AusLCI database manual

Version 1.40

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Version	Date	Author/ Contributor	Comment
1.0	21st November 2014	Timothy Grant	First official release document
1.1	4th March 2015	Rob Rouwette, Suphunnika Ibbotson and Tim Grant	Edit of original document
1.2	4th August 2015	Bharat Sharma and Tim Grant	Added concrete processes
1.3	20th April 2016	Tim Grant	Added Asphalt and geopolymer data
1.26	30th September 2016	Tim Grant	Corrections to Ecoinvent documented. Report numbering changed to match database numbering
1,27	05 May 2017	Timothy Grant	Minor fixes to waste treatment landfill processes
2.27	24th March 2017	Paul-Antoine Bontinck	Update of the shadow database to ecoinvent 3.3
X.28	March 2019	Timothy Grant	400 new agriculture processes Updated electricity, warm asphalt
X.29	19th June 2019	Timothy Grant	Recalibrate electricity processes to be NGA compliant
X.30	16th Sept 2019	Timothy Grant	Diesel and Natural Gas Energy processes added based on NGGI and NPI workbooks
X.31	10 Dec 2019	Timothy Grant	Future electricity grids and NGA compliant natural gas energy processes added.
X.32	18th May 2020	Timothy Grant	232 processes for Australian cattle added including prime beef, culled beef and weaners.
X.33	23rd June 2020	Timothy Grant	Corrected nitrogen balance in broad acre cropping which over estimated N requirements
x.34	26th September 2020	Timothy Grant	Corrected phosphate emission formulae in broad acre crops.
x.35	17th November 2020	Jeremy Macdonald Grant	Corrected heavy metal parameter formulae. Calibrated natural gas supply and electricity generation to 2020 NGA factors.
x.36	26th March 2021	Timothy Grant	Updates and corrections for asphalt data
X.37	16th October 2021	Jeremy Macdonald Grant	Updated electricity to NGA factors results.

X.38	20th May 2022	Timothy Grant	Minor correction to beef inventory data. Fix to incorrect transport unit in waste tyre input to electricity.
X.39	23rd luly 2022	Tim Grant Jeremy Macdonald Grant	Silica and silica fume production added. Changes to adjustment approach for electricity inventories being aligned to AusLCI – for South Australia used to be based on changes to efficiency of gas generation – change now to mix between gas and wind to achieve NGA factor alignment.
X.40	21 October 2022	Tim Grant and Hayder Rocha	Updates to electricity models to improve balancing to achieve NGA factor compliance. Shifting proportion of renewables V major non renewable to align mix rather than the efficiency of largest generation source (which was done previously).

Table of Contents

1 Introduction

1.1 Purpose of this document

The purpose of this document is to provide information to users of the database. It will describe the source of data and methodology behind the development of the datasets contained in AusLCI. It also contains a description of how gaps in the AusLCI database have been filled with a shadow database developed from ecoinvent data.

1.2 AusLCI project

The Australian National Life Cycle Inventory Database (AusLCI) is a major initiative delivered by the Australian Life Cycle Assessment Society (ALCAS). The aim is to provide and maintain a national, publicly accessible database with easy access to authoritative, comprehensive and transparent environmental information on a wide range of Australian products and services, covering a range of life cycle stages. It is an invaluable tool for those involved in environmental assessment and particularly life cycle assessment (LCA), as it provides consistent guidelines, principles and methodologies for the collection of life cycle inventory (LCI) data, along with protocols for LCA processes for different sectors.

The project has brought together stakeholders from industry, government and academia to develop a methodology to standardise the interpretation of ISO 14040 in Australia. The LCI database enables suppliers to use LCA to reduce environmental impacts and to appropriately promote the environmental attributes of their products and services to their clients and stakeholders.

The initiative delivers substantial benefits to manufacturers and retailers, who may be able to use it to demonstrate product credentials and increase sales, provide enhanced disclosure to consumers and obtain market advantage for individual products over competitors.

The database also provides a consistent source of information to support and provide benchmarks for eco-labelling and environmental product declarations (EPDs), and underpin the development of LCA-based policies and design tools for buildings and infrastructure.

AusLCI assists with:

- setting metrics and processes for comparing the environmental impact of products and services
- levelling the playing field for LCA-based product comparison
- fostering innovation in design and manufacturing
- promoting education and consensus-building processes
- providing LCA processes that can integrate with existing environmental tools and applications.

It enables industry users to:

- benchmark process and product performance against industry standards
- make informed decisions in driving process efficiencies, new purchases, furthering environmental goals and quantifying impacts
- proactively assess, mitigate and quantify the effort required to offset CO_2 emissions
- demonstrate product credentials and increase sales

- provide enhanced disclosure to consumers and the ability to respond to public criticism of products
- obtain market advantage in the anticipated low impacts and carbon sequestering benefits for individual products over competitors.

It enables governments to:

- guide policy direction and promote sustainable practices within the Australian economy
- provide a strong platform for funding, education, policy-making and legislation
- assist in decision-making, such as analysis of investment or purchasing decisions
- provide enhanced educational resources.

1.3   AusLCI data collection, review and publication process

The AusLCI data collection, review and publication process has been broken down into seven stages, as shown in Figure 1 overleaf and described below.

1. Different organisations and companies (data owner or data supplier) contribute data for a variety of reasons. Sometimes the company that produces the material or service develops the data, but third parties also develop data for other purposes. AusLCI has been structured to utilise data from a variety of initial sources.

2. All data submitted to AusLCI is expected to be reviewed for technical quality prior to submission. This may be a formal peer review or can be other types of review, for instance via journal publication.

3. Data is then submitted to the ALCAS AusLCI Database Committee to consider for inclusion in the AusLCI database. Information provided is checked against the ALCAS document *"Requirements for the Development of AusLCI Data sets".* If the information provided does not meet the requirements, the data owner will be advised of the identified concerns.

4. If the data meets the requirements, the ALCAS AusLCI database manager then works with the data owner to connect their data to relevant upstream processes (and where relevant to determine average industry data for that sector).

5. The ALCAS AusLCI Database Committee formally seeks approval from the data owner for publishing.

6. The data is published in the AusLCI national database.

7. It is expected that software suppliers continue to integrate AusLCI data into their tools, providing integrated unit process view of the data.
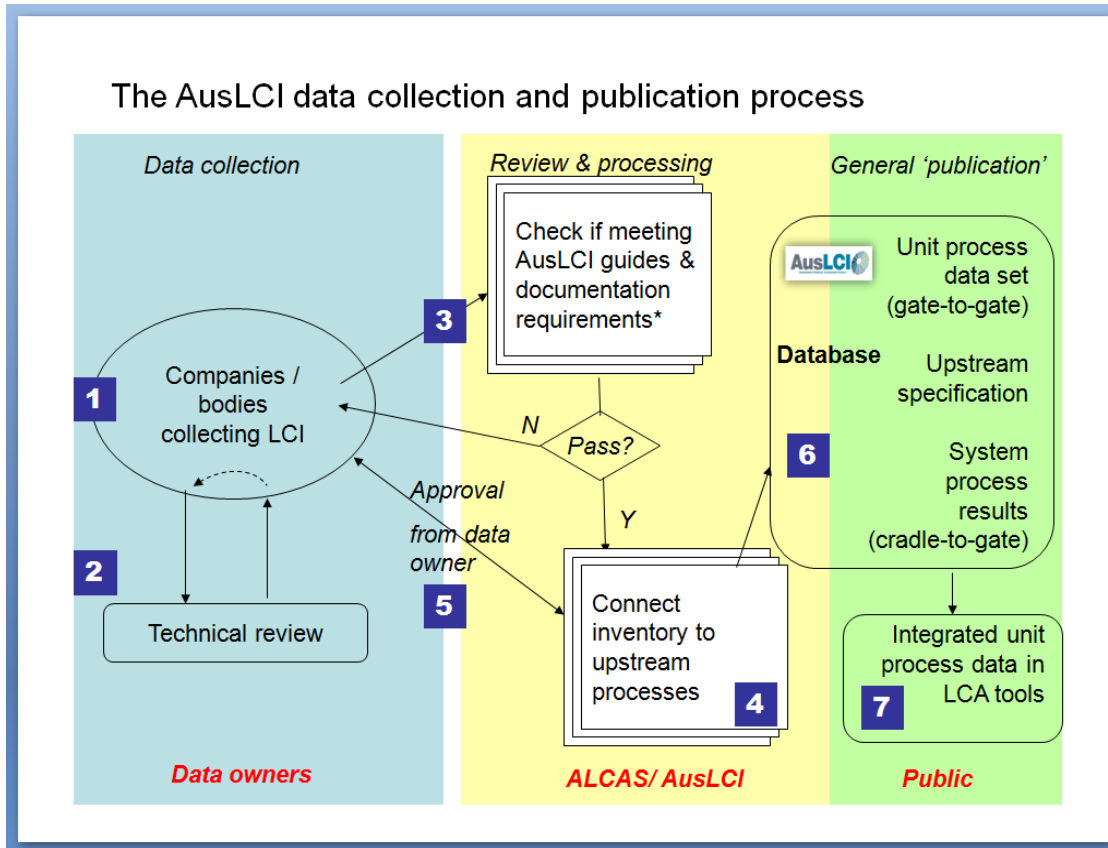
Figure 1: Summary process/flowchart for AusLCI data publication

1.4 Structure of the AusLCI database

The AusLCI database is effectively one fully connected unit process database made of four different types of data:

1. Submitted and verified AusLCI unit processes – This is referred to as AusLCI data, which are published on the AusLCI website.

2. Unit processes from the "shadow database". The shadow database is a modified version of an international LCI database – ecoinvent (currently version 3.3) – into which key background processes (e.g. energy and transport) have been substituted with Australian data. To produce the shadow database, each unique process is duplicated – meaning that when ecoinvent cover several geographies for one process, only one is duplicated (in most case 'GLO' or 'RoW'). This creates a self-sufficient 'regionalised' database, which uses about 7,300 of the 16,000 processes currently available in ecoinvent 3.3. The two databases are then linked by replacing ecoinvent processes with Australian data. Currently, 75 of the 7,300 regionalised processes are replaced. Readers are referred to **Error! Reference source not found.** for a list detailing correspondence between ecoinvent and AusLCI processes used. While this represent a very small proportion of the ecoinvent database, it includes crucial processes such as electricity, fuels and transport.

3. External data sources that are used either because they represent the most appropriate supply, for example overseas product supply – vinyl chloride monomer from the United States into

Australian PVC production, or because they are considered the best approximation for Australian supply. Any missing upstream processes for this data are taken from AusLCI or the shadow database.

4. Unreviewed supporting processes used for minor flows. Where a process contributes less than 5% of the environmental significance of a verified AusLCI process, the flow can be estimated with an unreviewed AusLCI process.

Shadow data, external data and unreviewed data are designed to be temporary, with the expectation that they will gradually be replaced as stakeholders submit more verified AusLCI data, driving an inherent continuous improvement procedure.

1.5   Constructing the AusLCI database

AusLCI data comes in different forms, covering different parts of the supply chain, because some organisations only have access to their own production data, while others may control or have studied the full supply chain. Thus, the database must be flexible enough to accommodate different level of complexity in the data provided. Figure 2 depicts different level of connections between unit processes, and shows variation in the level of complexity of the datasets. In some case, almost complete supply chains can be captured – for instance in the case of electricity. There, the only missing flows would generally be capital equipment, for instance the physical power plant construction. In other case a single supply chain is provided, but data for a significant number of ancillary materials is also required, or even for one of the main input (for example, vinyl chloride monomer used in the production of PVC). For other materials, only a single unit process in available. This is for instance the case for polypropylene, where the data collected is only representative of the facilities under the control of the data provider.

Figure 3 demonstrates how upstream gaps in the database are filled with external data from the ecoinvent database. Existing AusLCI datasets are linked to a total of 275 individual ecoinvent processes. Developed in Switzerland, ecoinvent is the largest inventory database available with over 16,000 individual processes in its latest iteration. Although it started as a European database, it increasingly has a global scope, and thus include more and more global data (currently about 4,000 individual processes represent global average production processes).

Figure 4 shows the final step where AusLCI data are linked back into the ecoinvent database where appropriate. When this is done, the original input of the ecoinvent processes are deleted and the links are replaced by AusLCI data. Currently, there are about 75 linkages back into ecoinvent, including critical datasets such as electricity, fuels and transport. These are specified in **Error! Reference source not found.**. This is limited to ecoinvent dataset published as unit processes. Parts of the ecoinvent database is strictly available as system processes. This is for instance the case for the inventory for polycarbonate production. In these particular instances it won't be possible to produce a linkage with AusLCI and the output will not change from the original version of the data.

If data from other external databases are identified as a better fit for AusLCI inputs, these may be used instead of ecoinvent, with the underlying condition that their scope and boundary conditions are compatible with AusLCI database, as is shown in Figure 5.

Complex data sets where most of the supply chain has been collected – e.g. electricity supply
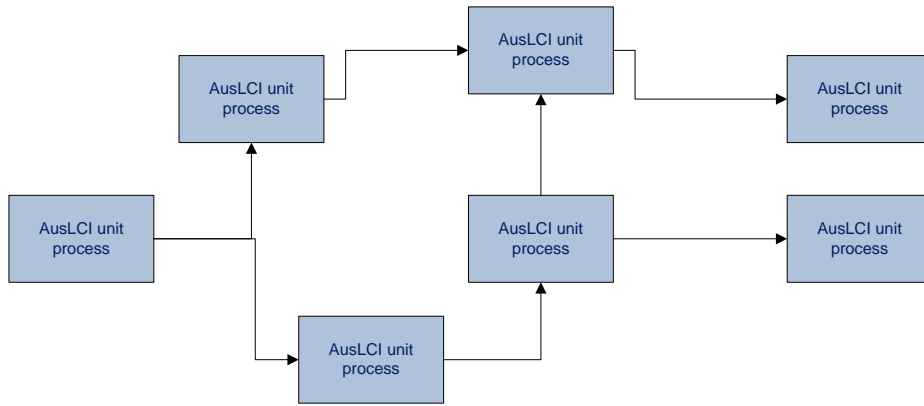
Simple data sets when one supply chain has been collected – e.g. PVC
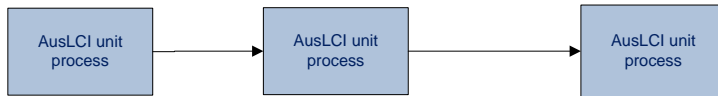
Single data sets where data is collected for one process – e.g. Polypropylene
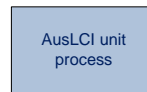

Figure 2: Different forms of AusLCI datasets
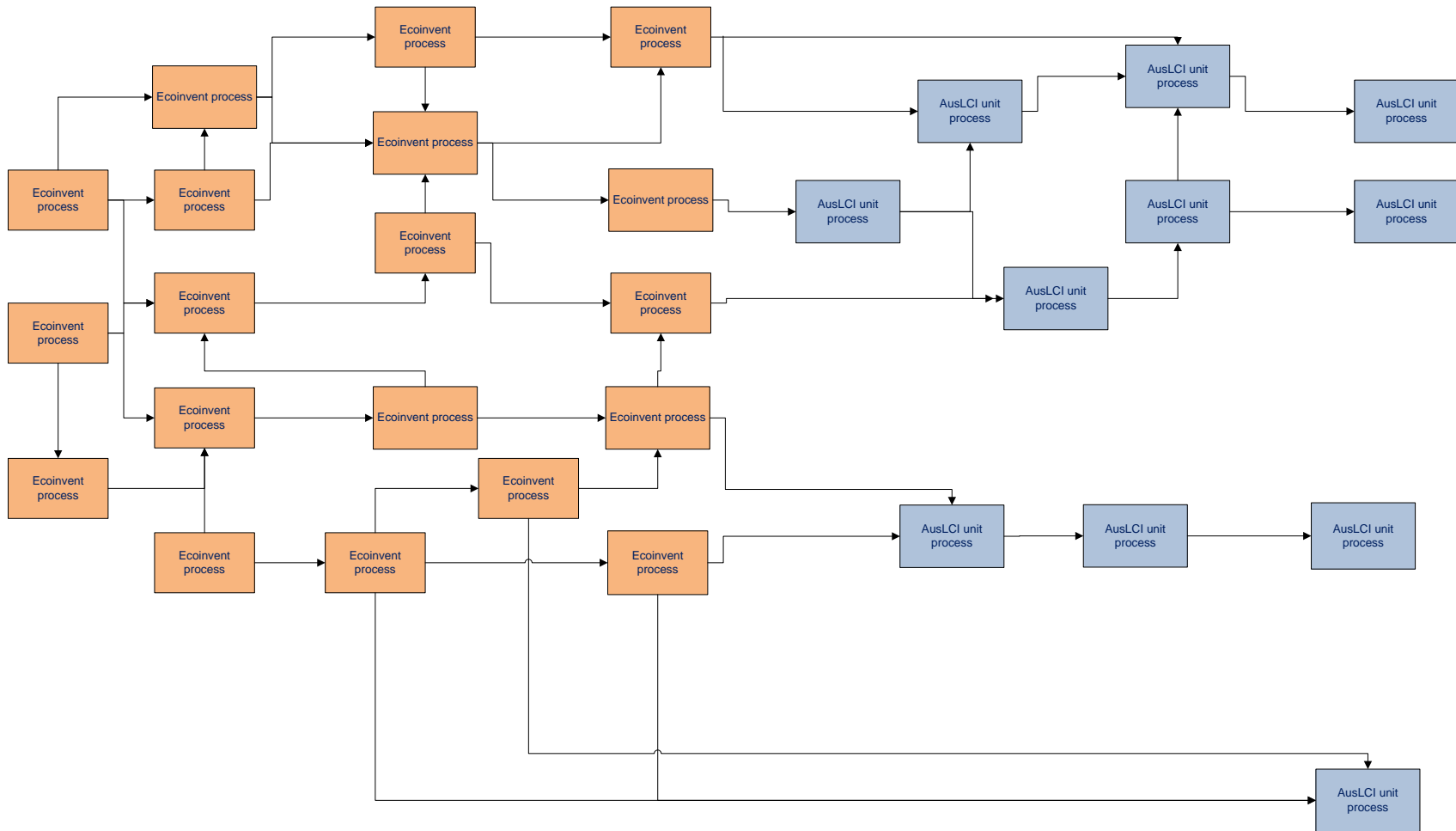
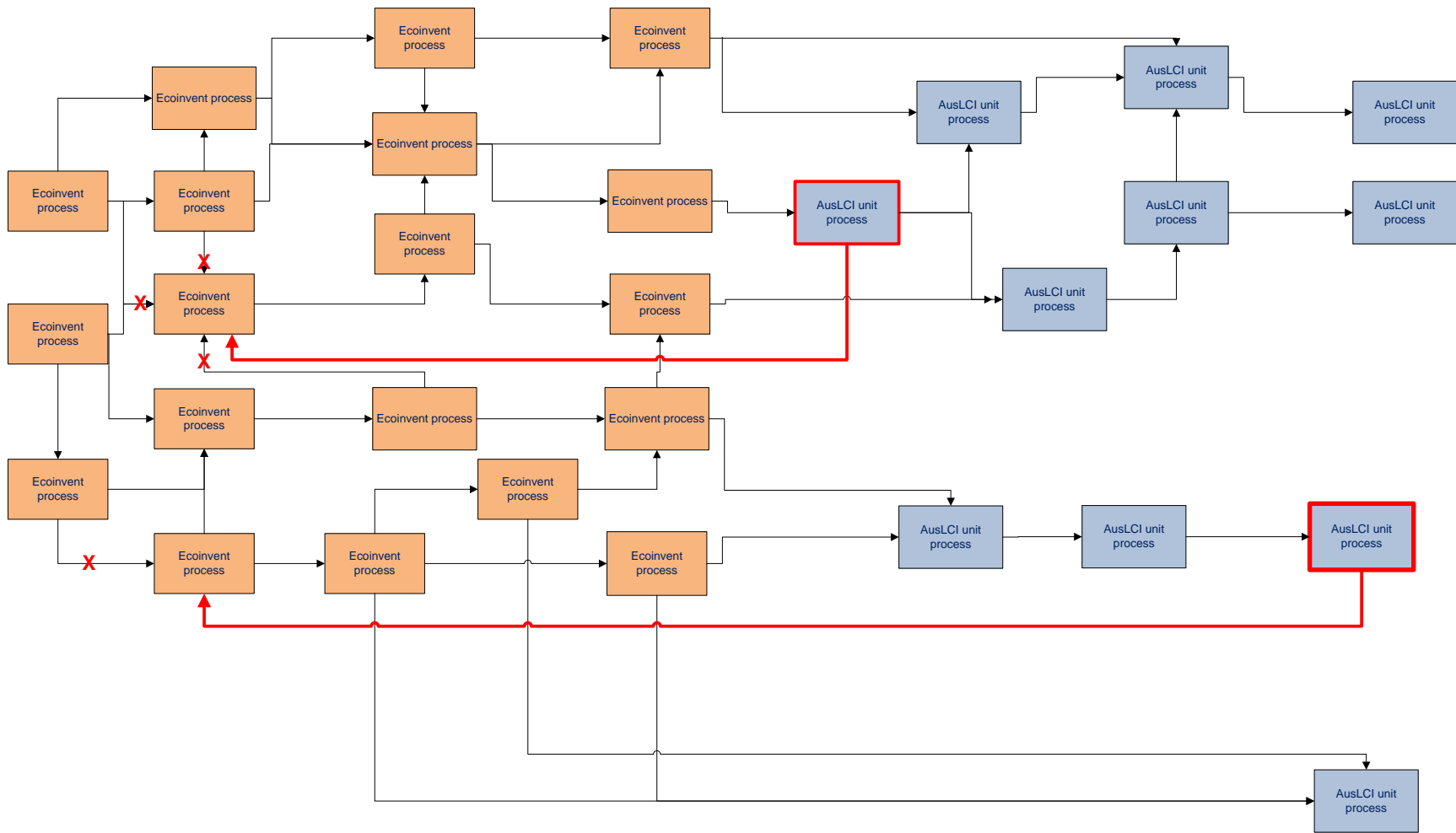**Figure 3: Ecoinvent (brown processes) is used to fill upstream gaps in AusLCI (Blue processes)**

Figure 4: The red arrows show how AusLCI is linked back into key processes in ecoinvent, which are unlinked from their original inputs (red crosses)
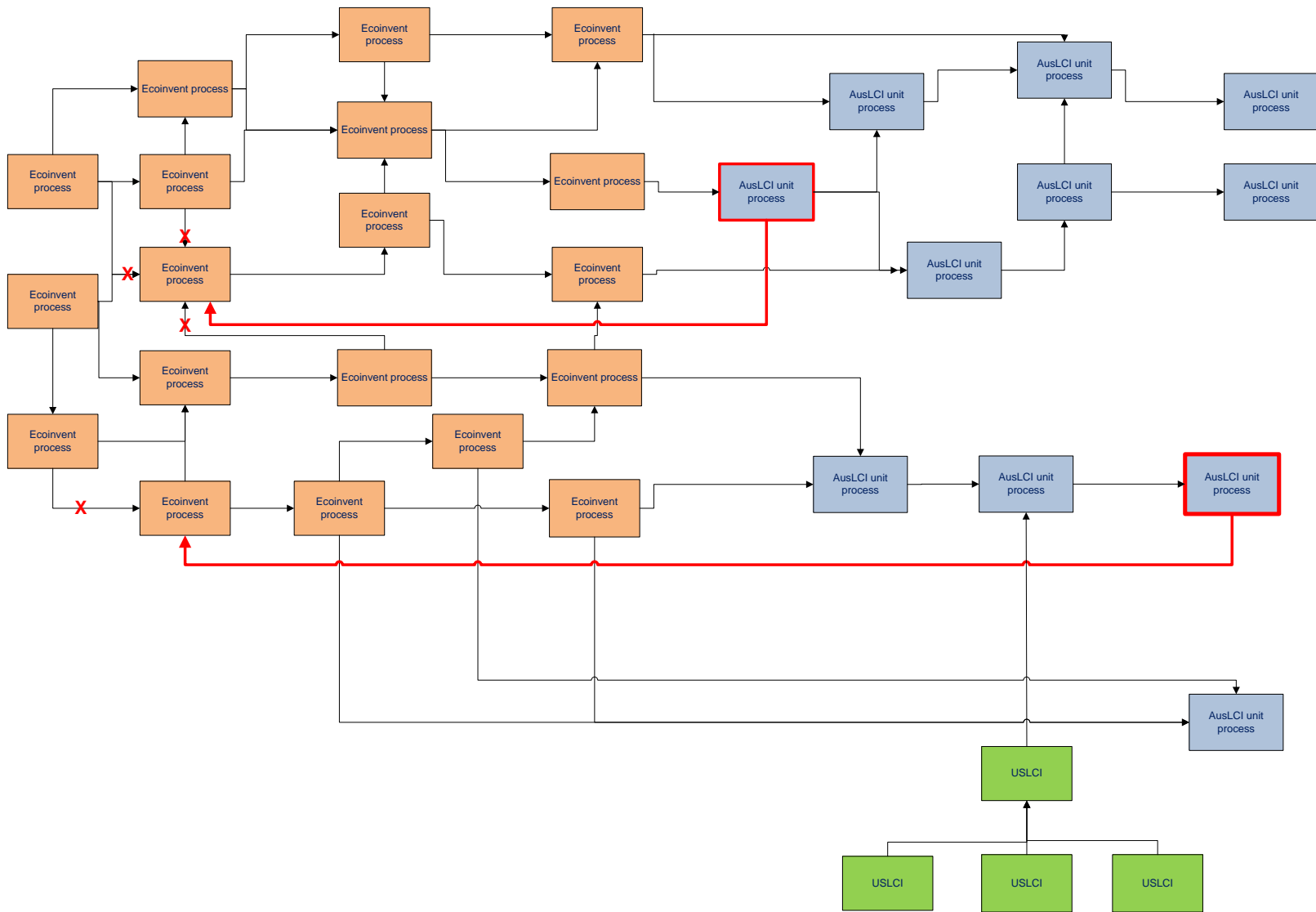
Figure 5: Other external databases (e.g. USLCI in green) may be used when they are more appropriate than ecoinvent

1.6 Publication of the AusLCI database

Only the first group of data outlined in the previous section are published under the AusLCI banner as:

- standalone unit process data

- system process (aggregated) results through calculation of elementary flows along the supply chain using data from the second and third categories.

Because the shadow database contains licensed datasets it cannot be published as such. However, a complete specification on how it is to be constructed (every alteration to the original datasets documented) is published. This allows licensed users to reconstruct it. External unmodified datasets will simply be referenced so that they can be linked to again by licensed users.

For users without access to these licensed databases, fully calculated, cradle to gate system process LCIs will be published providing the complete elementary flow LCI results but without the full disaggregation of the underlying unit process structure.

For transparency, the unreviewed AusLCI processes are published on the AusLCI website but are labelled as unreviewed AusLCI data.

This structure maintains usefulness for both professional and casual users while respecting data licensing rights.

The management of the AusLCI database and the shadow database is the responsibility of the AusLCI data manager under direction of the AusLCI Database Committee.

Data owners can update their data at any point and its suggested that data is check for currency every 5 years.

1.7 Attributional and consequential modelling

The data developed in a generic inventory are modelled based on an "attributional" approach, which seeks to establish the burdens associated with the production and use of a product, or with a specific service or process, at a point in time (typically in the recent past). The modules will not be developed as "consequential" LCAs, which seek to identify the environmental consequences of a decision or a proposed change in a system under study. However, through the development of disaggregated and transparent models, the data will support consequential LCA.

2 Summary of datasets

Below, in Table 1, is a brief description of the data sectors for the AusLCI dataset. Some data has separate reports, which describe the data collection and modelling, while other data have all the documentation embedded into the data format. A full list of unit processes in AusLCI is shown in Appendix A.

Table 1: Overview of data in AusLCI

Sector	
Agriculture	578
Transport	32
Energy	87
Fuels	58
Materials	91
Chemicals	60
Waste treatment	14
Total	379

2.1 Agricultural data

The agricultural datasets were developed as part of an AusAgLCI project. AusAgLCI was financially supported by industry via the Rural Industries Research and Development Corporation (RIRDC) in conjunction with the Cotton Research and Development Corporation (CRDC); Dairy Australia (DA); Grains Research and Development Corporation (GRDC); Forest and Wood Products Australia (FWPA); Horticulture Australia Limited (HAL); Meat and Livestock Australia (MLA); Sugar Research Australia (SRA); and project partners Department of Agriculture Fisheries and Forestry, Queensland (DAFF Qld); University of Southern Queensland (USQ); CSIRO; and Life Cycle Strategies Pty Ltd.

The agriculture methodology is documented in {Grant, 2019 #1323} and can be downloaded at https://www.lifecycles.com.au/_files/ugd/edab3d_6ff1435809194722babf67d3d7fd4322.pdf

Additional Agriculture data on maize production and the production of residues including bagasse, cotton seed and wheat straw were developed as part of a bio-based materials project undertaken by Life Cycle Strategies for ALCAS with funding from the commonwealth government. The report for this project is available at https://auslci.com.au/index.php/Biobased

2.2 Electricity data

Electricity data was developed based on the emission data reported (DIICCSRTE 2013) and using specific information on grid mixes from Electricity Gas Australia (Energy Supply Association Australia 2012). Other air and water pollution data were taken from the National Pollutant Inventory (Department of Environment and Heritage and Water 2011). Table 2 lists the datasets for electricity.

Table 2: Electricity datasets

Subcategory	Unit processes	Author	Documentation
High voltage	10	Life Cycle Strategies	Contained in processes
Low voltage	10	Life Cycle Strategies	Contained in processes
Electricity by fuel	17	Life Cycle Strategies	Contained in processes
Electricity mixes at generation	10	Life Cycle Strategies	Contained in processes

2.3 Fuels

Fuel data was developed for coal mine reports from selected Australian coal mines and from National Greenhouse Gas data (DIICCSRTE 2013). Natural gas inventories were developed using energy data from ABARE (ABARE 2011) and emissions data from (DIICCSRTE 2013). Biofuels data on ethanol was developed as part of a bio-based materials project and the report is available on the AusLCI website. Coal seam methane data was taken from a report by Worley Parsons (Clark, Hynes et al. 2011). Table 3 lists the datasets for fuel.

Table 3: Fuel datasets

Subcategory	Unit processes	Author	Documentation
Coal	6	Life Cycle Strategies	Contained in processes
Natural gas	21	Life Cycle Strategies	Contained in processes
Biofuels	8	Life Cycle Strategies	Contained in processes
Coal seam gas	1	Life Cycle Strategies	Contained in processes

2.4 Materials

Polypropylene and PVC data were developed by the manufacturing companies in Australia. An inventory report is available for PVC on the Australian Vinyls website http://vinyl.org.au/images/PVC_LCI/PVC_LCI_Reportv1_6.pdf. The timber data was developed as part of the bio-based materials project based on published data by CSIRO (England, May et al. 2013) and the report on the inventory is on the AusLCI website. The textile data is based on cotton and cotton linters and are part of the AusAgLCI project. The only mineral process currently is vermiculite, which is an unreviewed process used in agriculture inventories. Table 4 lists the datasets for materials.

Subcategory	Unit processes	Author	Documentation
Polypropylene	1	RMIT/ Lyondell Basel	Contained in processes
PVC	2	Australian vinyls	http://vinyl.org.au/images/PVC_LCI/PVC_LCI_Reportv1_6.pdf
Softwood	6	Life Cycle Strategies	http://www.alcas.asn.au/AusLCI/Documents/Timber_LCI_v1.pdf
Hardwood	6	Life Cycle Strategies	http://www.alcas.asn.au/AusLCI/Documents/Timber_LCI_v1.pdf
Textiles	2	AusAgLCI project	AusAgLCI methodology report
Minerals	1	AusAgLCI project	Unreviewed processes

2.5   Chemicals

The organic chemicals included in the database are starch production, starch waste and gluten from wheat, which are adapted unreviewed processes. The inorganic chemical is zinc oxide, which is also an unreviewed process used in fertiliser mixes in the agricultural inventories. Table 5 lists the datasets for chemicals.

Table 5: Datasets for chemicals

Subcategory	Unit processes	Author	Documentation
Organic	4	Life Cycle Strategies	Unreviewed processes
Inorganic	1	AusAgLCI project	Unreviewed processes

2.6   Waste treatment

Waste treatment processes are for organic waste treatment and are based on organic degradation models published in the National Greenhouse Gas Accounts (DIICCSRTE 2013) with supplementary data on landfill operation from waste treatment LCA studies (Grant, James et al. 2003). A report of this data is provided on the AusLCI website **http://www.alcas.asn.au/AusLCI/Documents/Landfill_LCI_V1.pdf**. Two recycling and waste collection processes are unreviewed processes used for metal recycling of agricultural infrastructure. The incineration is methane gas combustion, which is adapted from ecoinvent with assumptions from the National Greenhouse Gas Accounts (DIICCSRTE 2013). The three other processes are to do with land application of materials from the sugar industry as part of the AusAgLCI project. Table 6 lists the datasets for waste treatment.

Table 6: Waste treatment datasets

Subcategory	Unit processes	Author	Documentation
Incineration	9	Life Cycle Strategies	**http://www.alcas.asn.au/AusLCI/Documents/Landfill_LCI_V1.pdf**
Landfill	16	Life Cycle Strategies	**http://www.alcas.asn.au/AusLCI/Documents/Landfill_LCI_V1.pdf**
Others	3	AusAgLCI project	Part of AusAgLCI project
Recycling	2	Life Cycle Strategies	Unreviewed processes
Waste collection	2	Life Cycle Strategies	Unreviewed processes

2.7   Transport

Transport inventories on road, air and rail freight were developed based on National Transport Model data produced by Adam Pekol consulting (Adam Pekol Consulting Pty Ltd 2011) with emission data taken from ecoinvent and (DIICCSRTE 2013). Transport infrastructure was specifically developed for sugar cane transport, while infrastructure for all other transport is taken directly from the ecoinvent shadow

database. Given the international nature of shipping, Australian data were developed for general freight, however two inventories were developed for transport of vinyl chloride monomer as part of the PVC inventory because of the availability of primary data. Table 7 lists the datasets for transport.

Table 7: Transport datasets

Subcategory	Unit processes	Author	Documentation
Road	13	Life Cycle Strategies	Contained in processes
Infrastructure	4	Life Cycle Strategies	Contained in processes
Air	9	Life Cycle Strategies	Contained in processes
Water	2	Life Cycle Strategies	http://vinyl.org.au/images/PVC_LCI/PVC_LCI_Reportv1_6.pdf

2.8   Concrete

Concrete inventories have been developed based on data provided by Cement Industry Federation, Australia (CIF) and ecoinvent processes. The emissions have been adopted from National Pollutant Inventory database and ecoinvent wherever not available. Considerable amount of clinker is imported for making of cement therefore inventories have been developed keeping for cement made from domestic, imported and Australian average. The variation in transport modes and distance for the plants from mines have been considered. Concrete inventories have been modelled for various grades using cement quantity directly from BPIC. Table 8 lists the datasets for concrete.

Table 8: Concrete datasets

Subcategory	Unit processes	Author	Documentation
Concrete	15	Life Cycle Strategies	Concrete & Cement LCA report
Cement	6	Life Cycle Strategies	Concrete & Cement LCA report
Recycling	4	Life Cycle Strategies	Contained in processes
Others	11	Life Cycle Strategies	Contained in processes
Asphalt	6	Start-2-See	Contained in processes
Geopolymer	1	Start-2-See	Contained in processes

2.1 Water

Datasets on water supply have been developed by Lifecycles based on energy use data from CSIRO in 2002 Table 7 lists the datasets for transport.

Table 9: Transport datasets

Subcategory	Unit processes	Author	Documentation
State based	8	Life Cycle Strategies	Contained in processes
Catchment based	35	Life Cycle Strategies	Contained in processes

3 References

ABARE (2011). Energy in Australia 2011. Canberra ACT, ABARE, Australian Bureau of Agricultural Reseach Economics.

Adam Pekol Consulting Pty Ltd (2011). Australian Transport Facts 2011, Data tables.

CIF. "Cement Industry Federation website." Retrieved 14 March 2015, from http://www.cement.org.au/AustraliasCementIndustry/LocationofCementPlants.aspx.

Clark, T., R. Hynes, et al. (2011). Greenhouse Gas Emissions Study of Australian CSG to LNG, Worley Parsons.

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DIICCSRTE (2013). National Greenhouse Accounts Factors. Canberra, Department of Industry Innovation Climate Change Science Research and Tertiary Education, Commonwealth of Australia.

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Energy Supply Association Australia (2012). Energy Gas Australia 2012. Canberra, Energy Supply Association Australia.

England, J. R., B. May, et al. (2013). "Cradle-to-gate inventory of wood production from Australian softwood plantations and native hardwood forests: Carbon sequestration and greenhouse gas emissions." Forest Ecology and Management **302**(0): 295-307.

Grant, T., K. James, et al. (2003). Life Cycle Assessment of Waste and Resource Recovery Options (including energy from waste) - Final Report for EcoRecycle Victoria. Melbourne, Victoria, Centre for Design at RMIT University (www.cfd.rmit.edu.au).

Appendix A : Full list of unit processes

Processes removed from AusLCI

The following processes have been removed from the database as PVC is no longer produced in Australia

polyvinylchloride, granulate, at plant	Materials	Plastics
ethylene dichloride-vinyl chloride monomer, at plant	Chemicals	Organic