoma and non-Hodgkin’s lymphoma, near to a MSW incinerator. The study was undertaken following a report of high dioxin emissions from the incinerator. The study found highly significant clusters of both cancers in areas close to the incinerator but not in other surrounding regions.⁶⁵

Table 2 Health Impacts of Incinerator Pollutants

Toxic Agent	Health Impacts
Particulate Matter	Increased respiratory symptoms, decreased lung function, aggravated asthma, development of chronic bronchitis, irregular heartbeat, nonfatal heart attacks, and premature death in people with heart or lung disease
Carbon Monoxide	Chest pain, cardiovascular effects, vision problems, reduced ability to work or learn, reduced manual dexterity, difficulty performing complex tasks, and respiratory problems
Nitrogen Dioxide	Irritation of eyes, nose, throat, and lungs, nausea, shortness of breath, respiratory problems, reduced oxygenation of body tissues, and a build-up of fluid in the lungs

⁶³ Ohta S., Kuriyama S., Nakao T., Aozasa, O. and Miyata H. and Tanahashi M. (1997). Levels of PCDDs, PCDFs and non-ortho coplanar PCBs in soil collected from high cancer-causing area close to Batch-type municipal solid waste incinerator in Japan. *Organohalogen Compounds* 32: 155-160

⁶⁴ García-Pérez, J., et al (2013) Cancer mortality in towns in the vicinity of incinerators and installations for the recovery or disposal of hazardous waste. *Environment International* 51 (2013) 31–44

⁶⁵ Viel J.-F., Arveux P., Baverel J. and Cahn J.-Y., (2000) Soft-tissue sarcoma and non-Hodgkin's lymphoma clusters around a municipal solid waste incinerator with high dioxin emission levels. *Am. J. Epidem.* 152:13-19

HCl	Throat irritation, rapid breathing, blue coloring of the skin, accumulation of fluid in the lungs, swelling of the throat, reactive airways dysfunction syndrome, skin burns, respiratory problems, eye and skin irritation, and discoloration of teeth
Cadmium	Severe lung damage, kidney disease, stomach irritation, increased bone fragility, and increased risk of lung cancer
Lead	Adverse effects on nervous system, kidney function, immune system, reproductive and developmental systems, and cardiovascular system, and neurological effects (especially in children)
Mercury	Brain, kidney, and developing fetus damage, lung damage, nausea, vomiting, increased blood pressure, and ocular and dermal irritation
Chromium	Irritation of respiratory lining, runny nose, breathing problems (cough shortness of breath, wheezing), skin rashes, reproductive damage, increased lung cancer, and increased stomach tumors
Arsenic	Sore throat, irritated lungs, nausea, vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to blood vessels, darkening of skin, skin irritation, and increased risk of skin, liver, bladder, and lung cancer
Beryllium	Lung damage, acute beryllium disease, chronic beryllium disease, and increased risk of lung cancer
Dioxins and Furans	Chloracne, increased risk of cancer, increased risk of heart disease, and increased risk of diabetes
Polychlorinated Biphenyls (PCBs)	Increased risk of cancer, specifically rare liver cancers and malignant melanoma, immune system damage, reproductive system damage, nervous system damage, endocrine system damage, dermal and ocular effects, and elevated blood pressure, serum triglyceride, and serum cholesterol
Polycyclic Aromatic Hydrocarbons (PAHs)	Increased risk of cancer

Air Quality Regulation in Australia

At a minimum, waste incinerators require a robustly monitored and audited industrial regulatory framework if air quality standards are to be met and public health protected. Australia does not currently have a national industrial regulatory framework to manage waste incineration.

Virtually all regulation of industrial emissions occurs at State level where 'industry self-regulation' is common. Industry self-regulation evolved throughout the 1980's and 1990's under government policies to privatise and outsource compliance aspects of industrial regulation. Under this model 'Smokestack' industries pay for their own consultants to monitor their stack emissions and then jointly prepare reports which are provided to environmental agencies on a periodical basis. Prior to the implementation of industry self-regulation most state environmental agencies were equipped with in-house expertise. Agency staff included scientists who would conduct inspections and stack emission tests using their own equipment and interpretation of results ensuring the independence of the process.

State regulators issue environmental licences to industrial facilities with significant atmospheric emissions for a fee. The licences stipulate emission targets and limits for specified pollutants. The pollution limits often vary from state to state and can even vary between similar facilities in the same state. The licences require the facility operator to report instances of 'non-compliance' where conditions of the licence (including emission limits) have been breached. The regulator then has the option of taking enforcement action against the facility operator in the form of prosecution and a fine.

Many environmental reports are provided annually to regulators resulting in long periods when pollution can be occurring undetected by authorities. It has also been commonplace for industrial regulators to raise emission limits in environmental licenses when industry exceeds the original levels set in the permit.

Very few state environmental regulators have any internal capacity (either expertise or equipment) to conduct emission sampling and verify the reported emissions by industry. Many facilities have licenses that do not include some of their most harmful emissions. A hazardous waste incinerator burning chlorinated waste in the Port Hedland, Western Australia does not have any reference to dioxin emissions in their licence. Industrial risk management at a state level is often associated with a lack of a robust industrial regulatory framework as has been identified in at least three parliamentary inquiries in Western Australia⁶⁶ over six years. Similar criticisms have arisen in relation to regulators in other states.

⁶⁶ Western Australian Parliament (2007) *Education and Health Committee Inquiry into the Cause and Extent of Lead pollution in the Esperance Area*, Report No. 8 in the 37th Parliament 2007.

Western Australian Parliament (2004) *Public and Environment Affairs Committee Inquiry into Alcoa Alumina Refinery at Wagerup*. 2004;

Air quality standards remain inadequate in Australia with the National Environment Protection Council in 2010 advising that the current National Environment Protection Measures for air quality are not protective of public health and will be subject to review. There are only a limited set of criteria pollutants and do not represent more than a fraction of the full range of expected pollutants that affect air quality in Australia. Furthermore, a number of air toxics known to be emitted from waste incineration are not monitored and do not have health protective standards. Australia is still to implement the NEPM review's recommended National Plan for Clean Air and more specifically the associated exposure reduction framework.

Inadequate Control of Incinerator Dioxins

Incinerators produce a range of hazardous and toxic pollutants in solid and gaseous forms (and in some cases liquid forms⁶⁷), but of all the pollutants released by incinerators, the group that has been of most public concern are dioxins and furans. Dioxins are highly toxic and can cause reproductive and developmental problems, damage the immune system, interfere with hormones and also cause cancer⁶⁸.

Polychlorinated dibenzo-para-dioxins (PCDD) and *polychlorinated dibenzo-furans* (PCDF) have been identified among the most toxic chemicals ever assessed. Dioxins are persistent in the environment, bioaccumulative, toxic to humans and can travel long distances in the atmosphere from their source. As a result of these properties, PCDD/F has been listed on the Stockholm Convention on Persistent Organic Pollutants 2001, an international treaty enacted to eliminate persistent chemicals from the environment.

Dioxins are highly toxic at extremely low levels (effects have been reported in the parts per quadrillion range) making claims of 'low dioxin emissions' from incinerators somewhat meaningless.

Incinerator proponents commonly claim that dioxin emissions were only ever a problem with 'old' incinerators and that 'new' incinerators have overcome these problems. However, there is no definition of new or old incinerators and most current proposals are merely variations on the same technologies that have been in use for decades.

What has changed is the *branding* of these technologies. Proponents are now well aware that the public has a very negative perception of any technology called an incinerator and associate it with dioxin pollution.

In order to avoid this association the industry has been advised to use a range of new terms for incinerators including:

Western Australian Parliament (2001) *Economics and Industry Standing Committee Bellevue Waste Fire Inquiry*, Volume One, Report No. 1 2001.

⁶⁷ Liquid waste from incinerator operations is generally due to the use of 'wet scrubbers' or water sprays in the flue gas cleaning system which 'knock down' pollutants and return them to an internal reservoir. in the scrubbing system.

⁶⁸ World Health Organisation (2010) *Dioxins and their effects on human health* Fact sheet N°225

- waste to energy plants (WtE)
- gasification
- pyrolysis
- plasma arc
- resource recovery facilities

Dioxins still a problem for ‘new’ incinerators.

Despite this re-branding, a range of recent studies and incidents conclude that dioxin emissions remain a problem for incinerators. A number of these incidents are described in Chapter 2. The USEPA continue to rank waste incineration among the top 3 sources of dioxin emissions in the US⁶⁹. The industry now places its emphasis on the fact that atmospheric dioxin emissions from incinerators are less now than they were in the 1980’s and 1990’s at which time they were the principal source of dioxin in the US. In making these claims they refer to the results of monitoring data from stack emissions of incinerators operating from the 1990’s until the present day.

When waste incineration was found to be a major dioxin emitter in the 1980’s regulatory action gradually required better flue gas cleanup of incinerator emissions and specifically dioxin, using air pollution controls (APC). This resulted in minor changes to the actual incinerator engineering and considerably more attention to pollution scrubbing devices and filters; the ‘end of pipe solutions’ collectively referred to as APC’s. The result was the introduction of a number processes such as injected carbon, lime, wet scrubbers and goretex filters that reduced apparent dioxin emissions from the stack.

The reality is that these pollution filters reduced aggregate dioxin emissions from the stack and transferred it to the solid waste stream from incinerators. In this sense any given incinerator still produced similar amounts of dioxin as before but the mode by which the dioxin left the facility was less in the form of atmospheric emissions and more in the form of solid waste (primarily fly ash but also bottom ash). The fate of this ash should be of significant concern to the community as it is usually disposed of in hazardous waste landfill. Contrary to incineration industry claims there are no *new incinerators* only incremental developments on decades old technology.

In most cases, the ‘low’ dioxin stack emissions that incinerator proponents claim are compliant with the regulatory limits are an artefact of monitoring methods that grossly underestimate true dioxin emissions from a given facility. Unfortunately a major problem with dioxin monitoring from incinerator stacks is that a single method is widely employed by regulators and consultants that has been demonstrated to underestimate emissions by a large factor casting doubt on claims of compliance.

⁶⁹ USEPA (2005) The Inventory of Sources and Environmental Releases of Dioxin-Like compounds in the United States: The Year 2000 Update. March 2005 External Review Draft.

This was demonstrated by two Belgian scientists⁷⁰ who compared the global standard dioxin monitoring method developed by the USEPA (known as method EN 1948) with a system known as the Arnesa method. The USEPA method only takes a 6 hour snapshot of dioxin emissions once every 6 months. The Arnesa method takes a continuous 15 day sample that acts as a form of near continuous sampling. With this method De Fre and Wevers were able to detect the high levels of dioxins emissions during incinerator start-ups and shutdowns that the USEPA method could not detect.

The study found that the EN 1948 method underestimated incinerator dioxin emissions by between 30-50 times. However, the EN 1948 method continues to be used as the standard method of incinerator stack monitoring in the US, Europe and Australia. The implications are that any waste incinerators built in Australia will be monitored for dioxin emissions using a method that has been demonstrated to underestimate emissions by up to 50 fold. Incinerators will be able to claim they are compliant with their environmental licence while they may be releasing high levels of dioxin.

As there are no safe levels for human exposure to dioxins, there can be no truly safe levels of dioxin air emissions from incinerators – even those that meet the regulatory guidelines. Incinerator proponents will continue to claim that dioxins were only a problem for ‘old’ incinerators but have no response to the fact that better scrubbing of dioxin from the stacks has resulted in highly contaminated solid waste in the form of ash or liquids from wet scrubbers. The only method to eliminate and minimise dioxin formation from waste management is to avoid incineration and adopt alternatives. If Australia is to comply with its international obligations under the Stockholm Treaty on Persistent Organic Pollutants it must not approve any waste incinerators. Every new incinerator is a new source of dioxin for Australia that we can ill afford.

⁷⁰ De Fre R., and Wevers M., (1998) Underestimation in dioxin emission inventories. *Organohalogen Compounds* Vol 36 1998.

Chapter 5 Solid waste from incineration

Community pressure to reduce airborne dioxin emissions from waste incinerators has led to higher reported efficiency and performance of dioxin scrubber technology, particularly through the use of activated carbon beds and sprays. As mentioned previously in this report, the result has been to transfer most of the dioxin contamination from the flue gases to filter or scrubber matrices such as the electrostatic precipitator (ESP's) dusts, baghouse dusts and filter cake, liquid wastes (from wet scrubbers), adsorption onto activated carbon and then finally into fly ash and to a lesser extent bottom ash. For every 1000kg of MSW incinerated between 250-300kg (25-30%) of contaminated ash is generated.⁷¹

The same process applies to many of the other contaminants generated through incinerating waste. Other persistent organic pollutants (POPs) such as the PCB's and the flame retardants PBDE, have also been detected in ash. Some studies have also shown high levels of dioxin in bottom ash contrary to the claims of the waste incinerator industry⁷². In addition to POPs there are also a large range of other toxic chemicals and heavy metals in incinerator ash. The other major problem with incinerator ash is the high volumes generated by burning MSW.

The incinerator industry also promotes itself as a solution to landfill suggesting that the adoption of waste incineration to produce electricity can replace the need for landfills. This is seriously misleading as all MSW incinerators end up with around 25-30% by weight of the original waste feed being converted to contaminated ash.

The figure below is an incinerator industry estimate of its own process mass balance. In most countries all of this ash is sent to landfill where it can leach dangerous chemicals and heavy metals for decades. Waste incinerators need landfills to remain viable unless they can find alternative ways to get rid of their ash.

⁷¹ Vehlow, J., (2002) *Bottom ash and APC residue management*. Proceedings of the Expert Meeting on Power Production and Waste and Biomass – IV, Espoo, Finland, April 8-10, 2002

⁷² Wang, Mao-Sung et al (2010) Characterization of Persistent Organic Pollutants in Ash Collected from Different Facilities of a Municipal Solid Waste Incinerator. *Aerosol and Air Quality Research*, 10: 391–402, 2010

Figure 10. Mass balance of an incineration plant.



(Source: Kalogirou, E. (2012), The development of WtE as an integral part of the sustainable waste management worldwide, Recuwatt -Recycling and Energy conference-, Mataró (Spain), 4th October 2012.)

Increasingly, there is a trend in Europe to dispose of incinerator wastes (mainly bottom ash and slags) via reuse schemes. Predominant among these schemes are the use of ash in construction materials such as bricks and road building materials.

Given the growing evidence of bottom ash contamination and confirmed fly ash toxicity, it is a serious concern that widespread contamination of the environment and threats to human health have arisen from these practices⁷³. In one instance, researchers at Newcastle University investigated claims that incinerator ash from the Byker incinerator in Newcastle UK had been spread on pathways of community 'allotments' (community vegetable gardens). The gardens, which produced vegetables for community consumption contained dioxins eight times higher than the maximum permissible levels and lead, zinc and cadmium, up to 800 times recommended safety levels.⁷⁴ It emerged that over 2000 tonnes of ash had been distributed at the site.

The European regulatory controls upon the use of bottom ash as an input to construction products and as road base are sporadic, inconsistent and difficult to enforce. The regulations are preoccupied with the leaching characteristics of ash as the only mode of bioavailability of the contaminants in final disposal or re-use modes. The leaching tests are primarily focused on heavy metals such as lead, copper and zinc rather than POPs concentrations. Volatilisation of dioxin and other POPs from the ash are not readily considered in the regulatory regime.

The rapid development of a 'recycling industry' for waste incineration residues in Europe and its haphazard regulation has become a matter for concern for the European

⁷³ Schoevers, A. (2004) *Environmental pollution by dispersion of solid residues from waste incineration; the legacy of ignorance. Case study of persistent hazardous pollutants in fly ash and bottom ash in the Netherlands*. Report prepared for IPEN Dioxins, PCBs and Wastes Working Group by Waste & Environment, Rijswijk, Netherlands, February 2004.

⁷⁴ Hencke, D., and Boseley, S., (2000) Dioxins found in allotments near incinerator. *The Guardian* Friday 26 May 2000

Commission.⁷⁵ The Commission is concerned that the ad hoc regulation (where it exists) of these hazardous materials has a significant likelihood of creating '*important legal and illegal transport of waste across Europe*' and that this may give rise to possible negative effects on human health and the environment. The Commission has flagged the need for harmonizing of standards and legislation across Europe to manage such materials in a safer manner.

There are also growing concerns that proposed European regulatory concentration limits for POPs in ash from incineration are set too high allowing for the possible export of contaminated ash beyond Europe to developing countries that lack the technical ability and regulatory regimes to control the fate of the waste material in the environment. This could foreshadow a return to the controversies of the 1980's with global movement of hazardous waste (in the form of incinerator ash) from developed nations to dump sites in the developing world.

Heavy metals in waste incinerator ash have been a widely studied problem for many years and are the focus of regulatory measures that control the final distribution and fate of incinerator ash. Standard assessments of bottom ash for metal contamination consist of weak leaching tests (such as the Australian Standard Leaching Procedure) using distilled water to simulate leaching conditions in a natural environment or the more aggressive Toxicity Characteristic Leaching Procedure (TCLP) using dilute hydrochloric acid to simulate leaching in a more acidic landfill scenario. Maximum allowable levels of leaching of toxic metals (lead, cadmium, copper, mercury etc) for ash are stipulated by regulators although these may vary according to jurisdiction and proposed end use of the ash.

The focus on leaching of metals to the exclusion of other contaminants represents a serious data gap when assessing the environmental fate of incinerator ash that is reintroduced into the environment for 'beneficial purposes' such as construction materials, masonry additives and road-base. This is especially the case where POPs in the ash are likely to 'outlive' the construction materials and re-enter the environment when demolition of the building products take place at the end of their useful lives. Using ASLP tests to simulate metal leaching in landfills is also likely to underestimate metal contamination as landfill leachate is often acidic and will more readily mobilise metals towards groundwater.

Risk Associated with Current Disposal Practices for Incinerator Residues

A recent report by the International POPs Elimination Network (IPEN)⁷⁶ demonstrates major problems with the unregulated and partially regulated use of incinerator ash in Europe as a construction material. In the Netherlands, fly ash is a major route for dioxin releases from waste incineration to the environment. For the year 2000 the quantity of

⁷⁵ European Commission (2006) Management of Residues from Waste Incineration in Europe. Science for Environment Policy. *Environment News Alert Service*. February 2, 2006.

⁷⁶ Petrlik, M.S.J. and Ryder, R., (2005) *After Incineration – The Toxic Ash Problem*. The International POP's Elimination Network. "Keep the Promise, Eliminate POPs!" Campaign and Dioxin, PCBs and Waste Working Group of the International POPs Elimination Network (IPEN) Report

dioxins in ash is estimated at 2671 g ITEQ/ year (this figure includes dioxins in bottom ash and filter residues. To put this in perspective, the total release of dioxins from the top ten US sources of dioxin⁷⁷ in the year 2000 was 1529.49g ITEQ. The levels of heavy metals and POPs and other toxic compounds reported by IPEN in Netherlands fly ash is outlined in Table 3 below.

With the regulatory focus on ash leachability, little information is available on the projected environmental impacts of ash contaminants once the 're-use' option ends its useful life. Virtually no information is available on the fate of contaminants that have been introduced into construction materials when demolition and destruction of the building materials occur.

In May 2002, the UK Environment Agency⁷⁸ published a report on concerns with the use of incinerator ash following well publicised incidents of reuse of incinerator ash at Edmonton, North London, and Byker, Tyneside. The report estimated that dioxin levels in blocks made from bottom ash would be around 4ng TEQ/kg (compared to 1ng for blocks made out of power station ash), though one block was actually measured at 23ng. Although the practice ceased in 2000, both bottom and fly ash from the Edmonton incinerator was mixed and used to form construction blocks. Around 15,000 tonnes was used to make construction blocks (estimated at 5.3million blocks, enough to build 3,400 houses). Dioxin in the blocks was measured in the range 117-390ng TEQ/kg.

A major recommendation of the report was that standards need to be developed to define the permissible concentrations of PCDD/DF in building products, effectively arguing that the market had moved ahead of regulation. Similar concerns were echoed in the European Commission News alert cited previously.

Table 3 Average composition of fly ash and bottom ash from Dutch waste incinerators in 1997 (in mg/kg)

Contaminant	Average levels in fly ash (mg/kg)	Number of samples analysed	Average levels in bottom as (mg/kg)
aluminium (Al),	30	294	Not defined
arsenic (As)	97	17	19-23
cadmium (Cd)	379	17	2-8
chromium (Cr)	231	31	235-296
copper (Cu)	1,154	17	669-3212

⁷⁷ USEPA (2005) The Inventory of Sources and Environmental Releases of Dioxin-Like compounds in the United States: The Year 2000 Update. March 2005 External Review Draft.

⁷⁸ Environment Agency UK (2002), *Solid Residues from Municipal Waste Incinerators in England and Wales*, May 2002.

mercury (Hg)	2	17	0.03-0.2
lead (Pb)	7,671	17	1086-1637
molybdenum (Mo)	50	17	5-11
selenium (Se)	9	17	0.4-0.5
strontium (Sr)	245	17	Not defined
tin (Sn)	1,007	17	62-77
vanadium (V)	30	27	40-52
wolfram (W)	77	17	Not defined
zinc (Zn)	22,488	17	1239-2125
bromine (Br)	997	17	Not defined
chlorine (Cl)	74, 471	17	1050-2445
fluorine (F)	57	17	Not defined
dioxins (PCDD) and furans (PCDF) I-TEQ	0.0024	17	Below detection limit

NTN is among many other organisations concerned about the risks that contaminated ash presents to:

- workers at the re-processing operations
- workers involved in construction and maintenance of roads and buildings using contaminated materials
- demolition workers handling contaminated road base and building waste
- people residing in dwellings constructed of contaminated products
- people growing and consuming food in soil contaminated by ash
- environmental effects of final disposal of contaminated waste from demolition

Salt Mine Disposal

The highly toxic and soluble nature of fly ash limits the possibilities for its disposal. Closed-down, underground salt mines in the Ruhr, Germany are being used as deposits

for highly poisonous filter dust. In the 1990's Germany was sending over 500,000 tonnes per annum of fly ash waste to underground salt mines⁷⁹. The citizenry does not have any participatory power in the planning process because special mining laws apply that exclude the public and because the highly noxious hazardous waste has been declared an economic resource⁸⁰. What is stored in the mines cannot be taken out again. If the toxic ash leaks into ground water contaminating drinking water, the waste stored there cannot be removed and concerns are now being raised about the suitability of German salt for long term storage and disposal of hazardous waste.

In Australia, the most likely scenario is that highly contaminated fly ash will need to be disposed of at hazardous waste landfills with expensive pre-treatment to reduce solubility. Pre-treatment such as encapsulation or vitrification using plasma arc technology (as is the case in Japan) will likely be required to permit it to be dumped at hazardous waste landfills. This represents an ongoing cost to society of permanent storage of fly ash in landfill.

Bottom ash will be disposed of at Class 3 (municipal waste) or Class 4 (hazardous waste) landfills depending on the contamination concentrations. Using industry estimates that bottom ash will comprise 20-25% of the initial waste by weight, this would see a 200,000 tpa incinerator disposing of 50,000 tonnes of contaminated ash to landfill every year. Clearly incineration is not a 'solution' to landfill.

Char, Slag and Biochar

While this report primarily examines municipal waste incineration there are some overlapping issues with the emerging biomass to energy sector. Energy from biomass (agricultural waste, food waste, wood waste etc) follows the same principles as incineration of MSW to produce energy. The biogenic waste is combusted, gasified or pyrolysed to generate heat or syngas which in turn can be used to generate electricity. The issues associated with residues from biomass incineration bear some discussion.

While *combustion* of wastes (in the presence of high volumes of oxygen) tends to generate ash substances as a residue, gasification and pyrolysis tends to produce a slag or char material bound with ash. The composition of chars varies as does the concentration of contaminants that are present in the chars. The contaminant levels in the final char residue are dependant on contamination in the feedstock and formation of certain contaminants through the thermal processes (e.g. polycyclic aromatic hydrocarbons or PAHs and POPs). Char that has been derived from mixed wastes (including plastics) has been demonstrated to exhibit hazardous and ecotoxic⁸¹ characteristics that should result in the residue being disposed at an approved grade of

⁷⁹ Bertin Technologies (2000) Feasibility Study of the Salt Mines Storage Route. Step One report. Appraisal of the salt mines storage route for residues from incineration. Paris

⁸⁰ Dioxin in Germany - by Barbel Hohn, Speaker of Green Parliament List, North Rhine-Westphalia, Germany Available from *Synthesis/Regeneration*, A Magazine of Green Social Thought online < <http://www.greens.org/s-r/078/07-52.html> >

⁸¹ Bernardo, M., et al (2010) Toxicity of char residues produced in the co-pyrolysis of different wastes. *Waste Manag.* 2010 Apr;30(4):628-35. doi: 10.1016/j.wasman.2009.10.015. Epub 2009 Nov 22.

landfill (dependant of specific contaminant concentrations). The presence of POPs, PAHs and heavy metals in MSW derived char may creates significant risks if substantial volumes of this material is diverted to 're-use' schemes such as road building or construction material. The same concerns arise with char re-use as apply to ash re-use.

Biochar is essentially an industrial charcoal created through the exclusive use of biogenic feedstock in gasification and pyrolysis systems (mostly for energy generation). There has been considerable interest in biochar in Australia as a means to sequester carbon (it has a high carbon content), and improve soils while generating energy from 'renewable' fuels.

Biochar as a soil amendment has been popularized on the basis of associations with 'Terra preta' – a particularly dark and fertile soil type found in the Amazon basin that appears to be comprised of wood, charcoal, pottery, manure and soil microbes. It is unknown how this material formed over thousands of years but scientists have suggested it is unlikely that burying industrial charcoal will recreate this type of soil⁸². Claims that biochar can sequester carbon for long periods has also been questioned with some studies indicating that carbon retention is relatively brief⁸³.

Contamination of biochar with dioxin, PAH's and other POPs varies according to the contaminant concentration in feedstock⁸⁴, the configuration of the incinerator as well as the presence of precursors such as bromine (salts) and chlorine. It could be expected that agricultural wastes that have been treated with dioxin contaminated and/or chlorinated herbicides may also produce biochar with elevated POPs levels.

It has been argued by proponents of biochar (which is directly linked to biofuel production) that mass adoption of soil amendment with biochar will provide a key role in mitigating climate change while improving soils and crop yields. However, some scientists have argued that there is no evidence to support these claims and that

*"A critical analysis of the risks of applying biochar on a large scale is still totally missing"*⁸⁵

There are also a range of arguments that relate to whether burning biogenic material is actually the best use of scarce resources and by implication agricultural land. The problems that have arisen with the biofuel industry in the US and South America (particularly ethanol) with food crop displacement, rising food prices and social impacts point to concerns over mass adoption of bioenergy and biochar adoption.

⁸² Syngen , R., (2012) *Industrial Charcoal (biochar) just a dangerous technofix? A Short Primer*. Dr Rye Syngen Friends of the Earth Australia.

⁸³ Nguyen, B., et al (2008) Long--term black carbon dynamics in cultivated soil. *Biogeochemistry*, Volume 89, Number 3/July, 2008

⁸⁴ Hale, S., et al (2012) **Quantifying the total and bioavailable polycyclic aromatic hydrocarbons and dioxins in biochars**. *Environ Sci Technol*. 2012 Mar 6;46(5):2830-8. doi: 10.1021/es203984k. Epub 2012 Feb 27

⁸⁵ Op Cit at 82 p.3

Chapter 6 The high cost of incineration

Waste incinerators are extremely expensive to build and run. They destroy resources for a small, inefficiently generated amount of electricity and sustain low levels of employment due to their highly automated processes. The U.S. Energy Information Administration found that the costs of building WTE incinerators are 60% higher than nuclear power, and the operating costs are ten times higher than coal.⁸⁶

Over a twenty-year period, the city of Detroit, Michigan paid out over \$1.2 billion in costs and debt servicing for their WTE incinerator, coming close to bankruptcy on three different occasions in that time.

In some recent US cases waste incinerators have plunged whole cities into economic crisis. Over a twenty-year period, the city of Detroit, Michigan paid out over \$1.2 billion in costs and debt servicing for their WTE incinerator, coming close to bankruptcy on three different occasions in that time. In October 2011, Harrisburg, Pennsylvania became the largest city in the country to declare bankruptcy, due to its \$300 million toxic debt from fixing and upgrading a WTE incinerator operated by Covanta.⁸⁷ Diverting waste away from landfill and incineration toward recycling and cool technologies such as composting costs a lot less, saves an enormous quantity of GHG and generates high rates of employment.

In considering the overall environmental, social and economic benefits of these technologies and practices it is clear that waste incineration contributes little to economic benefits in society and is a poor environmental performer. Australia governments from Federal down to local level need to consider these issues before committing to technologies such as incinerators which will lock in waste streams for more than 20 years and deny the economic benefits of alternatives to the community.

The Productivity Commission (Australia) regards incineration as waste disposal and in assessing somewhat dated financial assessment of incineration stated,

“Energy-from-waste facilities are a financially costly waste disposal option. The New South Wales Alternative Waste Management Technologies and Practices Inquiry (Wright 2000) estimated that the net financial cost of such facilities in Australia in 2000 would be between \$180 and \$260 per tonne of waste⁸⁸.”

The Commission goes on to suggest this expenditure is due to the high costs of APC, which internalise some of the externalities such as pollution that impact on the environment. However, these do not recognise that redirecting toxic emissions to ash

⁸⁶ U.S. Energy Information Administration (Department of Energy), Updated Capital Cost Estimates for Electricity Generation Plants, November 2010. http://www.eia.gov/oiaf/beck_plantcosts/pdf/updatedplantcosts.pdf

⁸⁷ Global Anti Incineration Alliance (2011) *Not Renewable, Barely Energy*

⁸⁸ Productivity Commission (2006), Waste Management, Report no. 38, Canberra.p.77

merely configures the externalities. Nor do they recognise that maintaining and upgrading scrubber systems to comply with tighter air pollution regulations over time makes up high percentage of ongoing costs. Nevertheless, they do recognise the high cost to society of establishing incinerators.

These are critical issues for local and regional governments around Australia to consider as they prepare funds and strategies to invest in resource recovery technologies. If they choose the wrong system, ratepayers will inevitably be burdened with large debts, environmental degradation yet few extra jobs.

Australia has avoided the introduction of waste incinerators in recent decades with the exception of Brightstar Environmental's SWERF plant in Wollongong. This MSW gasification operation closed after 3 years of trials in 2004 without having become operational and with many emission breaches. The parent company Energy Developments Ltd lost around \$160 million along with the local community investment of \$1.5 million.⁸⁹

While the cost of the SWERF failure mainly fell on private investors, the US cities of Harrisburg and Detroit have recently provided more graphic examples of the economic burden of waste incineration on communities.

Harrisburg, the capital city of Pennsylvania is on the verge of filing for bankruptcy with up to US \$345million in debt mostly associated with the city's waste to energy incinerator. The City councilors believe they may be able to avoid filing for bankruptcy if they can secure a sale of the incinerator for US \$130 million which the Mayor stated *would "permanently absolve the City of Harrisburg, and the Harrisburg Authority, from all future liability related to the incinerator."*⁹⁰

Harrisburg tried to file for bankruptcy earlier but was stymied by Pennsylvania law makers who legislated to prevent the city claiming bankruptcy. Many argue that bankruptcy would have been a better option shifting the costs to *'bondholders and other financial creditors to share more of the pain of the restructuring'*. Now the costs are squarely on the city residents who will have services slashed, assets sold, wage freezes and increased waste management fees. The city has already had to cut 32 jobs and raise taxes in an effort to pay down debt.

What seemed like a modest investment in waste management soon spiraled out of control as the incinerator struggled to contain dioxin emissions,

Problems started soon after the incinerator was built in 1972. Although its original price tag was less than \$15 million, it required so many repairs and refinancings that it was saddled with \$94 million in debt by the time the federal government shut it down in 2003 because it was polluting the air with dioxin.

⁸⁹ Murphy, J., (2004) SWERF effort goes to waste. Illawarra Mercury. Saturday December 4, 2004

⁹⁰ Walsh, M., and Hurdle, J., (2013) Harrisburg Sees Path to Restructuring Debts Without Bankruptcy Filing. The New York Times. July 24, 2013

The city's decision to borrow another \$125 million to rebuild and expand it was essentially a double-down bet. Harrisburg's gamble was that by expanding the incinerator so it could burn up to 800 tons of trash a day, it would be able to burn more garbage from neighboring counties. The fees it would collect, the city hoped, would pay off the debt.⁹¹"

Harrisburg residents now pay some of the highest waste disposal fees in the country.

Detroit is an even larger US city that has just filed for bankruptcy. While there are numerous reasons for its financial problems and social decline, the Detroit incinerator, which is the largest waste burner in the world has contributed substantially to overall debt. The incinerator was sold to private interests in 1991 due to poor returns but since then has cost the residents over \$1.2 billion to service debt bonds borrowed to build it. Detroit residents now pay 3-5 times the average waste disposal costs for Wayne County while the average annual cost to run the incinerator has been estimated at US \$77million. The incinerator is also the largest source of criteria pollutants for Wayne County. Many community members have been trying to have the incinerator closed and replaced with a zero waste strategy that they argue will immediately save over \$US 50 million a year for the city of Detroit.

The hidden cost of incinerator upgrades

One of the common problems for incinerator operators and the communities that have contracts with them is the issue of upgrades. There are standard engineering issues such as replacement of boiler linings, refractory lining, corroded pipes, valves and spent scrubber materials but also regulatory upgrades. Over decades, international and national air quality standards are improved as science is better able to assess the impact of pollutants on public health and the environment. The trend has been toward recognition that smaller amounts of air toxics and combinations of air toxics can cause impacts. As air quality standards are gradually tightened, or new pollutants are listed for controls (eg the introduction of Air Toxic NEPM⁹² in Australia), permissible emissions from stacks are restricted to lower levels and are generally reflected in amendments to operating licences issued by the state regulators.

In the US during the 1990's, implementation of stricter controls on atmospheric dioxin emissions required incinerator operators to spend millions of dollars to retrofit incinerators with better dioxin scrubbers. These restrictions can include a range of pollutants that individual countries or the international community deem harmful and require special controls. As an example an international agreement to control releases of mercury to the environment (The Minamata Convention) is currently being developed. When it enters into force parties to the convention will be expected to implement Best Available Technology (BAT) and Best Environmental Practices (BEP) to control mercury releases from power stations and other known point sources of mercury pollution such as waste incinerators. Over time these requirements will be transferred into individual facility environmental licences as tighter limits on mercury emissions.

⁹¹ Ibid

⁹² See <http://www.environment.gov.au/atmosphere/airquality/standards.html#toxics>

This will require incinerators to fit new and expensive pollution capture devices in an attempt to maintain compliance with their permits and avoid penalties. These upgrades can cost millions of dollars which are handed directly to the community if their municipality owns the incinerator or indirectly in the form of higher tipping fees if the incinerator is privately owned and with waste supply contracts from a municipality. Many incinerators around the world have had to shut down completely because they cannot remain financially viable and incorporate these upgrades.

A recent example from Australia involved the East Arm Quarantine Incinerator in the Northern Territory which was closed on 4 November 2012, because it could not meet new dioxin standards. This followed *'six years of emissions of dioxins and furans up to 31 times over the national and international standard'*⁹³. Given the option of expensive upgrades, the incinerator closed and alternate means of dealing with the waste are being determined.

'Put or Pay' contracts.

The problem for many communities who have waste disposed of to an incinerator is that the operating company often demand 'put or pay' contracts from the municipal authorities. Because incinerators require at least a twenty year lifespan to pay off the massive capital investment required to construct them an attempt to make a profit, they need to guarantee a waste stream for the entire life of the incinerator. A put or pay contract requires the municipality to deliver an agreed volume of waste to incinerator per month or year.

If recycling, reuse and composting in that municipality diminish the available volumes of waste to a level where there is insufficient waste to meet the incinerator contract then the municipality must pay cash to make up the shortfall. In this way communities can be locked into contracts for decades even if they no longer supply waste to the incinerator. The incinerator simply signs new contracts with waste suppliers from further afield to keep the incinerator burning while still claiming the cash from the original contract. This can result in heavy debt burdens on communities which lock up resources that could be better spent on the community.

Burning waste requires landfill

While incinerator proponents like to present their technology as a solution to landfill the reality is that incinerators need landfills. Even the industry admits that 30% of the original volume of waste entering an incinerator must be disposed of after it has been burnt. The residual waste from incineration for every 1000kg burned is estimated at 220kg of bottom ash, 30kg of hazardous waste in the form of fly ash and 30kg of metals⁹⁴ (some of which may be hazardous). Bottom ash is generally landfilled in municipal waste landfills or special 'monofills' that just contain ash from incineration. Fly

⁹³ AECOM (2013) *Environmental Audit Report: Assessment of risks to beneficial uses from dioxin emissions East Arm Wharf Quarantine Incinerator, Port Darwin, Northern Territory*. Darwin Port Corporation .

⁹⁴ Kalogirou, E. (2012), The development of WtE as an integral part of the sustainable waste management worldwide, Recuwatt -Recycling and Energy conference-, Mataró (Spain), 4th October 2012.

ash contains high concentrations of dioxins, PCB's and heavy metals as well as other hazardous materials. These have to be landfilled in hazardous waste cells which can require disposal costs up to ten times higher than standards landfill.

A municipality that signs up to a waste incinerator also has to meet the costs of maintaining and monitoring a landfill (most of which require expensive groundwater monitoring) if it owns one, or must contribute to the ash tipping fees directly or indirectly through its waste incineration contract. The notion that incinerators 'replace' landfills in terms of cost or environmental impacts is clearly misleading.

Chapter 7 Cool technologies -more jobs, less waste.

As Australian government agencies and the waste management sector started to adopt sustainability principles in the 1990's it became clear that there needed to be a transition away from landfill to higher levels of recycling and resource recovery. Large scale waste treatment technology proposals began to emerge which were collectively termed Alternative Waste Treatment (AWT). The AWT technologies can be divided into two categories – 'cool' technologies and 'hot' technologies. Both of these categories can include resource recovery technologies including those that generate some form of energy from waste. 'Hot' technologies are incinerators or thermal treatment (gasification, pyrolysis, plasma arc and combustion) while 'cool' technologies include large scale composting, recycling and anaerobic digestion (AD).

Many assessments and comparisons between 'cool' and 'hot' technologies suggest that the triple-bottom-line outcomes (social, environmental and economic) of cool technologies are far greater.

A comprehensive modelling meta-analysis by renowned ecological economist Dr. Jeffrey Morris of Sound Resource Management⁹⁵ has compared a wide range of social, ecological and economic benefits of composting and cool technologies compared to modern 'hot' incinerator technologies in the US. In particular Morris studied and costed the impacts of a range of pollutants from different forms of resource recovery on different elements of the environment and human health. The findings clearly indicate that cool technologies provide clear benefits over waste incineration in nearly every category. As part of the comprehensive analysis Morris found that waste 'garbage' contains around 5250 British Thermal Units (BTUs)⁹⁶ per pound. Recycling saves 3000-5000 BTU per pound while incineration only saves 900-1000 BTU per pound. Some of the key findings are that incineration wastes large amounts of energy and performs very poorly against the following range of factors compared to composting and recycling.

- Climate Change
- Human Health – Particulates
- Acidification
- Eutrophication
- Human Health – Toxics
- Human Health – Carcinogens
- Ecosystems Toxicity
- Ozone Depletion
- Smog
- Habitat Disruption
- Biodiversity Depletion

⁹⁵ Morris, J., (2008) Recycling and Composting Saves Money, Energy & Pollution Compared to Disposal Via Waste-to-Energy(WTE) Conversion. Montreal Video Conference – October 21, 2008.

⁹⁶ British Thermal Units are a traditional unit of [energy](#) equal to about 1055 [joules](#). It is the amount of energy needed to cool or heat one pound of water by one degree Fahrenheit.

- Ecosystem Services Degradation
- Resource Depletion

A Case Study of Cool Technology

International Waste consultants Nolan ITU engaged in a triple bottom line economic analysis⁹⁷ of the benefits of a 'cool' technology recycling and composting operation in Australia. The process known as the UR-3R Process is owned by the company Global Renewables. The technology cluster included the recycling of dry recyclable material, the generation of energy and compost manufacture. The analysis was extrapolated to consider the benefits of rolling out the technology to all major population centres in Australia. Global Renewables state,

'The design philosophy of the UR-3R Process[®] is the recovery of materials to their highest net resource value i.e. to conserve embodied energy as much as possible and minimise / avoid emissions of all types (i.e. solid, liquid, gaseous).'

Nolan ITU had the brief,

- *To assess, quantify and substantiate the overall environmental life cycle benefits of the UR-3R Process[®] in accordance with international standards; and*
- *To report the overall net welfare benefits of UR-3R Process[®] in a true Triple Bottom Line (TBL) sense, incorporating economic, environmental and social impacts.*

The analysis assumed that the UR-3R Process[®] would be established in Sydney, Melbourne, Brisbane, Perth, Adelaide, Canberra, Newcastle, and Gold Coast serving around 70% of the Australian population.

Nolan ITU assessed financial, social and environmental impacts as well as macro-economic impacts of national scale roll-out of composting and recycling using the UR-3R Process[®] with the following results,

The following key results are presented for the project option relative to the "without project" Base Case:

- *The cost benefit analysis, encompassing dollar valuation of the financial costs and revenues as well as the environmental benefits, indicates a very significant net benefit to the community of \$130-\$150 per household per annum, depending on the waste collection scenario.*

⁹⁷ Nolan-ITU (2004) *Global Renewables, National Benefits of Implementation of UR-3R Process[®] - A Triple Bottom Line Assessment.*

- *When summed over the total number of households in the population centres modelled, the estimated annual net benefit for Australia is estimated at \$620-\$680 million per annum*
- *The analysis of social indicators provides a positive result – the UR-3R Process® is clearly preferred to the Base Case in terms of social indicators.*
- *Macro economic benefits are also significant on a national basis, with the UR-3R Process® potentially providing 1,780 full time equivalent jobs and contributing \$140 million in value added to the national economy.*

Australia faces many challenges similar to other OECD nations in terms of employment, climate change impacts and the ecological and health burdens associated with pollution. Job creation, human and ecological health protection will increasingly become priority issues facing our government into the future as a result of climate change. An enhanced national strategy for reuse, recycling and composting can provide significant social, economic and ecologically sustainable benefits for Australia.

In the US⁹⁸ and EU studies⁹⁹ provide evidence to support the benefits of an enhanced national recycling and composting strategy, that can be applicable to Australia as an OECD nation with similar consumption patterns and population growth projections. When compared to the thermal Waste to Energy Sector, it is clear that more jobs and greater public health and ecological benefits are provided through an enhanced recycling and composting industry.

These studies demonstrate how Australia could create greater waste diversion rates as part of an enhanced recycling and composting industry. It is entirely achievable to divert 75% of waste from landfill without the need for incineration. There are countries around the world meeting these targets already and provide valuable case studies for zero waste strategies in any jurisdiction. For example:¹⁰⁰

- Nova Scotia diverted 50% of waste from landfill within five years (2000 – 2005) with 1000 jobs created in collection and treatment of recyclables and compostables and another 2000 jobs created in the industries handling the recovered materials
- San Fransisco has diverted 77% of waste from landfill
- 2000 communities in Italy are diverting 50% of waste from landfill with more than 200 diverting 70% simply through door to door collections.
- Ursabil in Spain has achieved 86% diversion from landfill in 7 months

⁹⁸ Tellus Institute with Sound Resource Management (2011) *More Jobs, Less Pollution: Growing the Recycling Economy in the U.S.*

⁹⁹ Friends of the Earth (2010) *More jobs, less waste. Potential for job creation through higher rates of recycling in the UK and EU.* September 2010.

¹⁰⁰ Connett, P., (2011) *Waste Solutions We can All Live With*, Presentation by Dr P. Connett, Executive Director American Environmental Health Studies Project, Midland, Western Australia 5th Feb 2011.

- Flanders, Belgium has achieved 75% diversion through reuse, recycling and composting.

Employment creation from cool technologies

The creation of green jobs in the recycling and composting industries has the potential to provide much needed support for our citizens and our economy. A key benefit of composting and recycling waste is most evident in the area of employment creation (including indirect jobs associated with this growing sector.) Recent studies in the US and EU reveal that more than twice as many jobs are created through enhanced composting and recycling schemes when compared to waste incineration technologies. This is a significant and compelling argument challenging the establishment of the thermal Waste to Energy industry in Australia.

According to the Tellus Institute Report¹⁰¹ diverting MSW and Construction and demolition (C&D) waste in the US from landfill towards the reuse, recycling and composting sector will:

- Create almost twice as many jobs as would be created if the status quo of sending these wastes to landfills and incinerators continued in the US. There would also be a significant number of additional indirect jobs associated with suppliers to this growing sector, and additional induced jobs from the increased spending by the new workers.
- Lower greenhouse gas emissions: A reduction of almost 515 million metric tons of carbon dioxide equivalent (eMTCO₂) from diversion activities, which is 276 million eMTCO₂ more than if these wastes were sent to landfill or incineration, equivalent to emissions from about 72 coal power plants or taking 50 million cars off the road.
- Less pollution overall: Significant reductions in a range of conventional and toxic emissions that impact human and ecosystem health.
- Unquantified benefits of reducing ecological pressures associated with use of non-renewable resources, conserving energy throughout the materials economy, and generating economic resiliency through stable, local employment.

¹⁰¹ Op Cit at 98

Table 4: Estimated direct, indirect and induced jobs in the US recycling sector, 2001

Employment Direct	'000	Direct Employment	Indirect Employment	Induced employment	Total employment
Recycling collection		32.0	4.2	20.4	56.6
Recycling processing		159.9	84.2	150.4	394.5
Recycling manufacturing		759.7	1124.9	1237.1	3121.7
Reuse/Remanufacture		176.1	112.5	124.9	413.5
Total All Groups		1127.8	1325.9	1532.9	3986.6

Source: (R.W.Beck Inc , 2001) based on a large scale survey of the sector

The story is very similar in the EU and UK where Friends of the Earth report noted that,

“On a European level, if a target of 70% for recycling of key materials was met,

conservative estimates suggest that across the EU27 up to 322,000 direct jobs could be created in recycling an additional 115 million tonnes of glass, paper, plastic, ferrous and non ferrous metals, wood, textiles and biowaste. These jobs would have knock on effects in down and upstream sectors and the wider economy and could create 160,900 new indirect jobs and 80,400 induced jobs. The total potential is therefore for more than 563,000 net new jobs.

For the United Kingdom, if an ambitious but achievable recycling target of 70% for municipal waste was set and achieved by 2025, then conservative estimates suggest that across the UK this could create 29,400 new direct jobs in recycling, 14,700 indirect jobs in supply chains and 7,300 induced jobs in the wider economy relative to 2006. Of these potential 51,400 total new jobs some 42,300 might be in England with an estimated 4,700 in Scotland, 2,600 in Wales and 1,800 in Northern Ireland.”

According to the Australian Bureau of Statistics (ABS) Australia’s current unemployment rate is at 5.7% and trending upwards. This could be addressed by an enhanced recycling and composting strategy for Australia.

In June 2004 the ABS reported:

- At \$2,700 million (m), the income generated by Australia's waste management services businesses in 2002-03 was equivalent to 0.2% of Australia's Gross

Domestic Product (GDP), according to figures released today by the Australian Bureau of Statistics.

- Businesses providing waste management services were predominantly small employers, with 74.1% of all businesses having employment of 0-4 persons.
- The number of waste management services businesses in the private and public trading sector increased from 894 at the end of June 1997 to 1,092 at the end of June 2003, an average annual percentage change of 3.4%.

It is clear that the contribution of the waste management industry sector in Australia represents a stable and significant portion of the GDP. Given the disproportionately small percentage of employment in this sector there is obvious room for increased jobs at a time when Australia faces similar global financial pressures compared to other OECD nations.

Chapter 8 Toward ecologically sustainable resource recovery through Zero Waste principles.

“Zero Waste is a goal that is ethical, economical, efficient and visionary, to guide people in changing their lifestyles and practices to emulate sustainable natural cycles, where all discarded materials are designed to become resources for others to use.

Zero Waste means designing and managing products and processes to systematically avoid and eliminate the volume and toxicity of waste and materials, conserve and recover all resources, and not burn or bury them.

Implementing Zero Waste will eliminate all discharges to land, water or air that are a threat to planetary, human, animal or plant health.”¹⁰²

With respect to waste generation the ultimate objective of any society pursuing ecologically sustainable development is to create a closed loop system of production and consumption where all materials flow through the system and can be used as inputs at various levels of that system. This is a form of industrial ecology that would mimic natural processes to the greatest extent possible ensuring that no material becomes waste that cannot be reprocessed and continue to contribute to the cycle. This philosophy is best represented by the concept of moving toward ‘Zero Waste’ which is a strategy that prioritises waste avoidance, reuse, recycling and ecologically sustainable resource recovery.

Zero waste programmes have been demonstrated to have a positive contribution to social, economic and environmental outcomes for the community with lower establishment costs. For example, Markham County in Toronto Canada, boasts an 81% landfill diversion rate through the implementation of their zero waste strategy. Waste incinerators have very high establishment, operating and upgrade costs while providing low returns in terms of employment and social benefits per dollar invested when compared to operations that include recycling, composting and anaerobic digestion. The International Panel on Climate Change (IPCC) has acknowledged these additional benefits stating, *“Increased composting of municipal waste can reduce waste management costs and emissions, while creating employment and other public health benefits.”¹⁰³*

The appeal of the Zero Waste approach is that the whole community benefits while improving environmental outcomes without leaving sole responsibility for the waste stream to profit-maximising private corporations and their shareholders. To date market forces alone have not served society well in the area of waste and environmental impacts.

¹⁰² Internationally accepted, peer-reviewed definition adopted by the [Zero Waste International Alliance](#) 29 November 2004

¹⁰³ IPCC (2003) Climate Change 2001: Mitigation. Contribution of Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Chapter 3.7.2.3. Available at: http://www.grida.no/CLIMATE/IPCC_TAR/wg3/120.htm

In the recent past manufacturers made a great deal of the fact that their products were *disposable*, a concept that conveniently ignores the fact that burying and burning discarded products merely reintroduces that material into our ecosystems in a more toxic form which degrades the environment by polluting air, soil and groundwater. It also ignores the enormous waste of energy and virgin materials embedded in a single use, disposable product. This raises a critical issue in the transition to ecologically sustainable resource recovery which is *industrial responsibility through better design and substitution of toxic ingredients with non-toxic ingredients*.

Responsible industrial design aims to create or redesign a product to be reused, recycled or integrated safely into a composting or anaerobic process. Industrial design should address the entire life cycle of a new product ensuring that it is not only fit for purpose but that it can be easily reintroduced into the production chain or recovery processes at the end of its useful life. This notion is taking hold among many industrial designers with more products being developed or re-engineered to allow for better environmental outcomes. This raises real problems for the incinerator industry who claim that they do not undermine recycling because they are only interested in the 'residual fraction' of municipal waste that cannot be reused or recycled.

In current Australian waste streams this residual fraction has been variously estimated at 10-15 percent of the entire waste stream. If better industrial design and improved recycling and resource recovery rates reduce that residual fraction to much lower levels over the next two decades then incinerators will struggle for a fuel source and will inevitably seek to burn recyclable material in an attempt to remain economically viable.

Incinerator proponents insist that the target of 'zero waste' is impractical because it represents a fundamental barrier to their business model. Incineration takes relatively non-hazardous municipal waste and converts it into large amounts of hazardous gaseous and solid waste with a small amount of inefficient energy generation. The current business model for this process requires a return on capital investment over a 25 year term with revenue streams from gate fees, electricity sales and subsidies from governments. In Australia this may also include government payments for volumes of waste 'diverted from landfill'. This arrangement can become an economic and environmental 'ball and chain' burden for communities, which in extreme cases can result in an economic crisis such as the US City of Harrisburg bankruptcy case.

Pursuit of a zero waste programme does not entail these risks and ensures that valuable resources are directed to their best use in a climate friendly way, creating jobs and a sustainable revenue base for the community. Many Australian and New Zealand jurisdictions have developed policies supportive of zero waste before the current wave of incinerator proposals emerged. These include:

- the ACT Government (1996) adopted a strategy of No Waste by 2010;
- the Victorian Government (2005) adopted a Towards Zero Waste strategy;
- the South Australian Government (2005) adopted a zero waste goal in its Waste Strategy 2005–2010; and
- the Western Australian Government adopted a policy goal of towards zero waste in its Strategic Direction for Waste Management (Waste Management Board 2004).

Conclusion

Incineration of waste is not compatible with Zero Waste programmes despite aggressive campaigning from incinerator proponents that they must be 'a part of the mix'. The involvement of incineration in the resource recovery sector in Australia will inhibit the pursuit of Zero Waste for decades to come.

The National Toxics Network calls on policy makers and government authorities to take a broader view of the impacts of poor choices in resource recovery. This should not just be a discussion for the 'energy sector' or the 'waste management sector'. Resource recovery affects all Australians and we must strive for the best environmental, social and economic outcomes and not place our communities on a trajectory of waste burning from which we will not be able to deviate for decades.

Australia needs to create jobs and conserve resources without adding to climate change. A part of that solution is at hand in the form of zero waste policies and 'cool technologies'. These solutions should not have to compete for subsidies, tax breaks and renewable energy credits with dirty energy from waste burners. The National Toxics Network calls on Australian authorities to get the policy settings right and encourage solar, wind and wave technology alongside 'cool' resource recovery technologies.

This report recommends that Australian state and federal governments reject MSW incineration and adopt a national policy for enhanced waste avoidance and resource recovery that includes;

- Support and incentives for 'cool' technologies such as composting and anaerobic digestion.
- The adoption of zero waste principles in legislation.
- Increased support for an expanded recycling and composting sector.
- National Container Deposit and Extended Producer Responsibility legislation that mandate product recycling (while eliminating POPs recycling).
- Promotion of better industrial design to drive elimination of residuals from the waste stream.
- A review and removal of clauses in the **Renewable Energy (Electricity) Act 2000** that deem any aspect of MSW burning 'renewable energy' and allow municipal waste burners to access credits, subsidies or certificates for renewable energy generation which deprive genuine renewable energy projects of much need resources.

Renewable energy subsidies for waste incinerators should be reviewed and revoked. Waste incineration should be discouraged at all levels of governance as a poor solution to waste in the 21st century.

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