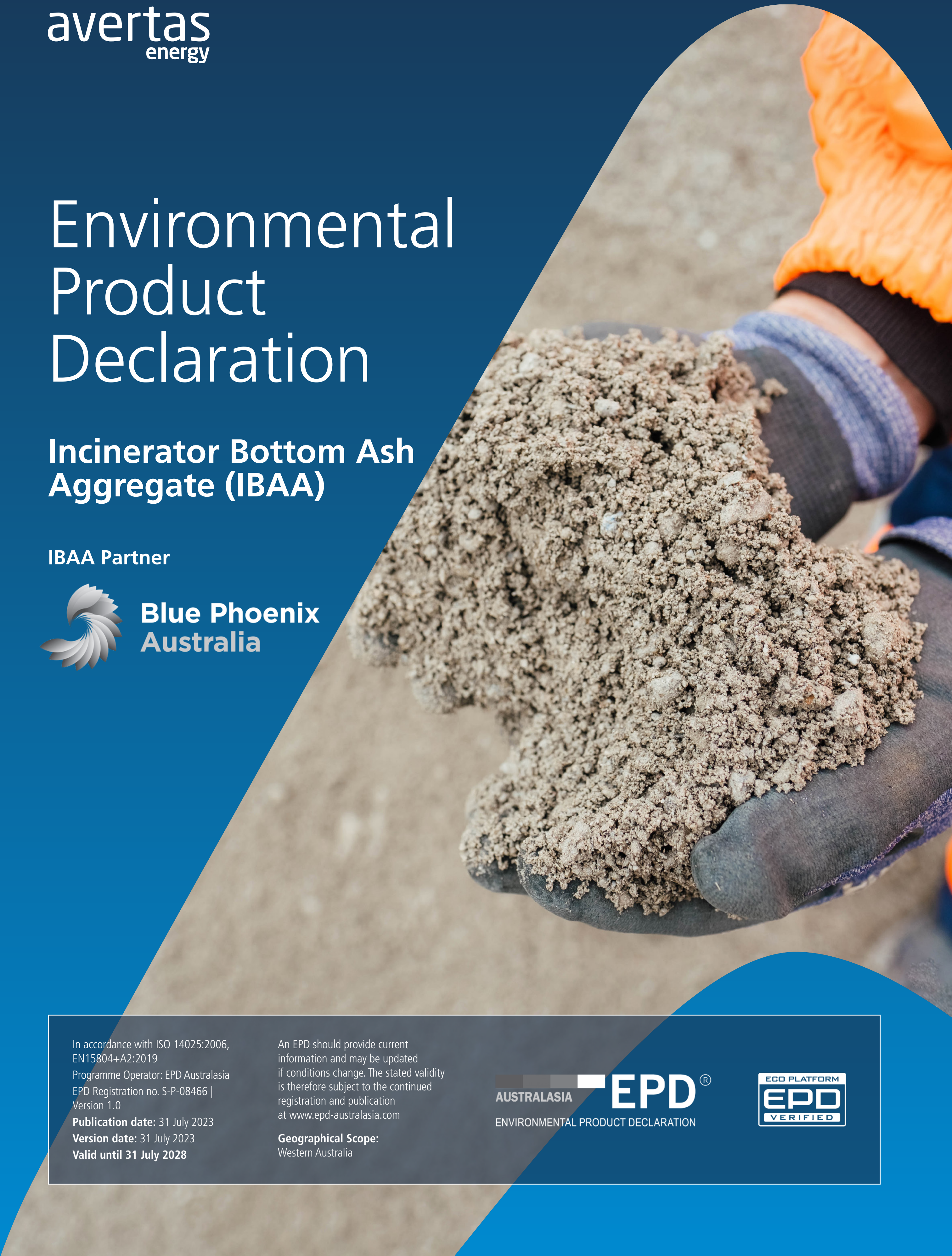
avertas energy

Environmental Product Declaration

Incinerator Bottom Ash Aggregate (IBAA)

IBAA Partner

Blue Phoenix Australia



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Geographical Scope:
Western Australia

AUSTRALASIA EPD®
ENVIRONMENTAL PRODUCT DECLARATION

ECO PLATFORM EPD VERIFIED

1. Programme Information and Verification

An Environmental Product Declaration (EPD) is a standardised way of quantifying the potential environmental impacts of a product or system. EPDs are produced according to a consistent set of rules – Product Category Rules (PCR) – that define the requirements within a given product category. These rules are a key part of ISO 14025 as they enable transparency and comparability between EPDs. This EPD provides environmental indicators for Incinerator Bottom Ash Aggregate (IBAA) produced from recovered materials from Avertas' Waste-to-Energy (WtE) plant in Kwinana, Western Australia. This scope of this EPD is cradle-to-gate with modules C1–C4 and module D.

This EPD is verified to be compliant with EN 15804+A2. EPDs of construction products may not be comparable if they do not comply with EN15804. EPDs within the same product category but from different programs or utilising different standards or PCRs may not be comparable. For further information about comparability, see EN 15804 and ISO 14025.

Avertas Energy, as the EPD owner, has the sole ownership, liability, and responsibility for the EPD.

Declaration Owner

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CEN standard EN 15804:2012+A2:2019 served as the core PCR	
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PCR review was conducted by:	The Technical Committee of the International EPD® System. Chair: Claudia A. Peña Contact via info@environdec.com
Independent verification of the declaration and data, according to ISO 14025:	◯ EPD process certification (Internal) ☑ EPD verification (External)
Procedure for follow-up of data during EPD validity involves third-party verifier:	◯ Yes ☑ No

2. Introduction

2.1. Avertas

Kwinana WTE Project Co Pty Ltd, trading as Avertas Energy, is located in the heart of the Kwinana Industrial area, south of Perth, Western Australia, and uses world-class technologies to process up to 460,000 tonnes per year of residual (post recycling) waste, significantly reducing CO_2 emissions and delivering 38MW of baseload electricity to the grid (CEFC 2018).

It is the first large scale facility in Australia to integrate recovery and recycling of waste with generation of energy to deliver baseload power. And these outcomes are the equivalent of taking 85,000 cars off Perth's roads and powering 52,000 Perth households every year (CEFC 2018).

Avertas Energy receives household waste that would otherwise be sent to landfill, occupying valuable productive land and producing a range of harmful greenhouse gases.

Avertas Energy uses tried and tested moving grate combustion technology already operational in more than 2,000 similar waste-to-energy facilities around the world.

Avertas Energy believes waste-to-energy (WtE) can act as an essential and integral part of a larger urban waste management strategies and systems, as the process of Recovery complements the 3Rs (Reduce, Reuse & Recycling) that underpin most modern waste management strategies.

Avertas Energy will not only process residential waste for energy recovery it will also produce Incinerator Bottom Ash (IBA), the source material for IBAA, and recover over 6,000 tonnes per year of recyclable metals not normally recovered by other means.

To recover the IBAA, an aggregate by-product which is used as a construction material, Avertas Energy partnered with Blue Phoenix Australia, who have built a bespoke IBAA recovery facility located in Hope Valley, Western Australia, 2.4km from Avertas Energy's WtE plant.

2.2. Blue Phoenix

The Blue Phoenix group operates IBA processing installations globally and helps the WtE sector with an alternative sustainable solution for their bottom ash. Blue Phoenix group has a history of developing customised new IBA processing sites, to assure the right solution for the situation.

Processing the IBA involves recovering Non-Ferrous and Ferrous Metals from the ash and removing any unburnt plastics, wood and paper to create a sustainable source of aggregate (IBAA) for use in many construction applications.

As the world's largest ash processor, Blue Phoenix Group achieves operational excellence through proven processes, professional teams and the highest commitment to health, safety and the environment.

With over 20 years' experience of processing and handling IBAA the company knows that IBA Aggregate, as an alternative Manufactured Aggregate, is a valuable resource, suitable for many construction applications.

A future in which waste-to-energy plants are fully circular

At Blue Phoenix Group we strongly believe there is no such thing as waste. With our passionate team we work globally to help waste-to-energy companies recycling the seemingly unrecyclable. We are not alone on our mission and join forces where we can. We work closely together with plant operators, governmental policy makers and regulators, visionary engineers and scientists. Together we can contribute to a more sustainable world.

We are Blue Phoenix Group building a sustainable future.

3. IBAA

3.1. Product

IBAA is the extracted aggregate from IBA that is a by-product of the WtE process that forms a key component of large urban waste management strategies and systems.

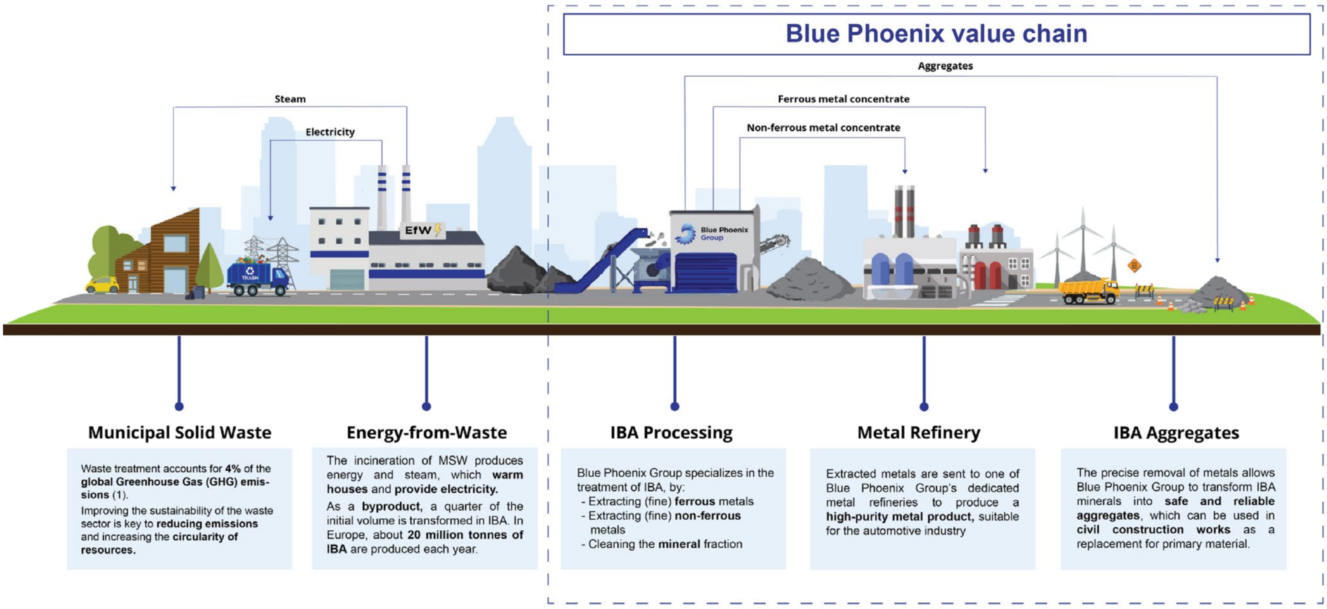


Figure 1: Steps in the production of IBAA (Source: Blue Phoenix Group)

The raw IBA material is delivered to the Blue Phoenix facility and placed in windrows within a concrete walled storage bunker with each windrow accommodating one week's supply of IBA.

Acceptance testing is undertaken in a NATA certified laboratory with IBA which fails to meet the assessment criteria placed in a separate quarantine bunker to be returned to the supplier for further treatment or disposal.

IBA material meeting the acceptance criteria is progressively treated in the bespoke processing facility. The process includes a range of techniques including:

- Screening to classify the material into various size fractions.
- Magnetic and eddy-current separation processes to separate ferrous and non-ferrous metals.
- Gravimetric separation to separate light fractions (e.g., plastics and timber) based on densities which are present in very small quantities.

The recovered IBAA is stockpiled in a dedicated storage area pending transport off-site for use as construction materials.

Ferrous and non-ferrous metals are temporarily stored in dedicated storage areas adjacent to process plant pending transport off-site for recycling.

Figure 2: IBA Processing Facility Overview

Figure 3: IBA (on the left) to IBAA (on the right)

The IBAA produced in the Blue Phoenix facility is intended to be used for a variety of applications, including:

- Road and paving crushed sub-base
- Concrete aggregate – non-structural
- Drainage aggregate
- Aggregate for reconstituted blocks – noise walls and retaining walls
- General Fill – embankments and foundations
- Other – depending on further testing and service history.

Aggregates including IBAA are classified under:

- UN CPC 39320–Ash and residue (except from the manufacture of iron or steel), containing metals or metallic compounds, except precious metals, and
- ANZSIC 2922 (Waste remediation and materials recovery services).

While classified under UN CPC 39320 IBAA goes through extensive processing for the extraction of metals, metallic compounds and precious metals.

Figure 4: Typical Uses of IBAA

3.2. Location

IBA is sourced from Avertas Energy's WtE facility in Leith Road, Kwinana and processed to extract IBAA at Blue Phoenix's IBA processing facility in Investigator Drive, Hope Valley.

This EPD covers the production of IBAA at Blue Phoenix's facility.

Figure 5: Location of Avertas WtE plant and Blue Phoenix IBA processing facilities

Figure 6: IBAA

3.3. Declared unit

1 tonne of incinerator bottom ash aggregate (in bulk)

3.4. Product composition

Table 1: Product composition, per declared unit

Product components	Mass, kg	Post-consumer material, mass-%	Renewable material, mass-%
Incinerator Bottom Ash Aggregate	1,000	0%	0%
TOTAL	1,000	0%	0%

The information contained in this EPD applies to bulk products (i.e. no packaging is used) from a specific location (i.e. no averaging across products or locations).

IBAA may contain small amounts of biogenic carbon. This EPD currently assumes no biogenic carbon is present and this assumption will be tested when 12 months of data for IBAA production sourced from the Kwinana Waste to Energy (KWtE) facility is available.

The products included in this EPD vary in chemical composition, based on the composition of the waste that goes into the waste-to-energy plant from which the bottom ash originates. IBAA may contain substances of very high concern as defined by European REACH regulation in concentrations >0.1% (m/m). Specifically, Lead Monoxide (CAS 1317-36-8)–a substance of concern that needs to be declared–can be present in a percentage up to 1.5%.

The operators will monitor the chemical composition of IBAA to ensure it meets relevant regulations and requirements through the life of the facility.

3.5. Technical Compliance

There is no current Australian Standard (AS) for IBAA, as the KWtE facility is the first one of its kind in Australia.

Avertas commissioned Golder to prepare a geotechnical assessment (Golder 2022) of IBAA, which was consulted for the preparation of the LCA. The assessment considered suitability of IBAA for use as sub-base material in road construction. The tested materials for this report were imported from the United Kingdom, for comparison with the following Western Australian Specifications:

- IPWEA/WALGA Specification for the supply of recycled road base (Class 1 and Class 2 Specifications).
- Main Roads Western Australia, Specification 501: Pavements – Crushed Recycled Concrete (CRC) Specification.

IBA/IBAA with similar properties as the imported material is expected to be extracted at the Kwinana Waste to Energy facility.

The Golder report states that IBAA can be used as sub-base material in granular pavements and below full depth asphalt pavements, but also as a basecourse in low to moderate traffic applications, if specific requirements are addressed (e.g. limited presence of foreign materials).

The WtE and IBA facilities both operate under the ISO 9001 and 14001 approved management systems.

4. Scope of the Environmental Product Declaration

This EPD covers the cradle-to-gate life cycle stages (modules A1-A3), end-of-life (C1-C4) and reuse/recovery/recycling potential (D). Information on downstream performance can be found in for example EPDs of roads. The modules declared, geographical scope, share of specific data (in GWP-GHG indicator) and data variation are shown in Table 2.

Table 2: Scope of EPD

	Product stage			Construction process stage		Use stage							End of life stage				Resource recovery stage
	Raw material supply	Transport	Manufacturing	Transport	Construction /installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction /demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
Module	**A1**	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Modules declared	✓	✓	✓	ND	ND	ND	ND	ND	ND	ND	ND	ND	✓	✓	✓	✓	✓
Geography	AU	AU	AU	-	-	-	-	-	-	-	-	-	AU	AU	AU	AU	AU
Specific data used	>90%			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – products	not relevant			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – sites	not relevant			-	-	-	-	-	-	-	-	-	-	-	-	-	-

✓: Module is declared ND: Module is not declared

Raw material supply, Transportation and Manufacturing (A1-A3)

As previously stated, IBAA is a recovered material from the by-product of the waste to energy process. In order to define the start of the life cycle, we need to understand at which stage the studied material reaches the end-of-waste state, i.e. a point where it turns from waste to a usable or valuable product.

The life cycle of IBAA starts after the material has passed the end-of-waste state. This occurs after unburnt organic matter and metals have been extracted from the incinerator bottom ash. Therefore, the only processing that occurs within the A1-A3 system boundaries is the handling and stockpiling of IBAA.

End-of-life (C1-C4) and reuse/recovery/recycling potential

A primary application for IBAA is likely to be pavement sub-base. As sub-base is likely to be left in place and not replaced, this EPD assumes modules C1-C4 and D have an environmental impact of 0.

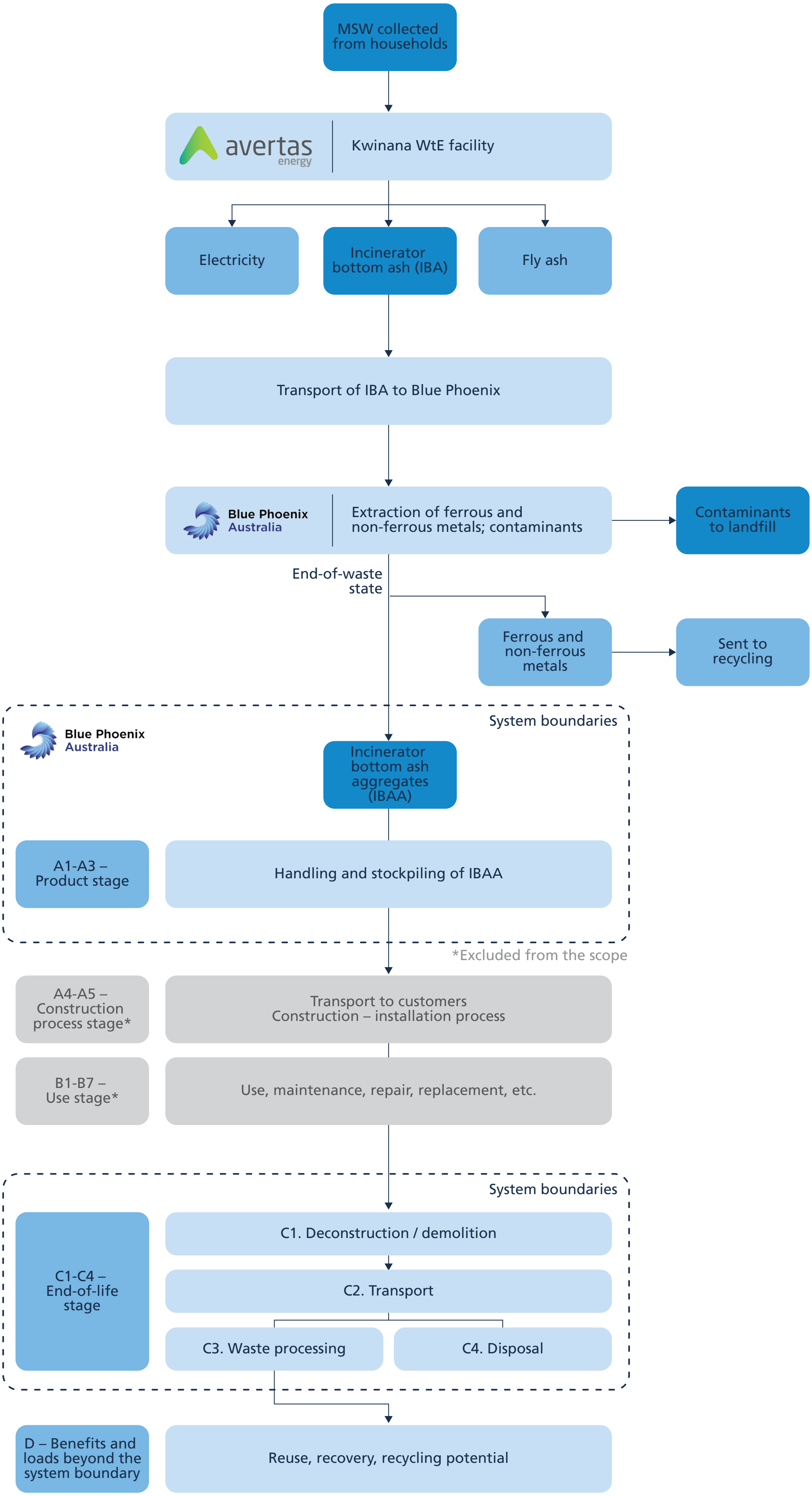


Figure 7: Life cycle of IBAA

5. Life Cycle Assessment (LCA) Methodology

5.1. Background Data

Blue Phoenix has provided estimated energy use (electricity; diesel) and water use for the processing plant included in this study. The data are averages from the batch testing undertaken during 2022 to assess expected plant outputs. Background data (e.g. for diesel use) have been sourced from AusLCI and the AusLCI shadow database (v1.36) (AusLCI 2021). Background data used are either less than 10 years old or have been reviewed within this period.

Methodological choices have been applied in line with EN 15804; deviations have been recorded.

5.2. Allocation

The key allocation choice for the LCA is the determination of the end-of-waste state for the material. This recycling allocation aspect determines which processes and thus environmental impacts are associated with the IBAA. The criteria for reaching the end-of-waste state are met when the unburnt organic matter and metals have been removed from the IBA and the remaining material (IBAA) is available as an aggregate product.

The consequence of the end-of-waste determination is that any of the processing up to that point is part of the previous life cycle, in line with the polluter-pays-principle. That leaves only diesel use for handling and storage of materials within the system boundaries. We have assumed that half of the diesel is used to handle the materials going into the plant, and half is used to handle the sorted material outputs. Conservatively, all diesel consumption attributed to the outputs has been allocated to the IBAA output.

5.3. Cut-off Criteria

The cut-off criteria applied are 1% of renewable and non-renewable primary energy usage and 1% of the total mass input of a process, while considering environmental impacts of small flows:

- Greases and lubricants used for maintenance of equipment have been excluded. The impact on the footprint of the IBAA products is expected to be negligible.
- The contribution of capital goods (production equipment and infrastructure) and personnel is excluded, as these processes are non-attributable and they contribute less than 10% to GWP-GHG.

5.4. Key Assumptions

The key choices and assumptions in the LCA are:

- The environmental performance for the IBAA is based on the determination that the material only reaches the end-of-waste state after IBAA has been formed.
- The IBA composition is based on four imported IBA batches used to undertake testing of the processing plant. The IBA composition has a minor effect on the LCA results in the current model.
- The energy use is based on measurements taken during processing of four imported IBA batches (400 tonnes in total) used to undertake testing of the processing plant. The diesel use currently drives the LCA results, so is important to validate when representative operational data are available.

6. Life Cycle Assessment (LCA) Results

The background LCA serves as the foundation for this EPD. An LCA analyses the environmental processes in the value chain of a product. It provides a comprehensive evaluation of all upstream (and sometimes downstream) material and energy inputs and outputs. The results are provided for a range of environmental impact categories, in line with EN5804:2012+A2:2019/AC:2021.

6.1. Environmental profiles for IBA aggregates

The cradle-to-gate (A1-A3) and end-of-life (C1-C4 and D) environmental profiles are expressed per tonne (1,000 kg) of bulk IBAA.

Mandatory indicators according to EN 15804:2012+A2:2019

Results per declared unit							
Indicator	**Unit**	**A1-A3**	**C1**	**C2**	**C3**	**C4**	**D**
GWPt	kg CO_2 eq.	1.25	0	0	0	0	0
GWPf	kg CO_2 eq.	1.25	0	0	0	0	0
GWPb	kg CO_2 eq.	1.25E-04	0	0	0	0	0
GWPluluc	kg CO_2 eq.	5.92E-07	0	0	0	0	0
ODP	kg CFC 11 eq.	1.98E-07	0	0	0	0	0
AP	mol H+ eq.	0.0137	0	0	0	0	0
EPfw	kg P eq.	1.79E-07	0	0	0	0	0
EPm	kg N eq.	5.93E-03	0	0	0	0	0
EPt	mol N eq.	0.0650	0	0	0	0	0
POCP	kg NMVOC eq.	0.0156	0	0	0	0	0
APDmm*	kg Sb eq.	1.46E-09	0	0	0	0	0
ADPf*	MJ	17.2	0	0	0	0	0
WDP*	m^3 world-eq. deprived	1.00	0	0	0	0	0

Acronyms
GWPt = Total Global Warming Potential (sum of GWP-fossil, GWP-biogenic, GWP-luluc)
GWPf = Global Warming Potential fossil fuels;
GWPb = Global Warming Potential biogenic;
GWPluluc = Global Warming Potential land use and land use change;
ODP = Depletion potential of the stratospheric ozone layer;
AP = Acidification potential, Accumulated Exceedance;
EPfw = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment;
EPm = Eutrophication potential, fraction of nutrients reaching marine end compartment
EPt = Eutrophication potential, Accumulated Exceedance;
POCP = Formation potential of tropospheric ozone;
APDmm = Abiotic depletion potential for non-fossil resources;
ADPf = Abiotic depletion for fossil resources potential;
WDP = Water (user) deprivation potential, deprivation-weighted water consumption

* Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties of these results are high or as there is limited experience with the indicator.

Additional indicators according to EN 15804:2012+A2:2019

Results per declared unit							
Indicator	**Unit**	**Total A1-A3**	**C1**	**C2**	**C3**	**C4**	**D**
PM	disease incidence	3.61E-07	0	0	0	0	0
IRP**	kBq U235 equivalent	2.52E-05	0	0	0	0	0
ETP-fw*	CTUe	4.96	0	0	0	0	0
HTP-c*	CTUh	6.18E-11	0	0	0	0	0
HTP-nc*	CTUh	5.71E-09	0	0	0	0	0
SQP*	-	0.0806	0	0	0	0	0

Acronyms
PM = Particulate matter emissions;
IRP = Ionising radiation, human health;
ETP-fw = Ecotoxicity, freshwater;
HTP-c = Human toxicity, cancer effects;
HTP-nc = Human toxicity, non-cancer effects;
SQP = Land use related impacts / soil quality

* Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties of these results are high or as there is limited experience with the indicator.

** Disclaimer: This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.

Use of Resources

Results per declared unit							
Parameter	**Unit**	**A1-A3**	**C1**	**C2**	**C3**	**C4**	**D**
PERE	MJ	0.0236	0	0	0	0	0
PERM	MJ	0.00	0	0	0	0	0
PERT	MJ	0.0236	0	0	0	0	0
PENRE	MJ	18.2	0	0	0	0	0
PENRM	MJ	0.00	0	0	0	0	0
PENRT	MJ	18.2	0	0	0	0	0
SM	kg	1000	0	0	0	0	0
RSF	MJ	0.00	0	0	0	0	0
NRSF	MJ	0.00	0	0	0	0	0
FW	m^3	2.51E-03	0	0	0	0	0

Acronyms
PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials;
PERM = Use of renewable primary energy resources used as raw materials;
PERT = Total use of renewable primary energy resources;
PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials;
PENRM = Use of non-renewable primary energy resources used as raw materials;
PENRT = Total use of non-renewable primary energy re-sources;
SM = Use of secondary material;
RSF = Use of renewable secondary fuels;
NRSF = Use of non-renewable secondary fuels;
FW = Use of net fresh water

Waste production

Results per declared unit							
Parameter	**Unit**	**A1-A3**	**C1**	**C2**	**C3**	**C4**	**D**
HWD	kg	0.00	0	0	0	0	0
NHWD	kg	1.76E-04	0	0	0	0	0
RWD	kg	0.00	0	0	0	0	0

Acronyms
HWD = Hazardous waste disposed;
NHWD = Non-hazardous waste disposed;
RWD = Radioactive waste disposed

Output flows

Results per declared unit							
Parameter	**Unit**	**A1-A3**	**C1**	**C2**	**C3**	**C4**	**D**
CRU	kg	0.00	0	0	0	0	0
MFR	kg	0.00	0	0	0	0	0
MER	kg	0.00	0	0	0	0	0
EE	MJ	0.00	0	0	0	0	0

Acronyms
CRU = Components for re-use;
MFR = Material for recycling;
MER = Materials for energy recovery;
EEE = Exported energy, electricity and thermal

We are also providing EN 15804:2012+A1:2013 compliant results (see table below) to assist our customers who want to use this EPD in tools, such as the Green Building Council of Australia's Green Star Tool and the Infrastructure Sustainability Council's Sustainability Rating Tool that are currently based on this method.

Indicators according to EN 15804:2012+A1:2013

Results per declared unit		
Indicator	**Unit**	**A1-A3**
(EN 15804+A1) GWP	kg CO_2 eq	1.24
(EN 15804+A1) ODP	kg CFC11 eq	1.56E-07
(EN 15804+A1) AP	kg SO_2 eq	9.67E-03
(EN 15804+A1) EP	kg PO_4^{3-} eq	1.99E-03
(EN 15804+A1) POCP	kg C_2H_4 eq	1.14E-03
(EN 15804+A1) ADPE	kg Sb eq	1.46E-09
(EN 15804+A1) ADPF	MJ (NCV)	16.8

Acronyms
GWP = Global Warming Potential
ODP = Depletion potential of the stratospheric ozone layer
AP = Acidification potential
EP = Eutrophication potential
POCP = Formation potential of tropospheric ozone
ADPE = Abiotic depletion potential for non-fossil resources
ADPF = Abiotic depletion potential for fossil resources

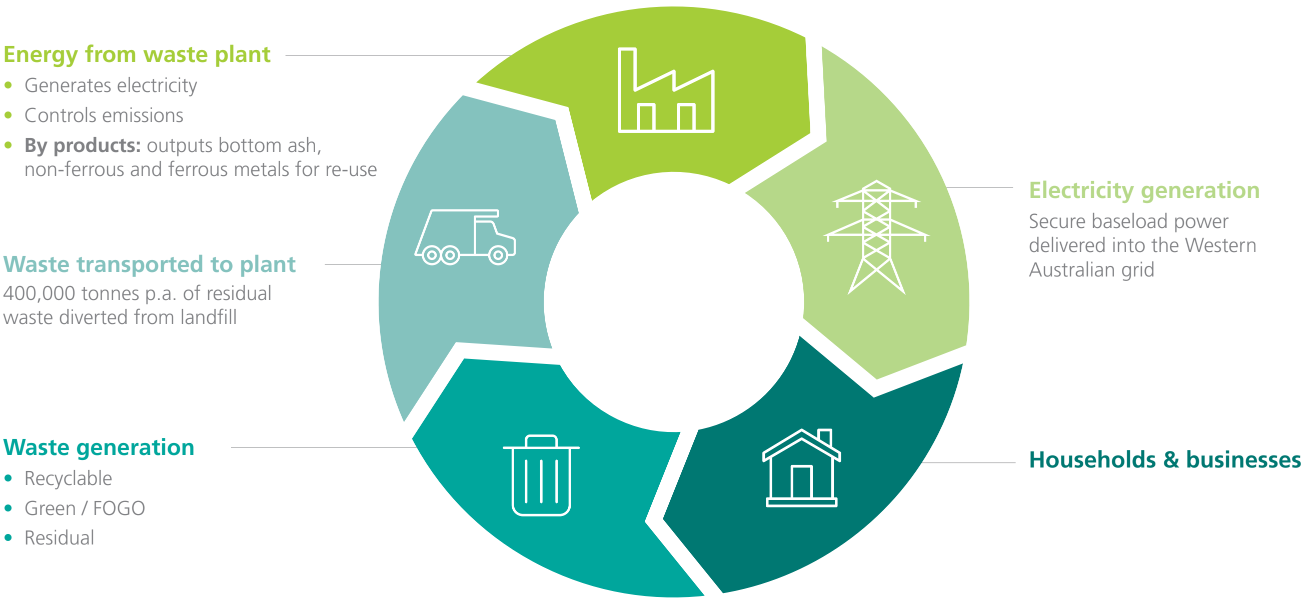
The GWP-GHG indicator (see table below) includes all greenhouse gases included in GWPt but excludes biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product as defined by IPCC AR 5 (IPCC 2013). This indicator is determined using the IPCC AR5 Global Warming Potentials (GWP) with a 100-year time horizon. The GWP-GHG indicator is aligned with current Australian climate change reporting frameworks, and therefore it is the indicator our clients are most likely to use.

Carbon footprint in line with Australian climate change reporting frameworks

Results per declared unit							
Indicator	**Unit**	**Total A1-A3**	**C1**	**C2**	**C3**	**C4**	**D**
GWP-GHG	kg CO_2 eq	1.24	0	0	0	0	0

7. Additional Information

Avertas Energy fulfils a key role in the circular economy. It provides a practical solution to two community challenges – waste disposal and renewable energy supply – see diagram below.



Our organisation is backed by global experience in renewable energy solutions coupled with the facility's environmental credentials of:

- Diverting waste from landfill
- Emissions measured continuously and independently and reported half hourly, hourly and daily
- Net reduction of greenhouse gases compared to Municipal Solid Waste going to landfill and conventional generation of electricity

For more information, please visit https://avertas.com.au/

8. References

Reference	Description
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