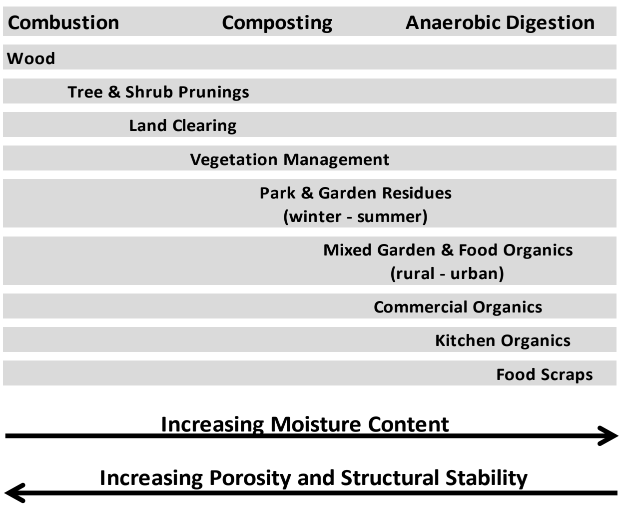
Understanding the processing options

There were more than 187 organics processing facilities in Australia in 2009–10, handling over 5.8 million tonnes of organic residues between them. The feedstock to these facilities included 1.58 million tonnes of garden organics and 211,000 tonnes of food organics (not including food residues in MSW).

NSW and Victoria recycled the bulk of source separated food organics, accounting for 100,000 and 84,000 tonnes respectively. While many facilities were originally designed to process garden organics, most have been modified to enable them to handle other putrescible feedstock such as mixed garden and food organics (as well as other putrescible organic residues), without causing environmental nuisance or harm.

There are three general treatment options for organic residues: combustion (including gasification); composting; and anaerobic digestion. The most suitable method of treatment for a given application will depend largely on the chemical and physical properties of the materials being processed (see table below).



Different processing options are better suited for different types of organics

As a general rule, organic residues with high carbon density and low moisture content (such as wood) are better suited to combustion whereas putrescible residues with high moisture content (such as food) are better suited for anaerobic digestion. These types of putrescible materials are also suitable for processing in vermiculture operations, which is not the case for dry and woody material. A wide variety of materials can be composted, although not always on their own. The ability to blend dry and moist, carbon-rich and nutrient-rich materials, makes composting a very versatile processing option.

The choice of processing technology is primarily governed by:

- ✓ What outcomes council and the community expect to achieve
- ✓ Location and size of proposed site and associated environmental constraints
- ✓ Type and quantity of expected feedstock
- ✓ Investment and operating costs
- ✓ Type of products to be manufactured
- ✓ Sustainability issues (such as measured through LCA or carbon footprinting).

A critical aspect of choosing an appropriate processing technology is site location. Even fully enclosed composting facilities can result in odour complaints when poorly operated and located close to residential areas. Negative headlines (for example caused by odour emissions, biosecurity, contamination in output, water contamination, fire or technical problems) can be detrimental to community engagement efforts.

A general rule of thumb is that the more material that is processed at a site and the higher the proportion of putrescible residues (for example food organics, biosolids, food processing residues or liquids), the higher the risk for nuisance and environmental problems to occur.

In some jurisdictions licensing requirements will dictate the design of an organics processing system and may, for example, preclude the use of open, uncovered windrow composting for the co-composting of food organics.

Technologies for processing organics

Simple pile composting has been modified and developed over the last sixty years into various mechanised and sophisticated composting technologies. Over the years, many different composting systems were developed and offered in the market place, some of which have endured, while many others vanished. Nevertheless, the basic principles of composting remain unchanged, as the process is governed by the fundamentals of biological and biochemical processes.

In the *Practical Handbook of Compost Engineering*, composting is defined as the biological decomposition and stabilisation of organic substrates under aerobic and thermophilic (>45°C) conditions to produce a product that is stable, free of pathogens and plant seeds, and can be beneficially applied to land. There are seven general types of processing technologies for organics, as outlined below and further explained on the following pages.

1. Vermicomposting
2. Open windrow composting
3. Aerated static pile composting (with or without covers)
4. In-vessel composting (tunnel, box, vertical silo, drum)
5. Fully enclosed composting (agitated bed, agitated pile)
6. Anaerobic digestion (wet, dry)
7. Combustion (including pyrolysis and gasification).

Most organics processing facilities can be compartmentalised into pre-processing, processing and post-processing operations. In the case of composting facilities, pre-processing includes segregation of physical contaminants, size reduction of bulky materials, blending of different feedstock, and addition of water, microbial inoculants or other additives that are designed to improve the composting process or the finished product.

The composting process can be divided into a first, high-rate phase, and a second, curing phase. Many composting systems are organised along this divide. The first stage is characterised by high oxygen uptake rates, elevated temperatures, high consumption of easily degradable components, and high odour emission potential.

The second stage is characterised by lower temperatures, reduced oxygen demand and lower odour potential. Traditionally, the intensive composting phase has been more engineered and controlled due to the need to reduce odours, supply high aeration rates and maintain process control. The curing phase is usually less engineered and less process control is applied.

Post-processing in a composting facility can include screening and air-sifting, blending, adding performance enhancing components (nutrients, microorganisms), or pelletising.

Comparison of composting technologies

There are a number of factors councils need to consider when choosing a composting technology. A primary consideration will be investment and operating costs, and budgetary constraints. Other factors include the type and quantity of feedstock, site location and size, regulatory requirements, and anticipated product use. These considerations will vary according to the circumstances of a specific project and council. A brief comparison between different composting technologies is provided in the table below.

Technology	Aeration	Air purification	Investment cost	Land area required
Vermi-composting	Passive	No, but possible	Low to medium	Large to medium
Windrowing	Turning, passive aeration	No	Low	Very large
Aerated static pile	Positive/negative forced aeration	No, but possible	Medium	Medium
In-vessel composting	Agitation, mechanical turning, forced aeration	Yes, but exceptions	Large	Medium to small
Fully enclosed composting	Agitation, mechanical turning, forced aeration	Yes	Very large	Medium to small

The following aspects need to be considered when assessing and comparing different processing technologies:

- ✓ Investment costs ($ / tonne throughput)
- ✓ Operating costs ($ / tonne throughput)
- ✓ Operational experience
- ✓ Options for process management
- ✓ Options for achieving desired product quality
- ✓ Risk of emitting odour / bio-aerosols and releasing leachate
- ✓ Ability to process different feedstock
- ✓ Options for expanding processing capacity
- ✓ Footprint (tonne annual throughput per square meter)
- ✓ Energy and water use.

Investment and operating costs

Although investment and operating costs are usually among the most important factors in deciding for or against a certain processing technology, this information is rarely available in the public domain. Processing costs and gate-fees for composting are commercially sensitive, and therefore not publicly divulged.

Costs for composting vary greatly, depending on the type of materials processed, annual throughput, the type of technology employed, and the kind of products generated. Data suggest that costs for composting range between $25 and $130 per tonne (note that processing cost may be different to gate-fee charged). Composting of garden organics alone incurs significantly lower costs than co-composting of garden organics with food or other putrescible materials.

Type and quality of product

The choice of processing technology determines, at a macro level, the type of products that are being generated. Fundamentally, the various processing technologies generate the following products:

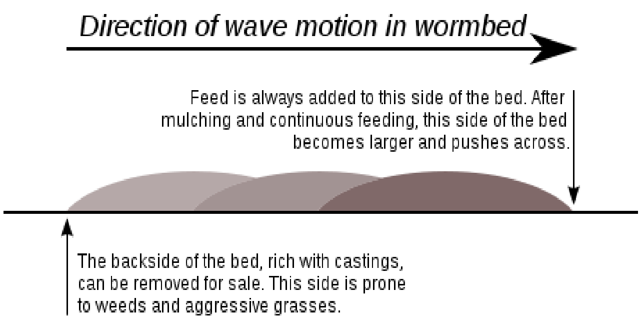
Technology	Product
Vermicomposting	Vermicast, possibly worm liquid
Composting	Compost of different maturity stages and particle size grading
Anaerobic digestion	Digestate (liquid) or digested residues, biogas
Combustion	Ash, heat energy
Gasification	Liquid, solid (char) and gaseous (syngas) products

As in many other manufacturing processes, the raw materials used in organics processing operations largely determine the quality of the finished product. Recycled organic products manufactured from source separated organics have shown low levels of physical and chemical contamination. These products therefore have wide potential application and the chance of being accepted in a wide variety of markets. The use of recycled organic products with low contaminant levels is central to developing agricultural and horticultural markets, and also for minimising soil contamination.

1 Vermicomposting

Large-scale vermicomposting is practised in various countries, and has been explored in Australia. At the turn of the century, there were four or five large vermicomposting operations processing municipal organics (biosolids, garden and food organics) and animal manures. However, today we understand there is only one such operation left in Australia, in Broken Hill. Fundamentally, vermicomposting requires a higher level of management and is less forgiving than windrow composting.

There are two main methods of large-scale vermicomposting: In the extending windrow system, small piles of organic material are provided for worms. More organic material is added to the pile continuously (see diagram).



The second type of large-scale vermicomposting, which is considered 'state-of-the-art', is the raised bed or flow-through system. Here the worms are fed by regularly adding a thin layer of fresh material across the top of the bed, which is subsequently harvested from the base of the suspended bed.

The vermicomposting facility in Broken Hill employs less sophisticated technology and incorporates windrow composting into the operation as a means of ensuring the finished product is pasteurised.

2 Open Windrow Composting

Open windrow composting is employed by the vast majority of organics processing facilities in Australia, and indeed the world. Open windrow composting is very widely used because it is relatively cheap, flexible and reliable as a means of processing and stabilising organic residues.

The downside of windrow composting is that it offers limited process control, which increases environmental risks, particularly odour and leachate emissions. Open windrow composting is obviously difficult in high rainfall areas. This problem can be alleviated by either using windrow covers, or by (partially) covering the operation with a roof.

In windrow composting, raw materials are set up in long rows that are then turned regularly, either with front end loaders or dedicated windrow turners. The type of turning equipment used determines the size of rows, and hence the area required for processing a given quantity of input material. Compared to other processing options, windrow composting has a relatively low throughput per unit surface area, which means demand for land is relatively high. On the other hand, investment and operating costs are relatively low, making windrow composting often the only organics processing technology able to compete with low landfill costs.

3 Aerated Static Pile Composting

Aerated static pile composting was originally developed for composting biosolids in North America. In aerated static pile composting, organic residues are mixed together in one large pile, instead of rows. To aerate the material, the piles are placed over a network of pipes that deliver air into (or draw air out of) the pile. Aeration can be via permanent sub-surface channels, or via mobile pipes that are located above ground. Air blowers might be activated by a timer or temperature/oxygen sensors.

Aerated static pile composting is suitable for a relatively homogenous mix of organic residues with acceptable moisture, bulk density and porosity characteristics. According to the US EPA, this technology should work well for composting garden and food organics, but not so well for processing animal by-products or grease from food processing industries.

Temperatures in the outside layer of the piles do not reach levels that ensure elimination of pathogens and weed seeds. This can be overcome by (i) physical turning of the pile, (ii) windrowing before or after static pile composting, (iii) covering the pile with finished compost or compost covers.

Aerated static pile composting typically requires equipment such as blowers, pipes, sensors, and access to electricity, which can be generated on site, or off the grid. The controlled supply of air enables construction of large piles (governed by material characteristics), which results in increased processing capacity per unit of land.

An example of a larger scale system utilising an aerated, static pile is the SITA Australia BioWise organics processing facility in Kwinana (WA), which has the capacity to process up to 50,000 tonnes per year of organic material.

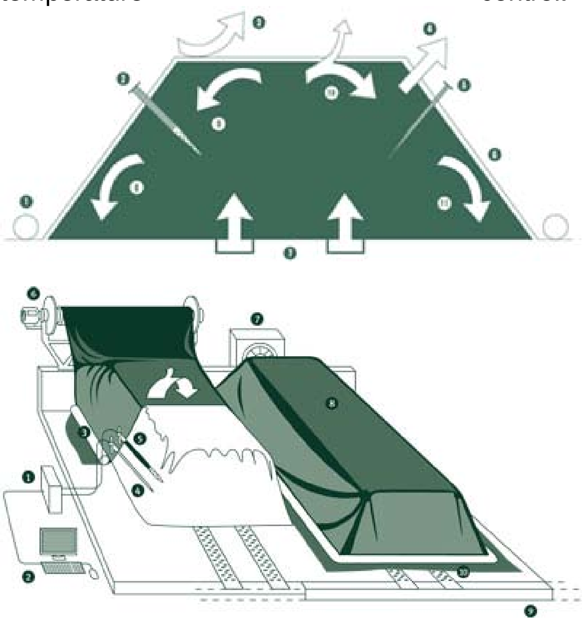
Over the last five or so years, several composting operations in Australia have integrated static aerated pile composting into their operations. Custom Composts (WA), Peats Soil and Garden Supplies (SA) and Pinegro Products (VIC), for example, employ an above ground mobile forced aeration system, while Jeffries (SA) opted for a non-mobile static aeration system. These companies use static aerated piles to compost kerbside collected organics, bark, manures and biosolids.

Establishing a mobile aerated floor (MAF) composting pile

3.1 Covered Aerated Pile Composting

The use of semi-permeable compost covers alleviates some of the potential problems associated with static aerated piles, such as drying out, rain water penetration, odour and bio-aerosol emission, and non-pasteurisation of the outer layer of the pile.

Examples of technologies that are utilised in covered static pile aerated composting include GORE-TEX Covers and the MOR Compost Cover Technology. In both cases the covers are provided as part of a complete composting system, including covers, cover handling equipment, an aeration system, monitoring equipment, and software for managing the system. These covers protect the composting material from the penetration of rainwater, while allowing CO_2 to escape. Condensation on the inside of the covers helps manage odours and other gaseous substances, while also reducing pathogenic microbes through better temperature control.



Principle of a GORE-TEX Cover in an aerated static pile (top) and schematic view of operational GORE-TEX composting system (bottom)

Timaru District Council in New Zealand established the first (and so far only) GORE-TEX Cover composting facility in the Southern Hemisphere in 2006, processing source segregated garden and kitchen organics.

4 In-vessel Composting

When in-vessel composting (IVC) systems are used, organic materials are fed into a drum, silo, tunnel, box or similar container where the initial, intensive composting process takes place in controlled environmental conditions (temperature, moisture, and aeration).

These IVC systems usually employ forced aeration or a mechanism to turn or agitate the material (or both) to facilitate proper aeration and process conditions. Materials are generally premixed before being loaded in the vessel. This must be done very thoroughly where no agitation occurs during the in-vessel composting phase.

Materials are typically processed 'in-vessel' for periods between one and three weeks before they are further composted and cured in (aerated) windrows or static piles. Most facilities with in-vessel containers only use them for the first phase of the composting process, where process control is critical. Using containers for the entire composting process would be costly. IVC equipment can be located in the open, or it can be housed fully or partly in a building to contain odours being generated during unloading and pre-processing of organic residues.

A wide range of IVC systems are available in the market place. They mainly vary in the type of vessel employed, size, aeration/agitation method, and details such as the control devices, loading equipment and leachate management approach used.

4.1 Tunnel Composting Systems

Tunnel composting systems are essentially long aerated concrete containers that can be closed, have forced aeration through a floor plenum, and allow for internal air circulation. They are loaded and unloaded from one end and operate in batch mode after the tunnel is fully loaded. Materials are loaded and unloaded either with front-end loaders or fully automated conveyer systems.

A number of tunnel composting facilities operate in Australia. Since 2000, Natural Recovery Systems has operated a tunnel composting facility in Dandenong, Victoria. The facility has five units and recycles a range of garden and food organics. The SITA SAWT facility at Kemps Creek, NSW, operates 8 to 10 tunnels (depending on incoming quantities) that are dedicated to processing source separated food and garden organics from Penrith City Council. The SAWT facility processes around 35,000 tpa of organic residues, including sludges. SITA also operates a 10-tunnel composting facility at its Spring Farm Advanced Resource Recovery Park in South-Western Sydney, which processes 30,000 tpa of garden organics from the Macarthur Regional Organisation of Councils (MACROC).

The Remondis Organic Resource Recovery Facility (ORRF) in Port Macquarie receives source separated organics from Port Macquarie Hastings Shire Council, which is shredded and blended with biosolids and loaded into one of eight tunnels.

Western Composting Technology processes domestic organic residues in a tunnel composting facility in Shepparton, Victoria. The facility is licensed to accept 2,000 tpa, but the modular nature of the operation (partially precast concrete tunnel) makes it easy to progressively increase throughput as the supply in the region increases.

Inside a composting tunnel with aeration channels

4.2 Box and Container Composting Systems

Box and container composting is fundamentally identical to tunnel composting. Boxes and containers, however, are smaller and tend not to be in enclosed buildings. Containers are mobile and can also be used for transporting organic residues from disposal points to the composting site. If a roll-on roll-off system is used, containers can be easily transported and emptied at the point of further processing.

As far as the authors are aware, no commercial box or container composting systems are currently operated in Australia or New Zealand. Nevertheless, the Herhof Box Composting System and the BIODEGMA Box Composting System, for example, are used widely in Europe, while Green Mountain Technologies supplies the North American market with its Containerised Compost System.

Containerised composting system

4.3 Vertical Composting Silos

Vertical composting units (VCU) are typically tall silos in which the organic material is contained in a vertical ‘chamber’ with a grid or perforated base that enables air to flow through. VCUs do not have forced aeration, with air flow instead driven by temperature gradients. The advantage of VCUs is their small physical foot print and energy efficiency. VCUs do not require agitation, bio-filtration, external heating or air injection. With minimal moving components, maintenance and operating costs are also very low.

The VCU prototype was tested at Long Bay Correction Centre (Malabar, NSW) in the mid-1990s, with subsequent units being established at the University of NSW (composting of catering residues) and at Lord Howe Island (composting of septic tank waste and food organics). Sydney's Royal Botanic Gardens uses a VCU to convert vegetation residues into compost. Waitakere City Council in New Zealand installed a 10 chamber plant in 2001, benefiting from the VCU's small footprint on their urban site. Wingecarribee Shire Council (NSW) trialled a 3,000 tpa VCU system in 2003, but did not retain it. Today, VCUs are primarily installed and operated in Europe.

4.4 Rotating Drum Composting Systems

There is no composting facility in Australia that employs Rotating Drum Composting technology for the processing of source segregated garden and kitchen organics. However, three Bedminster facilities in Port Stephens (NSW), Cairns (QLD) and Perth (WA) use composting drums for the processing of organics contained in household residual waste.

4.5 Other In-vessel Composting Systems

The HotRot composting unit is a longitudinal, fully enclosed continuous in-vessel composting module. Each unit incorporates a u-shaped concrete hull section with a sealed lid. A central tine bearing shaft runs longitudinally through the vessel. This shaft rotates periodically and slowly, mixing, and assisting with aeration and the physical breakdown of the composted material. Grinding or shredding of food and animal residues can generally be avoided.

In 2005 Selwyn District Council (New Zealand) bought two HotRot composting units to service its initial move into kerbside collection of garden and household organics. The Australian National University (ANU) in Canberra installed an 800 tpa HotRot unit on an 18 month trial basis in 2007. In early 2012, Melbourne Zoo installed a HotRot composting unit and feed system to manage animal bedding and other organic materials generated around the grounds.

Two medium size HotRot composting units

5 Fully Enclosed Composting

Fully enclosed composting systems represent technologies where composting takes place in a large building or section of a building, without containing the material in a separate, enclosed composting vessel. The pre-processed organic material is typically fed into the system at one end, and the compost is extracted at the other end. This flow-through system, enhanced by agitation and turning, minimises loss of production capacity due to volume reduction during the composting process.

Fully enclosed composting systems usually employ underfloor negative aeration to reduce condensation in the composting hall, while also extracting exhaust air overhead. Ducting for under-floor aeration and leachate collection is often combined, but can be cause for problems.

5.1 Agitated Bed Composting Systems

In agitated bed composting systems, organic residues are composted in 'beds' contained by long channels with concrete walls. A turning machine, travelling on top of the beds, agitates and moves the materials forward. Forced aeration is provided through the floor of the channel. As the top of the channel is open, agitated beds are usually located in an enclosed building. To reduce the volume of exhaust air to be deodorised and to improve working conditions inside the building (such as during loading and unloading operations), some systems have plastic curtains around the perimeter of the bays (and in some cases a further 'drop ceiling'). These measures also help to contain the moisture and ammonia being released from the composting materials, which contribute to corrosion of the building.

The Biomass Facility at Coffs Harbour (NSW) processes 55,000 tpa of garden organics, food organics and biosolids in an agitated bed composting system. Physical contaminants are removed from the incoming organic materials in the receival hall. In the composting hall, decontaminated material is composted in agitated beds for 21 days.

5.2 Agitated Pile Composting Systems

Enclosed agitated pile composting is very similar to agitated bed composting systems, except that there are only one or two very large rectangular beds. Feedstock is loaded into the composting hall at one end, and is extracted at the other end.

Starting at the discharge end the agitator / turner moves along the pile, discharging composted material for removal from the hall while turning and moving material in the process. With each pass, material is displaced a set distance (1–4m) toward the discharge side of the composting hall. Pile dimensions, turning frequency, and the distance the material is moved when turned determine the composting period in the hall. Loading and unloading of the hall, as well as agitation / turning, are fully automated processes without staff having to enter the composting hall.

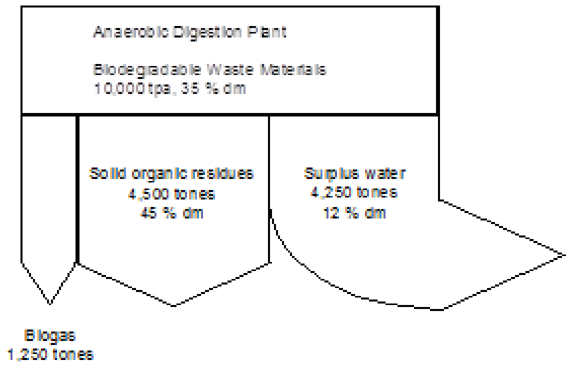
There is no composting facility in Australia that employs this type of technology for the processing of source segregated garden and kitchen organics. However, Global Renewables' UR-3R facility at Eastern Creek (NSW) uses an agitated pile composting system for the processing of organics contained in household residual waste.

6 Anaerobic Digestion

Anaerobic digestion breaks down organic carbon compounds in an environment that is devoid of oxygen (O_2) and nitrate (NO_3). Anaerobic digestion is a sequential process, which happens in four steps—hydrolysis, acidification, acetogenesis, and methanogenesis. The process generates biogas, containing 50–75% methane (CH_4).

Anaerobic digestion has become a popular choice for treating organic residues in various European countries, and to a lesser degree in North America. The rapid development of anaerobic digestion in European countries is driven by whole-of-government policy settings and significant subsidies for energy generation from renewable resources. Many municipal composting operations are retrofitted with an additional anaerobic digestion plant.

The main benefit of operating anaerobic digestion plants is that energy can be recovered from organic residues in the form of methane-rich biogas, which can be used to generate renewable power and/or heat. At the same time, solid organic matter (digestate / compost) and plant nutrients are retained and available for land management purposes.



Example of material flow in a dry anaerobic digestion facility that processes mixed garden and food organics

In Australia, anaerobic digestion is primarily used in wastewater treatment plants, food processing operations, and in a piggery (Berrybank, Victoria). Biogas, or landfill gas, is also harvested at more than 60 landfills.

The EarthPower facility in Camellia (NSW) uses wet digestion technology to process various organic residues including source segregated foods and food based residue streams from domestic, commercial and industrial food preparation, processing and consumer activities. When the facility is operational, feedstock arrives in various forms including raw, cooked or processed meats, fruit and vegetables, dairy products, confectionary, bakery products, cereals and grains.

A trial to process combined food and garden residues from Woollahra Council at the EarthPower facility in 2007 was unsuccessful as the woody material caused problems for the system. Leichardt City Council has also trialled processing of food organics at EarthPower.

There are two processing facilities in Australia that have the capacity to use anaerobic digestion for generating biogas from the organic fraction contained in MSW; the Anaeco facility in Perth (WA) and SITA's facility at Jacks Gully (NSW). In each case anaerobic digestion is part of a comprehensive mechanical-biological treatment (MBT) system for unsorted municipal waste.

7 Energy Generation Technologies

Biomass can be converted into energy (heat or electricity) or energy carriers (charcoal, oil, or gas) using both thermochemical and biochemical conversion technologies. Combustion is the most developed and most frequently applied process used for solid biomass fuels – mainly because of its low costs and high reliability – but other technologies, such as gasification, are also becoming available.

7.1 Combustion

By far the most common means of converting biomass to usable heat energy is through straightforward combustion, and this accounts for around 90% of all energy attained from biomass. There are a number of different technologies that can be used for biomass combustion, the main ones being fixed bed and fluidised bed combustion systems.

Different combustion technologies are available to deal with various fuel qualities – less homogeneous and low-quality fuels need more sophisticated combustion systems. For 'economy of scale' reasons, only medium and large-scale systems are suitable for using low quality and cheap biofuels, such as processed and graded garden organics or wood waste.

Co-firing biomass with coal in traditional coal-fired boilers is becoming increasingly popular, as it capitalises on existing investment and infrastructure, while reducing emission of pollutants and net greenhouse gas. Power plants in Lithgow, Liddell and Lake Macquarie (NSW), for example, currently supplement coal with relatively small volumes of wood residues. Biomass energy plants often use different types of fuel to overcome seasonality of supplies and also to minimize supply risks.

Several sugar mills in Queensland and NSW are now complementing bagasse with forestry residues and woody municipal residues for co-firing their boilers year round.

7.2 Gasification

Gasification is a process that converts carbon-based materials into synthetic gas (syngas). Gasification is achieved by reacting the organic material in a closed reactor at high temperatures (>700°C), without combustion, and with a controlled amount of oxygen and/or steam. The three main gasification technologies are fast pyrolysis, carbonisation and gasification. Each process produces different proportions of liquid, solid and gas in the end product (see table below).

	Liquid	Char	Gas
Fast Pyrolysis	**75%**	12%	13%
	moderate temperature short residence time		
Carbonisation	30%	**35%**	35%
	low temperature long residence time		
Gasification	5%	10%	**85%**
	high temperature long residence time		

A gasification system typically consists of four main stages: (i) feeding, including drying and storage, (ii) gasifier reactor, (iii) gas cleaning (mainly tar removal), and (iv) utilisation of the generated gas.

There are three primary varieties of gasification technologies, namely updraft and downdraft fixed bed gasifiers, as well as fluidized bed gasifiers.

The possibility of using syngas in a variety of ways makes biomass gasification a very interesting technology. Using the syngas is potentially more efficient than direct combustion of the original fuel because it can be combusted at higher temperatures or even in fuel cells. Syngas may be burned directly in gas engines, used to produce methanol and hydrogen, or converted into synthetic fuel.

Pyrolysis is a form of gasification that is relatively well known and advanced in Australia. Slow pyrolysis technology produces solid (charcoal), liquid (bio-oil), and gas (medium BTU) from biomass, in almost equal measures.

Slow pyrolysis, or carbonisation, creates the highest proportion of char, which can be used as a soil amendment for carbon sequestration to mitigate climate change. This appears to be the main focus of pyrolysing biomass in Australia. Pacific Pyrolysis, which is currently building Australia's first commercial biomass pyrolysis plant in Melbourne, makes relatively little mention of gas or electricity generation, and no mention at all of liquid bio-oil. Pacific Pyrolysis says its technology can deliver thermal or electrical energy outcomes in a modular format, which can be scaled depending upon the availability of feedstock and product markets. Energy output is directly linked to factors such as volume, type and moisture of feedstock.

The company's slow pyrolysis technology claims to be advantageous when dealing with:

- ✓ Low grade feedstock with a combination of high ash content, low ash melting points, high moisture content and varying and large particle size, including for example paper and waste water sludge, municipal green waste, animal manures, and crop residues
- ✓ Variability in feedstock supplies caused by seasonality or uncommitted feedstock
- ✓ The need for multiple revenue streams to de-risk the project from an over-reliance on any one type of revenue (i.e. gate fees, energy and/or biochar sales)
- ✓ Low emissions profile
- ✓ Agricultural or horticultural demand for biochar products.

NB: Information in this factsheet is taken from the *Food and Garden Organics Best Practice Collection Manual* (2012) published by the Department of Sustainability, Environment, Water, Population and Communities. The full document is available on the department's website www.environment.gov.au/wastepolicy/publications/organics-collection-manual