Australian Government

Office of the Renewable Energy Regulator

Office of Renewable Energy Regulator

Guideline for Determining the Renewable Components in Waste for Electricity Generation

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1 INTRODUCTION

1.1 Use of Guidelines

The combustion of Municipal Solid Waste is listed in the *Renewable Energy (Electricity) Act 2000* as being eligible as a renewable energy source. Waste streams contain both renewable and non-renewable components, and therefore, eligible components need to be determined. These guidelines detail a methodology for determining the eligible renewable components of municipal and commercial wastes for use by electricity generation plants which are utilising waste as a fuel source and want to create renewable energy certificates.

1.2 Eligible Technologies

For a renewable power generator to be eligible for accreditation under the Act, some or all of the energy sources it utilises must be from renewable sources. Applications are made to the Regulator, in which eligible sources shall be listed along with their estimated energy output. For an existing power generator to obtain renewable energy certificates, the output from renewable sources must exceed the 1997 renewable power baseline. Accredited generators can be audited to check renewable components.

In the context of municipal solid waste combustion the following technologies are acceptable:

- Solid waste incinerators;
- Gasification; and
- Pyrolysis.

Other forms of energy recovery from waste, such as landfill gas and anaerobic digestion, are covered by Section 17 of the Act, and are not considered further as these processes are biological and use exclusively renewable sources for energy recovery.

2 DEFINITION OF ELIGIBLE RENEWABLE COMPONENTS

Components of the waste stream, which come from renewable sources and considered to be renewable, are:

- Kitchen Organics –vegetable;
- Kitchen Organics – meat;
- Municipal Garden Organics;
- Paper composite;
- Mixed Paper;
- Liquid Paper Board (renewable component only);
- Newspaper;
- Magazines;
- Cardboard;
- Disposable Nappies (renewable component only); and
- Wood.

Components of the waste stream, which are not eligible, include:

- Textiles (unless from consistent source of natural fibre);
- Compounds (radios etc);
- Mixed Plastics;
- Plastic composite;
- Plastic Film;
- Polystyrene (PS);
- Polyethylene (PE);
- Polyvinyl chloride (PVC);
- Polyethylene terephthalate (PET);
- Polypropylene (PP); and
- Rubber.

Inert materials such as concrete, soil and metal waste are not taken into consideration, as they are non-combustible. Liquid paperboard has approximately 15% plastic content, and nappies have approximately 10%, which is not eligible. Textiles from mixed municipal and commercial and industrial sources are not eligible due to the difficulty in identifying them and determining the natural fibre component. However, textiles from single sources, which can be easily identified as renewable, can be included in the renewable component. Timber and wood waste sourced from forestry or land-clearing operations is also non-eligible, unless it can be demonstrated that it would be eligible under the provisions of clause 9 of the *Renewable Energy (Electricity) Regulations 2001*.

3 SAMPLING FOR DETERMINING ELIGIBLE AND NON-ELIGIBLE FUEL COMPONENTS IN WASTE STREAM

All sampling procedures shall be managed by experienced professionals. The Office of the Renewable Energy Regulator (ORER) can carry out spot audits to check the procedures being used to determine the renewable component of energy generated.

3.1 Municipal Wastes

Municipal waste, which is sourced from domestic garbage collections and council operations such as street sweeping and litter bins, is made up of many components including food waste, organic matter, plastics, paper and a variety of other materials. Due to the fairly consistent nature of the waste stream (as householder activities do not vary dramatically from week to week), a random sampling method can be used to determine the components of the total municipal waste stream.

3.1.1 Sampling

The auditors accompany the collection truck with a second vehicle and take every 5^{th} to 20^{th} bin – depending on statistical considerations given in the table below. The sampling frequency depends on how many households can be represented with one sample analysis. The collection container size is also important. The maximum amount that can be processed daily, with sorting and moisture content determinations, is 1,000 kg.

Table 3.1 below is illustrative of the effect of different containers sizes on the number of households represented by one days sampling (1000kg). The yield per household per week is taken from the National Audit (BIEC, 1997). The actual yield per household per week shall be determined for each municipality. The percentage of population represented by one sample is 0.2%.

Table 3.1: Sample Sizes

	240L Mobile Garbage Bin	80L Mobile Garbage Bin
Average weight (kg per week)	13.2	9.0
Number of households per 1000kg sample	75	110
Households represented by one sample	37,500	55,000
Frequency for **full** truck loads	every 11^{th} bin	every 8^{th} bin

The catchment area shall be subdivided into homogenous sub-regions according to socio-economic criteria using the NSW EPA procedure (section 4.1.4). The samples are distributed amongst the sub-regions.

3.1.2 Sorting

The sorting of the waste once it is sampled shall follow the methodology put forward by the NSW EPA (EPA NSW, 1996 Manual One) with the addition of moisture content determination (see below). The fractions sorted are limited to those listed in Table 4.1.

3.1.3 Moisture Content

The moisture content shall be measured by heating the sample at 105^{o} C in an oven until the weight loss stabilises. The weight of the sample before and after gives the moisture content. The different fractions of the waste stream shall have their moisture content measured separately. Representative samples shall be selected from the sorted fractions depending on the waste materials. Solid plastics do not need to be dried to find the moisture content, but bottles need to be emptied before weighing. Plastic films do need to be dried to find moisture content. The moisture content measurement has to be carried out on the same day as the sample collection to avoid drying out.

3.1.4 Other Municipal Waste

Sampling and sorting other domestic waste (brought by householders in cars and trailers to a landfill or transfer station) and other Council waste (litter bins, street sweepings and parks and gardens) shall follow the procedure in NSW EPA Manual one.

3.2 Commercial and Industrial Wastes

Mixed Commercial and Industrial (C&I) waste shall be visually audited (described in EPA NSW, 1996 Manual Two). All loads are audited over the sampling period. The previously weighed load is dumped in view of a team of visual sorters to allow a visual assessment of the comparative volume % of each fraction. The load is spread with a bobcat to make sure there are no hidden parts in the load. The volume % is converted to weight % by applying density factors. The fractions used shall be limited to the following:

- Paper/cardboard;
- Food/kitchen;
- Garden/vegetation;
- Wood/timber;
- Textiles/rags;
- Rubber;
- Plastic; and
- Polystyrene.

One percent of the loads shall be selected for detailed sorting and weighing to train the visual assessors to "calibrate" their eyes and to provide information on densities and moisture content. The samples are sorted and moisture content measured using the same method as for Municipal Waste.

The sampling period of the survey shall be based on the waste cycle of the source businesses. Typically, commercial wastes are collected on a weekly basis or more frequently. Therefore a

one-week survey period is appropriate, as it will capture all the sources of waste. If it is known that the collection cycle is longer than a week for a significant proportion of the C&I waste sources the survey period shall be extended.

3.3 Building and Demolition Wastes

Mixed B&D will not be acceptable at a waste to energy plant, as most of the components are non-combustible. Separated loads of combustible waste, such as timber off-cuts, will be acceptable, but shall be treated on a load by load basis.

3.4 Occupational Health and Safety

The procedures described by the NSW EPA (EPA, 1996, Manual Three) shall be adhered to.

3.5 Frequency of Audits

The audits of domestic garbage and mixed C&I wastes shall be carried out six-monthly, in November and May for the temperate zones of Australia and in the wet and dry seasons in the tropical zones. Audits of domestic garbage shall also be carried out after any significant changes to the kerbside service provided, such as:

- the introduction of a new service (e.g. garden organics collection); and
- change in recyclables collected (e.g. collection of more plastic types such as polystyrene).

3.6 Process for Using Different Sampling Methodologies

Organisations using conversion technologies for obtaining energy from waste which feel that the methodology described in this document does not adequately represent the eligible and non-eligible fuel component of its conversion technology shall provide a submission to the Regulator detailing:

- Why the methodology does not apply to them; and
- Proposed alternative methodology.

4 DETERMINATION OF ELIGIBLE COMPONENT OF ELECTRICAL OUTPUT

4.1 Calorific Values of Components

To determine the energy value of the waste components as they are delivered to the plant allowances shall be made for the moisture content and hydrogen content of the wastes.

The formula for determining the calorific value of waste components as delivered is as follows:

$$\mathbf{CV_{raw} = ((1-w) \times (CV_{upper} - (2441^* \times 9) \times \mathit{H}))- 2441 \times w}$$

Where:
CV= calorific value ('raw' is real 'as delivered' value, 'upper' is value for dried material) in kJ/kg
w= % moisture content (by weight)
H = % Hydrogen content (from literature values)
* vaporisation enthalpy of water (2441 kJ/kg at 25^0 C)

To determine the calorific value of a waste stream the following steps are carried out:

- Sample is sorted and analysed into the fractions;
- CV_{upper} is applied from known data (literature);
- CV_{upper} is analysed for unknown fractions;
- % Hydrogen is applied from known data (literature);
- Moisture of fractions is determined; and
- Calculate values for $CV_{raw.}$

Default higher calorific values and hydrogen contents for solid fractions of solid waste are shown in Table 4.1 below. These values can be used in power generating operations. Power station operators may carry out further tests with materials at Australian sites to develop their own standard for use under the *Renewable Energy (Electricity) Regulations 2001*.

The moisture contents shown in Table 4.1 are for illustration only. The moisture content of the waste stream shall be determined for each fraction at each site. Moisture content varies by location (climatic variation) and by season and causes a directly proportional change in the CV_{raw}.

LPB and disposable nappies contain both renewable materials and plastics, and the equivalent values are shown in Table 4.1 in both the eligible and non-eligible component lists.

Mixed textiles are made of an unknown mix of mix of synthetic and natural fibres, and cannot therefore be included as an eligible component. Loads of textiles from a single source, which are of known, eligible composition, may be included however as a special waste.

Eligible municipal garden organics and timber do not include green or wood waste from forestry operations or land clearing, unless it can be demonstrated that it would be eligible under the provisions of clause 9 of the *Renewable Energy (Electricity) Regulations 2001*.

Table 4.1: Calorific Values of MSW Components

Material in MSW	Moisture[1]	Hydrogen content	CV upper kJ/kg	CV raw kJ/kg
Eligible Components				
Kitchen Organics – vegetable	80.9%	6.2%	19,800	1,540
Kitchen Organics – meat	52.9%	9.4%	11,900	3,340
Municipal Garden Organics	46.5%	6%	16,800	7,140
Paper composite	12%	7.5%	21,450	17,130
Mixed Paper	29.7%	5.8%	15,150	9,030
Liquid Paper Board	4.5%	7.5%	21,450	12,520[2]
Newspaper	7.2%	6.1%	17,330	14.660
Magazines	5%	5.1%	13,500	11,640
Cardboard	6.7%	5.9%	18,670	16,050
Disposable Nappies	55%	6.4%	22,900	4,190[2]
Wood(timber)[3]	19%	6%	20,630	15,070
Non-Eligible Components				
Textiles[4]	26.8%	6.4%	16,780	10,600
Liquid Paper Board	4.5%	7.5%	21,450	6,360
Disposable Nappies	55%	6.4%	22,900	4,140
Compounds (radios etc)	10%	5.1%	12,000	9.570
Mixed Plastics	10%	10%	39,000	32,880
Plastic composite	<1%	10%	37,100	34,900
Plastic Film	<1%	10%	40,000	37,800
Polystyrene (PS)	<1%	8.4%	40,000	38,150
Polyethylene (PE)	<1%	14.2	45,000	41,880
Polyvinyl chloride (PVC)	<1%	5.6%	25,000	23,770
Polyethylene terephthalate (PET)	<1%	6%	25,000	23,680
Polypropylene (PP)	<1%	14%	44,000	40,920
Rubber	18.7%	8.7%	23,100	16,770

Note 1 – Caution: Moisture content changes seasonally, regionally and due to rainfall.
Note 2 – For these mixed materials the CV has been adjusted to 15% plastic (LPB), 10% plastic (Disposable Nappies) and split into eligible and non-eligible components.
Note 3 – Excludes green organics and wood waste from forestry or land clearing operations.
Note 4 – Textiles may be eligible if from known source of natural fibre.

4.2 Methodology for Proportioning Renewable Component in Total Energy Generation

The proportioning of the renewable energy component in the electrical output is calculated as shown in Equation 4.1. The masses of raw eligible and non-eligible fractions of the waste, and the CV_{raw} of each fraction, are used to calculate the proportion of the electrical output from eligible fuel sources. CV_{raw} is calculated according to the method in Section 1.

The calculation is shown below.

$$E\% = \frac{\Sigma(E_{mun} \times CV_{raw,Emun}) + \Sigma(E_{C\&I} \times CV_{raw,EC\&I}) + \Sigma(E_{spec} \times CV_{raw,Espec})}{\Sigma(T_{mun} \times CV_{raw,Tmun}) + \Sigma(T_{C\&I} \times CV_{raw,TC\&I}) + \Sigma(T_{spec1} \times CV_{raw,Tspec})}$$

Equation 4.1

Where:

$E\%$ = Eligible percentage of electricity generation.

E_{mun} = The mass of the municipal waste delivered to the plant multiplied by the % of each eligible component found in the surveys, for each eligible component i.e. the mass of each eligible component.

$\Sigma(E_{mun} \times CV_{raw,Emun})$ = Sum of the mass of each eligible municipal waste component multiplied by the CV_{raw} for the component.

$E_{C\&I}$ = The mass of the C&I waste delivered to the plant multiplied by the % of each eligible component found in the surveys, for each eligible component i.e. the mass of each eligible component.

$\Sigma(E_{C\&I} \times CV_{raw,EC\&I})$ = Sum of the mass of each eligible C&I waste component multiplied by the CV_{raw} for the component

T_{mun} = The mass of the municipal waste delivered to the plant multiplied by the % of each eligible and non-eligible component found in the surveys i.e. the mass of each eligible and non-eligible component.

$\Sigma(T_{mun} \times CV_{raw,Tmun})$ = Sum of the mass of each eligible and non-eligible municipal waste component multiplied by the CV_{raw} for the component.

$T_{C\&I}$ = The mass of the C&I waste delivered to the plant multiplied by the % of each eligible and non-eligible component found in the surveys, i.e the mass of each eligible and non-eligible component.

$\Sigma(T_{C\&I} \times CV_{raw,TC\&I})$ = Sum of the mass of each eligible and non-eligible C&I waste component multiplied by the CV_{raw} for the component.

E_{spec} = The mass of the special waste loads (i.e. timber or waste from specific industries) delivered to the plant multiplied by the % of each eligible component in the special load, i.e. the mass of each eligible component.

$\Sigma(E_{spec} \times CV_{raw,Espec})$= Sum of the mass of each eligible special waste component multiplied by the CV_{raw} for the component.

T_{spec} = The mass of the special waste delivered to the plant multiplied by the % of each eligible and non-eligible component in the waste determined by specific analysis, i.e. the mass of each eligible and non-eligible component.

$\Sigma(T_{spec} \times CV_{raw,Tspec})$ = Sum of the mass of each eligible and non-eligible special waste component multiplied by the CV_{raw} for the component.

4.2.1 Municipal Domestic Waste

The masses of municipal wastes used for the calculation in Equation 4.1 shall be summed for the period for which the E% applies. The masses used in the formula should be as received (i.e. not dried etc.).

Municipal domestic waste composition shall be determined by kerbside bin audits. Other municipal waste compositions are carried out by visual audits at the point of disposal. These data are used when determining the mass of each component.

The audits are carried out according to a sampling program every 6 months in May and November. Surveys shall be carried out after changes to the collection system or services offered.

4.2.2 Mixed C & I Waste from Multiple Pickup Compactor Trucks

Mixed C&I waste load compositions shall be determined by visual audits managed by personnel experienced in visual assessment of waste composition. These visual audits are periodically (1% of audits) verified by sorting and weighing of loads, which also provide density data for use in determining masses to be utilised in the calculation and training for the auditors.

The C&I visual audits are carried out for every truck over a typical collection cycle every 6 months in May and November.

4.2.3 Special Waste Loads

Plants may wish to accept waste loads of single type materials from specific industries, which have a high eligible renewable component (e.g. wood waste, textile waste etc) and can be used to increase the proportion of renewable energy produced. The renewable component of these materials shall be determined by specific analysis, and the masses incoming recorded on a load-by-load basis. The masses, composition and properties can be utilised in Equation 4.1 to determine the E% values over minimum periods of one week.

Municipal garden organics collected in a separate kerbside collection shall be treated as a special waste. Municipal waste transferred from a transfer station shall be considered a special waste.

Building and Demolition waste (B&D) shall be treated as special wastes and not as mixed waste. Only the separated combustible fraction will be acceptable at a waste to energy plant and the eligible quantity will depend on the specific waste loads.

If materials are recovered for recycling within the plant after the waste is received, the masses, composition and properties can be utilised in the formula to determine the E% values over a minimum period of one week. In this case the masses have a negative value in Equation 4.1.

5 REFERENCES.

BIEC (Beverage Industry Environment Council), 1997. National Recycling Audit and Garbage Bin Analysis

EPA NSW (Environment Protection Authority), 1996. NSW Waste Stream Analysis Methodology. Manual One, Municipal Waste Stream.

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EPA NSW (Environment Protection Authority), 1996. NSW Waste Stream Analysis Methodology. Manual Three, On Site Procedures.