Planning an Organic Resource Recovery Facility

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This document is provided by Global Composting Solutions Ltd to help individuals and organisations plan a successful organic resource recovery facility. The document outlines those issues and questions that should be addressed in the planning phase of the project. Further information and assistance can be provided by contacting Global Composting Solutions direct by email: info@globalcomposting.com or phone +64 3 377 8822.

Location

Consideration needs to be given to both where the waste (organic resources) might be generated and collected from as well as where the compost product might be utilised. A landfill site might be attractive from a planning and license perspective but might not be ideal with respect to proximity to waste generation and product utilisation; a waste transfer station or green-field site might be more appropriate.

Some technologies are more suited to a single centralised site, which can increase waste and product transportation costs. The HotRot technology, with provision for remote monitoring and low operator involvement makes it suitable for decentralised installations. HotRot units are also available in a range of sizes that are applicable for varying quantities of waste. The use of mobile shredders can be more economic in these situations; it's often cheaper to take the shredder to the waste than the reverse.

HotRot systems have also been installed in centralised urban areas, and can be installed outdoor, under a roofed area or in a building (warehouse).

When considering location also consider staffing. Even a relatively sizeable HotRot facility may need less than one full-time employee; as such it makes sense to locate a facility where other activities are undertaken so that staff and amenities can be shared. Locating a HotRot facility at a sewage treatment plant or waste transfer station may not result in any additional labour demands at these sites. In general, a HotRot composting facility will use 50-75% less labour than a comparable facility using other technology.

Plan for Expansion

You will often need to plan for expansion and consider waste volume increases over the next 5-10 years. Will the technology you choose enable you to easily increase capacity? The modularity of the HotRot system ensures that by choosing the right sized module initially future expansion is not only planned for but is achieved through manageable, economic increments.

Think about expansion when planning site layouts and purchasing ancillary equipment such as shredders. Smaller, cheaper, shredders may cost more in increased maintenance than the initial capital saving.

What Resource to Compost

Think about the organic waste (resource) you are considering composting, as its method of collection and transport will impact on the design of the composting facility's waste reception area. The type of waste may also impact on potential markets and marketing. If you have to transport the waste to the composting facility, consider issues such as bulk density and moisture content, as a rule the higher the bulk density and the lower the moisture content the better. Don't transport air and don't transport water - both are expensive! You add approximately $0.60 per tonne to processing costs for every kilometre you need to transport one tonne of waste.

Consider issues with regards to source separation, delivery volumes and collection frequency. Food or organic waste collected from commercial premises should be relatively free of contaminants, as it is often easier to educate a small number of waste generators. I you want to make a quality product you should always look to collected source separated material rather than rely on post-collection sorting. Food residues can be wrapped in paper and placed in wheelie bins for collection. While compostable or degradable bags can be useful these must be clearly identifiable and there must be a mechanism in place for rejecting normal plastic bags. Opaque bags can also 'hide' other gross contaminants and it will be necessary to split these open and inspect the contents at some stage.

It must be remembered that "garbage waste in - equals' garbage compost out", so we would always recommend source separation backed up with the provision of some waste inspection at the composting facility. No matter how good source separation is, there will always be potential for contamination. However, effective and economic sorting facilities can be incorporated into a facility, if considered during the design phase.

Bulking Agents

Material to be composted should have a moisture content of 40-60%. Food, animal wastes and biosolids all tend to have moisture contents much higher than this and will need to have moisture removed, or where this is not practical be mixed with a 'dry' bulking agent. Food, animal waste and biosolids also lack 'structure'; that is, they have minimal free airspace between particles or lose this structure as they break down. Even if the moisture content is correct, a bulking agent may need to be added to provide porosity or structure. This is true in any composting process, but one of the benefits of the HotRot composting technology is that due to the lofting and aerating action of the tines, much less bulking agent is needed to effectively compost these 'sticky' wastes, thus improving the efficiency of the plant.

Woody green waste, as distinct from lawn clippings, is often the bulking agent of choice. It is generally readily available and indeed is often collected at the same time as household organics. However, green waste can be seasonal and tends to have higher moisture contents at certain times of the year (30-40%). Bark, wood chip and sawdust may all have lower moisture contents and be available in more consistent quantities. However, these materials are often in demand for other uses. Untreated construction and demolition waste timber is generally dry and when ground or shredded makes an excellent bulker or amendment.

You need to consider the moisture content of the organic waste you are wanting to process and the moisture content of the bulking agent as this will impact on mixing ratios and the overall size of the composting facility (see table below). Waste reception and storage facilities will need to be designed based on volumes to be processed over a reasonable period of time, this may mean having adequate capacity to store a week or more quantity of bulker.

Any bulking agent should be kept dry both prior to and after shredding. Shredded material will readily absorb rainwater thus reducing its effectiveness in adjusting the moisture content of the material to be composted. *You will use 25% less bulker if its moisture content is 20% than if it is 35%.* With appropriate dry storage it is entirely feasible to shred material periodically using a mobile shredder serving several sites. Shredded material can then be mixed with food residuals or biosolids (which do not require shredding) as these are delivered to the composting facility.

Ratio of Bulker to Waste to provide a mix with appropriate moisture content and structure.											
		Moisture content of wood bulker (% w/w)									
		10	15	20	25	30	35	40	45	50	55
Food waste / sludge moisture content (% w/w)	55	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
	60	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.30	0.50
	65	0.20	0.20	0.20	0.25	0.30	0.33	0.45	0.55	0.70	1.50
	70	0.33	0.33	0.33	0.33	0.51	0.51	0.60	0.70	1.10	2.00
	75	0.40	0.40	0.50	0.57	0.65	0.75	0.85	1.20	1.75	3.00
	80	0.50	0.55	0.60	0.70	0.80	0.90	1.20	1.50	2.10	4.00
	85	0.55	0.60	0.70	0.80	0.95	1.15	1.30	1.75	2.60	5.00
	90	0.70	0.80	0.90	1.00	1.20	1.40	1.60	2.00	3.00	7.50
	95	0.80	0.85	0.95	1.10	1.35	1.60	1.85	2.50	4.00	9.00

Dewatering Options

Removing water from the organic waste can help reduce the amount of bulking agent required and indeed the size of the composting facility. The options for dewatering are varied depending on the material to be processed and the location. Thermal or solar drying or conditioning of sludge to reduce moisture content can be economic in some circumstances but in general mechanical or physical separation will be involved.

Chemical flocculation and filtration may be more cost effective for smaller scale sludge plants than centrifuges or belt presses. Screw presses can be effective for dewatering food waste and other materials such as feathers but there need to be facilities in place for dealing with the liquid effluent. Reducing the moisture content of the organic waste from 85% to a readily achieved 70% will halve the mass of the waste to be composted and reduce the amount of bulking agent required by 55%. The composting plant can be as much as 60% smaller.

Mechanical dewatering of food and animal wastes may well generate liquor with 5-10% solids, which is an ideal feedstock for a liquid AD system. A combination of composting of dewatered food waste with a minimal amount of bulker and anaerobic digestion of the liquor removed from the waste can be an ideal process for dealing with large volumes of domestic and commercial food waste. Such a combined system offers several advantages:

- Mechanical dewatering of food waste can more than half the required capacity of the composting plant; the mass of food waste is significantly reduced as is its moisture content; this in turns leads to a dramatic reduction in the amount of bulker or amendment required.
- The liquor removed from food waste, etc., by mechanical dewatering is essentially filtered avoiding the need for glass, plastic and sand removal prior to digestion. The liquor will typically have a total solids content of 5-10% avoiding the need to add additional water prior to anaerobic digestion. The size of the AD plant is optimised and significantly simplified.

HotRot can design and build hybrid composting/wet AD facilities.

Product Marketing

Consider the market for your compost product before deciding which wastes to accept and even where you might site the facility. There is no point in “composting for composting sake” and have a large volume of composted material build up on a site, which may cause its own problems. In many cases it is better to link with existing compost supply systems. A smaller council or organisation might be able to use all the compost it produces internally, others may elect to sell to a small number of wholesale distributors, whereas others may market direct to a selected group of end users such as farmers, golf courses and horticulturists.

Compost that is consistent and stable is going to be more marketable than material that is highly variable and unstable. Due to regular mixing the HotRot system ensures a highly consistent and relatively stable product; no parts of the material become too wet or dry or too hot or cold during the process. Continual monitoring and automatic generation of processing performance reports provides both you and your clients with an assurance of product quality.

Compost produced from a mix of food and green waste or biosolids and green waste will be far superior to compost produced from green waste only. Green waste only compost has a low nitrogen content which can result in induced nitrogen deficiency when used. Food waste and biosolids also tend to be seasonally uniform resulting in a more consistent product with more predicable benefits when applied to soils.

Compost produced from biosolids may experience some market resistance through perceived issues regarding the utilisation of human waste. These are issues that need to be addressed, understood and worked through. In some cases, market resistance may restrict product use to non-food producing soils.

Size of Plant

The physical size of the plant is a function of the throughput capacity, and the space required for product storage. Systems that produce immature, unstable compost will require much larger areas for storage and maturation and indeed may need additional areas of hard standing or cover. Immature compost can result in the release of odours and this may necessitate increased buffer zones, etc.

The HotRot composting system has a compact footprint and produces a relatively stable product, requiring minimal or no storage areas. In addition, the volume of air exhausted from a HotRot system is minimised thus reducing the size of any biofilter or odour control system.

Product discharged from the HotRot system can be used, after screening, in broad-acre applications with little or no further storage. Product to be bagged should be matured/cured for 4 to 6 weeks prior to screening and bagging.

Environmental Impacts

It is important that the composting facility remains clean and tidy and should have a minimal visual impact. Any buildings should be designed to tone in with the surroundings. Tree plantings and landscaping should be used to improve the look of the facility. Ensure waste and product storage and handling facilities are designed to eliminate the impacts of wind and rain.

The HotRot composting units are low horizontal vessels that present a minimal visual impact. Even the largest units, the HotRot 3518s, are only 4.5 m tall. There are no tall structures or unsightly smokestacks, etc. HotRot units can, if necessary, be installed inside buildings and we have several urban installations where this has been done with success.

The single most critical factor with respect to any composting operation is the potential release of odour. It is also one of the costliest, either through on-going costs of mitigation or the ultimate cost of plant closure due to odour complaints. Provision for odour control and treatment is an essential element of any composting facility design and operation. The composting process releases warm moist air, and this will contain volatile organic compounds some of which will produce unacceptable odour. Efficient aeration and mixing will minimise the potential for odours but the provision of a low cost biofilter represents worthwhile insurance and puts in place disciplines with respect to air movement and control. Moving compost and waste using wheel loaders etc will release odours and these activities should be minimised or avoided at certain times, or otherwise conducted inside a building.

Suppliers should be able to supply odour emission rates for any odour treatment technology, fresh compost and product storage areas. This data should be in the form of area emission rates (odour units per m^2), allowing the data to be up-scaled according to plant capacity, etc, and used in odour modelling.

Truck movements and heavy machinery all contribute to noise pollution, as may the operation of the composting machinery and fans, etc. Restricting hours of operation can mitigate the impact of vehicle movements and heavy machinery such as shredders but the operation of the composting apparatus itself is usually 24/7. In this case, it is imperative that noise production is addressed.

The main drive for each HotRot unit utilises a 3-phase electric motor operating through a large reduction gearbox. This system is very quiet and only operates intermittently. Similarly, exhaust air fans are operated via variable frequency drives and discharge against the backpressure of the biofilter. Measurements of noise levels immediately adjacent to a HotRot composting facility operating four HotRot 1811 composting units indicates levels between 60-75dB.

Areas of impervious hard standing are not essential for product storage as the compost can absorb significant quantities of rainwater without runoff. However, areas should be contoured for drainage and any surface runoff that may entrain compost particulates should be controlled.

A well operated composting system should not produce a contaminated leachate. Condensate may be collected from the air exhaust system and this can often be reused on site for keeping storage piles moist and minimising dust. Drains should be provided in the base of any biofilter and this liquor should be disposed of appropriately.

Energy Efficiency

The two largest consumers of power at a composting facility will be bulking agent shredding and air movement. Shredders can be supplied with electric or diesel drives. Where electric drives are used you need to plan for the starting current; this can be 4-8 times the full load current rating for the motor and will have a significant impact on the size of your power supply and indeed your power bill. All large drives should be fitted with variable frequency drives or ‘soft-starters’ to minimise power requirements. High efficiency motors should be used. Moving air is expensive; air fans should be as small as practical and offered with intelligent control.

All HotRot unit main drives and fans operate via variable frequency drives and fan speeds are regulated according to exhaust air temperature or HotRot shaft rotation. Significant vapour (and potential odour) is only released from the material in the HotRot unit when the main shaft rotates. By linking exhaust fan speeds to the shaft rotation, fan use and power consumption is minimised without compromising odour control.

The HotRot main shaft rotates periodically and slowly, less than 0.5 rpm, facilitating the use of large reduction gearboxes and small electric motors. The largest HotRot unit utilises a main drive of only 37 kW and a typical HotRot composting facility will consume between 25-35 kW of electricity per tonne of waste processed.

Product Certification and Quality

Quality and certification of the product becomes more important where you are selling to an external client. However, any composting system should integrate process monitoring and control. Being able to facilitate this monitoring remotely is a major operational cost saver.

Products can be certified by regular testing, but this can add significantly to costs, so monitoring systems that provide surrogate data should be in place. Monitoring and recording waste type and quantities can help demonstrate uniformity of inputs and by default uniformity of product. A few selected samples can then provide indicative data for product quality. You should deal in averages; for example, it doesn’t really matter if this week’s material has 1.3% nitrogen or 1.4%, or 200 or 300 mg/kg of zinc.

Similarly, by measuring process temperatures it is possible to predict compliance with pathogen levels. An unmixed system may provide refuge for high levels of pathogens in areas that are not appropriately treated. These can re-infest the product after discharge. It has been shown that material needs to be mixed a minimum of 9-10 times and the mixed material exposed to conditions needed for pathogen control to ensure efficient pathogen elimination. Very high temperatures in localised areas are not sufficient or indeed efficient. The HotRot system mixes material in the unit between 200 and 500 times before discharge.

A good composting system should also provide simple online data for operators to allow them to assess plant performance. The HotRot composting system utilises a touch screen operator interface and the ability to add remote web-based monitoring system. The control system has been designed from the ground up to provide simple easy monitoring access via any computer with internet access and appropriate username and password login. The system is simple to implement and does not require a specific user or seat license as do many more expensive SCADA systems. Thus, if you want all your staff to monitor the plant, they can do so without incurring additional cost.

Maintenance and Spares

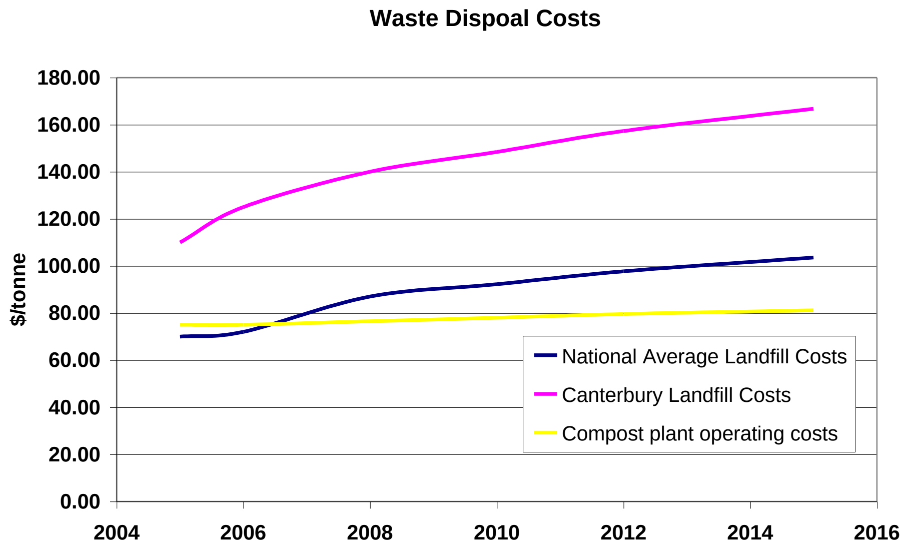
The more moving parts (and the faster they move) the more things to go wrong and the greater the amount of maintenance. While this is true, no moving parts does not mean no maintenance, and indeed it certainly does not mean a consistent or well controlled composting process. With its single slow-moving shaft HotRot represents the ideal compromise - a single robust moving part. Maintenance on the HotRot unit is restricted to an annual gearbox oil change and regular greasing of bearings. Tines can be easily removed and replaced. Electric motors are standard off-the-shelf units and are available anywhere in the world. Gearbox components are available on short notice.

Some composting systems utilise proprietary components that are only available from the vendor and may not be readily available.

The composting atmosphere is warm and moist and as a result corrosive, meaning that any equipment exposed to this atmosphere will experience corrosion. All electrical and mechanical components of the HotRot system are external to the vessel and are not exposed to the corrosive environment. Internal surfaces are stainless steel, fumed silica concrete or fibreglass and are thus corrosion resistant, or in the case of the central shaft kept polished and free of corrosion by movement through the material being processed.

Funding Options

The operation of a composting facility should be viewed in the same way as any alternative waste disposal process. The operation of the facility should be supported via the cost of disposal (a gate fee), or the cost of the alternative. However, unlike existing options, installing a composting facility is likely to future proof costs. Landfill costs are rising and will continue to do so. Similarly, the value and demand for good quality compost, as distinct from low grade compost manufactured from green waste only, will also increase, although any revenue from this source should be regarded as a bonus and not an economic driver.



The graph above illustrates projected increased in landfill disposal costs in New Zealand (national average) and Canterbury (Kate Valley Landfill). Increasing costs are based on inflation adjustment at 2.8% pa and the introduction of a proposed $15/tonne waste levy in 2007/8. The operating costs for a HotRot composting plant include direct costs (power, labour and maintenance) adjusted for annual inflation, depreciation at 10% pa and return on capital of 8.5% pa.

Recent data from the US suggests that landfill charges are increasing on average 8% p.a. Here, in New Zealand, the waste levy (charged additional to any gate fee) has increase from $20.00 NZD in 2021 to $60.00 NZD in 2024. Public green waste disposal charges (charged at waste transfer stations) in Canterbury is now $135-155 NZD per tonne, this waste is generally composted. However, general waste, which can include food waste, is now between $345 and $410 per tonne and goes from the transfer station to a landfill serving several municipalities.

In short, you should understand the full costs of all alternatives and build these into your assessments.

Greenhouse Gas Emissions

GHG emissions are receiving increasing attention globally.

The practice of landfilling organic waste is problematic because the waste is not stable. The greenhouse gas methane is produced in high quantities (up to 100 kg/tonne of waste) and ground water may be impacted by leachate. Appropriate engineering can mitigate these issues at a cost, but avoidance is generally more cost effective and is without long-term risk. Even the most efficient landfill gas capture systems only prevent the release of approximately 50% of greenhouse gases. A 2002 USEPA study clearly identified that composting of food waste could reduce GHG emissions by 1.0 metric tonne equivalents of CO_2 per tonne of organic waste composted when compared to disposal to landfill with gas capture[1]. A more recent document released by the Ministry of Environment, New Zealand[2], indicated that disposal of food waste to a class 1 landfill with gas capture could release 674 g CO_2-e per kg of dry matter and 552 g per kg for garden waste, without gas capture these figure increase by a factor of 3. The same document indicated that windrow compost will release 176 g CO_2-e per kg of dry matter. A paper by Komilis and Ham (2006)[3] gave figures of 220 g/kg for mixed paper and yard waste and 370 g/kg for food waste composting.

Other Environmental Benefits

Composting removes organic waste from landfill, but more importantly applying the product to land replaces organic matter and restores the carbon cycle. Soil organic matter gives the soil structure and preserves biodiversity. In purely functional terms, it improves water retention, (counter-intuitively) improves drainage, suppresses crop disease and increases productivity. Essentially the natural cycles can be restored even though they may now be discontinuous in both time and space. This is a practical and achievable sustainability solution for modern society.

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[1] Solid Waste Management and Greenhouse Gases: A life cycle assessment of emissions and sinks. EPA530-R02-006, May 2002.

[2] Measuring emissions: A guide for organisations, 2023 detailed guide. Ministry for Environment. July 2023 - ME 1764.

[3] DP Komilis and RK Ham. 2006. Carbon dioxide and ammonia emissions during composting of mixed paper, yard waste and food waste. *Waste Manag. 2006; 26(1):62-70.*

Adding organic matter in the form of compost can also build fertile soils in substrates such as clays and sand. Adding digestate from anaerobic digestion can add nutrients but does not build soils and can pollute groundwaters via leaching.

Summary

This summary of factors to consider when planning a compost plant is not exhaustive but does cover the major factors, especially early in the process. You might also like to obtain a copy of these documents from Global Composting Solutions:

- A series of three reports that explore issues relating to organic waste disposal:
  - *Part 1 – The Science of Organic waste Disposal.pdf*
  - *Part 2 - HotRot System Summary.pdf*
  - *Part 3 Understanding HotRot.pdf*
- A brief technical paper that outlines the technical advantages of the HotRot system
  - *HotRot - A New Generation Composting System.pdf*
- A brief technical paper outlining why HotRot can produce a relatively stable compost in a relatively short period
  - *Why is HotRot different.pdf*
- A brief technical document outlining the cost savings HotRot offers by avoiding the production of leachate
  - *HotRot units do not produce leachate.pdf*
- A summary of the HotRot OdourFree Guarantee
  - *GCS - OdourFree Guarantee Contract Version.pdf*
- A paper that outlines the requirements for bulkers and amendments
  - *Amendments and bulkers.pdf*
- A document discussing compost storage and use
  - *Guidelines for Compost Storage and Utilisation.pdf*

Our team at Global Composting Solutions is committed to assisting any genuine prospective waste minimiser to achieve the most sustainable and cost-efficient composting solution for their circumstances, whether this involves the utilisation of a HotRot Composting System or not.

If you need assistance, just give us a call, and we will advise if and how we can help.