EPiC
Database

Environmental Performance in Construction

A database of embodied environmental flow coefficients

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EPiC

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Contents

Material Coefficients

Foreword

The construction sector provides buildings and infrastructure, and ultimately habitat for humanity. But our homes and cities come at a cost, economically and environmentally. Buildings account for more than a third of global energy use, 39 per cent of global energy-related greenhouse gas emissions, and create a huge demand for freshwater resources. Construction and demolition waste together, are the largest contributor to landfill.

This represents a unique opportunity. We can shift from being the problem to being the solution if we dramatically change the way we design and construct our buildings and cities. Understanding how they perform is the first step. This starts with a greater awareness of the resource demands and environmental effects that result from our use of construction materials.

In the early 1990s the late Graham Treloar developed a passion for assessing and improving the environmental performance of buildings. This led him to develop a new method for quantifying the resource flows associated with materials, specifically their embodied energy. He went on to combine process and input-output data, pioneering what is now known as the Path Exchange hybrid approach, which he subsequently used to develop embodied energy coefficients for a range of construction materials.

Since then, Graham's work has been further developed and continues to be used by practitioners and researchers all over the world. The coefficients contained within the EPiC Database build upon this work and several decades of internationally recognised research by a group of dedicated, world-leading researchers.

The EPiC Database will be an invaluable resource for anyone involved in the planning, design, construction, operation or management of our buildings and cities. It provides decision-makers with critical information needed to understand, predict and improve the environmental performance of building and engineering projects.

Graham died from cancer at the age of 39 and was my much-admired brother-in-law. He is survived by two daughters. If we continue under the current 'business-as-usual' emissions scenario, his two girls are likely to live to experience the catastrophic reality of our planet under three to four degrees warming.

The release of the EPiC Database is well-timed, given the urgent need to reduce the environmental effects of construction while still providing habitat for humanity. The EPiC Database gives the industry the information needed to make informed choices that we all can live with. It is especially pleasing to know that it will continue a legacy left by others.

Tanya Ha

Science journalist, environmental advocate and author

Preface

The construction of buildings and built infrastructure assets is a major contributor to global resource demands, waste production, and greenhouse gas and pollutant emissions. Therefore, the construction industry has an important role to play in reducing the current and future effects of human activities on the natural environment. In order to facilitate this, information on how various design and construction-related decisions affect the environment, are needed. If key decision makers, such as asset owners, architects, engineers and contractors have access to detailed information about the resource demands and environmental effects associated with materials, they are in a better position to make decisions around material selection in order to improve the overall environmental performance of a project. While some data already exists for informing these critical decisions, it is often based on disparate data sources, limited in coverage to only a fraction of the environmental flows associated with the production of any given material, and difficult or costly to access.

The aim of the EPiC Database is to provide open-access data on the environmental flows associated with construction materials, based on a consistent methodological approach and ensuring maximum coverage of environmental flows, helping to reduce the environmental effects of construction. The database contains embodied energy, embodied water and embodied greenhouse gas emissions coefficients for over 250 common construction materials. The approach used to compile the EPiC coefficients is based on over 60 years of research, stemming from the work of researchers like Walter Isard and Wassily Leontief. More recently, the work of Graham Treloar forms the most critical basis for the EPiC coefficients. Graham's work on hybrid methods for compiling life cycle inventories and quantifying embodied energy, as well as its subsequent development in recent years provides the EPiC Database with consistency and broad coverage of material-related environmental flows.

A key strength of the EPiC Database is its high level of transparency. The approach used to compile the coefficients is outlined in detail within this book and has been peer-reviewed in multiple scientific papers. The data used is made available as open-access (see Related Resources) and individual material fact sheets provide further insight into the environmental flows associated with each material. This EPiC Database is an invaluable resource for anyone involved in the construction industry, including material specifiers, planners, architects, engineers, asset owners, developers and contractors. The EPiC coefficients can be used to compare materials or quantify the environmental flows associated with entire construction projects. They can also be integrated into broader life cycle assessment studies to ensure that the environmental effects of construction projects are optimised across their entire life cycle.

The EPiC Database would not have happened were it not for the support and contribution of a number of people and organisations. The database and associated resource hub are the result of a four-year Australian Research Council funded Discovery Project – ‘Improving the Environmental Performance of Australian Construction Projects’ (DP150100962) and we acknowledge the Australian Research Council for their support. In addition to this, The University of Melbourne has provided on-going support and facilities to the project, which is also greatly appreciated. We also acknowledge Thomas Wiedmann and Man Yu as members of the Discovery Project team for their contribution to the broader project and Paul-Antoine Bontinck for his many years of dedication to the project and in particular his assistance in compiling the raw data and the environmental flow coefficients contained within the EPiC Database.

Glossary

Direct environmental flows	The natural resource *inputs* and waste, greenhouse gas emissions and pollutant *outputs* associated with a main production process, at the point of the activity
Embodied energy	The *primary energy* required by all of the activities associated with a production process and the share of energy used in making equipment and other supporting functions (i.e. *direct* and *indirect*)
Embodied greenhouse gas emissions	The greenhouse gas emissions (in carbon dioxide equivalent) released during all of the activities associated with a production process and the share of emissions associated with making equipment and other supporting functions (i.e. *direct* and *indirect*)
Embodied water	The water required by all of the activities associated with a production process and the share of water used in making equipment and other supporting functions (i.e. *direct* and *indirect*)
Environmental flows	The natural resource *inputs* and waste, greenhouse gas emissions and pollutant *outputs* associated with the production and provision of goods and services
Environmental Product Declaration	A document outlining the findings of a process-based *life cycle assessment* of a particular product, covering a range of *environmental flows*
Environmentally-extended input-output analysis	A life cycle inventory *analysis* technique for quantifying *inputs* and *outputs* of a product, process or activity, based on *environmentally-extended input-output data*
Environmentally-extended input-output data	Top-down macro-economic data covering the entire economy that is combined with *environmental flow* data, by economic sector
Functional unit	A reference unit for the performance of a product or process
Hybrid analysis	A *life cycle inventory analysis* technique for quantifying *inputs* and *outputs* of a product, process or activity that combines the use of process and *environmentally-extended input-output data*
Indirect environmental flows	The natural resource *inputs* and waste, greenhouse gas emissions and pollutant *outputs* associated with the processes and activities upstream of, and supporting, a main production process
Inputs	The resources required by a process (e.g. energy or raw materials)

Life cycle	The stages through which something (e.g. a product or a building) passes during its life (usually from raw material acquisition to final disposal)
Life cycle assessment	A tool for measuring the environmental effects associated with a product, process or activity over its *life cycle* from raw material acquisition through to production, use and disposal
Life cycle impact assessment	The third phase of a *life cycle assessment*, which involves the evaluation of the magnitude and significance of potential environmental effects of a product, process or activity across its *life cycle*, based on the findings from a *life cycle inventory analysis*
Life cycle inventory analysis	The second phase of a *life cycle assessment*, which involves quantifying the inputs to, and outputs from, a product across its *life cycle*
Node	A single *input* or *output* of an *environmental flow* within a *product system*, at a particular point of a *pathway*
Outputs	The waste, emissions, materials and products produced by a process
Pathway	A collection of *nodes* through which goods or services and related *environmental flows* are transferred within a *product system*
Primary energy	The energy contained within a *primary energy* source (e.g. coal, oil or natural gas) that has not been processed or converted
Process analysis	A life cycle inventory *analysis* technique for quantifying *inputs* and *outputs* of a product, process, or activity, by breaking it down into its constituent parts and tracing the *inputs* and *outputs* through the supply chain
Process data	Bottom-up industry data of *inputs* and *outputs* to a *product system* related to specific products, processes or activities
Product system	A collection of processes used to produce or provide a good or service
System boundary	Defines the processes included within a *product system*
Total environmental flow requirement	The total *environmental flow* required by a process or economic sector, per unit of product output

Related Resources

Open Access Data

In the interest of data transparency, all data used in the compilation of the environmental flow coefficients contained within the EPiC Database can be found on the EPiC Database Figshare site at: http://melbourne.figshare.com/projects/Environmental_Performance_in_Construction_EPiC_Database/68177#

The code for the object-oriented programming used to conduct structural path analysis is also made freely available on GitHub (http://github.com/hybridlca/pyspa) with further information located at: http://doi.org/10.6084/m9.figshare.8080763.v1. It is available as a Python package (pyspa) from the central Python package index (PyPi).

EPiC Resource Hub

The EPiC Resource Hub is an online resource that supplements this report, providing further resources on life cycle assessment, a searchable and interactive version of the EPiC Database as well as further information on the compilation of the EPiC coefficients. The EPiC Resource Hub can be accessed at: www.epicdatabase.com.au

Publications

The following publications supplement the EPiC Database and provide additional insight into the methods and data used to compile the EPiC coefficients.

Crawford, R.H., Stephan, A., & Prideaux, F. (2019) *A comprehensive database of environmental flow coefficients for construction materials: closing the loop in environmental design*. Paper presented at the Revisiting the Role of Architecture for 'Surviving' Development, Architectural Science Association, Roorkee, India.

Stephan, A., Crawford, R.H., & Bontinck, P.-A. (2019) A model for streamlining and automating path exchange hybrid life cycle assessment. *The International Journal of Life Cycle Assessment, 24*(2), 237-252. http://doi.org/10.1007/s11367-018-1521-1

Crawford, R.H., Stephan, A., & Schmidt, M. (2018) Embodied Carbon in Buildings: An Australian Perspective. In F. Pomponi, C. D. Wolf, & A. Moncaster (Eds.), *Embodied Carbon in Buildings*. Cham: Springer. http://doi.org/10.1007/978-3-319-72796-7

Crawford, R.H., Bontinck, P.-A., Stephan, A., Wiedmann, T., & Yu, M. (2018) Hybrid life cycle inventory methods – A review. *Journal of Cleaner Production, 172*, 1273-1288. http://doi.org/10.1016/j.jclepro.2017.10.176

Crawford, R.H., Bontinck, P., & Stephan, A. (2018) *Establishing a comprehensive database of construction material environmental flow coefficients for Australia*. Paper presented at the Engaging Architectural Science: Meeting the Challenges of Higher Density, Architectural Science Association, Melbourne, Australia.

Bontinck, P.-A., Crawford, R. H., & Stephan, A. (2017) Improving the uptake of hybrid life cycle assessment in the construction industry. Procedia Engineering, 196, 822-829. http://dx.doi.org/10.1016/j.proeng.2017.08.013

Yu, M., Wiedmann, T., Crawford, R., & Tait, C. (2017) The carbon footprint of Australia's construction sector. *Procedia Engineering, 180*, 211-220. http://doi.org/10.1016/j.proeng.2017.04.180

Crawford, R.H., Bontinck, P.-A., Stephan, A., & Wiedmann, T. (2017) Towards an automated approach for compiling hybrid life cycle inventories. *Procedia Engineering, 180*, 157-166. http://doi.org/10.1016/j.proeng.2017.04.175

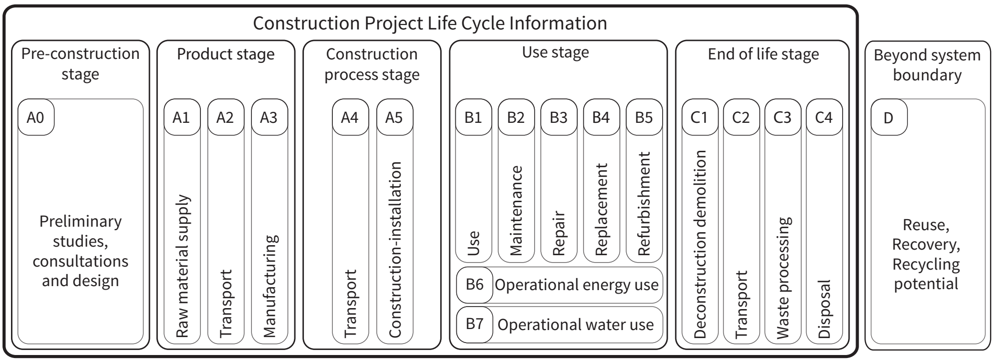
1

THE ENVIRONMENTAL EFFECTS OF CONSTRUCTION

The construction of built assets, such as buildings, roads, bridges and other infrastructure demands a large volume of natural resources and results in significant effects on the natural environment. The production of construction materials is one of the largest contributors.

The Environmental Effects of Construction

The construction industry is responsible for the construction of buildings, roads, bridges, railways, energy networks and other infrastructure assets. These assets are typically long-lived and require a significant quantity of natural resources in their construction and throughout their life, from pre-construction activities through to their final disposal. They also generate considerable quantities of waste, greenhouse gases and pollutants.



Demand for natural resources and production of waste, greenhouse gases and pollutants occur across the building life cycle (based on EN 15978:2011 and EN 15643-5:2017)

Each stage of the life cycle requires direct and indirect resource inputs and results in direct and indirect outputs to the environment. Energy, water and raw materials are essential resources for almost all stages of the built asset life cycle. Likewise, each life cycle stage results in the production of waste, greenhouse gases and pollutants. These inputs and outputs can also be referred to as *environmental flows*.

Direct environmental flows

Direct flows are those associated with a main process, such as heating a building, operating machinery or melting iron ore. These flows represent direct inputs of resources or outputs of waste, emissions and pollutants for specific life cycle stages.

Indirect environmental flows

Almost every stage of the built asset life cycle requires inputs of goods and services from other industries. The environmental flows associated with the production of these goods or provision of these services are direct flows for the industry in which they are produced. However, they are considered indirect flows associated with the subsequent life cycle stages in which they are ultimately used. For example, direct water use associated with manufacturing cement is an indirect water flow associated with building construction.

The energy required for manufacturing steel is an indirect environmental flow associated with the construction sector

What are embodied environmental flows?

The use of natural resources, such as energy, water and raw materials, the generation of waste, and the release of emissions and pollutants are integral to the production of most goods and provision of most services. These environmental flows are considered to be 'locked in' once the goods are produced. The term *embodied* is commonly used to reflect that these flows have already occurred. The embodied environmental flows of a construction project include all of the direct and indirect environmental flows associated with the production of construction materials, construction activities and the provision of services that support the entire construction process.

Construction results in a broad range of environmental effects that are geographically and temporally dispersed. The type and extent of these effects depend on the scale and type of direct and indirect environmental flows associated with a construction project. Each environmental flow can be converted to an effect on the natural environment, using tools such as life cycle assessment (ISO 14040:2006). This conversion, also known as life cycle impact assessment (LCIA), is necessary as different flows will have different environmental consequences. For example, energy from fossil fuels contributes much more to global warming than renewable energy sources do.

Embodied energy

The term *embodied energy* refers to the total energy required to produce a particular good or provide a particular service. It covers all direct and indirect energy flows for that good or service. While *environmental flows* cover a broad range of resource inputs and outputs to the environment, embodied energy only considers energy flows. Other commonly considered environmental flows include *embodied water* and *embodied greenhouse gas emissions*.

Want more information about embodied energy?

See http://www.yourhome.gov.au/materials/embodied-energy

The construction and use of buildings and other built assets represents a considerable proportion of global environmental effects caused by human activity. Buildings alone account for 36% of global energy use, 39% of global energy-related greenhouse gas emissions and 40% of global material use (International Energy Agency and the United Nations Environment Programme, 2018; Roodman, 1995). Understanding the environmental flows and effects associated with the construction industry is therefore of critical importance.

36%
of the world's energy is used by buildings

40%
of the world's materials are used by buildings

39%
of energy-related greenhouse gas emissions are associated with buildings

40%
of landfill waste comes from construction and demolition

2

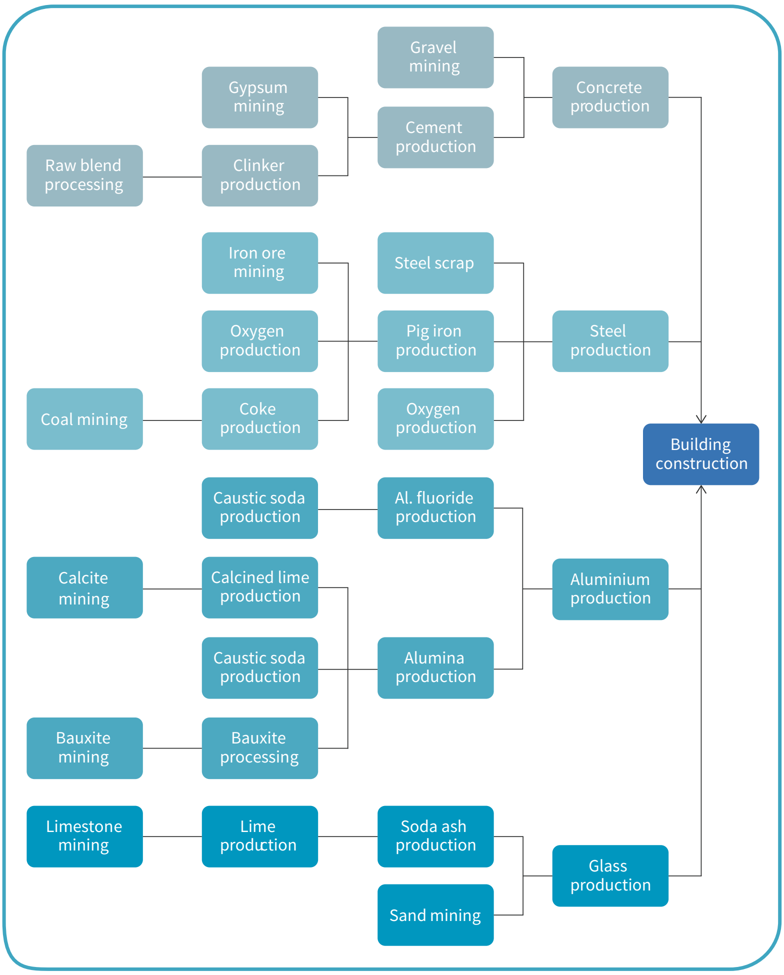
QUANTIFYING ENVIRONMENTAL FLOWS

Environmental flows associated with construction can be quantified using data from life cycle inventory databases, environmental product declarations and environmental flow coefficients.

Quantifying Environmental Flows

In order to determine the environmental effects caused by the construction industry and prioritise efforts to improve its environmental performance, it is necessary to understand the environmental flows associated with construction projects.

Environmental flows are typically quantified using an approach known as *process analysis*. This begins with drawing a diagram outlining all of the individual processes that form part of the project being assessed. This could be anything from a simple structure up to an entire city. This *process flow diagram* helps identify the processes for which data will need to be collected.



Example of a process flow diagram

The data to be collected depends on the focus of the analysis. This can range from a single environmental flow for one life cycle stage (e.g. the energy used during the construction process) to a full life cycle assessment that considers a broad range of flows across the entire project life cycle, from raw material extraction to eventual demolition and disposal of materials.

Data is collected for each process identified in the process flow diagram. This can include a combination of process, product and location-specific data. Types of data that might be collected include quantities of resource inputs, such as units of raw materials, energy or water; raw material characteristics and their source; hours of operation for machinery and equipment; machinery and equipment production efficiencies; production capacity and output; and transport modes and distances.

Data can be collected from a range of sources, including physical observation, utility bills, orders, invoices, and other company records. Once all available data has been collected, it is then collated to form a life cycle inventory for the project, specifying all inputs and/or outputs for the specific processes considered.

As an example, a life cycle inventory for steel may include: quantities of raw materials (e.g. iron ore, coke and limestone); as well as flows of energy, water, greenhouse gas emissions, waste and various pollutants associated with transporting raw materials and factory production processes (such as operating the blast furnace, steel casting, rolling and finishing).

Life cycle inventory databases

Databases containing pre-compiled life cycle inventories can significantly reduce the time involved in collecting data and analysing the environmental performance of a construction project. These databases contain life cycle inventories for a wide range of products, across multiple sectors (e.g. agriculture, energy, manufacturing) and across the different life cycle stages of a product. They will often contain data collected from process analyses conducted by industry, researchers and environmental consultants. These databases are commonly accessed from within environmental assessment tools which make identifying relevant processes much easier.

Environmental Product Declarations or EPDs

The generation of Environmental Product Declarations (EPDs) is becoming increasingly common among material and product manufacturers. An EPD summarises the findings of a process analysis for a specific product or a group of similar products. While much of the data contained within an EPD is often generated and sourced from a single producer, data from life cycle inventory databases can also be used to fill in data gaps. An EPD typically covers a broad range of environmental flows and often a range of life cycle stages. The guidelines for compiling an EPD are outlined in ISO 14025:2006.

Environmental flow coefficients

An environmental flow coefficient represents a complete life cycle inventory of a specific material or product for a single environmental flow. For example, an embodied energy coefficient will give the total direct and indirect energy flows (or inputs) for the production of a particular material or product. Ideally it will cover all processes involved in its production from raw material extraction to the factory gate. These coefficients are measured in units of flow (e.g. megajoules of energy or litres of water) per unit of material (e.g. tonnes or cubic metres), or per product. Environmental flow coefficients are useful for quantifying a single environmental flow, whereas life cycle inventory databases and EPDs can be more useful for understanding a broader range of environmental flows and effects associated with a product.

Limitations of process analysis

Access to process data can have a significant influence on the time and costs involved in identifying environmental flows and compiling a life cycle inventory for a particular product, especially for more complex products like buildings. Conducting a process analysis can be incredibly time intensive and sufficient resources are rarely available for undertaking these for an entire construction project. Life cycle inventory databases, EPDs and environmental flow coefficients can considerably streamline the process.

When undertaking a process analysis, it is unrealistic to include every single process. Resource constraints and supply chain complexity generally limit the ability for this to be achieved. Hence, a boundary is usually drawn around the processes to be included, usually based on those which are seen to be important or for which data is readily available. Many other processes are excluded, considered to be insignificant or just not able to be identified.

The processes excluded from a process analysis have been shown to represent around 50% of total environmental flows for moderately complex products (Norris, 2001) and up to 87% for more complex products (Born, 1996; Crawford, 2005, 2008; Hendrickson et al., 1998; Lenzen & Dey, 2000). For very energy or resource-intensive manufacturing processes, such as metals and glass production, this issue is reduced, due to the much higher significance of the main production process (where process data is typically readily available).

Environmental flows excluded within a process-based life cycle inventory may include those associated with: the production of minor materials; basic material conversion into fabricated or more complex products; higher order processes in the supply chain; providing services, such as finance, insurance and telecommunications to all supply chain organisations; and those associated with the production of capital machinery and equipment.

Filling data gaps in process-based life cycle inventories

Data gaps in process-based life cycle inventories can be significant. Minimising these gaps by collecting additional process data is preferred due to its relevance for particular processes. While this is often not possible due to the sheer complexity of the supply chain, alternative data sources can be used. One such source, known as environmentally-extended input-output (EEIO) data is useful as it uses a whole-of-economy approach. This means that it includes all activity that occurs within a national or global economy and can thus be used to fill any gaps that exist in a process-based life cycle inventory.

Monetary-based transactions generally represent a flow of goods or services within and between industries and supply chains. These transactions represent sales and purchases made by organisations and individuals within the economy. All of these transactions are summarised in input-output (IO) tables published by statistics agencies such as the Australian Bureau of Statistics (ABS). This data can be converted to environmental terms by combining it with economic sector-based environmental flow data from national statistics, such as energy accounts. Environmental flows for individual or groups of goods or services can then be determined, in environmental flow units (e.g. megajoules of energy or litres of water) per monetary unit.

Combining data from a process analysis with environmentally-extended input-output data is known as *hybrid analysis*. There are a number of ways that this data can be combined, but ultimately the aim is to use the environmentally-extended input-output data to model environmental flows that have not been included in a process-based life cycle inventory.

Hybrid analysis

Want more information about hybrid analysis?

See Hybrid life cycle inventory methods – A review (Crawford et al., 2018b)

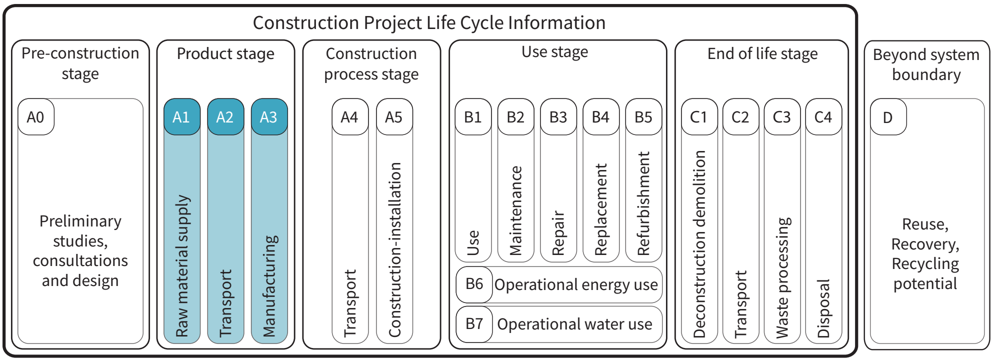
3

DEVELOPING THE EPiC COEFFICIENTS

Completeness, consistency and transparency were prioritised in the development of the EPiC coefficients. Industry-based process data is combined with national macro-economic data using a comprehensive hybrid approach.

Developing the EPiC Coefficients

The environmental flow coefficients contained within the EPiC Database cover commonly used construction materials and products. The scope of the EPiC coefficients includes the processes associated with the production of these materials and products, including raw materials supply, transport and manufacturing (A1-A3 in EN 15978:2011). This scope is also known as *cradle-to-gate*.



Life cycle inventory scope for EPiC coefficients

The environmental flows covered within the EPiC Database include energy (megajoules), water (litres) and greenhouse gas emissions (kilograms of carbon dioxide equivalent). As the coefficients include all direct and indirect flows, they represent the total embodied environmental flows associated with the production of the materials and products covered. The coefficients can therefore also be referred to as embodied energy, embodied water and embodied greenhouse gas emissions coefficients.

Key Characteristics

In the development of the EPiC Database a number of key characteristics were prioritised – completeness, consistency and transparency.

Completeness

To ensure that all processes are accounted for, from cradle to gate, the EPiC coefficients have been produced using a hybrid analysis, filling gaps in available process data with environmentally-extended input-output data. Life cycle inventories based on process analysis suffer from varying degrees of incompleteness. This variation in coverage of the processes included makes comparability between materials and products problematic. The completeness of the system boundary if EPiC coefficients ensures a full coverage of the supply chain and enables meaningful comparisons to be made.

Consistency

The EPiC coefficients have been developed using a common methodology, as well as consistent data source (where practicable), approach to data integration, and data cut-off rules. The use of coefficients from different sources or based on data from different sources limits the ability to compare the environmental performance of different materials or products. It can also result in misleading findings at a whole project level. The approach used to produce the EPiC coefficients maximises comparability between materials or products and improves the reliability of assessments.

Transparency

To maximise transparency within the EPiC Database, the methods and data used to produce the coefficients have been made freely available through open-access platforms (see Related Resources). In contrast, environmental flow coefficients are often treated as a black box, with little information about how they were compiled or the source of the data used. This can reduce the level of confidence in their use. The open access to all metadata behind the EPiC Database allows in-depth sensitivity analysis to be performed and the relevance of individual coefficients to be assessed.

Data

The EPiC Database relies on two main sources of data, namely process and environmentally-extended input-output data. These data are presented below along with details about how they were processed.

Process data

The EPiC Database uses the Australian Life Cycle Inventory Database Initiative (AusLCI), which is collected as a matrix of processes from the LCA software Simapro. AusLCI is a process-based life cycle inventory containing process data collected from Australian sources, and supplemented with ecoinvent data (Frischknecht et al., 2005) when no local data is available (Grant, 2016). The European ecoinvent data is made Australia-specific by modifying energy generation and transmission processes. Additional processes were also created to represent processed materials, such as rolled steel or extruded aluminium where these didn't already exist. In total, this process-based life cycle inventory contains 4 598 individual processes.

Environmentally-extended input-output data

Environmentally-extended input-output data is used in the compilation of the EPiC Database and is sourced from official Australian government reports, for the 2014-2015 financial year. A detailed description of the input-output data sources is available in Crawford et al. (2018a) and the data is freely available (see Related Resources and Appendices A and B).

Input-output tables (representing monetary transactions between sectors of the economy) were collected from the Australian Bureau of Statistics (ABS) at a disaggregation level of 114 sectors (ABS, 2018). Energy accounts were collected from the Department of Industry (2016), water accounts from the ABS (2016) and greenhouse gas (GHG) emissions accounts from the Department of the Environment and Energy (2015).

Data processing

Prior to the compilation of the EPiC coefficients, the process and environmentally-extended input-output data need to be further processed. The final data format is represented by a square matrix of processes/input-output data and a list of processes/economic sectors and their environmental flow requirements (direct and total) along with other relevant metadata.

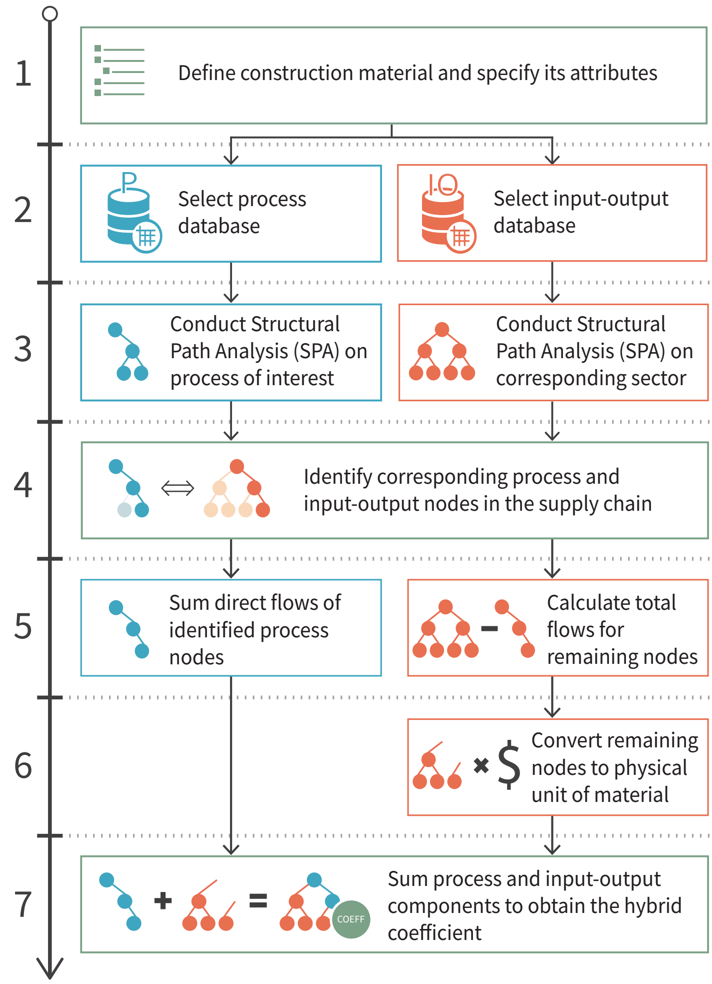
Energy, water and greenhouse gas emissions accounts were available at lower sectoral resolution than input-output data and had to be manually disaggregated to match the resolution of the input-output data. The allocation and disaggregation of environmental accounts was based on the expenditure for each economic sector in the input-output tables. This enabled the calculation of direct and total environmental flow requirements for each environmental flow, and each economic sector.

Process data was collected in a standardised format requiring minimal manipulation. The entire AusLCI database (Grant, 2016) was collected as a square matrix (PRé Sustainability, 2018). The direct and total environmental flow requirements for each process were calculated using raw data from AusLCI and the square matrix.

Hybrid approach

The EPiC coefficients have been produced by combining the process and environmentally-extended input-output data described above using a hybrid approach known as Path Exchange hybrid analysis (Lenzen & Crawford, 2009). This approach uses an input-output model of the national economy, into which available process data is integrated, or *exchanged*. This ensures that the entire supply chain of a material is covered, across the economy, while using as much detailed and relevant process data as possible.

The following diagram outlines the steps involved in producing the EPiC coefficients, which are further described below.



Summary of the hybrid approach used to produce the EPiC coefficients

Step 1. Define construction material or product

The first step involves defining a particular construction material or product (e.g. hot rolled steel), and its attributes (e.g. density, basic price, functional unit). This definition is critical as it dictates the selection of a relevant process and economic sector in Step 3.

Step 2. Select databases

The second step is to select which process and input-output database are to be used. For the EPiC coefficients, the same process and input-output databases (as described above) were used.

Step 3. Conduct structural path analyses

Once the process and input-output databases have been selected, the relevant process and economic sector that represent the material are identified in order to conduct a structural path analysis (SPA). This analysis involves mapping the supply chain of the material using both the process and input-output data. The outcome of this analysis is two lists of mutually exclusive *nodes*, one based on process data and the other based on input-output data. Each node represents a good (such as a material) or service (such as transportation) provided from one process or organisation to another and an associated environmental flow.

Step 4. Matching process and input-output nodes

The fourth step consists of reviewing the process and input-output structural path analyses of the material's supply chain and identifying equivalent nodes. A fundamental assumption in the compilation of the EPiC coefficients is that the process and input-output databases provide two representations of the same supply chains. This means, for instance, that the analysis of the process *'concrete 20 MPa, at batching plant/AU U'* and the input-output sector *'Cement, Lime and Ready-Mixed Concrete Manufacturing'* provide two representations of the production of concrete and its supply chain. It is then possible to identify equivalent *nodes* between the supply chains of the two data types.

Step 5-7. Hybridisation and calculation of an EPiC coefficient

The fifth, sixth and seventh steps consist of combining the process and input-output data to produce the hybrid environmental flow coefficient. Based on the two structural path analyses, for input-output *nodes* where an equivalent process node is available, the associated environmental flow is replaced with the process-based environmental flow. This avoids double counting, ensures system boundary completeness and maximises specificity. During this process, all input-output *nodes* that were replaced by process nodes are excluded and the remaining input-output data is deemed to represent all of the environmental flows associated with the nodes not covered by the process data.

A word on automation

It is important to highlight the novelty in the automation of the steps described above. These typically highly manual steps were significantly automated through the development and use of object-oriented Python programming. This enabled the consistent, transparent and streamlined creation of the EPiC coefficients. Apart from creating a dedicated graphical user interface to compile the coefficients (Stephan, 2018), multiple aspects were automated, including: the processing of process and input-output data, the structural path analysis of process and input-output data, the exchange of process and input-output *nodes*, the calculation of EPiC coefficients, and exporting all data associated with the compilation of a coefficient.

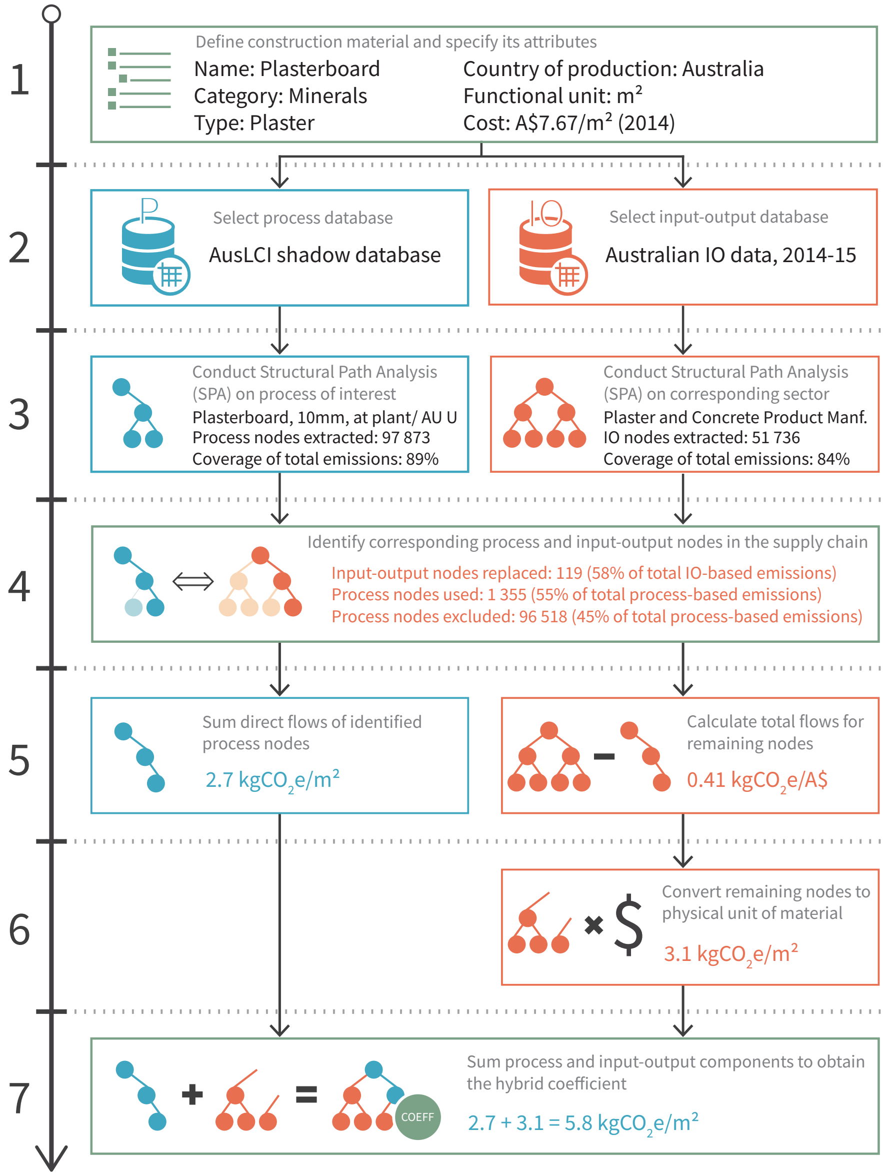
Hybrid approach

Want more information about the hybrid approach used?

See A model for streamlining and automating path exchange hybrid life cycle assessment (Stephan et al., 2019) and Hybrid life cycle inventory methods – A review (Crawford et al., 2018b)

Example compilation of an EPiC coefficient

This section provides an example of the process involved in compiling an EPiC coefficient. This example calculates the embodied greenhouse gas emissions of 10 mm plasterboard. The following diagram summarises the results obtained from each step.



Example of step by step process for calculating the EPiC embodied greenhouse gas emissions coefficient for 10mm plasterboard

4

USING THE EPiC COEFFICIENTS

The EPiC coefficients are used to assess the embodied energy, water or greenhouse gas emissions of construction projects. This step-by-step guide streamlines the assessment process to assist with design and project decision-making.

Using the EPiC Coefficients

This section describes how to use the EPiC coefficients to quantify the embodied environmental flows of a construction project. While the coefficients can be integrated into existing environmental assessment tools that automate the quantification of embodied environmental flows, this section describes how to conduct this assessment manually. This process ensures all material as well as all non-material-related environmental flows are included.

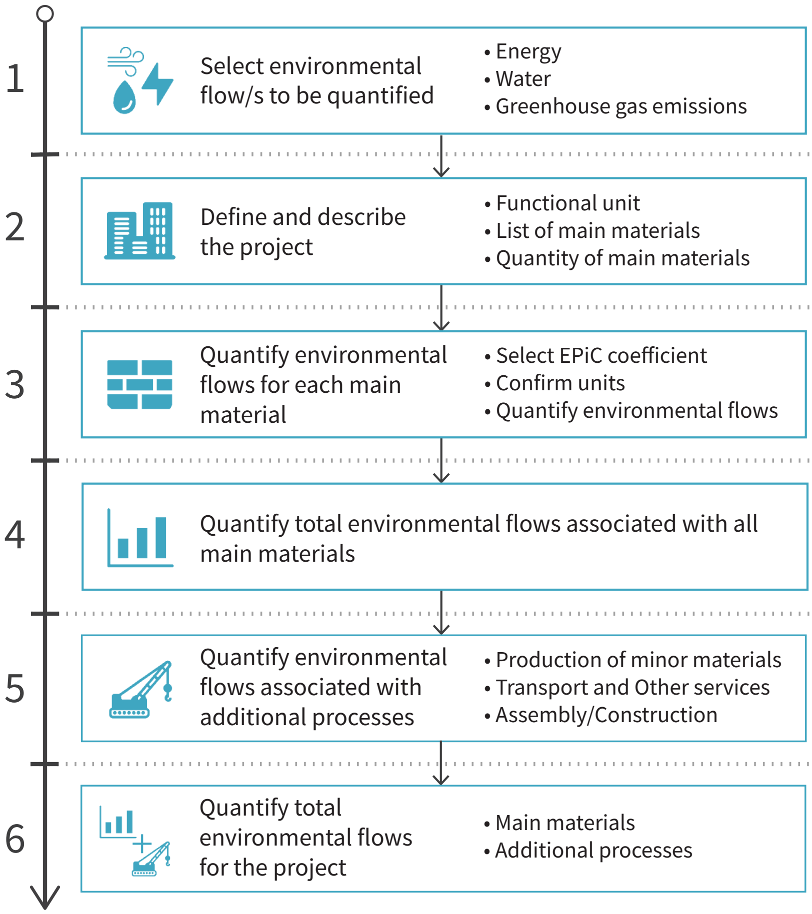
How can the coefficients be used?

There are a number of ways that the EPiC coefficients can be used:

- To select materials with the lowest environmental effects for one or across a range of environmental flows, informing design aimed at maximising project environmental performance;
- To quantify the embodied environmental flows associated with a construction project or a larger development, and identify areas with greatest potential for improvement;
- As part of a life cycle assessment to understand the life cycle environmental performance of a construction project and identify areas or life cycle stages with greatest potential for improvement;
- To demonstrate compliance with specific performance benchmarks.

Quantifying environmental flows

This section provides a step-by-step description of the use of the EPiC coefficients to quantify the environmental flows of a construction project.



Steps for using the EPiC coefficients to quantify embodied environmental flows

Step 1.

The environmental flow/s to be quantified are selected.

- Energy
- Water
- Greenhouse gas emissions

Step 2.

The project being assessed is defined and described.

- **Establish** functional unit – e.g. total building floor area or length of road.
- **Develop** a list of the main materials contained within the project - This information can usually be extracted from construction documentation, including drawings, specifications and schedules. If a bill of quantities (BoQ) is available, this can significantly streamline this process.
- **Determine** the quantity of each main material contained within the project, including on-site wastage, if relevant.

Sample – defining the project

Material	Quantity	Unit	Coefficient	Flow
Cross laminated timber	**10**	**m^3**		
Cork slab – 10 mm	**10**	**m^2**		
Water-based paint	**100**	**m^2**		

Step 3.

The embodied environmental flow/s for each of the main materials contained within the project are quantified.

- **Select** relevant coefficient for each material from the EPiC Database.
- **Ensure** material quantities are in identical units to coefficients.
- **Multiply** main material quantities by respective coefficient.

Sample – quantifying embodied environmental flow of main materials

Material	Quantity	Unit	Coefficient	Flow
Cross laminated timber	*10*	*m^3*	**9 607 MJ/m^3**	**96 070 MJ**
Cork slab – 10 mm	*10*	*m^2*	**215 MJ/m^2**	**2 150 MJ**
Water-based paint	*100*	*m^2*	**8.7 MJ/m^2**	**870 MJ**

Step 4.

The total embodied environmental flow/s associated with the main materials is quantified.

- **Sum** environmental flow/s of main materials.

Sample – quantifying total embodied environmental flow of main materials

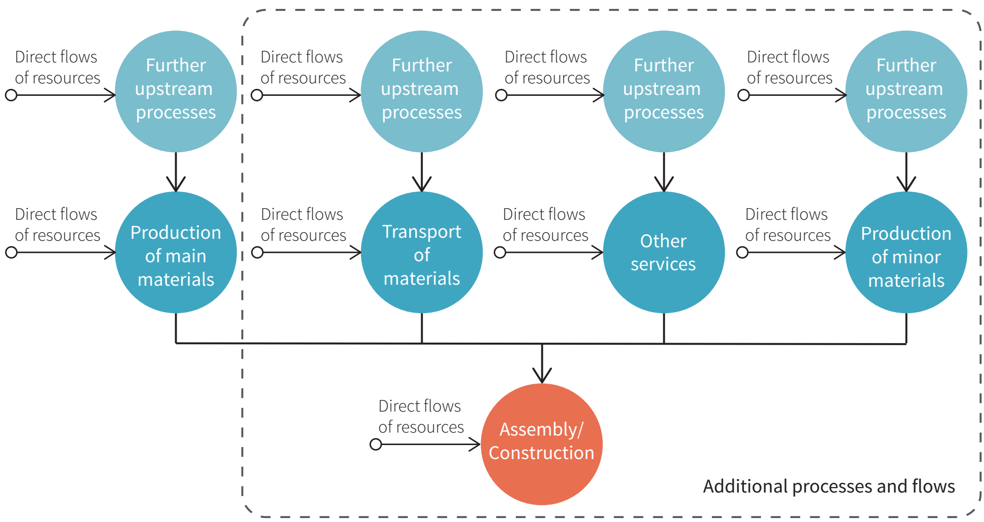
Material	Quantity	Unit	Coefficient	Flow
Cross laminated timber	*10*	*m^3*	*9 607 MJ/m^3*	*96 070 MJ*
Cork slab – 10 mm	*10*	*m^2*	*215 MJ/m^2*	*2 150 MJ*
Water-based paint	*100*	*m^2*	*8.7 MJ/m^2*	*870 MJ*
			Total	**99 090 MJ**

Step 5.

The embodied environmental flows associated with the assembly/construction and minor materials of the project are quantified. The EPiC coefficients include the environmental flows for all processes associated with the production of the individual materials and products (A1-A3 as per EN 15978:2011 and EN 15643-5:2017). When these individual materials or products are used together within a larger or more complex product (such as a building or infrastructure asset), additional environmental flows are required. This is represented by A4-A5 within EN 15978:2011 and EN 15643-5:2017 and includes those associated with:

- transport of materials to a construction site – for example, the fuel used to operate trucks;
- the assembly or construction process – for example, the energy used to cut and fix materials or operate machinery; and
- providing services needed to support the assembly or construction process – for example, the energy used to provide financial, insurance, telecommunications, regulatory, employment, and professional services to the organisations involved in constructing the project.

In addition to this, further minor materials may be required that are often not quantified as part of Step 2. This could include fixings such as nails and screws, electrical wiring and fittings.



Additional processes to be included as part of Step 5

Environmental flows for these additional processes could be quantified using a process analysis. However, the complexity of identifying the source of all main materials and tracing their journey from factory to site, or identifying the environmental flows associated with the provision of services, is unlikely to be feasible on an individual construction project. Also, without physical quantities of minor materials, coefficients are not useful. Environmentally-extended input-output data can be used in the absence of process data for these additional processes. This is a unique characteristic of the hybrid approach used here, accounting for processes and related environmental flows not typically included in a process analysis.

- **Identify** relevant economic sector responsible for the construction of the project being assessed – for construction projects this will be one of: Residential Building Construction, Non-Residential Building Construction or Heavy and Civil Engineering Construction (for full sector list, see Appendix A).
- **Identify** total environmental flow requirement of relevant economic sector for the environmental flow/s being considered (as per Appendix B).

Relevant Economic Sector	Total Flow Requirement
Residential Building Construction	**6.26 MJ/A$**

- **Select** table of sector-based inputs for relevant economic sector responsible for the construction of the project (Appendix C – construction sectors provided).
- For each main material quantified in Step 2, **select** the relevant economic sector responsible for its production and identify its total environmental flow requirement for the environmental flow/s being considered (as per table selected from Appendix C).

Sample – identifying total environmental flow of sectors representing main materials

Material	Relevant Economic Sector	Total Flow
Cross laminated timber	**Other Wood Product Manufacturing**	**0.589 MJ/A$**
Cork slab – 10 mm	**Other Wood Product Manufacturing**	**0.589 MJ/A$**
Water-based paint	**Polymer Product Manufacturing**	**0.138 MJ/A$**

- **Sum** the total environmental flow requirements of each unique economic sector for the environmental flow/s being considered.

Sample – quantifying total environmental flow of sectors representing main materials

Material	Relevant Economic Sector	Total Flow
Cross laminated timber	*Other Wood Product Manufacturing*	*0.589 MJ/A$*
Cork slab – 10 mm	*Other Wood Product Manufacturing*	**0.589 MJ/A$*
Water-based paint	*Polymer Product Manufacturing*	*0.138 MJ/A$*
	Total Flows	**0.727 MJ/A$**

**this flow is not unique and thus not included to avoid double counting.*

- **Subtract** the sum of environmental flows representing main materials for the flow/s being considered from the total environmental flow requirement of the relevant economic sector.

Sample – quantifying total additional embodied environmental flows per A$ of project

Material		Relevant Economic Sector	Total Flow
Cross laminated timber		*Other Wood Product Manufacturing*	*0.589 MJ/A$*
Cork – 10mm slab		*Other Wood Product Manufacturing*	*0.589 MJ/A$*
Water-based paint		*Polymer Product Manufacturing*	*0.138 MJ/A$*
Sector Total Flow (6.26 MJ/A$)	–	*Total Flows*	*0.727 MJ/A$*
	=	**Additional Flows**	**5.53 MJ/A$**

- **Multiply** the total additional environmental flows by the cost of construction.

Sample – quantifying total additional embodied environmental flows for the project

Additional Flows per A$		Cost of Construction		Additional Flows per Project
5.53 MJ	x	**A$100 000**	=	**553 000 MJ**

Step 6.

Total embodied environmental flows for the project are quantified.

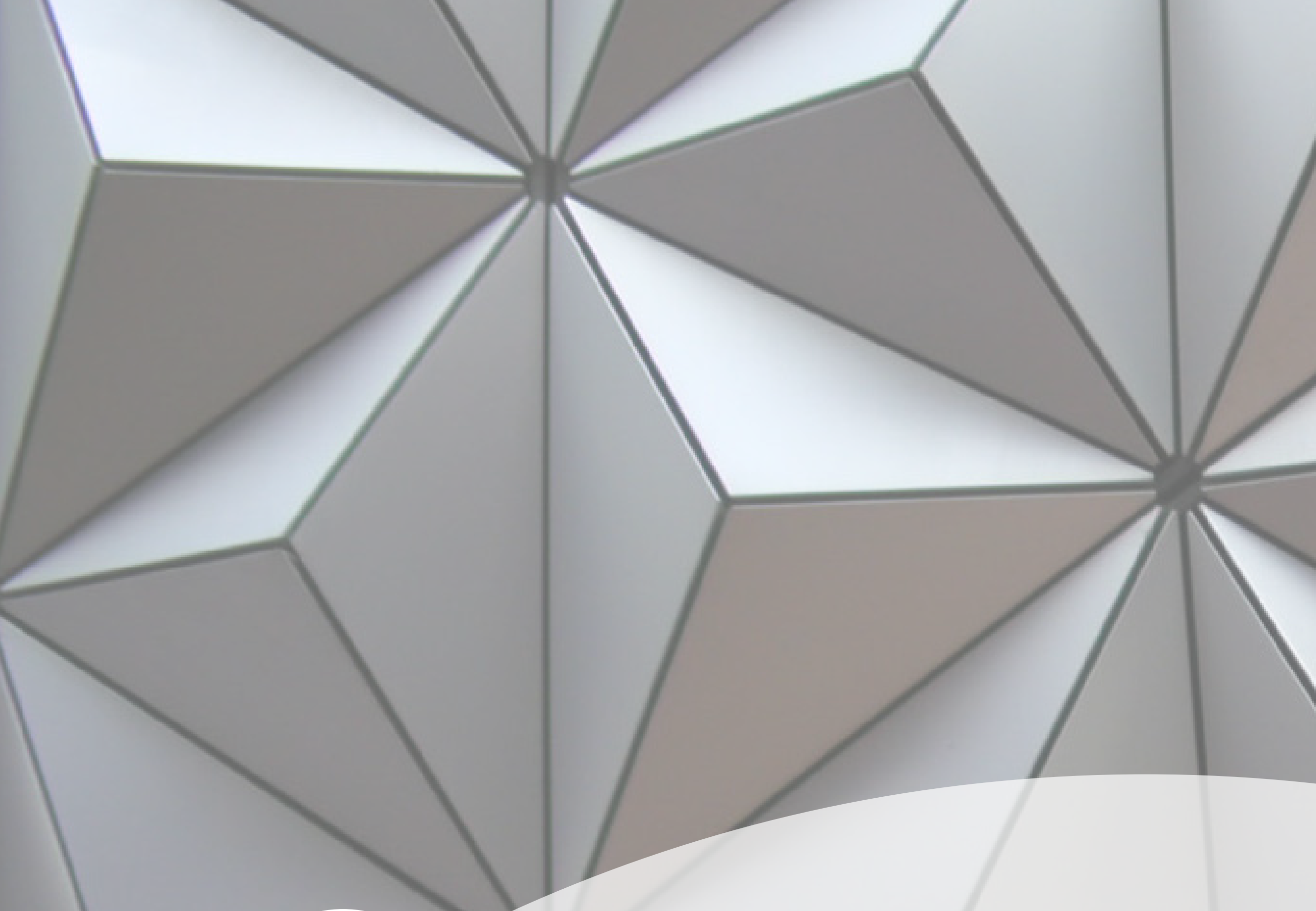
- **Add** the total embodied environmental flows associated with the main materials (from Step 4) to the total additional environmental flows (from Step 5).

Sample – combining main material flows and additional flows

Flows for Main Materials		Additional Flows		Total Flows per Project
99 090 MJ	+	*553 000 MJ*	=	**652 090 MJ**

Notes

1. The proportion of additional flows in the sample above is higher than in reality. This is due to the limited number of materials quantified, and thus the small amount of process data used.
2. Materials and environmental flows associated with on-site wastage are not typically accounted for in the material quantities extracted from a BoQ. Thus, as part of Step 2, wastage multipliers may be used to ensure these are covered.



5

EPiC DATABASE

A database of embodied environmental flow coefficients for over 250 common construction materials and products. Detailed factsheets provide insight into each material and their respective embodied energy, water and greenhouse gas emissions.

EPiC Database

The EPiC Database contains hybrid environmental flow coefficients for 89 main construction materials and products as well as a further 195 material variations. A total of 284 coefficients are provided across three environmental flows - energy, water and greenhouse gas emissions. The reported embodied energy coefficients are in *primary energy* terms, covering the entire energy supply chain.

Materials and products are grouped into eight broad categories:

- Concrete and plaster products
- Glass
- Insulation
- Metals
- Miscellaneous
- Plastics
- Sand, stone and ceramics
- Timber products

While the database does not contain an exhaustive list of materials, additional materials can be added, especially where process data in the form of environmental product declarations or life cycle inventories already exist, as further data becomes available, or new materials are developed.

This section provides a summary of all coefficients contained within the EPiC Database, followed by individual material factsheets which provide further details about each material.

EPiC Database

CONCRETE AND PLASTER PRODUCTS			Functional Unit	Embodied Energy (MJ)	Embodied Water (L)	Embodied Greenhouse Gas Emissions ($kgCO_2e$)
	Blocks	Concrete block	kg	2.6	3.7	0.24
		390 × 190 × 90 mm	no.	24.3	34.2	2.2
		390 × 190 × 140 mm	no.	29.6	41.6	2.7
		390 × 190 × 190 mm	no.	35.2	49.4	3.2
	Cement	Cement mortar	kg	3.9	3.7	0.35
		Portland cement	kg	11.8	7.8	1.3
	Concrete	Autoclaved aerated concrete (AAC)	kg	8.5	8.4	0.71
		Block - 600 × 200 × 100 mm	no.	56.4	55.4	4.7
		Block - 600 × 200 × 150 mm	no.	84.5	83.0	7.0
		Block - 600 × 200 × 200 mm	no.	113	111	9.4
		20 MPa	m^3	2 404	4 154	328
		20 MPa - 30% fly ash	m^3	2 026	4 011	251
		20 MPa - 30% GGBFS	m^3	2 186	4 034	263
		25 MPa	m^3	2 581	4 196	361
		25 MPa - 30% fly ash	m^3	2 241	4 028	277
		25 MPa - 30% GGBFS	m^3	2 441	4 105	293
		32 MPa	m^3	3 015	4 300	416
		32 MPa - 30% fly ash	m^3	2 484	4 066	314
		32 MPa - 30% GGBFS	m^3	2 704	4 103	331
		40 MPa	m^3	3 476	4 355	497
		40 MPa - 30% fly ash	m^3	2 854	4 075	373
		40 MPa - 30% GGBFS	m^3	3 106	4 120	392
		50 MPa	m^3	3 998	4 365	600
		50 MPa - 30% fly ash	m^3	3 634	4 246	467
		50 MPa - 30% GGBFS	m^3	3 958	4 325	492

			Functional Unit	Embodied Energy (MJ)	Embodied Water (L)	Embodied Greenhouse Gas Emissions ($kgCO_2e$)
CONCRETE AND PLASTER PRODUCTS	**Fibre cement**	Sheet	kg	18.3	19.8	1.6
		4.5 mm	m^2	119	129	10.2
		6 mm	m^2	159	172	13.5
		7.5 mm	m^2	198	214	16.9
		18 mm	m^2	475	514	40.6
		24 mm	m^2	634	686	54.2
		Weatherboard	kg	26.0	31.3	2.2
		205 × 7.5 mm - per m^2 wall	m^2	304	365	26.0
		230 × 7.5 mm - per m^2 wall	m^2	284	341	24.2
		300 × 7.5 mm - per m^2 wall	m^2	294	354	25.2
		150 × 16 mm - per m^2 wall	m^2	549	660	46.9
		180 × 16 mm - per m^2 wall	m^2	549	660	46.9
	Plaster	Gypsum plaster	kg	6.5	6.5	0.44
		Plasterboard - 10 mm	m^2	86.1	85.6	5.8
		Plasterboard - 13 mm	m^2	95.7	97.9	6.5
	Tiles	Concrete roof tile	kg	4.3	5.7	0.39
GLASS	**Flat glass**	Single glazing	kg	28.5	32.2	2.0
		3 mm	m^2	222	251	15.7
		4 mm	m^2	296	335	21.0
		5 mm	m^2	370	418	26.2
		6 mm	m^2	444	502	31.4
		10 mm	m^2	740	837	52.4
		12 mm	m^2	888	1 004	62.9
		Double glazing - 4:6:4	m^2	1 336	1 558	101
		Double glazing - 4:12:4	m^2	1 336	1 558	101
		Double glazing - 6:6:6	m^2	1 441	1 671	108
		Double glazing - 6:12:6	m^2	1 441	1 671	108

			Functional Unit	Embodied Energy (MJ)	Embodied Water (L)	Embodied Greenhouse Gas Emissions ($kgCO_2e$)
GLASS	**Laminated glass**	Single glazing	kg	36.4	59.7	2.8
		6.38 mm	m^2	604	991	46.8
		8.38 mm	m^2	794	1 302	61.4
		10.38 mm	m^2	983	1 613	76.1
		12.38 mm	m^2	1 172	1 923	90.7
	Toughened glass	Single glazing	kg	29.8	30.2	2.2
		3 mm	m^2	232	235	17.1
		4 mm	m^2	310	314	22.8
		5 mm	m^2	387	392	28.5
		6 mm	m^2	465	471	34.2
		10 mm	m^2	775	785	56.9
		12 mm	m^2	929	942	68.3
		Double glazing - 4:6:4	m^2	1 536	1 772	115
		Double glazing - 4:12:4	m^2	1 536	1 772	115
		Double glazing - 5:6:5	m^2	1 635	1 879	122
		Double glazing - 5:12:5	m^2	1 635	1 879	122
		Double glazing - 6:6:6	m^2	1 729	1 980	128
		Double glazing - 6:12:6	m^2	1 729	1 980	128
		Double glazing - 10:6:6	m^2	2 254	2 543	165
		Double glazing - 10:12:6	m^2	2 254	2 543	165
		Double glazing - 10:6:10	m^2	2 779	3 107	202
		Double glazing - 10:12:10	m^2	2 779	3 107	202

			Functional Unit	Embodied Energy (MJ)	Embodied Water (L)	Embodied Greenhouse Gas Emissions ($kgCO_2e$)
INSULATION	**Cellulose**	General	kg	12.1	20.5	0.79
		Insulation - 80 mm (R2)	m^2	48.3	82.1	3.1
		Insulation - 100 mm (R2.5)	m^2	60.3	103	3.9
	Other	Aluminium foil insulation	m^2	25.6	33.8	1.9
		Glasswool	kg	57.5	40.7	4.0
		Insulation - 80 mm (R2)	m^2	115	81.4	8.0
		Insulation - 100 mm (R2.5)	m^2	144	102	10.1
		Rockwool	kg	57.1	62.2	3.8
		Insulation - 80 mm (R2)	m^2	320	348	21.1
		Insulation - 100 mm (R2.5)	m^2	400	435	26.4
	Polystyrene	Rigid foam (EPS/XPS)	kg	155	841	8.0
		Insulation - 72 mm (R2)	m^2	251	1 362	12.9
		Insulation - 90 mm (R2.5)	m^2	314	1 703	16.2
	Polyurethane	Rigid foam	kg	293	690	17.5
		Insulation - 44 mm (R2)	m^2	387	911	23.1
		Insulation - 55 mm (R2.5)	m^2	484	1 138	28.8

			Functional Unit	Embodied Energy (MJ)	Embodied Water (L)	Embodied Greenhouse Gas Emissions ($kgCO_2e$)
METALS	**Aluminium**	Bar	kg	345	219	29.6
		Flat - 12 mm × 3 mm	m	33.7	21.3	2.9
		Flat - 40 mm × 3 mm	m	112	71.2	9.6
		Flat - 100 mm × 6 mm	m	562	356	48.2
		Round - 16 mm dia.	m	188	119	16.2
		Round - 50 mm dia.	m	1 838	1 164	158
		Round - 150 mm dia.	m	16 542	10 479	1 420
		Composite panel	m^2	1 196	1 174	102
		Extruded	kg	358	182	29.4
		Round tube - 25 mm dia., 3.2 mm thick	m	114	57.9	9.4
		Round tube - 60 mm dia., 10 mm thick	m	871	442	71.5
		Round tube - 80 mm dia., 6 mm thick	m	705	357	57.8
		Square tube - 20 mm, 1.6 mm thick	m	59.7	30.3	4.9
		Square tube - 40 mm, 2 mm thick	m	152	76.8	12.4
		Square tube - 100 mm, 3 mm thick	m	574	291	47.1
		Extruded powdercoated	kg	415	251	33.6
		Extruded angle	kg	383	244	32.7
		Sheet	kg	295	160	26.7
		1.6 mm	m^2	1 280	693	116
		3 mm	m^2	2 400	1 300	217
		6 mm	m^2	4 800	2 600	434

			Functional Unit	Embodied Energy (MJ)	Embodied Water (L)	Embodied Greenhouse Gas Emissions ($kgCO_2e$)
METALS	**Copper**	Sheet	kg	226	389	15.1
		0.9 mm	m^2	1 819	3 132	121
		1.2 mm	m^2	2 426	4 175	162
		2 mm	m^2	4 043	6 959	270
		3 mm	m^2	6 064	10 438	405
		Pipe	kg	150	289	10.1
		12.7 mm outer dia., 0.91 mm thick	m	45.1	87.0	3.0
		19.05 mm outer dia., 1.02 mm thick	m	77.3	149	5.2
		40 mm outer dia., 1.22 mm thick	m	199	384	13.4
		Wire	kg	671	897	41.8
	Stainless steel	Cold rolled	kg	123	168	9.2
		Extruded	kg	155	138	11.8
		Sheet	kg	97.6	140	7.2
		Sheet products	kg	238	263	14.7
		Wire	kg	226	253	13.9
		Bare - 2 mm dia.	m	5.5	6.2	0.34
		Bare - 3.2 mm dia.	m	14.1	15.8	0.87
		Rope - 1.6 mm dia.	m	2.4	2.7	0.15
		Rope - 4 mm dia.	m	14.2	15.9	0.87
		Rope - 8 mm dia.	m	57.8	64.9	3.6
		Rope - 12 mm dia.	m	127	143	7.8

			Functional Unit	Embodied Energy (MJ)	Embodied Water (L)	Embodied Greenhouse Gas Emissions ($kgCO_2e$)
METALS	**Steel**	Cold rolled	kg	51.7	77.6	3.7
		Hot rolled galvanised structural steel	kg	43.0	43.2	3.3
		Hot rolled structural steel	kg	38.8	37.1	2.9
		Reinforcement bar - 6 mm dia.	m	8.6	8.2	0.64
		Reinforcement bar - 8 mm dia.	m	15.3	14.6	1.1
		Reinforcement bar - 12 mm dia.	m	34.5	32.9	2.6
		Bar	kg	29.5	44.3	2.1
		Extruded hollow section	kg	54.8	45.2	4.6
		Square tube - 20 mm, 1.6 mm thick	m	55.0	45.4	4.6
		Square tube - 50 mm, 2 mm thick	m	172	142	14.5
		Square tube - 100 mm, 4 mm thick	m	688	568	57.8
		Pipe	kg	42.9	78.1	3.5
		21.3 mm outer dia., 2.6 mm thick	m	51.4	93.7	4.2
		42.4 mm outer dia., 2.6 mm thick	m	110	199	9.0
		88.9 mm outer dia., 4 mm thick	m	359	654	29.6
		165.1 mm outer dia., 4.9 mm thick	m	831	1 512	68.5
		Corrugated sheet	kg	79.6	73.4	5.5
		per m^2	m^2	259	239	17.9
		Corrugated sheet - pre-painted	m^2	293	286	24.9

			Functional Unit	Embodied Energy (MJ)	Embodied Water (L)	Embodied Greenhouse Gas Emissions ($kgCO_2e$)
MISCELLANEOUS	**Asphalt**	General	kg	4.2	2.9	0.20
	Carpet	Tufted nylon - average	m^2	465	1 149	31.2
		Tufted nylon - quality	m^2	484	1 161	33.3
		Tufted nylon - prestige	m^2	785	1 866	55.3
		Woven nylon - average	m^2	364	908	23.9
		Woven nylon - quality	m^2	376	911	24.8
		Tufted wool - average	m^2	360	1 343	41.0
		Tufted wool - quality	m^2	407	1 545	49.1
		Tufted wool - prestige	m^2	509	1 945	64.2
	Other	Silicone	kg	224	589	13.8
		Water	kg	0.017	1.02	0.0013
		Wood glue (PVA)	kg	106	171	5.4
		Solar hot water system	no.	24 537	30 097	1 863
	Paint	Solvent-based	kg	124	197	6.3
		per m^2	m^2	9.3	14.7	0.47
		Water-based	kg	111	206	6.8
		per m^2	m^2	8.7	16.1	0.53
	Paper	Wallpaper	kg	263	448	16.0
		per m^2	m^2	45.5	77.5	2.8
	Rubber	Natural	kg	75.2	92.1	2.5
		Synthetic	kg	92.8	111	3.7

			Functional Unit	Embodied Energy (MJ)	Embodied Water (L)	Embodied Greenhouse Gas Emissions ($kgCO_2e$)
PLASTICS	**High density polyethylene (HDPE)**	Film	kg	147	172	6.4
		100 µm	m^2	13.8	16.2	0.60
		200 µm	m^2	27.6	32.4	1.2
		Pipe	kg	135	130	5.6
		32 mm inner dia., 1.88 mm thickness	m	12.3	11.9	0.51
		63 mm inner dia., 3.75 mm thickness	m	47.7	46.1	2.0
		125 mm inner dia., 7.35 mm thickness	m	188	181	7.8
		250 mm inner dia., 14.71 mm thickness	m	752	726	31.0
		500 mm inner dia., 29.41 mm thickness	m	3 007	2 903	124
		800 mm inner dia., 47.06 mm thickness	m	7 698	7 433	318
	Low density polyethylene (LDPE)	Film	kg	136	122	6.4
		100 µm	m^2	12.3	11.1	0.58
		200 µm	m^2	24.7	22.2	1.2
		Pipe	kg	130	89.6	6.0
		13 mm inner dia., 3.95 mm thickness	m	11.0	7.6	0.51
		19 mm inner dia., 4.4 mm thickness	m	17.3	11.9	0.80
		25 mm inner dia., 5.2 mm thickness	m	26.6	18.4	1.2
		32 mm inner dia., 6.7 mm thickness	m	43.9	30.3	2.0
	Nylon	Nylon 66	kg	335	910	22.2
		Sheet - 1.5 mm	m^2	572	1 556	37.9
		Sheet - 3 mm	m^2	1 145	3 113	75.8
		Sheet - 5 mm	m^2	1 908	5 188	126
	Other	Acrylonitrile butadiene styrene (ABS)	kg	270	359	16.0
		Panel - 2mm	m^2	577	767	34.3
		Panel - 3mm	m^2	866	1 151	51.4
		Pipe - 21.4 mm outer dia., 2.1 mm thick	m	36.8	48.9	2.2
		Pipe - 48.3 mm outer dia., 3.6 mm thick	m	146	194	8.7
		Pipe - 168.3 mm outer dia., 7.7 mm thick	m	1 122	1 491	66.6

			Functional Unit	Embodied Energy (MJ)	Embodied Water (L)	Embodied Greenhouse Gas Emissions ($kgCO_2e$)
PLASTICS	**Other**	Ethylene tetrafluoroethylene (ETFE)	kg	12 063	22 606	798
		Film - 25.4 µm	m^2	306	574	20.3
		Film - 50.8 µm	m^2	613	1 148	40.5
		Film - 127 µm	m^2	1 532	2 871	101
		Glass reinforced plastic (GRP)	kg	299	529	18.8
		Panel - 10 mm	m^2	4 037	7 144	254
		Panel - 20 mm	m^2	8 075	14 288	509
		Panel - 50 mm	m^2	20 187	35 719	1 271
		Linoleum	kg	58.2	195	4.4
		Sheet - 2 mm	m^2	140	469	10.6
		Sheet - 2.5 mm	m^2	175	586	13.3
		Sheet - 3.2 mm	m^2	223	750	17.0
		Sheet - 4 mm	m^2	279	937	21.2
		Polycarbonate	kg	190	265	14.0
		Roofing sheet - 1 mm	m^2	228	318	16.7
		Roofing sheet - 2 mm	m^2	457	635	33.5
		Roofing sheet - 3 mm	m^2	685	953	50.2
		Roofing sheet - 6 mm	m^2	1 371	1 905	100
		Polymethyl methacrylate (PMMA)	kg	230	215	15.4
		Sheet - 3 mm	m^2	822	768	54.9
		Sheet - 4 mm	m^2	1 096	1 023	73.2
		Sheet - 5 mm	m^2	1 370	1 279	91.4
		Sheet - 6 mm	m^2	1 644	1 535	110
		Sheet - 8 mm	m^2	2 192	2 047	146
		Sheet - 10 mm	m^2	2 740	2 558	183

			Functional Unit	Embodied Energy (MJ)	Embodied Water (L)	Embodied Greenhouse Gas Emissions ($kgCO_2e$)
PLASTICS	**Polypropylene**	Sheet	kg	159	186	7.4
		Sheet - 2 mm	m^2	287	335	13.4
		Sheet - 3 mm	m^2	431	502	20.0
		Sheet - 4 mm	m^2	574	670	26.7
		Sheet - 6 mm	m^2	861	1 005	40.1
		Sheet - 10 mm	m^2	1 435	1 675	66.8
		Sheet - 12 mm	m^2	1 722	2 010	80.2
		Sheet - 15 mm	m^2	2 153	2 512	100
	Polyurethane	Flexible foam	kg	127	443	7.7
		Underlay - 7 mm, 64 kg/m^3	m^2	56.8	198	3.4
		Underlay - 7 mm, 69 kg/m^3	m^2	61.4	214	3.7
		Underlay - 10 mm, 73 kg/m^3	m^2	92.5	323	5.6
		Underlay - 10 mm, 123 kg/m^3	m^2	156	543	9.4
	Polyvinyl chloride (PVC)	Film	kg	190	758	11.2
		19 µm	m^2	5.0	20.0	0.30
		25 µm	m^2	6.6	26.3	0.39
		uPVC	kg	76.3	561	4.2
		Pipe - 21.35 mm outer dia., 1.8 mm thick	m	11.7	86.2	0.64
		Pipe - 60.25 mm outer dia., 2.6 mm thick	m	50.0	367	2.7
		Pipe - 114.3 mm outer dia., 4.85 mm thick	m	177	1 301	9.7
		Pipe - 225.3 mm outer dia., 11.1 mm thick	m	792	5 826	43.2
SAND, STONE & CERAMICS	**Brick**	General	kg	3.5	1.8	0.32
	Other	Gravel	kg	0.48	1.9	0.036
		Recycled aggregate	kg	0.11	0.10	0.008
		Sand	kg	0.34	1.8	0.024
		Sanitary ceramic	kg	98.0	89.8	6.4
	Stone	Dimension stone	kg	16.3	16.5	1.3
	Tiles	Ceramic tile	kg	18.9	15.2	1.3
		Clay roof tile	kg	7.5	4.7	0.61

			Functional Unit	Embodied Energy (MJ)	Embodied Water (L)	Embodied Greenhouse Gas Emissions ($kgCO_2e$)
TIMBER PRODUCTS	**Cork**	Slab	kg	179	199	9.5
		6 mm	m^2	129	143	6.8
		10 mm	m^2	215	238	11.4
		12 mm	m^2	258	286	13.6
		20 mm	m^2	430	477	22.7
		50 mm	m^2	1 074	1 192	56.8
	Hardwood	Air-dried	m^3	13 632	19 110	944
		Kiln-dried - dressed	m^3	41 597	58 411	2 269
		Kiln-dried - structural	m^3	19 389	25 332	1 178
	Manufactured timber product	Cross laminated timber (CLT)	m^3	9 607	8 608	645
		60 mm	m^2	576	516	38.7
		105 mm	m^2	1 009	904	67.7
		175 mm	m^2	1 681	1 506	113
		Glulam - indoor	m^3	29 996	35 813	1 718
		Glulam - outdoor	m^3	28 279	31 246	1 605
		Laminated veneer lumber (LVL)	m^3	17 479	18 025	1 059
		MDF board	m^3	15 016	8 471	899
		Melamine-coated - 16 mm	m^2	344	283	18.7
		Melamine-coated - 18 mm	m^2	390	323	21.3
		Melamine-coated - 25 mm	m^2	557	453	30.5
		OSB sheet	m^3	14 422	17 997	751
		Particleboard - indoor	m^3	12 717	10 720	696
		Particleboard - outdoor	m^3	15 879	20 491	813
		Plywood - indoor decorative	m^3	63 691	69 363	3 680
		Plywood - outdoor	m^3	26 790	23 083	1 777
		Structural insulated panel (SIP) - 112 mm	m^2	2 624	4 219	135
		142 mm	m^2	3 327	5 349	171
		162 mm	m^2	3 795	6 103	195
	Softwood	Air-dried	m^3	9 392	13 091	549
		Kiln-dried	m^3	9 704	13 181	583

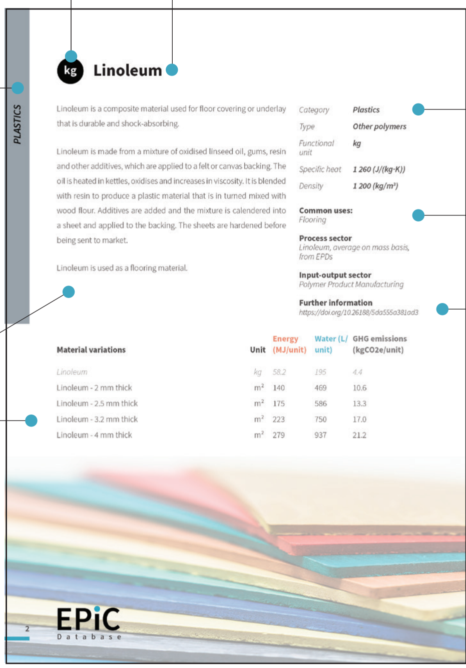
Interpreting EPiC Database Factsheets

Functional unit
This is the base unit of measurement for the material. Coefficients relate to this specific quantity of the material

Material name

Material metadata
A selection of the key characteristics of the material

Material category
The category in which the material is grouped



PLASTICS

kg **Linoleum**

Linoleum is a composite material used for floor covering or underlay that is durable and shock-absorbing.

Linoleum is made from a mixture of oxidised linseed oil, gums, resin and other additives, which are applied to a felt or canvas backing. The oil is heated in kettles, oxidises and increases in viscosity. It is blended with resin to produce a plastic material that is in turned mixed with wood flour. Additives are added and the mixture is calendered into a sheet and applied to the backing. The sheets are hardened before being sent to market.

Linoleum is used as a flooring material.

Category	***Plastics***
Type	***Other polymers***
Functional unit	***kg***
Specific heat	***1 260 (J/(kg·K))***
Density	***1 200 (kg/m³)***

Common uses:
Flooring

Process sector
Linoleum, average on mass basis, from EPDs

Input-output sector
Polymer Product Manufacturing

Further information
https://doi.org/10.26188/5da555a381ad3

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO2e/unit)
Linoleum	*kg*	*58.2*	*195*	*4.4*
Linoleum - 2 mm thick	m^2	140	469	10.6
Linoleum - 2.5 mm thick	m^2	175	586	13.3
Linoleum - 3.2 mm thick	m^2	223	750	17.0
Linoleum - 4 mm thick	m^2	279	937	21.2

EPiC Database

2

Common uses
Some of the most common uses for the material

Description
A description of the material including how it is made and some of its key characteristics

Material variations
These variations provide coefficients for common sizes or thicknesses of the material

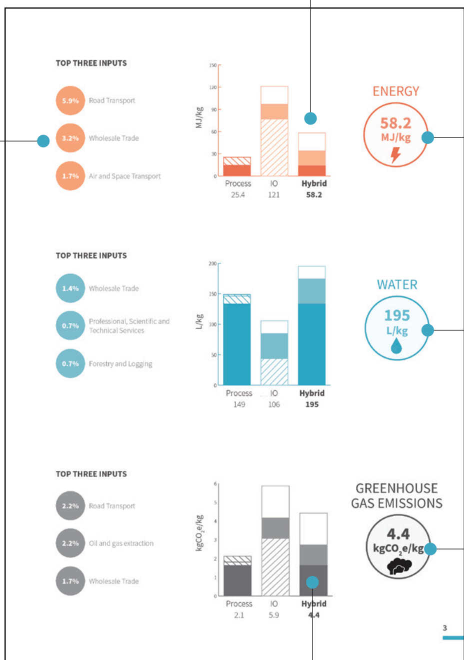
Further information
Additional details about the material's coefficients are available at this link

Coefficient comparison

The material coefficient based on process data or input-output data can be useful for comparing to the final hybrid coefficient

Energy

This is the embodied energy coefficient for the base functional unit of the material



Top three inputs

A list of the inputs associated with the top three flows for the material, showing their contribution as a proportion of the total hybrid environmental flow. Process-based flows are denoted in a darker shade

Water

This is the embodied water coefficient for the base functional unit of the material

Coefficient breakdown

A breakdown of the hybrid coefficient, showing contribution of process and input-output data. Hatched input-output data are those considered equivalent to process data, and thus excluded. White input-output data are inputs outside the scope of the input-output structural path analysis, but subsequently included.

Greenhouse gas emissions

This is the embodied greenhouse gas emissions coefficient for the base functional unit of the material

kg Concrete block

Concrete blocks (also known as concrete masonry units or CMU) are precast rectangular shaped blocks manufactured from concrete. They generally contain one or more hollow cavities, which reduces their weight and makes handling easier. Steel reinforcement is often inserted into these cavities, which are then filled with concrete in situ to provide added strength and loadbearing capacity.

Concrete blocks come in a range of sizes, with typical blocks coming in a length of 390 mm, a height of 190 mm and depth of 90, 140 and 190 mm. Each block weighs around 10 kg and has a minimum strength of 15 MPa. A range of colours and surface textures are available.

Blocks are typically used for internal and external walls in both domestic and commercial construction and can be used with or without mortar for loadbearing and non-loadbearing applications.

Category *Concrete and plaster products*

Type *Concrete*

Functional unit *kg*

Specific heat *1 000 J/(kg·K)*

Density *1 400 kg/m^3*

Common uses
External walls, internal walls, landscaping

Process name
Concrete block, at plant/DE U/AusSD U

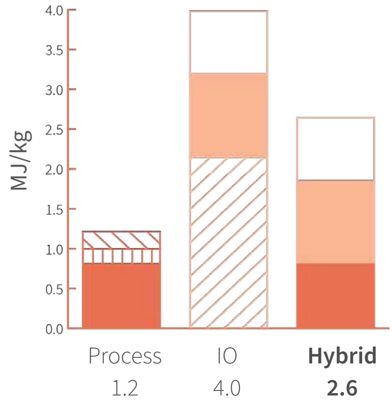
Input-output sector
Plaster and Concrete Product Manufacturing

Further information
doi.org/10.26188/5da552ea39cdc

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO$_2$e/unit)
Concrete block	*kg*	*2.6*	*3.7*	*0.2*
Concrete block - 390 × 190 × 90 mm	no.	24.3	34.2	2.2
Concrete block - 390 × 190 × 140 mm	no.	29.6	41.6	2.7
Concrete block - 390 × 190 × 190 mm	no.	35.2	49.4	3.2

TOP THREE INPUTS

- **6.7%** Road Transport
- **6.1%** Structural Metal Product Manufacturing
- **5.6%** Basic Chemical Manufacturing

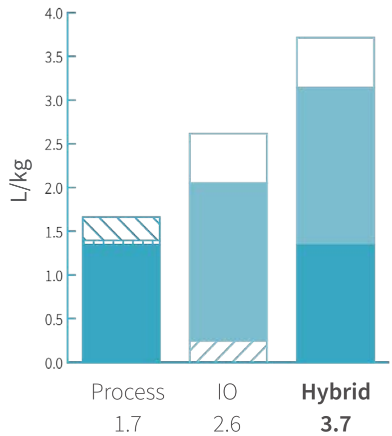


ENERGY

2.6 MJ/kg

TOP THREE INPUTS

- **7.5%** Tanned Leather, Dressed Fur and Leather Product Manufacturing
- **5.0%** Structural Metal Product Manufacturing
- **3.3%** Meat and Meat product Manufacturing

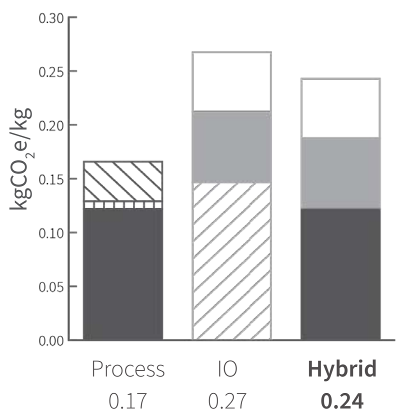


WATER

3.7 L/kg

TOP THREE INPUTS

- **4.1%** Structural Metal Product Manufacturing
- **3.5%** Basic Chemical Manufacturing
- **2.4%** Oil and gas extraction



GREENHOUSE GAS EMISSIONS

0.24 $kgCO_2e/kg$

kg Cement mortar

Cement mortar contains Portland cement, sand and hydrated lime. It is used as a bonding layer for bricks, masonry blocks and stonework.

It is generally available in bags (usually up to 20 kg) and is mixed with water on site to form a highly workable paste. Once cured, it becomes hard but is designed to be weaker than the masonry elements it is used with.

A range of mortar types are available, ranging in strength depending on the mix ratio, with stronger mortars containing a higher proportion of cement. Mortars containing alternative binders are also available, including polymer cement and lime mortars.

Category	*Concrete and plaster products*
Type	*Other minerals*
Functional unit	*kg*
Specific heat	*837 J/(kg·K)*
Density	*1 858 kg/m^3*

Common uses
Bonding masonry walls, pointing, render

Process name
Cement mortar, at plant/CH U/AusSD U

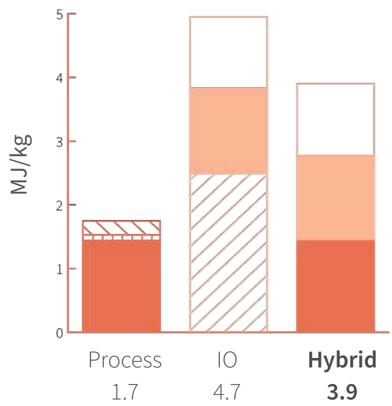
Input-output sector
Cement, Lime and Ready-Mixed Concrete Manufacturing

Further information
doi.org/10.26188/5da5528f75432

EPiC Database

TOP THREE INPUTS

- **14.2%** Road Transport
- **2.7%** Petroleum and Coal Product Manufacturing
- **1.5%** Non Ferrous Metal Ore Mining

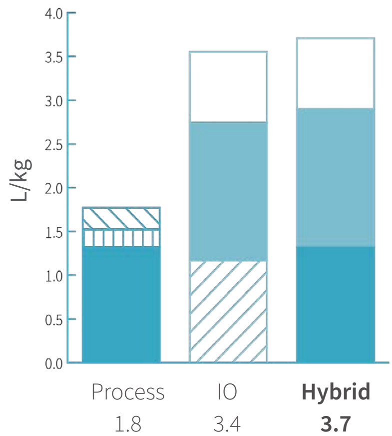


ENERGY

3.9
MJ/kg

TOP THREE INPUTS

- **4.1%** Non Ferrous Metal Ore Mining
- **2.2%** Professional, Scientific and Technical Services
- **2.1%** Road Transport

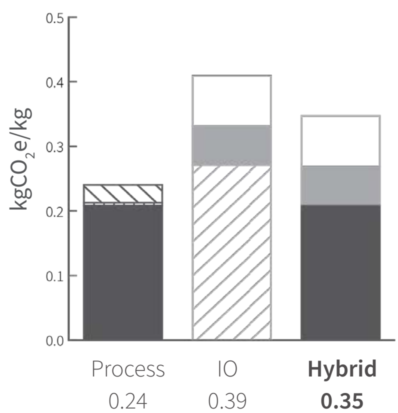


WATER

3.7
L/kg

TOP THREE INPUTS

- **4.8%** Road Transport
- **1.4%** Non Ferrous Metal Ore Mining
- **0.9%** Petroleum and Coal Product Manufacturing



GREENHOUSE GAS EMISSIONS

0.35
$kgCO_2e/kg$

kg Portland cement

Portland cement (also known as common or general-purpose cement) is manufactured from limestone, clay and gypsum. A range of additional minerals or additives can be added to control the properties of the finished cement.

Limestone and other raw materials are heated at over 1 000°C to produce clinker. The clinker is then mixed with gypsum and ground into a fine powder to produce Portland cement.

Portland cement is typically used as a binder for concrete and cement-based products, such as fibre cement sheet and cement mortar. When mixed with water it forms a workable slurry that undergoes a process known as hydration, setting within a few hours and forming its final hardened state within weeks.

Category	*Concrete and plaster products*
Type	*Other minerals*
Functional unit	*kg*
Specific heat	*920 J/(kg·K)*
Density	*1 500 kg/m^3*

Common uses
Concrete, fibre cement sheet, fibre cement weatherboard, cement mortar, cement render

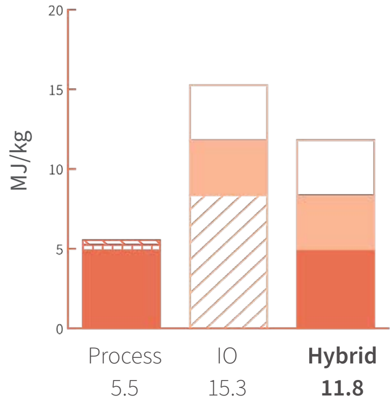
Process name
Ordinary portland cement, at plant/AU U

Input-output sector
Cement, Lime and Ready-Mixed Concrete Manufacturing

Further information
doi.org/10.26188/5da55701cee5d

TOP THREE INPUTS

- **37.7%** Clinker, at plant/AU U
- **15.3%** Road Transport
- **3.7%** Electricity, low voltage, Australian/AU U

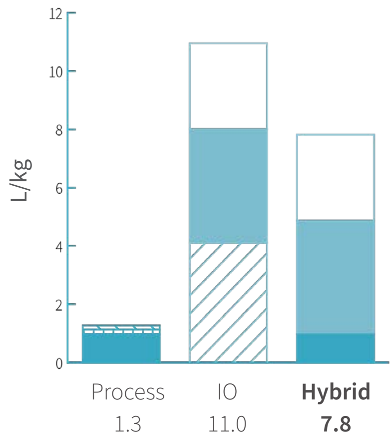


ENERGY

11.8
MJ/kg

TOP THREE INPUTS

- **11.7%** Clinker, at plant/AU U
- **3.2%** Professional, Scientific and Technical Services
- **2.9%** Road Transport

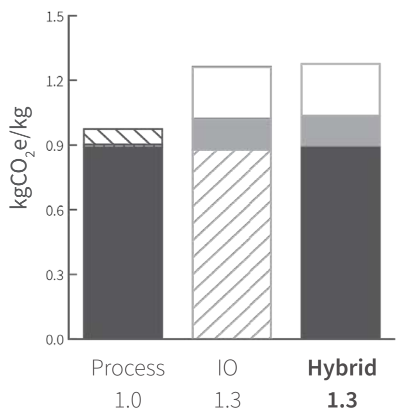


WATER

7.8
L/kg

TOP THREE INPUTS

- **68.1%** Clinker, at plant/AU U
- **4.2%** Road Transport
- **1.7%** Electricity, low voltage, Australian/AU U



GREENHOUSE GAS EMISSIONS

1.3
$kgCO_2e/kg$

kg Autoclaved aerated concrete (AAC)

Autoclaved Aerated Concrete, also known as AAC, is a lightweight concrete product manufactured from cement, water, aluminium powder and sand. Hydrogen gas is used to create air bubbles in the mix. AAC is generally rated at 8 MPa, with up to 80% of its volume made up of air.

Its lightweight nature, which is 20% lighter than standard concrete, makes it easier to work with. AAC materials can be sanded and cut to size using standard power tools and have superior thermal properties to standard concrete.

AAC comes in a variety of product types, including blocks and panels. AAC blocks are typically used for domestic wall construction and are available as a 600 mm wide and 200 mm high block in thicknesses ranging from 50 to 300 mm. Blocks can be used for loadbearing walls up to three storeys. Panels are often used for both wall and floor construction in residential and commercial applications. They are 600 mm wide, 75 mm thick and come in lengths ranging from 1800 to 4 800 mm.

Category *Concrete and Plaster Products*

Type *Concrete*

Functional unit *kg*

Specific heat *880 J/(kg·K)*

Density *550 kg/m^3*

Common uses
External walls, internal walls, floors

Process name
Autoclaved aerated concrete block, at plant/CH U/AusSD U

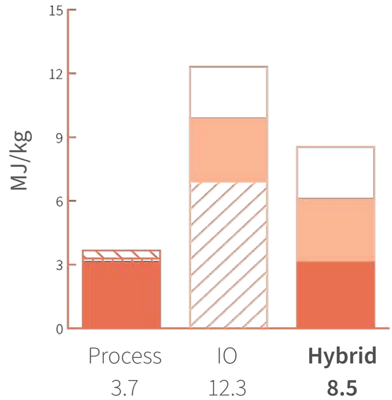
Input-output sector
Plaster and Concrete Product Manufacturing

Further information
doi.org/10.26188/5da551fc254d7

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO$_2$e/unit)
Autoclaved aerated concrete (AAC)	*kg*	*8.5*	*8.4*	*0.7*
AAC block - 600 × 200 × 100 mm	no.	56.4	55.4	4.7
AAC block - 600 × 200 × 150 mm	no.	84.5	83.0	7.0
AAC block - 600 × 200 × 200 mm	no.	113	111	9.4

TOP THREE INPUTS

- **6.4%** Road Transport
- **5.8%** Structural Metal Product Manufacturing
- **5.4%** Basic Chemical Manufacturing

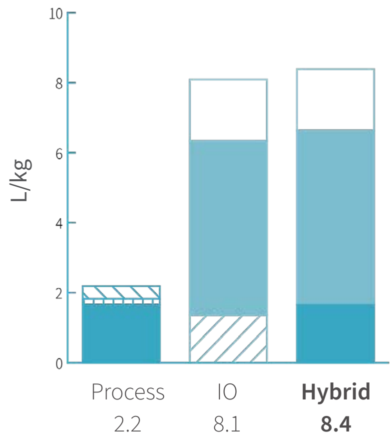


ENERGY

8.5
MJ/kg

TOP THREE INPUTS

- **10.2%** Tanned Leather, Dressed Fur and Leather Product Manufacturing
- **8.3%** Sand, at mine/CH U/AusSD U
- **6.9%** Structural Metal Product Manufacturing

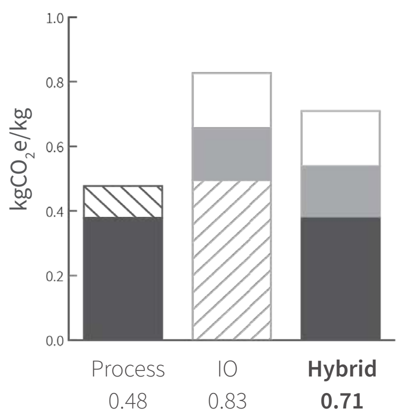


WATER

8.4
L/kg

TOP THREE INPUTS

- **4.3%** Structural Metal Product Manufacturing
- **3.7%** Basic Chemical Manufacturing
- **2.2%** Road Transport



GREENHOUSE GAS EMISSIONS

0.71
$kgCO_2e/kg$

m³ Concrete 20 MPa

Concrete is a composite material combining sand or other fine aggregates, coarse aggregates, a binder and water. Portland cement is the most commonly used binder, however other binders, such as polymers, may also be used. Supplementary Cementitious Materials (SCM) such as Fly Ash and Ground, Granulated Blast Furnace Slag (GGBFS), are also commonly used as a part replacement for Portland cement. Additives, such as plasticisers can be added to the mix to control concrete properties, such as workability. Concrete is usually combined with steel reinforcement to improve tensile strength.

Concrete is one of the most commonly used construction materials. It is highly durable and is thus typically used for structural elements in buildings and infrastructure projects. Concrete can be manufactured to meet a variety of strength grades. Concrete 20 MPa is commonly used in domestic floor construction, garage floors and driveways, where the loads supported are lighter. The typical mix ratio is 1:1.5:3 (cement, sand, coarse aggregate).

Category *Concrete and Plaster Products*

Type *Concrete*

Functional unit *m^3*

Specific heat *880 J/(kg·K)*

Density *2 335 kg/m^3*

Common uses
Floor slabs, suspended slabs, driveways, precast wall panels

Process name
Concrete 20 MPa, at batching plant/ AU U

Input-output sector
Cement, Lime and Ready-Mixed Concrete Manufacturing

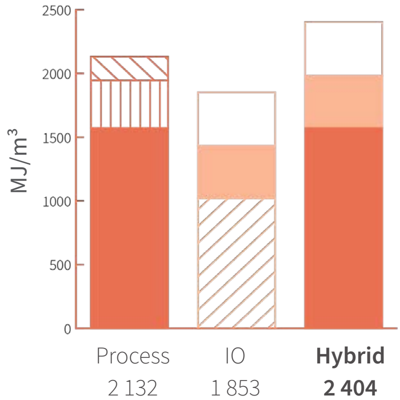
Further information
doi.org/10.26188/5da54a205d0e5

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Concrete 20 MPa	*m^3*	*2 404*	*4 154*	*328*
Concrete 20 MPa - 30% fly ash	m^3	2 026	4 011	251
Concrete 20 MPa - 30% GGBFS	m^3	2 186	4 034	263

EPiC Database

TOP THREE INPUTS

- **9.1%** Road Transport
- **1.2%** Sand, at mine/CH U/AusSD U
- **0.9%** Diesel, burned in building machine/GLO U/AusSD U

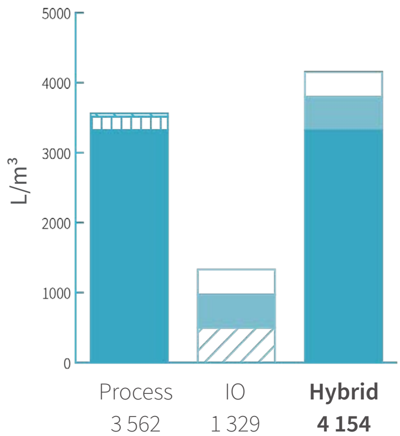


ENERGY

2 404
MJ/m³

TOP THREE INPUTS

- **22.8%** Sand, at mine/CH U/AusSD U
- **3.4%** Tap water, at user, Australia/ AU U
- **0.7%** Professional, Scientific and Technical Services

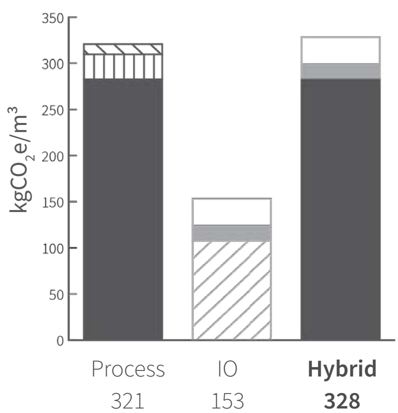


WATER

4 154
L/m³

TOP THREE INPUTS

- **2.0%** Road Transport
- **0.8%** Sand, at mine/CH U/AusSD U
- **0.5%** Diesel, burned in building machine/GLO U/AusSD U



GREENHOUSE GAS EMISSIONS

328
$kgCO_2e/m^3$

m³ Concrete 25 MPa

Concrete is a composite material combining sand or other fine aggregates, coarse aggregates, a binder and water. Portland cement is the most commonly used binder, however other binders, such as polymers, may also be used. Supplementary Cementitious Materials (SCM) such as Fly Ash and Ground, Granulated Blast Furnace Slag (GGBFS), are also commonly used as a part replacement for Portland cement. Additives, such as plasticisers can be added to the mix to control concrete properties, such as workability. Concrete is usually combined with steel reinforcement to improve tensile strength.

Concrete is one of the most commonly used construction materials. It is highly durable and is thus typically used for structural elements in buildings and infrastructure projects. Concrete can be manufactured to meet a variety of strength grades. Concrete 25 MPa is commonly used in domestic and commercial floor construction and is considered to be a multi-purpose concrete mix. The typical mix ratio is 1:1:2 (cement, sand, coarse aggregate).

Category	*Concrete and Plaster Products*
Type	*Concrete*
Functional unit	*m^3*
Specific heat	*880 J/(kg·K)*
Density	*2 409 kg/m^3*

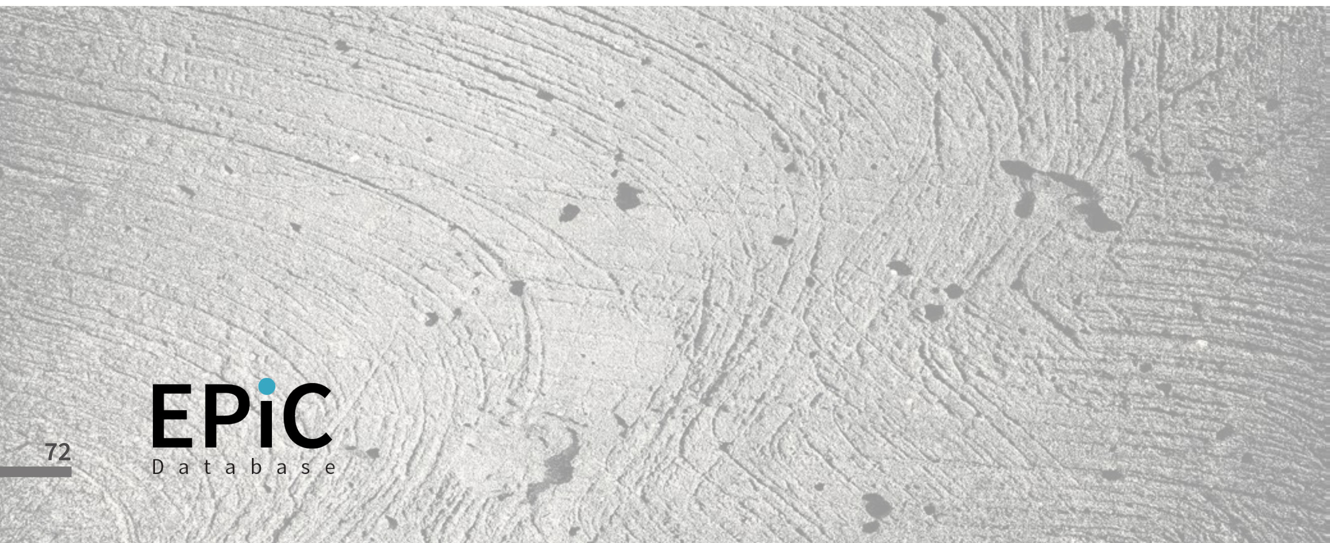
Common uses
Floor slabs, suspended slabs, precast wall panels

Process name
Concrete 25 MPa, at batching plant/ AU U

Input-output sector
Cement, Lime and Ready-Mixed Concrete Manufacturing

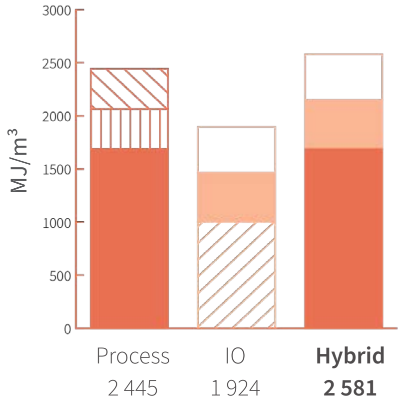
Further information
doi.org/10.26188/5da54a4ae57a1

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Concrete 25 MPa	*m^3*	*2 581*	*4 196*	*361*
Concrete 25 MPa - 30% fly ash	m^3	2 241	4 028	277
Concrete 25 MPa - 30% GGBFS	m^3	2 441	4 105	293



TOP THREE INPUTS

- **8.8%** Road Transport
- **1.0%** Sand, at mine/CH U/AusSD U
- **0.9%** Non Ferrous Metal Ore Mining

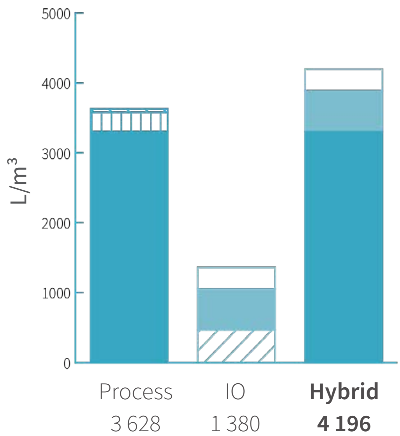


ENERGY

2 581 MJ/m³

TOP THREE INPUTS

- **22.2%** Sand, at mine/CH U/AusSD U
- **3.4%** Tap water, at user, Australia/ AU U
- **1.5%** Non Ferrous Metal Ore Mining

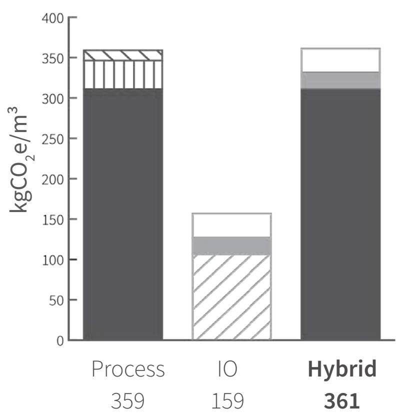


WATER

4 196 L/m³

TOP THREE INPUTS

- **1.9%** Road Transport
- **0.7%** Sand, at mine/CH U/AusSD U
- **0.6%** Non Ferrous Metal Ore Mining



GREENHOUSE GAS EMISSIONS

361 $kgCO_2e/m^3$

m³ Concrete 32 MPa

Concrete is a composite material combining sand or other fine aggregates, coarse aggregates, a binder and water. Portland cement is the most commonly used binder, however other binders, such as polymers, may also be used. Supplementary Cementitious Materials (SCM) such as Fly Ash and Ground, Granulated Blast Furnace Slag (GGBFS), are also commonly used as a part replacement for Portland cement. Additives, such as plasticisers can be added to the mix to control concrete properties, such as workability. Concrete is usually combined with steel reinforcement to improve tensile strength.

Concrete is one of the most commonly used construction materials. It is highly durable and is thus typically used for structural elements in buildings and infrastructure projects. Concrete can be manufactured to meet a variety of strength grades. Concrete 32 MPa is commonly used in commercial and civil construction, for structural piling, floor slabs, external walls, paths and roads, where increased durability, weather-resistance and load-bearing capacity are required.

Category *Concrete and Plaster Products*

Type *Concrete*

Functional unit *m^3*

Specific heat *880 J/(kg·K)*

Density *2 327 kg/m^3*

Common uses
Floor slabs, suspended slabs, precast wall panels, in situ loadbearing walls, structural piling, roads, footpaths

Process name
Concrete 32 MPa, at batching plant/AU U

Input-output sector
Cement, Lime and Ready-Mixed Concrete Manufacturing

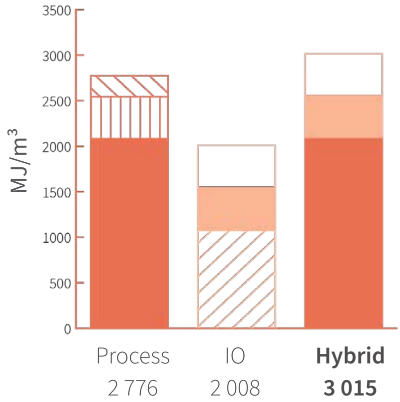
Further information
doi.org/10.26188/5da550538b369

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Concrete 32 MPa	*m^3*	*3 015*	*4 300*	*416*
Concrete 32 MPa - 30% fly ash	m^3	2 484	4 066	314
Concrete 32 MPa - 30% GGBFS	m^3	2 704	4 103	331

EPiC Database

TOP THREE INPUTS

- **7.9%** Road Transport
- **0.9%** Sand, at mine/CH U/AusSD U
- **0.8%** Non Ferrous Metal Ore Mining

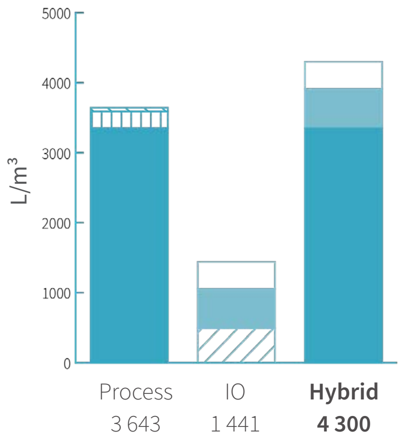


ENERGY

3 015
MJ/m³

TOP THREE INPUTS

- **20.8%** Sand, at mine/CH U/AusSD U
- **3.6%** Tap water, at user, Australia/AU U
- **1.4%** Non Ferrous Metal Ore Mining

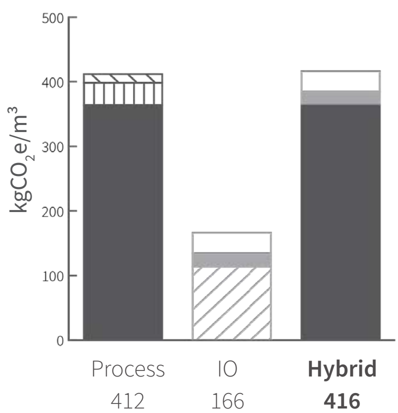


WATER

4 300
L/m³

TOP THREE INPUTS

- **1.7%** Road Transport
- **0.6%** Sand, at mine/CH U/AusSD U
- **0.5%** Non Ferrous Metal Ore Mining



GREENHOUSE GAS EMISSIONS

416
$kgCO_2e/m^3$

m^3 Concrete 40 MPa

Concrete is a composite material combining sand or other fine aggregates, coarse aggregates, a binder and water. Portland cement is the most commonly used binder, however other binders, such as polymers, may also be used. Supplementary Cementitious Materials (SCM) such as Fly Ash and Ground, Granulated Blast Furnace Slag (GGBFS), are also commonly used as a part replacement for Portland cement. Additives, such as plasticisers can be added to the mix to control concrete properties, such as workability. Concrete is usually combined with steel reinforcement to improve tensile strength.

Concrete is one of the most commonly used construction materials. It is highly durable and is thus typically used for structural elements in buildings and infrastructure projects. Concrete can be manufactured to meet a variety of strength grades. Concrete 40 MPa is commonly used in commercial and civil construction, for structural beams and columns, where increased durability and load-bearing capacity are required.

Category *Concrete and Plaster Products*

Type *Concrete*

Functional unit *m^3*

Specific heat *880 J/(kg·K)*

Density *2 400 kg/m^3*

Common uses
Structural beams, structural columns, in situ loadbearing walls, structural piling

Process name
Concrete 40 MPa, at batching plant/ AU U

Input-output sector
Cement, Lime and Ready-Mixed Concrete Manufacturing

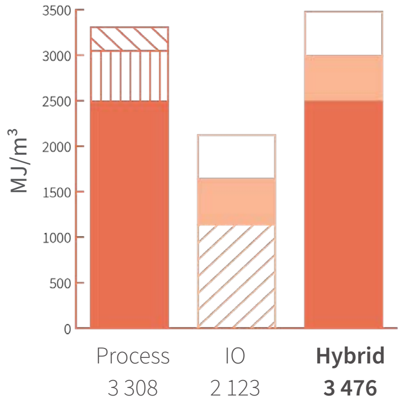
Further information
doi.org/10.26188/5da5507e33fe6

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Concrete 40 MPa	*m^3*	*3 476*	*4 355*	*497*
Concrete 40 MPa - 30% fly ash	m^3	2 854	4 075	373
Concrete 40 MPa - 30% GGBFS	m^3	3 106	4 120	392

EPiC Database

TOP THREE INPUTS

- **7.2%** Road Transport
- **0.8%** Non Ferrous Metal Ore Mining
- **0.7%** Sand, at mine/CH U/AusSD U

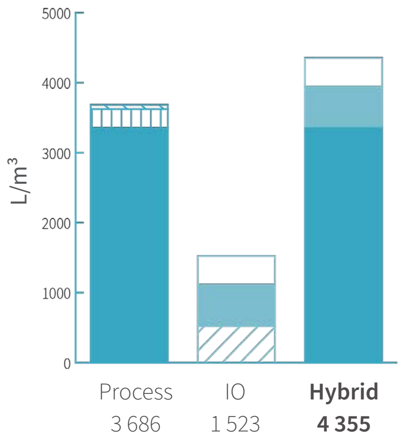


ENERGY

3 476
MJ/m³

TOP THREE INPUTS

- **19.4%** Sand, at mine/CH U/AusSD U
- **3.9%** Tap water, at user, Australia/ AU U
- **1.5%** Non Ferrous Metal Ore Mining

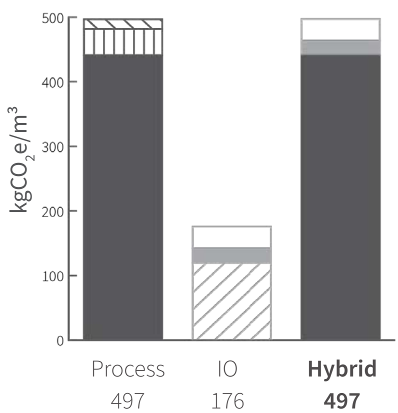


WATER

4 355
L/m³

TOP THREE INPUTS

- **1.5%** Road Transport
- **0.5%** Non Ferrous Metal Ore Mining
- **0.4%** Sand, at mine/CH U/AusSD U



GREENHOUSE GAS EMISSIONS

497
$kgCO_2e/m^3$

m³ Concrete 50 MPa

Concrete is a composite material combining sand or other fine aggregates, coarse aggregates, a binder and water. Portland cement is the most commonly used binder, however other binders, such as polymers, may also be used. Supplementary Cementitious Materials (SCM) such as Fly Ash and Ground, Granulated Blast Furnace Slag (GGBFS), are also commonly used as a part replacement for Portland cement. Additives, such as plasticisers can be added to the mix to control concrete properties, such as workability. Concrete is usually combined with steel reinforcement to improve tensile strength.

Concrete is one of the most commonly used construction materials. It is highly durable and is thus typically used for structural elements in buildings and infrastructure projects. Concrete can be manufactured to meet a variety of strength grades. Concrete 50 MPa is commonly used in commercial and civil construction where high strength and durability are required. The mix will generally have a lower water to cement ratio than standard concrete.

Category	*Concrete and Plaster Products*
Type	*Concrete*
Functional unit	*m^3*
Specific heat	*880 J/(kg·K)*
Density	*2 332 kg/m^3*

Common uses
Structural beams, structural columns, in situ loadbearing walls, structural piling

Process name
Concrete 50 MPa, at batching plant/ AU U

Input-output sector
Cement, Lime and Ready-Mixed Concrete Manufacturing

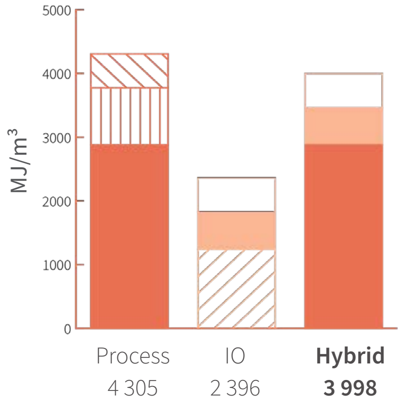
Further information
doi.org/10.26188/5da5514c0eea5

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Concrete 50 MPa	*m^3*	*3 998*	*4 365*	*600*
Concrete 50 MPa - 30% fly ash	m^3	3 634	4 246	467
Concrete 50 MPa - 30% GGBFS	m^3	3 958	4 325	492

EPiC Database

TOP THREE INPUTS

- **7.1%** Road Transport
- **0.8%** Non Ferrous Metal Ore Mining
- **0.7%** Basic Chemical Manufacturing

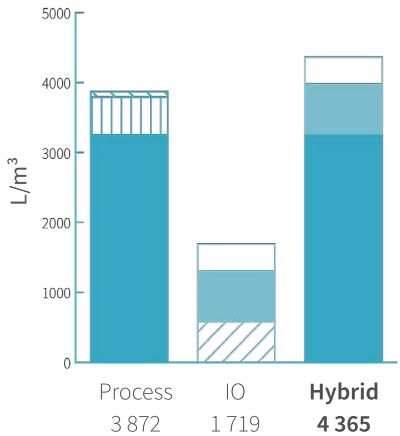


ENERGY

3 998
MJ/m³

TOP THREE INPUTS

- **18.0%** Sand, at mine/CH U/AusSD U
- **4.1%** Tap water, at user, Australia/ AU U
- **1.8%** Non Ferrous Metal Ore Mining

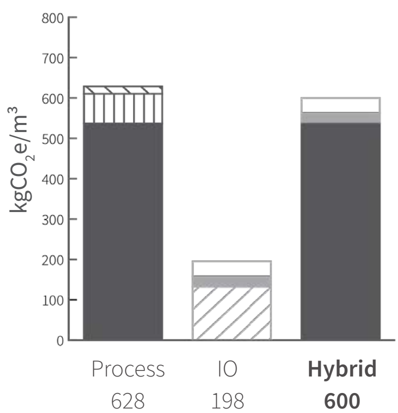


WATER

4 365
L/m³

TOP THREE INPUTS

- **1.4%** Road Transport
- **0.4%** Non Ferrous Metal Ore Mining
- **0.3%** Sand, at mine/CH U/AusSD U



GREENHOUSE GAS EMISSIONS

600
$kgCO_2e/m^3$

kg Fibre cement sheet

Fibre cement sheet is a non-structural material manufactured from Portland cement, cellulose fibres and water. Sheets come in standard sizes, generally 1 800 to 3 000 mm in length, 900 or 1 200 mm wide and in thicknesses ranging from 4.5 mm to 24 mm. They can be easily cut to size on site. Thicker boards provide superior impact resistance while thinner boards are typically used in situations where impact resistance is not as crucial.

Thermal and acoustic performance is generally poor and additional insulation is usually needed when used as external cladding. However, it is termite and rot resistant and has very high fire resistance properties.

Fibre cement sheet is often used as a replacement for plasterboard, particularly in situations that are exposed to water (such as wet areas). It can be used for both residential and commercial buildings in a range of applications, including internal and external cladding, soffit linings and structural bracing.

Category	*Concrete and plaster products*
Type	*Fibre cement*
Functional unit	*kg*
Specific heat	*832 J/(kg·K)*
Density	*1 445 kg/m³*

Common uses
Internal wall lining, external wall cladding, soffit lining, structural bracing

Process name
Fibre cement roof slate, at plant/CH U/AusSD U

Input-output sector
Other Non-Metallic Mineral Product Manufacturing

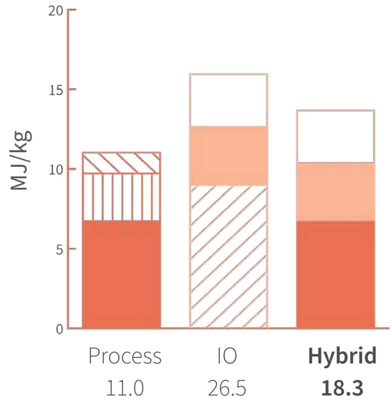
Further information
doi.org/10.26188/5da554545f280

Material variations	**Unit**	**Energy (MJ/unit)**	**Water (L/unit)**	**GHG emissions ($kgCO_2e$/unit)**
Fibre cement sheet	*kg*	*18.3*	*19.8*	*1.6*
Fibre cement sheet - 4.5 mm	m^2	119	129	10.1
Fibre cement sheet - 6 mm	m^2	159	172	13.5
Fibre cement sheet - 7.5 mm	m^2	198	214	16.9
Fibre cement sheet - 18 mm	m^2	475	514	40.6
Fibre cement sheet - 24 mm	m^2	634	686	54.2

EPiC Database

TOP THREE INPUTS

- **12.1%** Road Transport
- **6.1%** Structural Metal Product Manufacturing
- **3.2%** Non Ferrous Metal Ore Mining

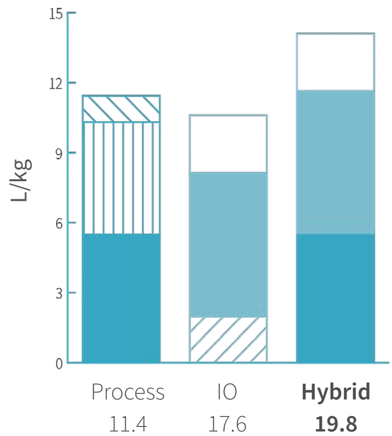


ENERGY

18.3 MJ/kg

TOP THREE INPUTS

- **9.0%** Tanned Leather, Dressed Fur and Leather Product Manufacturing
- **7.1%** Non Ferrous Metal Ore Mining
- **6.6%** Structural Metal Product Manufacturing

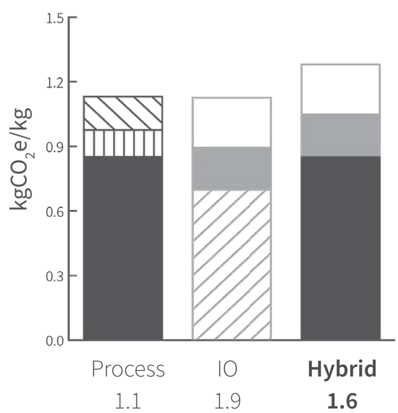


WATER

19.8 L/kg

TOP THREE INPUTS

- **4.4%** Structural Metal Product Manufacturing
- **4.2%** Road Transport
- **3.1%** Non Ferrous Metal Ore Mining



GREENHOUSE GAS EMISSIONS

1.6 $kgCO_2e/kg$

kg Fibre cement weatherboard

Fibre cement weatherboards are a non-structural material manufactured from Portland cement, cellulose fibres and water. Boards generally come in 4 200 mm lengths, in widths from 150 to 300 mm and in thicknesses ranging from 7.5 mm to 16 mm. They can be easily cut to size on site. Thicker boards provide superior impact resistance while thinner boards are typically used in situations where impact resistance is not as crucial. They come in a range of textured finishes.

Fibre cement weatherboards are used as an external wall cladding. Each board is installed to overlap the board below, and as such, the effective wall coverage area is typically 80-90% of the actual area of boards used.

Thermal and acoustic performance is generally poor and additional insulation is usually needed. However, it is termite and rot resistant and has very high fire resistance properties.

Category *Concrete and plaster products*

Type *Fibre cement*

Functional unit *kg*

Specific heat *832 J/(kg·K)*

Density *1 445 kg/m^3*

Common uses
External wall cladding

Process name
Fibre cement facing tile, at plant/CH U/AusSD U

Input-output sector
Other Non-Metallic Mineral Product Manufacturing

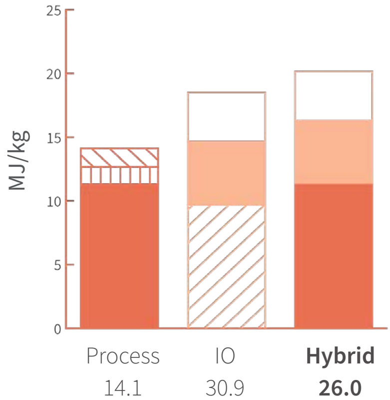
Further information
doi.org/10.26188/5da55463adae0

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO$_2$e/unit)
Fibre cement weatherboard	*kg*	*26.0*	*31.3*	*2.2*
205 × 7.5 mm - per m^2 wall	m^2	304	365	26
230 × 7.5 mm - per m^2 wall	m^2	284	341	24.2
300 × 7.5 mm - per m^2 wall	m^2	294	354	25.2
150 × 16 mm - per m^2 wall	m^2	549	660	46.9
180 × 16 mm - per m^2 wall	m^2	549	660	46.9

EPiC Database

TOP THREE INPUTS

- **30.9%** Fibre cement facing tile, large format, at plant/CH U/AusSD U
- **12.5%** Fibre cement facing tile, small format, at plant/CH U/AusSD U
- **9.9%** Road Transport

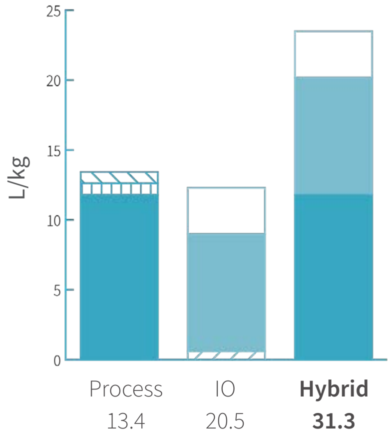


ENERGY

26.0
MJ/kg

TOP THREE INPUTS

- **25.6%** Fibre cement facing tile, large format, at plant/CH U/AusSD U
- **13.3%** Non Metallic Mineral Mining
- **12.1%** Fibre cement facing tile, small format, at plant/CH U/AusSD U

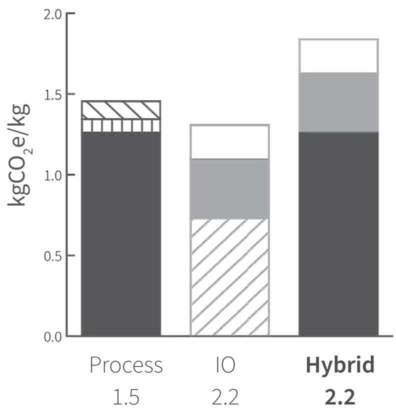


WATER

31.3
L/kg

TOP THREE INPUTS

- **39.6%** Fibre cement facing tile, large format, at plant/CH U/AusSD U
- **17.1%** Fibre cement facing tile, small format, at plant/CH U/AusSD U
- **6.7%** Non Metallic Mineral Mining



GREENHOUSE GAS EMISSIONS

2.2
kgCO_2e/kg

kg Gypsum plaster

Gypsum plaster (traditionally known as plaster of Paris) is manufactured from gypsum rock and additives. The gypsum is heated to produce a dry plaster powder. It is then mixed with water to form a highly workable paste, which then hardens. It is a non-loadbearing material that is commonly used as a protective or decorative coating for walls and ceilings and for moulding and casting decorative building elements.

Gypsum plaster is often used to simulate other materials, such as timber, metal and stone, due to its ability to be formed into any shape, which can be easily sanded. It is also a core material for plasterboard and other plaster-based products, such as cornices. Alternative forms of plaster include lime and cement-based plasters.

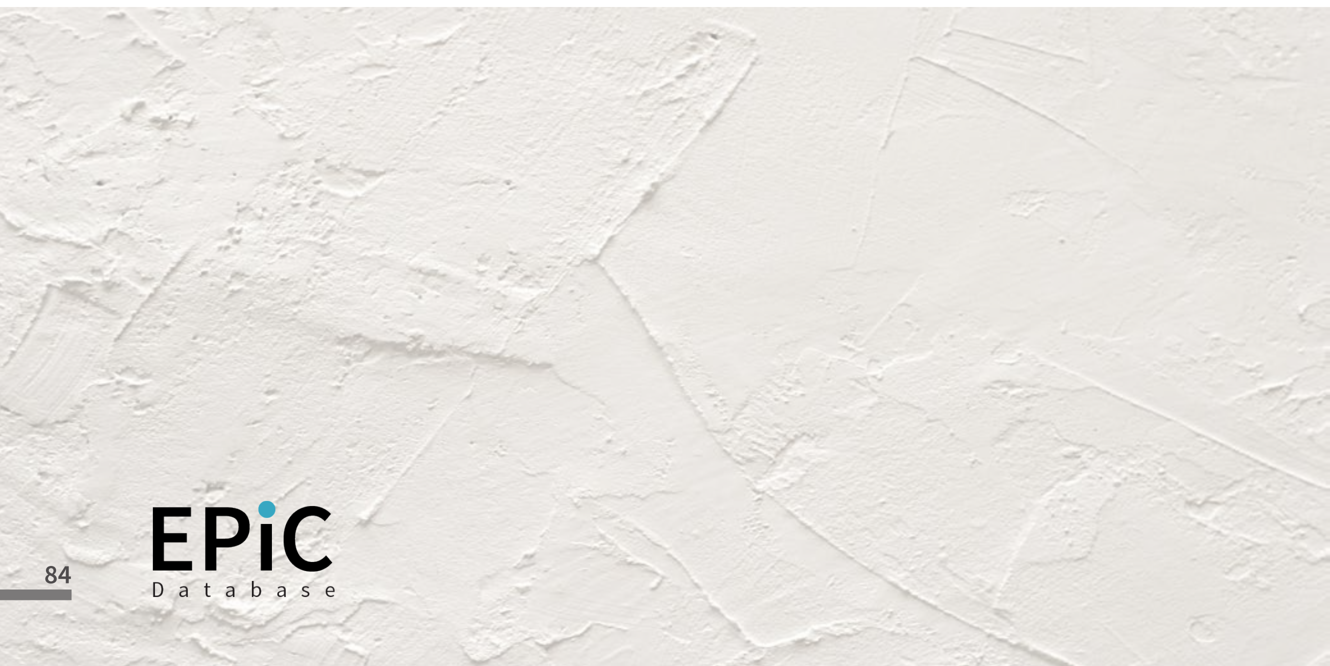
Category	*Concrete and plaster products*
Type	*Plaster*
Functional unit	*kg*
Specific heat	*840 J/(kg·K)*
Density	*1 956 kg/m^3*

Common uses
Decorative building elements, plasterboard, plaster cornices, filling gaps, wall finish

Process name
Stucco, at plant/CH U/AusSD U

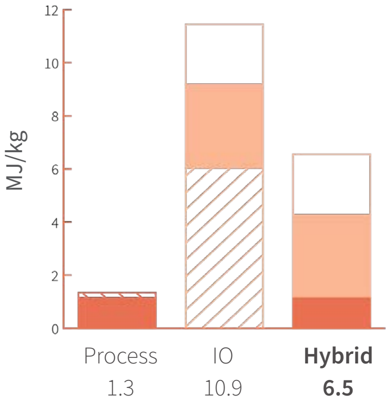
Input-output sector
Plaster and Concrete Product Manufacturing

Further information
doi.org/10.26188/5da554d7d6197



TOP THREE INPUTS

- 7.4% Road Transport
- 6.7% Structural Metal Product Manufacturing
- 6.2% Basic Chemical Manufacturing

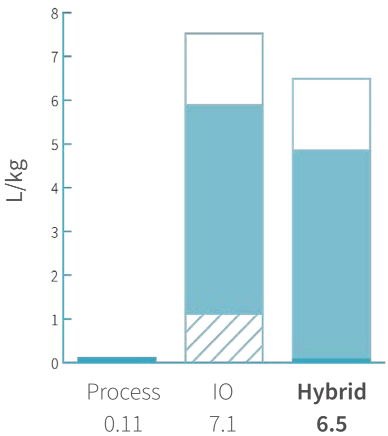


ENERGY

6.5
MJ/kg

TOP THREE INPUTS

- 11.6% Tanned Leather, Dressed Fur and Leather Product Manufacturing
- 7.8% Structural Metal Product Manufacturing
- 5.2% Meat and Meat product Manufacturing

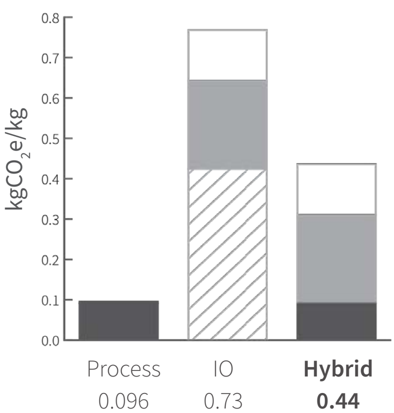


WATER

6.5
L/kg

TOP THREE INPUTS

- 8.7% Cement, Lime and Ready-Mixed Concrete Manufacturing
- 7.2% Structural Metal Product Manufacturing
- 5.7% Basic Chemical Manufacturing



GREENHOUSE GAS EMISSIONS

0.44
$kgCO_2e/kg$

m² Plasterboard - 10 mm

Plasterboard, also known as gypsum board, is a wall and ceiling lining material manufactured from gypsum, water and paper. A gypsum-based plaster is sandwiched between two layers of paper. The plaster often contains a paper or fibreglass fibre as well as various additives. After the plaster sets it is then dried in a large drying chamber. It is then cured at high temperatures before being cut to size.

Plasterboard is used to provide a lining for internal walls and ceilings. A variety of product types are available, including acoustic-rated, fire-rated and moisture-resistant plasterboard. It is typically finished with paint once installed. It has a relatively low durability and is thus easily damaged, but can usually be repaired with gypsum plaster products. It comes in standard sizes, typically 1 200 × 2 400 mm, 1 200 × 4 800 mm and 1 200 × 6 000 mm and 10 or 13 mm thick. The 13 mm board is generally used in commercial applications due to its better durability and acoustic properties.

Category *Concrete and plaster products*

Type *Plaster*

Functional unit *m^2*

Specific heat *1 225 J/(kg·K)*

Density *570 kg/m^3*

Common uses
Internal wall lining, internal ceiling lining

Process name
Plasterboard 10 mm, at regional store/AU U

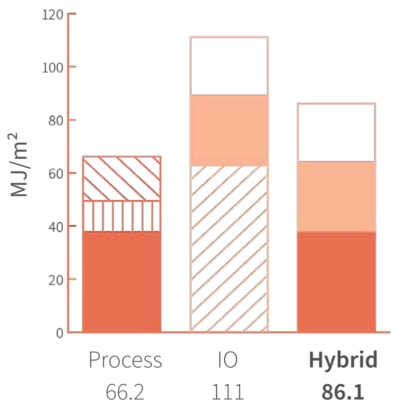
Input-output sector
Plaster and Concrete Product Manufacturing

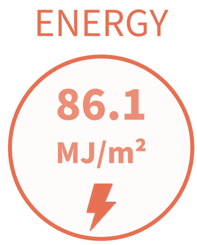
Further information
doi.org/10.26188/5da556516b6e3

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO$_2$e/unit)
Plasterboard - 10 mm	*m^2*	*86.1*	*85.6*	*5.8*
Plasterboard - 13 mm	m^2	95.7	97.9	6.5

TOP THREE INPUTS

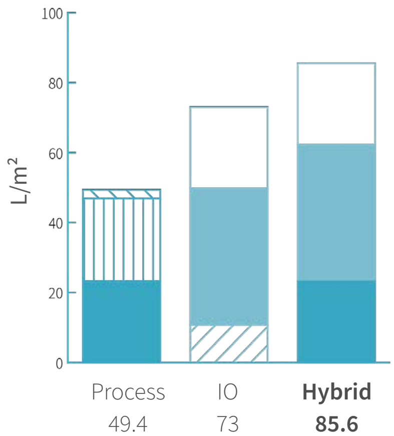
- **5.8%** Road Transport
- **5.2%** Structural Metal Product Manufacturing
- **4.8%** Cement, Lime and Ready-Mixed Concrete Manufacturing

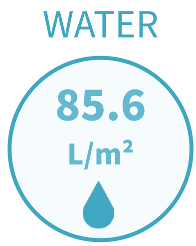




TOP THREE INPUTS

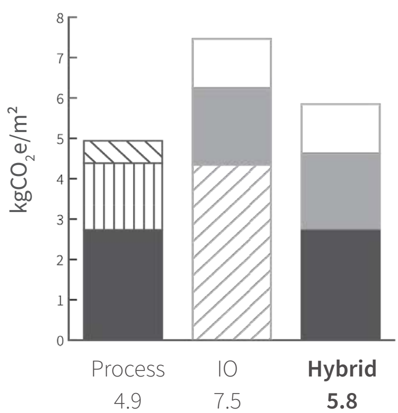
- **8.8%** Tanned Leather, Dressed Fur and Leather Product Manufacturing
- **5.1%** Structural Metal Product Manufacturing
- **3.9%** Meat and Meat product Manufacturing

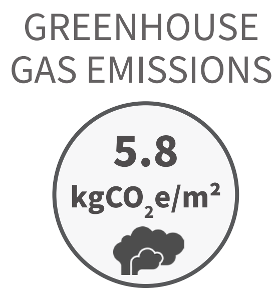




TOP THREE INPUTS

- **6.6%** Cement, Lime and Ready-Mixed Concrete Manufacturing
- **5.5%** Structural Metal Product Manufacturing
- **2.7%** Road Transport





kg Concrete roof tile

Concrete roof tiles are a roof cladding material manufactured from concrete. A concrete mix, containing sand, cement and water is extruded into moulds and kiln dried for a number of hours. Concrete roof tiles come in a range of colours and profiles with a typical weight of around 5 kg per tile and an average thickness of around 20 mm. A range of capping tiles are also available for ridges and other roofing junctions.

They are installed using clips attached to timber or steel roof battens and overlap to ensure no water ingress into a building. Concrete roof tiles are typically used in domestic construction where the roof pitch is at least 15 degrees.

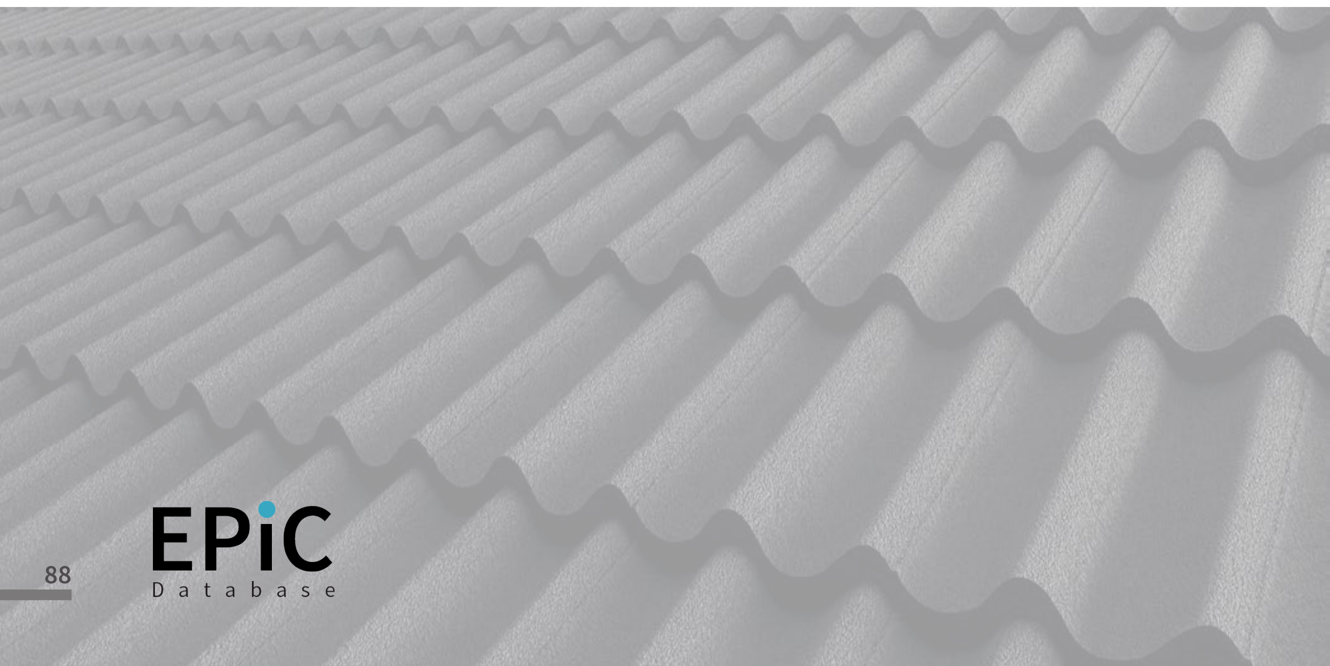
Category	*Concrete and plaster products*
Type	*Concrete*
Functional unit	*kg*
Specific heat	*837 J/(kg·K)*
Density	*2 100 kg/m^3*

Common uses
Roof cladding

Process name
Concrete roof tile, at plant/CH U/AusSD U

Input-output sector
Plaster and Concrete Product Manufacturing

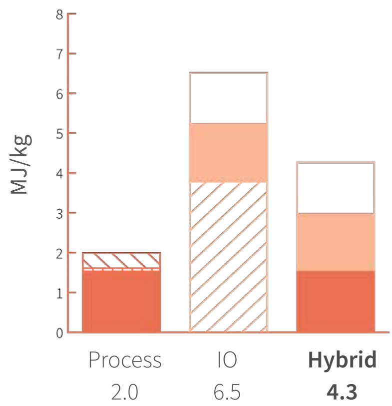
Further information
doi.org/10.26188/5da552f96c488



EPiC Database

TOP THREE INPUTS

- **12.9%** Acrylic dispersion, 65% in H2O, at plant/RER U/AusSD U
- **6.8%** Road Transport
- **6.2%** Structural Metal Product Manufacturing

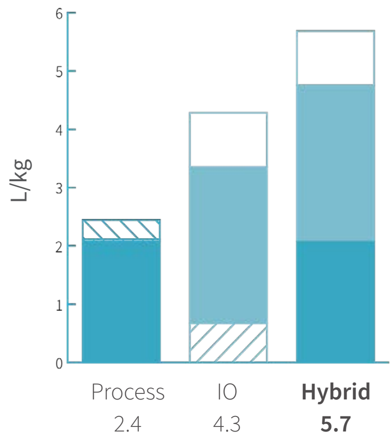


ENERGY

4.3
MJ/kg

TOP THREE INPUTS

- **17.0%** Sand, at mine/CH U/AusSD U
- **15.8%** Acrylic dispersion, 65% in H2O, at plant/RER U/AusSD U
- **8.0%** Tanned Leather, Dressed Fur and Leather Product Manufacturing

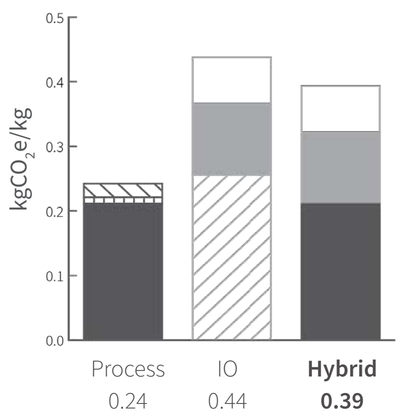


WATER

5.7
L/kg

TOP THREE INPUTS

- **7.5%** Acrylic dispersion, 65% in H2O, at plant/RER U/AusSD U
- **4.8%** Structural Metal Product Manufacturing
- **2.6%** Oil and gas extraction



GREENHOUSE GAS EMISSIONS

0.39
$kgCO_2e/kg$

Flat glass

kg

Flat glass, also known as soda-lime glass, is made from a combination of silica, soda, lime (from limestone), dolomite and aluminium oxide. Cullet, or waste glass, can also be added. The raw materials are melted at high temperature and the molten glass is then formed into flat glass using a variety of processes. A floating process, where the molten glass is floated on a bed of tin, is most common for manufacturing window glass. This gives it the common name of float glass.

The speed at which glass flows across the tin bath determines the glass thickness, which typically ranges from 2 to 25 mm. The glass is then gradually cooled (annealed) and cut to size. It can also be coated with a range of materials to provide particular characteristics (such as thermal, reflective, privacy).

Flat glass is commonly used in buildings to provide daylight and views. It is used for windows, glass doors and transparent walls.

Category	*Glass*
Type	*Glass*
Functional unit	*kg*
Specific heat	*840 J/(kg·K)*
Density	*2 600 kg/m^3*

Common uses
Windows, skylights, internal partitions, doors

Process name
Flat glass, uncoated, at plant/RER U/AusSD U

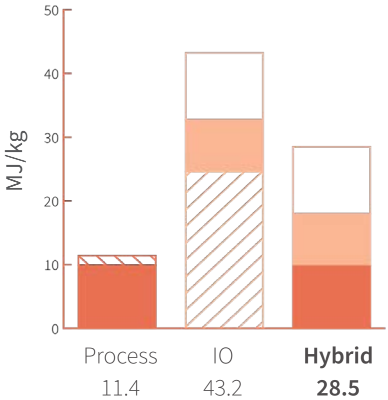
Input-output sector
Glass and Glass Product Manufacturing

Further information
doi.org/10.26188/5da554738e0e0

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO_2e/unit)
Flat glass	*kg*	*28.5*	*32.2*	*2.0*
Flat glass sheet - 3 mm	m^2	222	251	15.7
Flat glass sheet - 4 mm	m^2	296	335	21
Flat glass sheet - 5 mm	m^2	370	418	26.2
Flat glass sheet - 6 mm	m^2	444	502	31.4
Flat glass sheet - 10 mm	m^2	740	837	52.4
Flat glass sheet - 12 mm	m^2	888	1 004	62.9

TOP THREE INPUTS

- **10.2%** Road Transport
- **2.3%** Soda, powder, at plant/RER U/ AusSD U
- **2.2%** Structural Metal Product Manufacturing

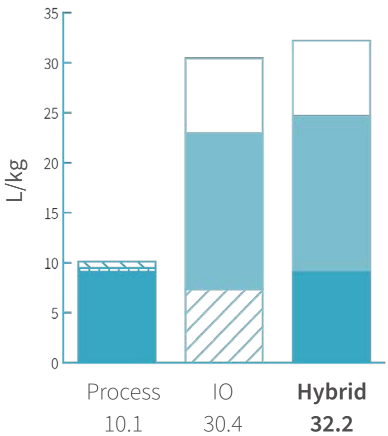


ENERGY

28.5 MJ/kg

TOP THREE INPUTS

- **21.2%** Soda, powder, at plant/RER U/ AusSD U
- **4.3%** Water Supply, Sewerage and Drainage Services
- **2.4%** Structural Metal Product Manufacturing

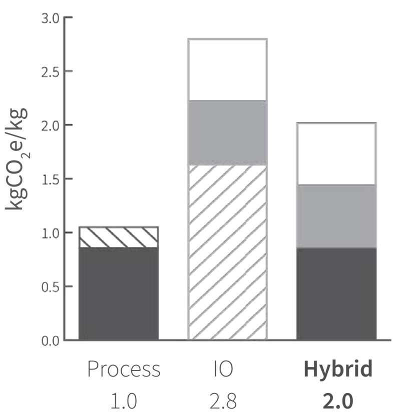


WATER

32.2 L/kg

TOP THREE INPUTS

- **4.5%** Road Transport
- **3.1%** Soda, powder, at plant/RER U/ AusSD U
- **2.3%** Structural Metal Product Manufacturing



GREENHOUSE GAS EMISSIONS

2.0 $kgCO_2e/kg$

m² Double glazing - flat glass

Double glazing - flat glass is a glazing system that combines two sheets of flat glass separated by a sealed gas-filled cavity. These systems are also commonly referred to as insulated glass units (IGU). An aluminium spacer is used to separate the glass panes, attached to the glass with an adhesive. The cavity is then filled with an inert gas. Argon, xenon and krypton are the most commonly used gases.

The double glazed system is typically used to improve the acoustic or thermal performance of a window. The thickness of each glass pane generally ranges from 3 to 10 mm and the gas-filled cavity typically ranges from 6 to 12 mm.

The same glass thickness is usually used for both panes, but in some circumstances the thickness may vary. Laminated or toughened glass can also be used in place of flat glass. Various coatings (such as low-e) can also be applied to the glass surfaces to improve its thermal, acoustic or privacy characteristics.

Category *Glass*

Type *Glass*

Functional unit *m^2*

Specific heat *840 J/(kg·K)*

Density *2 600 kg/m^3*

Common uses
Windows

Process name
Glazing, double (2-IV), U<1.1 W/m2K, at plant/RER U/AusSD U

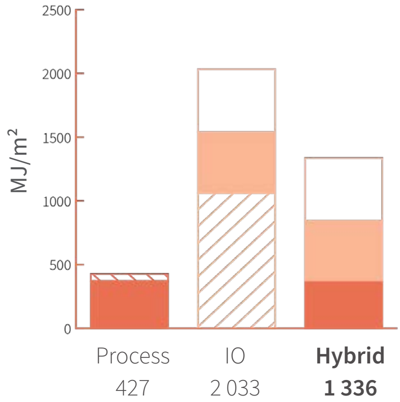
Input-output sector
Glass and Glass Product Manufacturing

Further information
doi.org/10.26188/5da55375f3452

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Double glazing - flat glass, 4:6:4	*m^2*	*1 336*	*1 558*	*101*
Double glazing - flat glass, 4:12:4	m^2	1 336	1 558	101
Double glazing - flat glass, 6:6:6	m^2	1 441	1 671	108
Double glazing - flat glass, 6:12:6	m^2	1 441	1 671	108

TOP THREE INPUTS

- **10.2%** Road Transport
- **7.8%** Flat glass, coated, at plant/RER U/AusSD U
- **7.1%** Flat glass, uncoated, at plant/ RER U/AusSD U

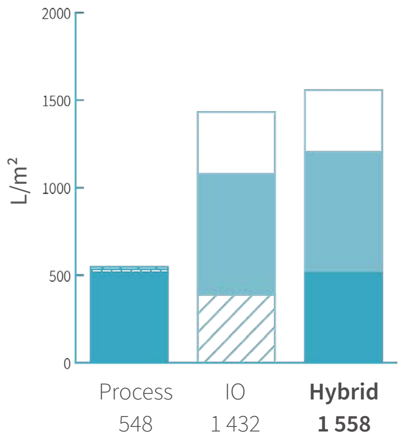


ENERGY

1 336
MJ/m²

TOP THREE INPUTS

- **17.9%** Zeolite, powder, at plant/RER S/ AusSD U
- **5.9%** Flat glass, coated, at plant/RER U/AusSD U
- **5.7%** Flat glass, uncoated, at plant/ RER U/AusSD U

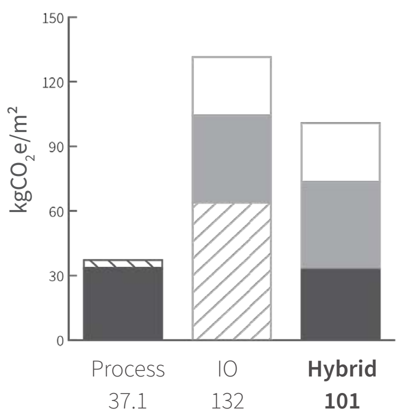


WATER

1 558
L/m²

TOP THREE INPUTS

- **9.8%** Flat glass, coated, at plant/RER U/AusSD U
- **9.0%** Flat glass, uncoated, at plant/ RER U/AusSD U
- **6.4%** Oil and gas extraction



GREENHOUSE GAS EMISSIONS

101
$kgCO_2e/m^2$

kg Laminated glass

Laminated glass is a composite safety glass, made by combing two or more sheets of flat glass with a plastic, or polyvinyl butyral (PVB) interlayer (usually 0.38 mm thick). The layers are bonded together using heat and pressure.

Flat glass is made from a combination of silica, soda, lime, dolomite and aluminium oxide. The raw materials are melted at high temperature and the molten glass is then formed into flat glass using a variety of processes. A floating process, where the molten glass is floated on a bed of tin, is most common for manufacturing window glass. The glass is then gradually cooled (annealed) and cut to size.

Laminated glass is commonly used for windows, glass doors and transparent walls, where there is an increased chance of damage, as when broken, the glass remains intact, held together by the PVB layer. It provides added safety, security, thermal and acoustic properties over flat glass. The glass comes in a range of thicknesses, starting from 6.38 mm.

Category *Glass*

Type *Glass*

Functional unit *kg*

Specific heat *840 J/(kg·K)*

Density *2 600 kg/m^3*

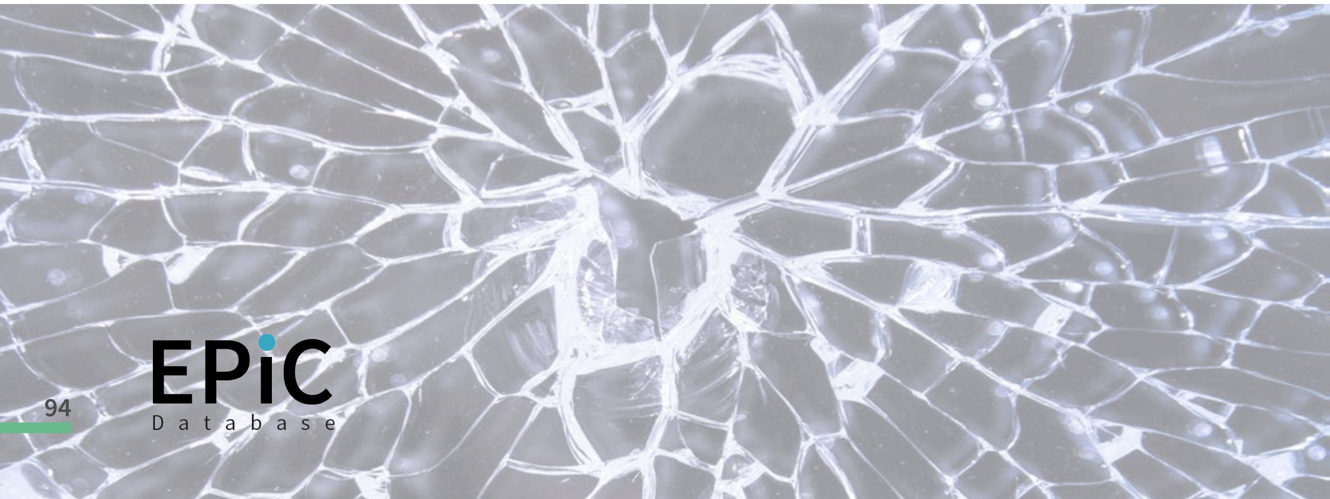
Common uses
Windows, doors, partitions, skylights, ballustrades

Process name
Laminated safety glass (per mass), at plant/RER U/AusSD U

Input-output sector
Glass and Glass Product Manufacturing

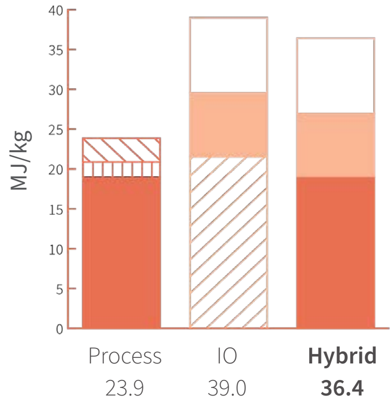
Further information
doi.org/10.26188/5da5556225c38

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO$_2$e/unit)
Laminated glass	*kg*	*36.4*	*59.7*	*2.8*
Laminated glass sheet - 6.38 mm	m^2	604	991	46.8
Laminated glass sheet - 8.38 mm	m^2	794	1 302	61.4
Laminated glass sheet - 10.38 mm	m^2	983	1 613	76.1
Laminated glass sheet - 12.38 mm	m^2	1 172	1 923	90.7



TOP THREE INPUTS

- **7.2%** Road Transport
- **2.2%** Oil and gas extraction
- **1.5%** Structural Metal Product Manufacturing

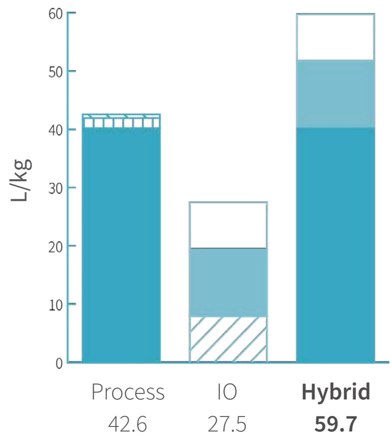


ENERGY

36.4 MJ/kg

TOP THREE INPUTS

- **1.1%** Structural Metal Product Manufacturing
- **1.0%** Wholesale Trade
- **0.9%** Oil and gas extraction

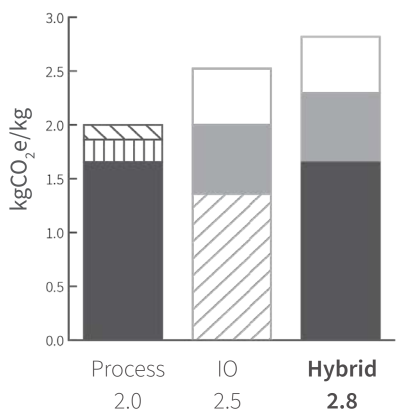


WATER

59.7 L/kg

TOP THREE INPUTS

- **4.4%** Oil and gas extraction
- **2.9%** Road Transport
- **1.5%** Structural Metal Product Manufacturing



GREENHOUSE GAS EMISSIONS

2.8 $kgCO_2e/kg$

kg Toughened glass

Toughened, or tempered glass is made from flat glass that has been strengthened. Flat glass is made from a combination of silica, soda, lime, dolomite and aluminium oxide. The raw materials are melted at high temperature and the molten glass is then formed into flat glass using a variety of processes. A floating process, where the molten glass is floated on a bed of tin, is most common for manufacturing window glass. The glass is then gradually cooled (annealed) and cut to size.

To produce toughened glass, the flat glass is then heated and rapidly cooled, increasing compressive stress on the outer surfaces of the glass. This produces glass that is 5 times stronger than standard flat glass.

Toughened glass is commonly used for windows, glass doors, balustrades, shower screens and pool fences. It provides added safety over flat glass as when broken, the glass shatters into small even pieces.

Category *Glass*

Type *Glass*

Functional unit *kg*

Specific heat *840 J/(kg·K)*

Density *2 600 kg/m^3*

Common uses
Windows, doors, partitions, skylights, ballustrades, shower screens

Process name
Tempered glass (custom)

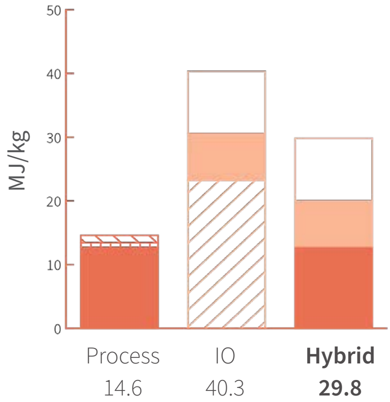
Input-output sector
Glass and Glass Product Manufacturing

Further information
doi.org/10.26188/5da5589913df4

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Toughened glass	*kg*	*29.8*	*30.2*	*2.2*
Toughened glass sheet - 3 mm	m^2	232	235	17.1
Toughened glass sheet - 4 mm	m^2	310	314	22.8
Toughened glass sheet - 5 mm	m^2	387	392	28.5
Toughened glass sheet - 6 mm	m^2	465	471	34.2
Toughened glass sheet - 10 mm	m^2	775	785	56.9
Toughened glass sheet - 12 mm	m^2	929	942	68.3

TOP THREE INPUTS

- **34.3%** Flat glass, uncoated, at plant/ RER U/AusSD U
- **9.1%** Road Transport
- **1.9%** Structural Metal Product Manufacturing

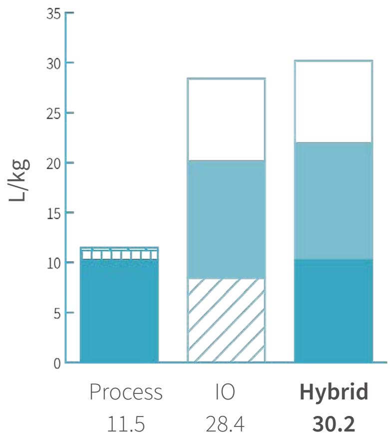


ENERGY

29.8
MJ/kg

TOP THREE INPUTS

- **30.3%** Flat glass, uncoated, at plant/ RER U/AusSD U
- **2.2%** Structural Metal Product Manufacturing
- **2.1%** Wholesale Trade

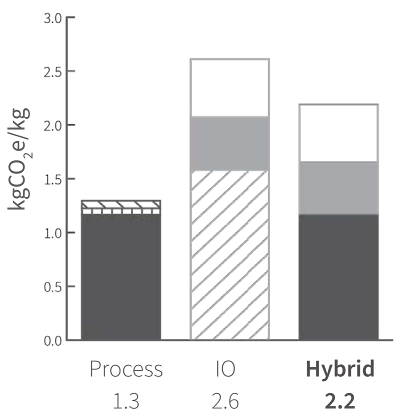


WATER

30.2
L/kg

TOP THREE INPUTS

- **44.0%** Flat glass, uncoated, at plant/ RER U/AusSD U
- **3.9%** Road Transport
- **2.0%** Structural Metal Product Manufacturing



GREENHOUSE GAS EMISSIONS

2.2
$kgCO_2e/kg$

m² Double glazing - toughened glass

Double glazing - toughened glass is a glazing system that combines two sheets of toughened glass separated by a sealed gas-filled cavity. These systems are also commonly referred to as insulated glass units (IGU). An aluminium spacer is used to separate the glass panes, attached to the glass with an adhesive. The cavity is then filled with an inert gas. Argon, xenon and krypton are the most commonly used gases.

The double glazed system is typically used to improve the acoustic or thermal performance of a window. The thickness of each glass pane generally ranges from 3 to 10 mm and the gas-filled cavity typically ranges from 6 to 12 mm.

The same glass thickness is usually used for both panes, but in some circumstances the thickness may vary. Laminated or flat glass can also be used in place of toughened glass. Toughened glass is used where additional strength is required or there is increased risk of damage. Various coatings (such as low-e) can also be applied to the glass surfaces to improve its thermal, acoustic or privacy characteristics.

Category *Glass*

Type *Glass*

Functional unit *m^2*

Specific heat *840 J/(kg·K)*

Density *2 600 kg/m^3*

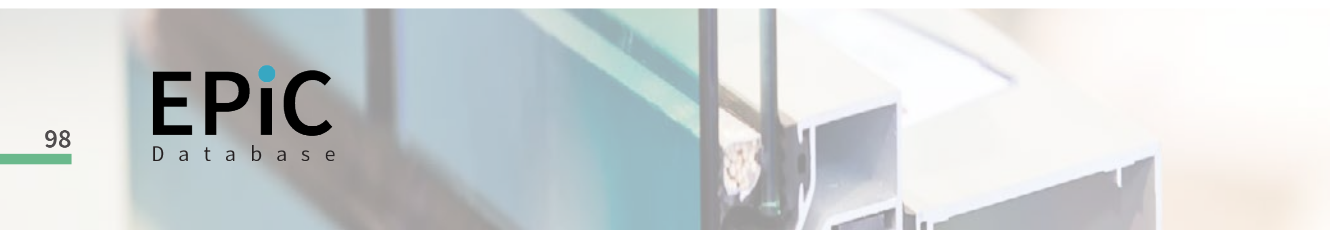
Common uses
Windows, doors, skylights, internal partitions

Process name
Glazing, double (2-IV), U<1.1 W/m2K, at plant/RER U/AusSD U

Input-output sector
Glass and Glass Product Manufacturing

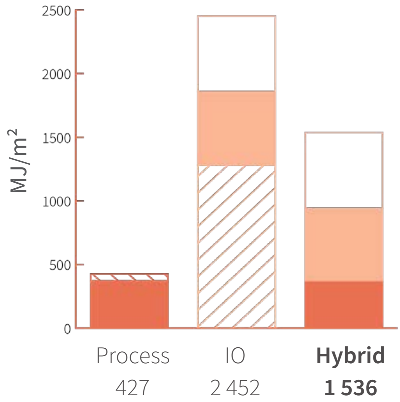
Further information
doi.org/10.26188/5da553f3e04ff

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Double glazing - toughened glass, 4:6:4	*m^2*	*1 536*	*1 772*	*115*
Double glazing - toughened glass, 4:12:4	m^2	1 536	1 772	115
Double glazing - toughened glass, 5:6:5	m^2	1 635	1 879	122
Double glazing - toughened glass, 5:12:5	m^2	1 635	1 879	122
Double glazing - toughened glass, 6:6:6	m^2	1 729	1 980	128
Double glazing - toughened glass, 6:12:6	m^2	1 729	1 980	128
Double glazing - toughened glass, 10:6:6	m^2	2 254	2 543	165
Double glazing - toughened glass, 10:12:6	m^2	2 254	2 543	165
Double glazing - toughened glass, 10:6:10	m^2	2 779	3 107	202
Double glazing - toughened glass, 10:12:10	m^2	2 779	3 107	202



TOP THREE INPUTS

- **10.7%** Road Transport
- **6.8%** Flat glass, coated, at plant/RER U/AusSD U
- **6.2%** Flat glass, uncoated, at plant/RER U/AusSD U

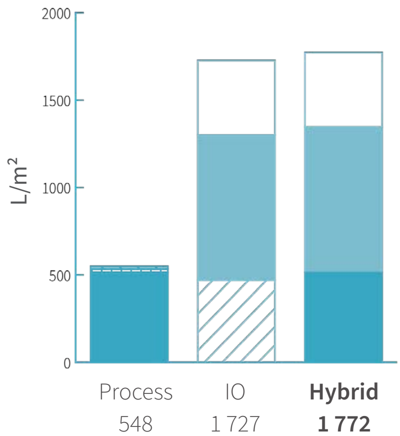


ENERGY

1 536
MJ/m²

TOP THREE INPUTS

- **15.7%** Zeolite, powder, at plant/RER S/AusSD U
- **5.2%** Flat glass, coated, at plant/RER U/AusSD U
- **5.0%** Flat glass, uncoated, at plant/RER U/AusSD U

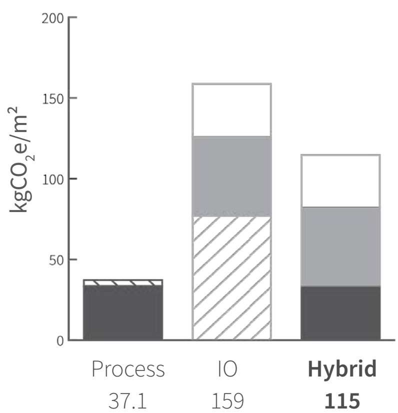


WATER

1 772
L/m²

TOP THREE INPUTS

- **8.6%** Flat glass, coated, at plant/RER U/AusSD U
- **7.9%** Flat glass, uncoated, at plant/RER U/AusSD U
- **6.8%** Oil and gas extraction



GREENHOUSE GAS EMISSIONS

115
$kgCO_2e/m^2$

kg Cellulose insulation

Cellulose is an organic compound that constitutes the primary cell wall of green plants and is the most abundant polymer on Earth. Cellulose insulation has good thermal insulation properties (heat conductivity = 0.04 W/(m·K)). It also acts as sound insulation.

Cellulose insulation is made from recycled newspaper (75-85%) and from natural fire retardants and anti-fungal agents such as boric acid (15-25%). Newspapers are shredded and mixed with boric acid before being turned into small fibres. These are packaged for installation on site.

Cellulose insulation is mostly used in roofs and walls and is typically blown.

Category *Insulation*

Type *Cellulose*

Functional unit *kg*

Specific heat *1 400 J/(kg·K)*

Density *50 kg/m³*

Common uses
Insulation

Process name
Cellulose fibre, inclusive blowing in, at plant/CH U/AusSD U

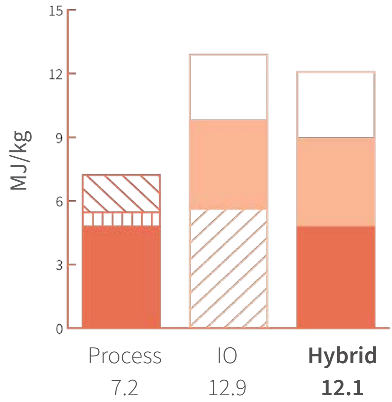
Input-output sector
Other Wood Product Manufacturing

Further information
doi.org/10.26188/5da5528023cab

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Cellulose insulation	*kg*	*12.1*	*20.5*	*0.8*
Cellulose insulation - 80 mm (R2)	m^2	48.3	82.1	3.1
Cellulose insulation - 100 mm (R2.5)	m^2	60.3	103	3.9

TOP THREE INPUTS

- **17.3%** Road Transport
- **4.5%** Boric acid, anhydrous, powder, at plant/RER U/AusSD U
- **2.8%** Kraft paper, unbleached, at plant/RER U/AusSD U

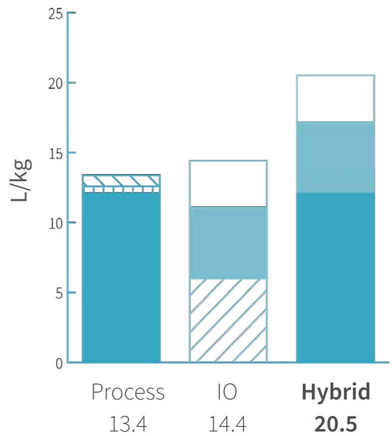


ENERGY

12.1 MJ/kg

TOP THREE INPUTS

- **34.3%** Boric acid, anhydrous, powder, at plant/RER U/AusSD U
- **22.9%** Kraft paper, unbleached, at plant/RER U/AusSD U
- **1.2%** Wholesale Trade

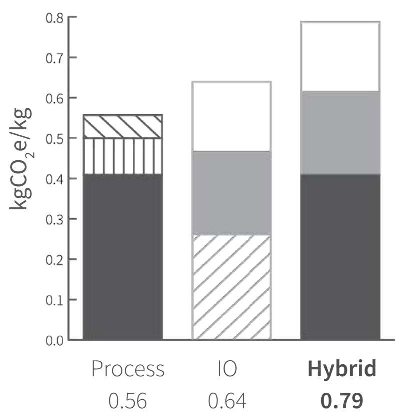


WATER

20.5 L/kg

TOP THREE INPUTS

- **8.4%** Road Transport
- **7.0%** Boric acid, anhydrous, powder, at plant/RER U/AusSD U
- **5.4%** Kraft paper, unbleached, at plant/RER U/AusSD U



GREENHOUSE GAS EMISSIONS

0.79 $kgCO_2e/kg$

m² Aluminium foil insulation

Aluminium is a ductile non-ferrous metal. It is a lightweight metal with an average density of 2 700 kg/m^3. It is durable, corrosion resistant, a good reflector of both visible and infrared radiation, and highly recyclable. Aluminium insulation foils provide a barrier to light, infrared radiation and sometimes air, moisture and bacteria, depending on perforation and treatment.

Aluminium insulation foil is manufactured by rolling aluminium slabs cast from molten aluminium into a mill for a desired thickness. It is produced into rolls of specific widths and lengths.

Aluminium insulation foil is commonly installed in cavities to reflect infrared radiation and trap heat inside or outside of a building (depending on its placement).

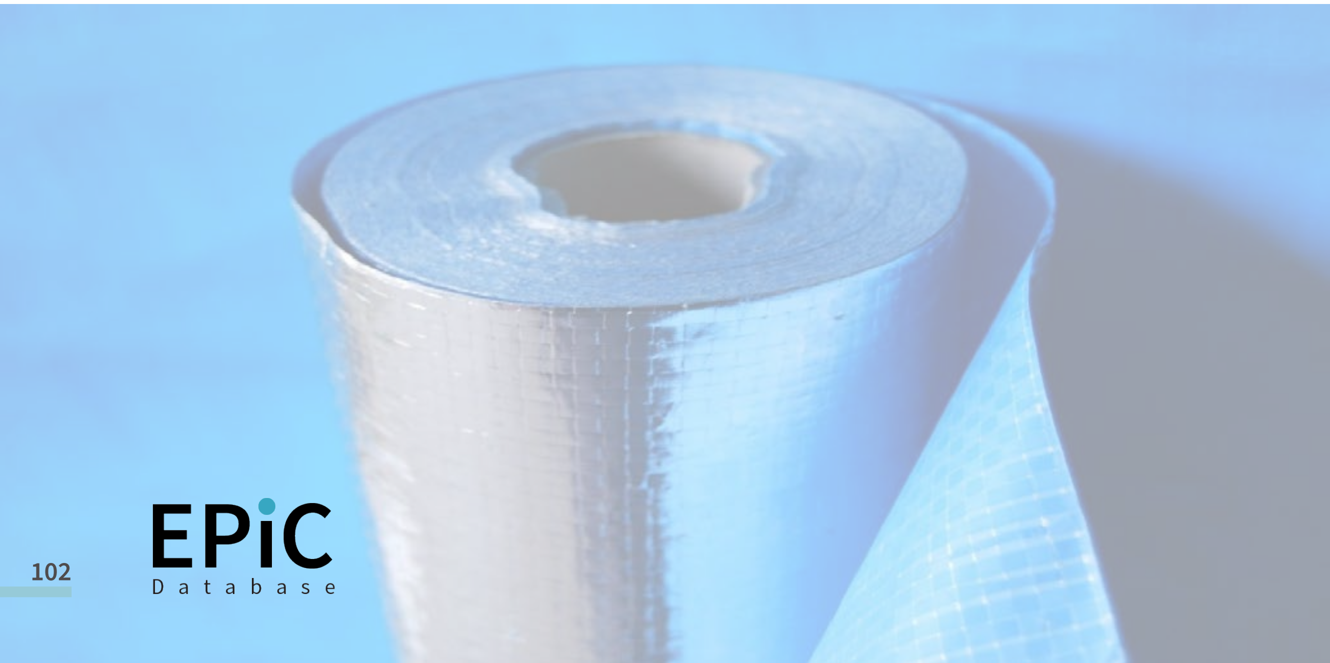
Category	*Insulation*
Type	*Aluminium*
Functional unit	*m^2*
Specific heat	*0.01 J/(kg·K)*
Density	*321 kg/m^3*

Common uses
Insulation

Process name
Aluminium foil insulation (custom)

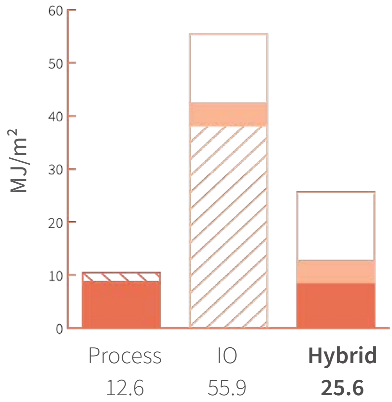
Input-output sector
Basic Non-Ferrous Metal Manufacturing

Further information
doi.org/10.26188/5da551d0640fa



TOP THREE INPUTS

- **4.2%** Road Transport
- **0.6%** Oil and gas extraction
- **0.6%** Electricity Transmission, Distribution, On Selling and Electricity Market Operation

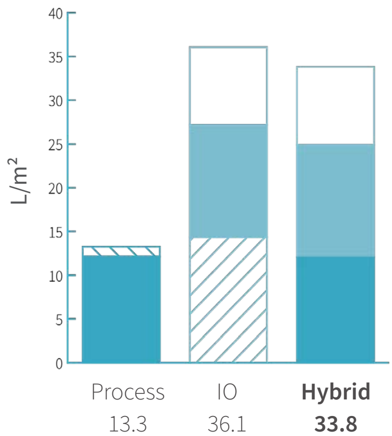


ENERGY

25.6
MJ/m²

TOP THREE INPUTS

- **21.0%** Kraft paper, unbleached, at plant/RER U/AusSD U
- **5.3%** Glass fibre, at plant/RER U/AusSD U
- **1.5%** Ethylene vinyl acetate copolymer, at plant/RER U/AusSD U

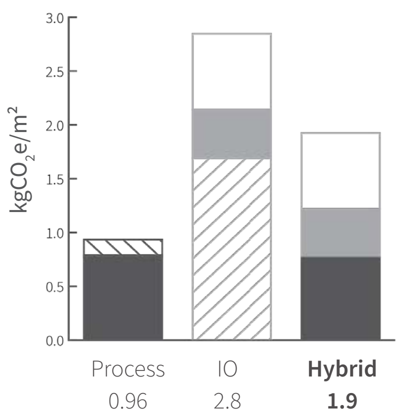


WATER

33.8
L/m²

TOP THREE INPUTS

- **7.3%** Glass fibre, at plant/RER U/AusSD U
- **1.7%** Road Transport
- **1.4%** Oil and gas extraction



GREENHOUSE GAS EMISSIONS

1.9
$kgCO_2e/m^2$

kg Glasswool insulation

Glasswool or fibreglass insulation contains micro fibres of glass that trap pockets of air within. This results in a low density and low thermal conductivity (0.04 W/(m·K)), which is ideal for insulation materials.

Glasswool is made by mixing sand and recycled glass and melting them at 1 450°C to obtain glass. This glass is turned into fibres using a process similar to making cotton candy, by forcing it through a mesh and cooling it by contact with air. A binder is added beforehand to ensure cohesion and mechanical strength. The resulting fibre is heated at 200°C to polymerise the resin. The resulting insulation is calendered, before being cut and packed in rolls or panels.

Glasswool insulation is widely used in the construction industry as an insulation material.

Category *Insulation*

Type *Glass*

Functional unit *kg*

Specific heat *840 J/(kg·K)*

Density *25 kg/m^3*

Common uses
Insulation

Process name
Glass wool mat, at plant/CH U/AusSD U

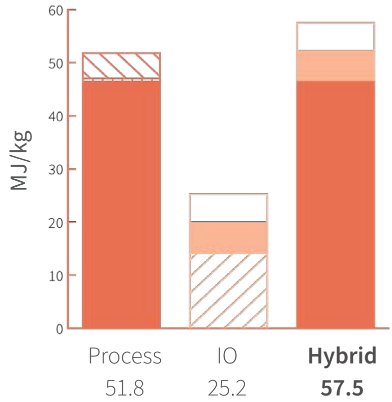
Input-output sector
Other Non-Metallic Mineral Product Manufacturing

Further information
doi.org/10.26188/5da55494afb75

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO$_2$e/unit)
Glasswool insulation	*kg*	*57.5*	*40.7*	*4*
Glasswool insulation - 80 mm (R2)	m^2	115	81.4	8
Glasswool insulation - 100 mm (R2.5)	m^2	144	102	10.1

TOP THREE INPUTS

- **13.0%** Natural gas, burned in industrial furnace low-NOx >100kW/RER U/AusSD U
- **5.9%** Formaldehyde, production mix, at plant/RER U/AusSD U
- **5.3%** Phenol, at plant/RER U/AusSD U

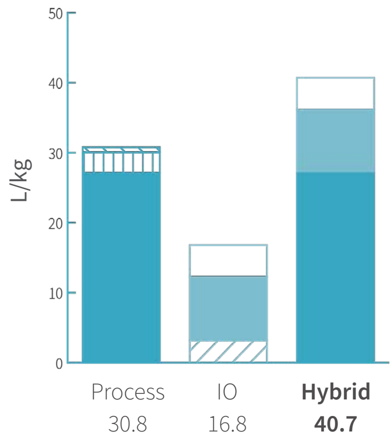


ENERGY

57.5
MJ/kg

TOP THREE INPUTS

- **18.4%** Silicone product, at plant/RER U/AusSD U
- **12.0%** Phenol, at plant/RER U/AusSD U
- **6.1%** Soda, powder, at plant/RER U/AusSD U

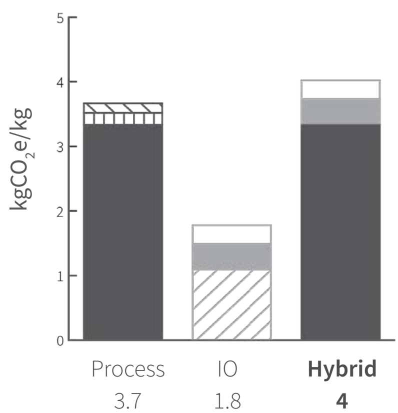


WATER

40.7
L/kg

TOP THREE INPUTS

- **12.0%** Natural gas, burned in industrial furnace low-NOx >100kW/RER U/AusSD U
- **3.0%** Phenol, at plant/RER U/AusSD U
- **2.7%** Urea, as N, at regional storehouse/RER U/AusSD U



GREENHOUSE GAS EMISSIONS

4.0
$kgCO_2e/kg$

kg Rockwool insulation

Rockwool, also called mineral wool, is made by spinning or drawing molten rock materials into fibres. The resulting fibrous material has a very low density and low thermal conductivity (0.04 W/(m·K)).

Rockwool is produced by melting rock at 1 600°C and blowing air or steam through the furnace to generate the fibres. Fibres can also be produced by spinning, similar to the process of making cotton candy (the same process used to make fibreglass, or glasswool). The wool is packed in rolls or matts.

Rockwool insulation is widely used in the construction industry as thermal insulation. It has a high fire resistance depending on the constituting material, with ceramic fibre wool withstanding up to 1 200°C of heat.

Category	*Insulation*
Type	*Other minerals*
Functional unit	*kg*
Specific heat	*840 J/(kg·K)*
Density	*70 kg/m^3*

Common uses
Insulation

Process name
Rock wool, packed, at plant/CH U/AusSD U

Input-output sector
Other Non-Metallic Mineral Product Manufacturing

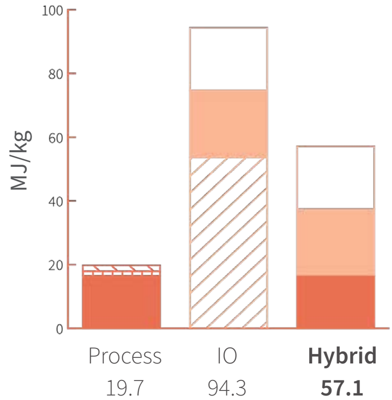
Further information
doi.org/10.26188/5da55737d3e5e

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO$_2$e/unit)
Rockwool insulation	*kg*	*57.1*	*62.2*	*3.8*
Rockwool insulation - 80 mm (R2)	m^2	320	348	21.1
Rockwool insulation - 100 mm (R2.5)	m^2	400	435	26.4

EPiC Database

TOP THREE INPUTS

- **27.2%** Rock wool, at plant/CH U/ AusSD U
- **13.8%** Road Transport
- **7.0%** Structural Metal Product Manufacturing

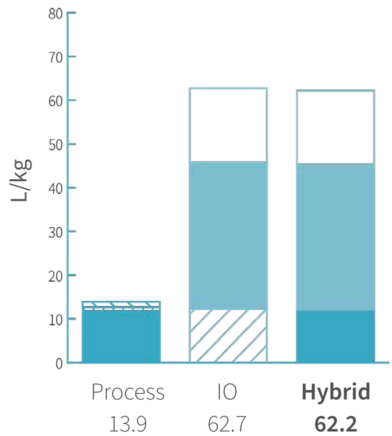


ENERGY

57.1 MJ/kg

TOP THREE INPUTS

- **17.8%** Rock wool, at plant/CH U/ AusSD U
- **10.1%** Tanned Leather, Dressed Fur and Leather Product Manufacturing
- **7.7%** Non Ferrous Metal Ore Mining

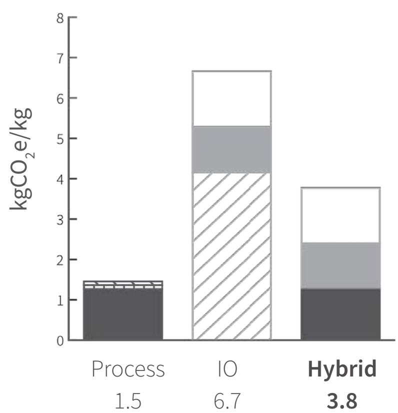


WATER

62.2 L/kg

TOP THREE INPUTS

- **32.3%** Rock wool, at plant/CH U/ AusSD U
- **6.6%** Structural Metal Product Manufacturing
- **6.2%** Road Transport



GREENHOUSE GAS EMISSIONS

3.8 $kgCO_2e/kg$

kg Polystyrene (EPS/XPS) insulation

Polystyrene (PS) is a synthetic polymer and thermoplastic. Polystyrene insulation is made from Expanded (EPS) or Extruded Polystyrene (XPS). It has a low thermal conductivity (0.03-0.038 W/(m·K)) and is a lightweight material.

PS insulation is made by polymerising styrene monomers in polystyrene before moulding it (EPS) or extruding it (XPS) into rigid foam panels.

PS insulation is widely used in the construction industry. EPS is used in walls and on roofs that do not require stepping onto. XPS, with its increased compressive strengths, can be stepped upon and is therefore more common on roofs.

Category *Insulation*

Type *Polystyrene*

Functional unit *kg*

Specific heat *1 223 J/(kg·K)*

Density *23 kg/m^3*

Common uses
Insulation

Process name
Polystyrene foam slab, from expandable polystyrene (EPS)

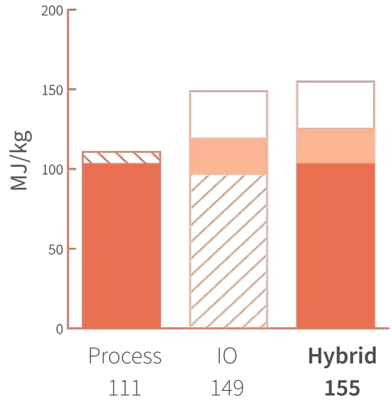
Input-output sector
Polymer Product Manufacturing

Further information
doi.org/10.26188/5da556cc242c5

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO_2e/unit)
Polystyrene (EPS/XPS) insulation	*kg*	*155*	*841*	*8.0*
EPS/XPS insulation - 72 mm (R2)	m^2	251	1 362	12.9
EPS/XPS insulation - 90 mm (R2.5)	m^2	314	1 703	16.2

TOP THREE INPUTS

- **59.5%** Polystyrene ,general purpose, modelled from USLCI data
- **6.9%** Polymer foaming
- **2.7%** Road Transport

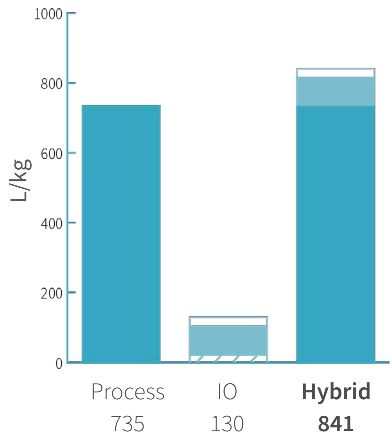


ENERGY

155
MJ/kg

TOP THREE INPUTS

- **78.7%** Polymer foaming
- **8.4%** Polystyrene ,general purpose, modelled from USLCI data
- **4.3%** Other Agriculture

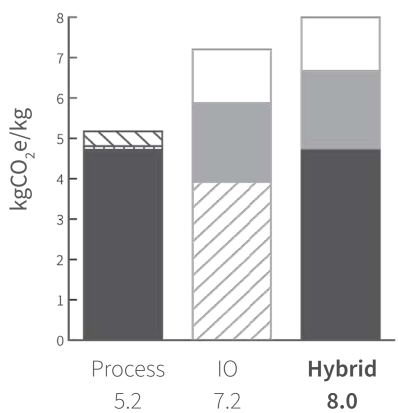


WATER

841
L/kg

TOP THREE INPUTS

- **45.6%** Polystyrene ,general purpose, modelled from USLCI data
- **13.4%** Polymer foaming
- **1.9%** Wholesale Trade



GREENHOUSE GAS EMISSIONS

8.0
$kgCO_2e/kg$

kg Polyurethane (PU) rigid foam insulation

Polyurethane (PU) is a polymer with a low density, low thermal conductivity and high durability.

PU is produced by mixing a stream of isocyanate and a stream of polyol, including any other additives. The proportion of each stream in the mix is often used to alter the material properties. The resulting mixture is poured into a mould or onto a surface. Once cured, the PU is demoulded.

PU insulation consists of rigid foam panels that are used for high-performance insulation.

Category *Insulation*

Type *Polyurethane*

Functional unit *kg*

Specific heat *1 800 J/(kg·K)*

Density *30 kg/m^3*

Common uses
Insulation

Process name
Polyurethane, rigid foam, at plant/ RER U/AusSD U

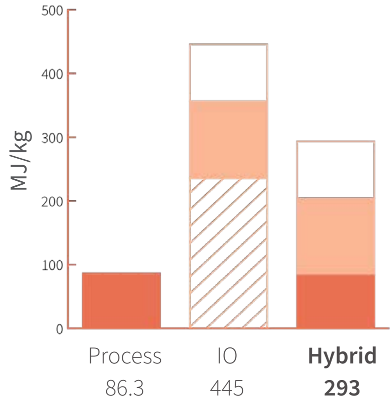
Input-output sector
Polymer Product Manufacturing

Further information
doi.org/10.26188/5da556ef90771

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Polyurethane (PU) rigid foam insulation	*kg*	*293*	*690*	*17.5*
PU rigid foam insulation - 44 mm (R2)	m^2	387	911	23.1
PU rigid foam insulation - 55 mm (R2.5)	m^2	484	1 138	28.8

TOP THREE INPUTS

- **16.0%** Methylene diphenyl diisocyanate, at plant/RER U/AusSD U
- **9.6%** Polyols, at plant/RER U/AusSD U
- **7.0%** Petroleum and Coal Product Manufacturing

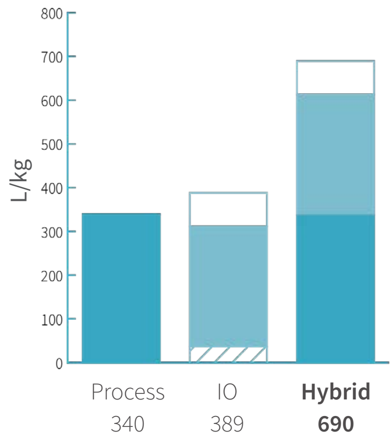


ENERGY

293 MJ/kg

TOP THREE INPUTS

- **29.2%** Methylene diphenyl diisocyanate, at plant/RER U/AusSD U
- **19.7%** Polyols, at plant/RER U/AusSD U
- **15.6%** Other Agriculture

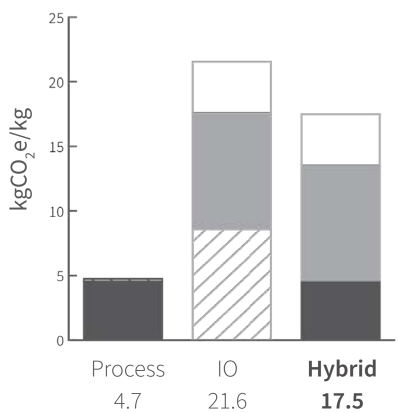


WATER

690 L/kg

TOP THREE INPUTS

- **14.8%** Methylene diphenyl diisocyanate, at plant/RER U/AusSD U
- **8.2%** Polyols, at plant/RER U/AusSD U
- **4.1%** Petroleum and Coal Product Manufacturing



GREENHOUSE GAS EMISSIONS

17.5 $kgCO_2e/kg$

kg Aluminium bar

Aluminium is a ductile non-ferrous metal. It is a lightweight metal with an average density of 2.7 t/m^3. It is durable, corrosion resistant, a good reflector of both visible and infrared radiation, and highly recyclable. Aluminium alloys are used in the construction industry as raw aluminium typically lacks the strength required for most of its applications.

Aluminium is extracted from bauxite, its common ore, through an extensive process. Bauxite is converted to aluminium oxide through the Bayer process. Aluminium oxide (or Alumina) is then converted to aluminium billets by the electricity-intensive Hall-Héroult process, made of 99% aluminium, which can be further purified if needed. Aluminium billets are then thermoformed into the relevant shape. Powder coating provides additional durability, custom colour and improved performance.

Aluminium is commonly used as a construction material, notably as cladding, structural and window framing, and as a thermal reflector. Aluminium bars are typically extruded and can be used as a finishing product (flat bars) and as ventilation grilles.

Category *Metals*

Type *Aluminium*

Functional unit *kg*

Specific heat *910 J/(kg·K)*

Density *2 712 kg/m^3*

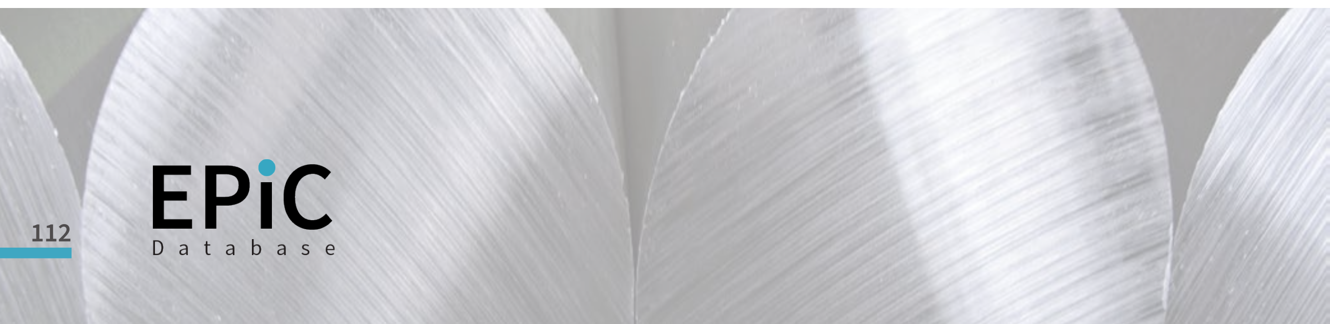
Common uses
Finishes, ventilation grilles

Process name
Aluminium section bar (custom)

Input-output sector
Basic Non-Ferrous Metal Manufacturing

Further information
doi.org/10.26188/5da5519635948

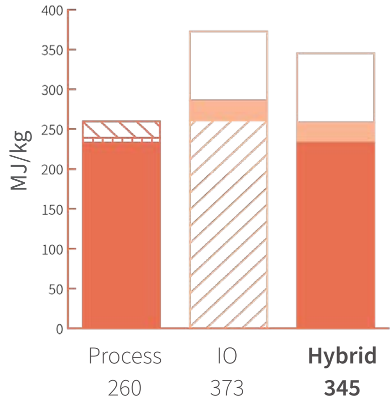
Material variations	**Unit**	**Energy (MJ/unit)**	**Water (L/unit)**	**GHG emissions (kgCO$_2$e/unit)**
Aluminium bar	*kg*	*345*	*219*	*29.6*
Aluminium bar flat - 12 mm × 3mm	m	33.7	21.3	2.9
Aluminium bar flat - 40 mm × 3mm	m	112	71.2	9.6
Aluminium bar flat - 100 mm × 6mm	m	562	356	48.2
Aluminium bar round - 16 mm dia.	m	188	119	16.2
Aluminium bar round - 50 mm dia.	m	1 838	1 164	158
Aluminium bar round - 150 mm dia.	m	16 542	10 479	1 420



EPiC Database

TOP THREE INPUTS

- **56.2%** Aluminium, primary, at plant/ RER U/AusSD U
- **5.3%** Section bar extrusion, aluminium/RER U/AusSD U
- **2.1%** Road Transport

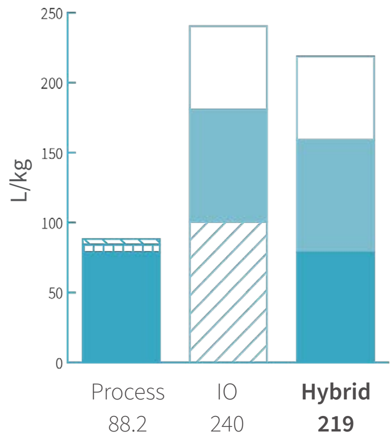


ENERGY

345 MJ/kg

TOP THREE INPUTS

- **20.3%** Aluminium, primary, at plant/ RER U/AusSD U
- **8.9%** Section bar extrusion, aluminium/RER U/AusSD U
- **0.5%** Road Transport

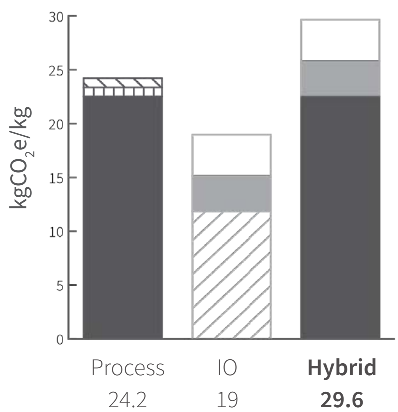


WATER

219 L/kg

TOP THREE INPUTS

- **68.9%** Aluminium, primary, at plant/ RER U/AusSD U
- **5.3%** Section bar extrusion, aluminium/RER U/AusSD U
- **0.8%** Road Transport



GREENHOUSE GAS EMISSIONS

29.6 $kgCO_2e/kg$

m² Aluminium composite panel

Aluminium composite panels consist of a layer of foam insulation, sandwiched between two aluminium sheets. Aluminium sheets are chosen for their durability, resistance to corrosion, large colour palette and strength. The foam is typically polyethylene or polyurethane.

Rolled aluminium coils are used to sandwich the foam insulation, which is also fed to the manufacturing line as a roll. Adhesives are used to glue the aluminium sheets to the core.

Aluminium composite panels are typically used as cladding. The panel specified here is 4 mm thick.

Category	*Metals*
Type	*Aluminium*
Functional unit	*m^2*
Specific heat	*1 000 J/(kg·K)*
Density	*1 900 kg/m^3*

Common uses
Cladding

Process name
Aluminium composite panel, ALUCOBOND, 4mm, FR (custom)

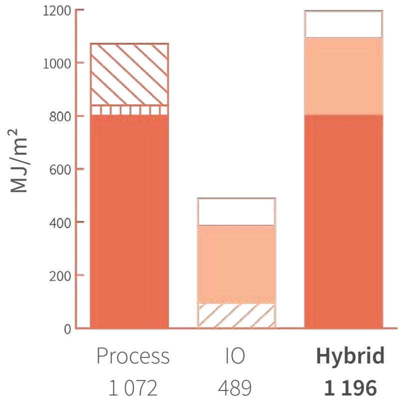
Input-output sector
Structural Metal Product Manufacturing

Further information
doi.org/10.26188/5da551a4afce4

EPiC Database

TOP THREE INPUTS

- **10.5%** Iron and Steel Manufacturing
- **6.2%** Thermoforming, with calendering/RER U/AusSD U
- **5.3%** Rock wool, at plant/CH U/AusSD U

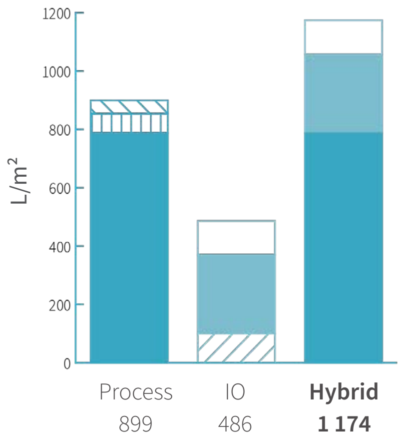


ENERGY

1 196 MJ/m²

TOP THREE INPUTS

- **44.4%** Thermoforming, with calendering/RER U/AusSD U
- **7.5%** Iron and Steel Manufacturing
- **4.3%** Rock wool, at plant/CH U/AusSD U

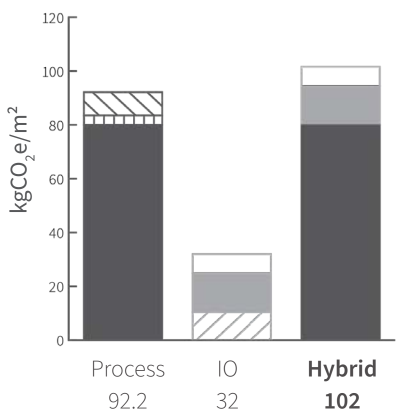


WATER

1 174 L/m²

TOP THREE INPUTS

- **5.6%** Thermoforming, with calendering/RER U/AusSD U
- **4.8%** Rock wool, at plant/CH U/AusSD U
- **4.6%** Iron and Steel Manufacturing



GREENHOUSE GAS EMISSIONS

102 $kgCO_2e/m^2$

kg Aluminium extruded

Aluminium is a ductile non-ferrous metal. It is a lightweight metal with an average density of 2.7 t/m^3. It is durable, corrosion resistant, a good reflector of both visible and infrared radiation, and highly recyclable. Aluminium alloys are used in the construction industry as raw aluminium typically lacks the strength required for most of its applications.

Aluminium is extracted from bauxite, its common ore, through an extensive process. Bauxite is converted to aluminium oxide through the Bayer process. Aluminium oxide (or Alumina) is then converted to aluminium billets by the electricity-intensive Hall-Héroult process, made of 99% aluminium, which can be further purified if needed. Aluminium billets are then thermoformed into the relevant shape. Powdercoating provides additional durability, custom colour and improved performance.

Aluminium is commonly used as a construction material, notably as cladding, structural and window framing, and as a thermal reflector. Extruded aluminium is commonly used for window frames, profiles for tracks, frames and rails, and mullions.

Category	*Metals*
Type	*Aluminium*
Functional unit	*kg*
Specific heat	*910 J/(kg·K)*
Density	*2 712 kg/m^3*

Common uses
Window frames, profiles

Process name
Aluminium extruded (custom)

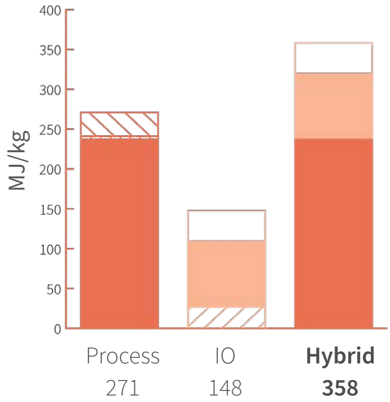
Input-output sector
Structural Metal Product Manufacturing

Further information
doi.org/10.26188/5da551b3248d5

Material variations	**Unit**	**Energy (MJ/unit)**	**Water (L/unit)**	**GHG emissions ($kgCO_2e$/unit)**
Aluminium extruded	*kg*	*358*	*182*	*29.4*
Aluminium round tube - 25 mm dia., 3.2 mm thick	m	114	57.9	9.4
Aluminium round tube - 60 mm dia., 10 mm thick	m	871	442	71.5
Aluminium round tube - 80 mm dia., 6 mm thick	m	705	357	57.8
Aluminium square tube - 20 mm, 1.6 mm thick	m	59.7	30.3	4.9
Aluminium square tube - 40 mm, 2 mm thick	m	152	76.8	12.4
Aluminium square tube - 100 mm, 3 mm thick	m	574	291	47.1
Aluminium extruded powdercoated	kg	415	251	33.6
Aluminium angle extruded	kg	383	244	32.7

TOP THREE INPUTS

- **59.0%** Aluminium, primary, at plant/ RER U/AusSD U
- **10.3%** Iron and Steel Manufacturing
- **2.8%** Road Transport

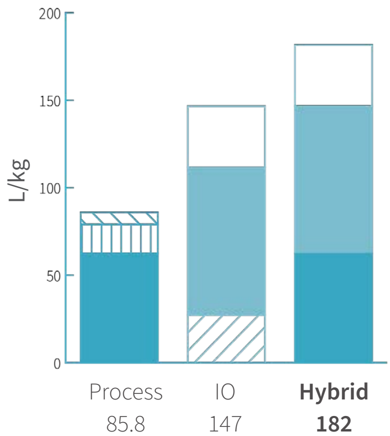


ENERGY

358 MJ/kg

TOP THREE INPUTS

- **32.3%** Aluminium, primary, at plant/ RER U/AusSD U
- **14.6%** Iron and Steel Manufacturing
- **2.3%** Other Fabricated Metal Product manufacturing

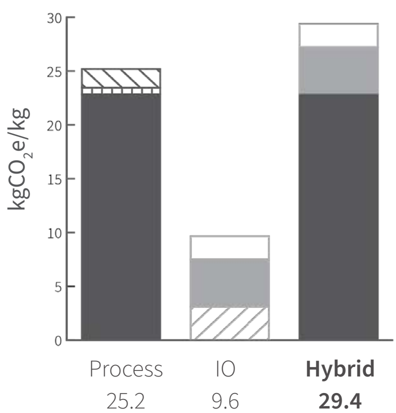


WATER

182 L/kg

TOP THREE INPUTS

- **70.4%** Aluminium, primary, at plant/ RER U/AusSD U
- **4.8%** Iron and Steel Manufacturing
- **1.1%** Road Transport



GREENHOUSE GAS EMISSIONS

29.4 $kgCO_2e/kg$

kg Aluminium sheet

Aluminium is a ductile non-ferrous metal. It is a lightweight metal with an average density of 2.7 t/m^3. It is durable, corrosion resistant, a good reflector of both visible and infrared radiation, and highly recyclable. Aluminium alloys are used in the construction industry as raw aluminium typically lacks the strength required for most of its applications.

Aluminium is extracted from bauxite, its common ore, through an extensive process. Bauxite is converted to aluminium oxide through the Bayer process. Aluminium oxide (or Alumina) is then converted to aluminium billets by the electricity-intensive Hall-Héroult process, made of 99% aluminium, which can be further purified if needed. Aluminium billets are then thermoformed into the relevant shape.

Aluminium is commonly used as a construction material, notably as cladding, structural and window framing, and as a thermal reflector. Aluminium sheets or plates are used as the base material for aluminium cladding, gutters, and structural elements.

Category	*Metals*
Type	*Aluminium*
Functional unit	*kg*
Specific heat	*910 J/(kg·K)*
Density	*2 712 kg/m^3*

Common uses
Cladding, structural elements, tubes, plates

Process name
Aluminium sheet rolled (custom)

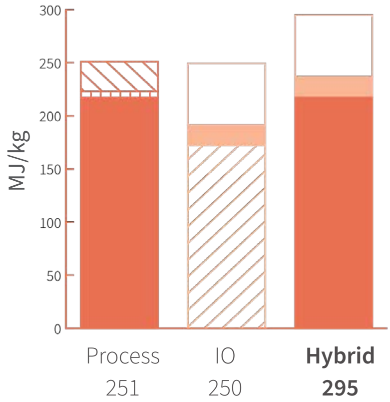
Input-output sector
Basic Non-Ferrous Metal Manufacturing

Further information
doi.org/10.26188/5da551dec2e47

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO$_2$e/unit)
Aluminium sheet	*kg*	*295*	*160*	*26.7*
Aluminium sheet - 1.6 mm	m^2	1 280	693	116
Aluminium sheet - 3 mm	m^2	2 400	1 300	217
Aluminium sheet - 6 mm	m^2	4 800	2 600	434

TOP THREE INPUTS

- **65.1%** Aluminium, primary, at plant/ RER U/AusSD U
- **3.2%** Sheet rolling, aluminium/RER U/AusSD U
- **1.6%** Road Transport

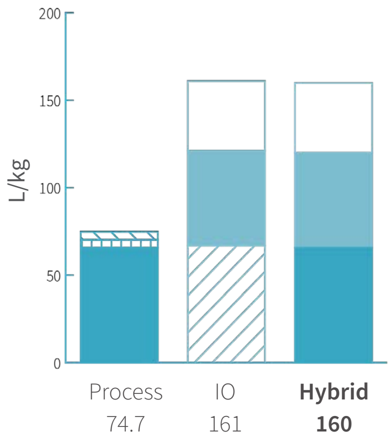


ENERGY

295 MJ/kg

TOP THREE INPUTS

- **27.8%** Aluminium, primary, at plant/ RER U/AusSD U
- **4.6%** Sheet rolling, aluminium/RER U/AusSD U
- **0.4%** Road Transport

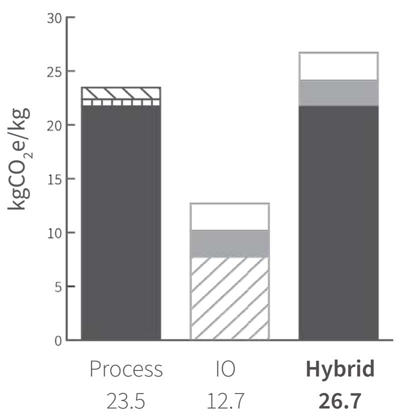


WATER

160 L/kg

TOP THREE INPUTS

- **76.5%** Aluminium, primary, at plant/ RER U/AusSD U
- **3.3%** Sheet rolling, aluminium/RER U/AusSD U
- **0.6%** Road Transport



GREENHOUSE GAS EMISSIONS

26.7 $kgCO_2e/kg$

kg Copper sheet

Copper is a soft and malleable non-ferrous metal and has been used in construction for hundreds of years. It has high thermal and electric conduction properties.

Copper is made by crushing mined copper ores and flash smelting them. The resulting copper sulphite is further heated with oxygen to obtain copper oxide. The latter is heated to obtain blister copper, which is used to cast anodes that are turned into pure copper cathodes through electroplating.

Copper has multiple uses in construction. Copper sheets are often used to manufacture roofing, cladding, gutters, antimicrobial finished surfaces and others.

Category	*Metals*
Type	*Copper*
Functional unit	*kg*
Specific heat	*390 J/(kg·K)*
Density	*8 940 kg/m³*

Common uses
Roofing, cladding, gutters, antimicrobial finished surfaces

Process name
Copper sheet (custom)

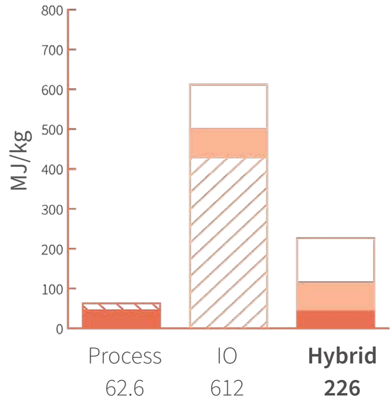
Input-output sector
Basic Non-Ferrous Metal Manufacturing

Further information
doi.org/10.26188/5da55308b9bbe

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Copper sheet	*kg*	*226*	*389*	*15.1*
Copper sheet - 0.9 mm	m^2	1 819	3 132	121
Copper sheet - 1.2 mm	m^2	2 426	4 175	162
Copper sheet - 2 mm	m^2	4 043	6 959	270
Copper sheet - 3 mm	m^2	6 064	10 438	405

TOP THREE INPUTS

- **15.9%** Copper, primary, at refinery/ GLO U/AusSD U
- **5.4%** Road Transport
- **2.0%** Sheet rolling, copper/RER U/ AusSD U

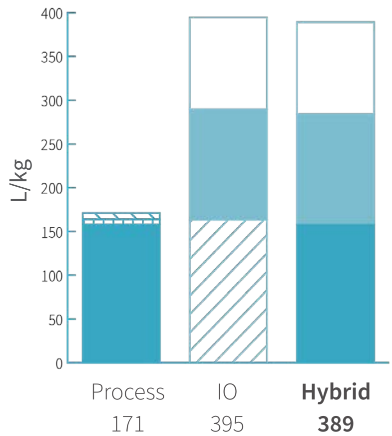


ENERGY

226
MJ/kg

TOP THREE INPUTS

- **37.6%** Copper, primary, at refinery/ GLO U/AusSD U
- **2.1%** Sheet rolling, copper/RER U/ AusSD U
- **1.1%** Electricity Transmission, Distribution, On Selling and Electricity Market Operation

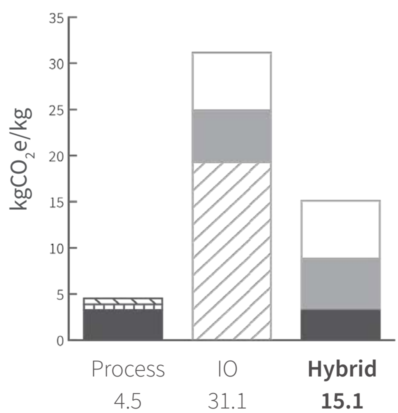


WATER

389
L/kg

TOP THREE INPUTS

- **16.5%** Copper, primary, at refinery/ GLO U/AusSD U
- **2.5%** Sheet rolling, copper/RER U/ AusSD U
- **2.4%** Road Transport



GREENHOUSE GAS EMISSIONS

15.1
$kgCO_2e/kg$

kg Copper pipe

Copper is a soft and malleable non-ferrous metal and has been used in construction for hundreds of years. It has high thermal and electric conduction properties.

Copper is made by crushing mined copper ores and flash smelting them. The resulting copper sulphite is further heated with oxygen to obtain copper oxide. The latter is heated to obtain blister copper, which is used to cast anodes that are turned into pure copper cathodes through electroplating. These are then heated and extruded into pipes.

Copper has multiple uses in construction. Copper pipes are used for building services, including for gas and in heating, cooling and ventilation systems.

Category *Metals*

Type *Copper*

Functional unit *kg*

Specific heat *390 J/(kg·K)*

Density *8 940 kg/m^3*

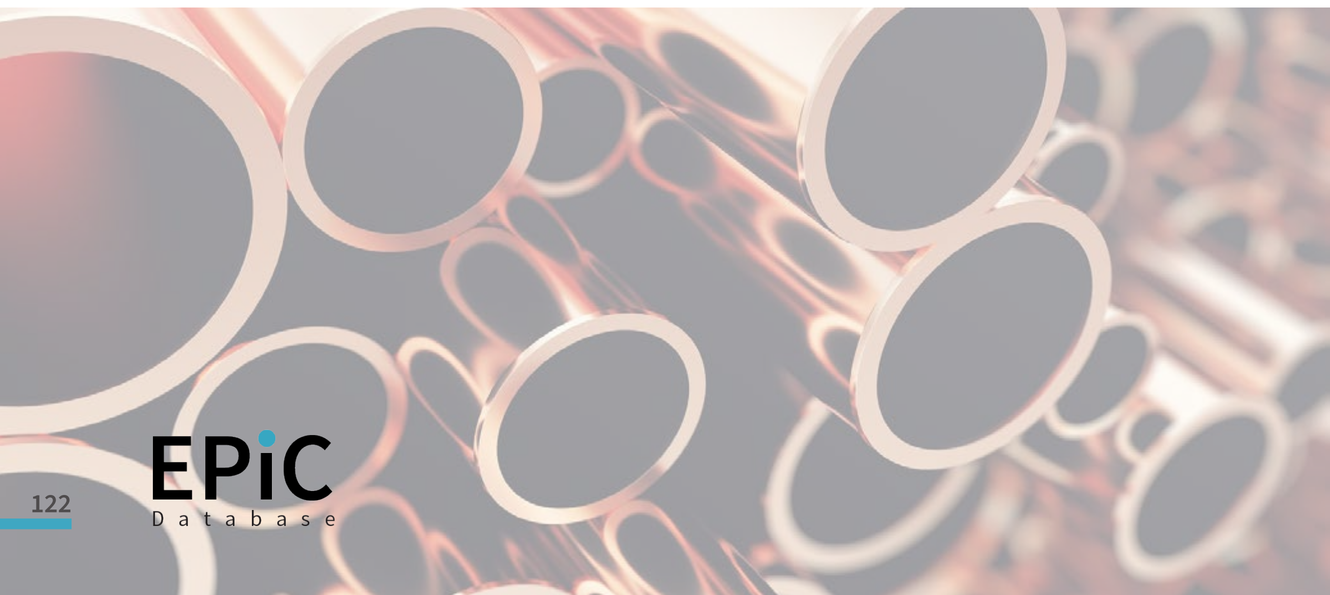
Common uses
Gas pipes, coolant pipes, water pipes

Process name
Copper wire (custom)

Input-output sector
Basic Non-Ferrous Metal Manufacturing

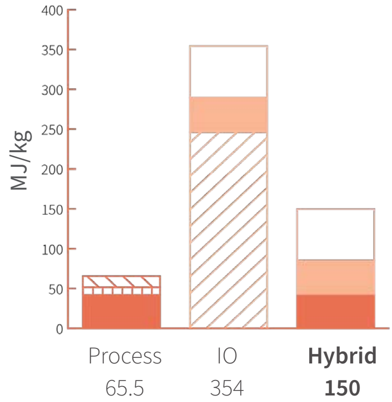
Further information
doi.org/10.26188/5da55317e50fc

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO_2e/unit)
Copper pipe	*kg*	*150*	*289*	*10.1*
Copper pipe - 12.7 mm outer dia., 0.91 mm thick	m	45.1	87.0	3.0
Copper pipe - 19.05 mm outer dia., 1.02 mm thick	m	77.3	149	5.2
Copper pipe - 40 mm outer dia., 1.22 mm thick	m	199	384	13.4



TOP THREE INPUTS

- **23.2%** Copper, primary, at refinery/ GLO U/AusSD U
- **4.7%** Road Transport
- **4.6%** Wire drawing, copper/RER U/ AusSD U

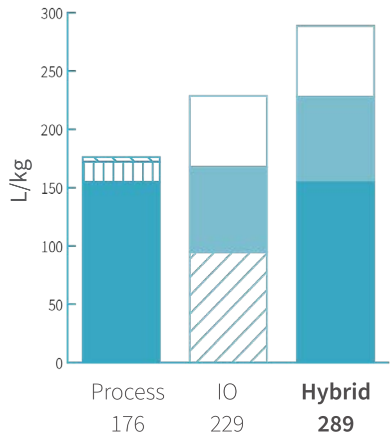


ENERGY

150
MJ/kg

TOP THREE INPUTS

- **49.2%** Copper, primary, at refinery/ GLO U/AusSD U
- **4.5%** Wire drawing, copper/RER U/ AusSD U
- **0.9%** Electricity Transmission, Distribution, On Selling and Electricity Market Operation

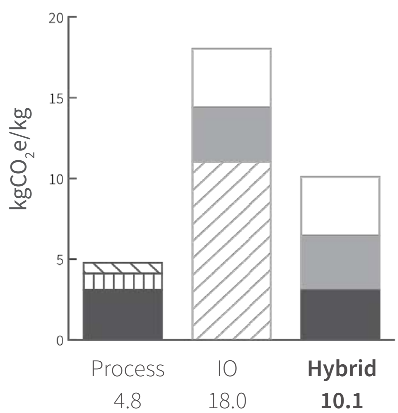


WATER

289
L/kg

TOP THREE INPUTS

- **24.7%** Copper, primary, at refinery/ GLO U/AusSD U
- **6.0%** Wire drawing, copper/RER U/ AusSD U
- **2.2%** Road Transport



GREENHOUSE GAS EMISSIONS

10.1
$kgCO_2e/kg$

kg Copper wire

Copper is a soft and malleable non-ferrous metal and has been used in construction for hundreds of years. It has high thermal and electric conduction properties.

Copper is made by crushing mined copper ores and flash smelting them. The resulting copper sulphite is further heated with oxygen to obtain copper oxide. The latter is heated to obtain blister copper, which is used to cast anodes that are turned into pure copper cathodes through electroplating. These cathodes are melted, roll milled to a very small thickness and fed to a coiler than produces the wire.

Copper has multiple uses in construction. Copper wires are used in the majority of electrical cables.

Category	*Metals*
Type	*Copper*
Functional unit	*kg*
Specific heat	*390 J/(kg·K)*
Density	*8 940 kg/m^3*

Common uses
Electrical cables

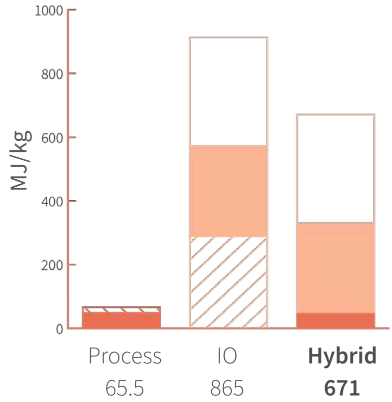
Process name
Copper wire (custom)

Input-output sector
Electrical Equipment Manufacturing

Further information
doi.org/10.26188/5da553272580f

TOP THREE INPUTS

- **6.0%** Road Transport
- **5.9%** Copper, primary, at refinery/ GLO U/AusSD U
- **5.1%** Iron and Steel Manufacturing

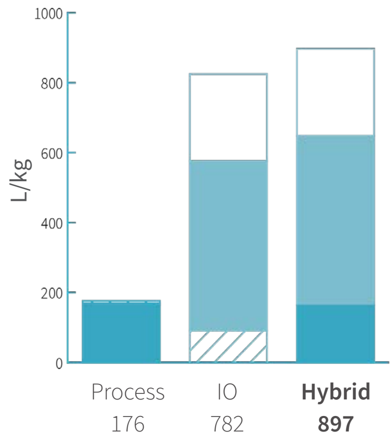


ENERGY

671 MJ/kg

TOP THREE INPUTS

- **16.7%** Copper, primary, at refinery/ GLO U/AusSD U
- **5.5%** Professional, Scientific and Technical Services
- **5.4%** Wholesale Trade

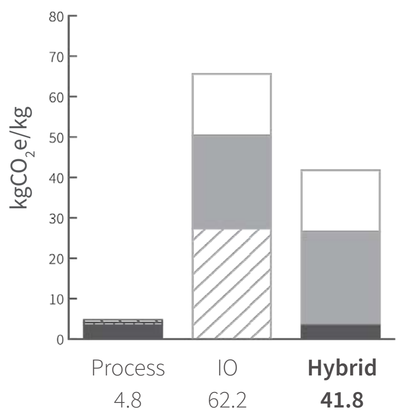


WATER

897 L/kg

TOP THREE INPUTS

- **6.9%** Copper, primary, at refinery/ GLO U/AusSD U
- **6.9%** Electrical Equipment Manufacturing
- **4.9%** Wholesale Trade



GREENHOUSE GAS EMISSIONS

41.8 $kgCO_2e/kg$

kg Cold rolled stainless steel

Steel is a ferrous metal and is an alloy of iron and carbon, as well as potential other elements. It has a very high tensile strength. Steel has been used in the construction industry for over a century. Stainless steel is extremely resistant to corrosion.

The core material for making steel is iron, which is found in iron ore. Iron is extracted from iron ore in blast furnaces through the smelting process, while controlling for the content of carbon. To render the steel stainless, chromium is needed and is typically added as stainless steel scraps. The molten steel is usually further processed before being cast for its final use. Cold rolled steel is cooled at room temperature and then annealed or tempered.

Steel is commonly used in the construction industry, mainly as a structural material. Cold rolled stainless steel is used to produce a range of high-precision corrosion resistant materials.

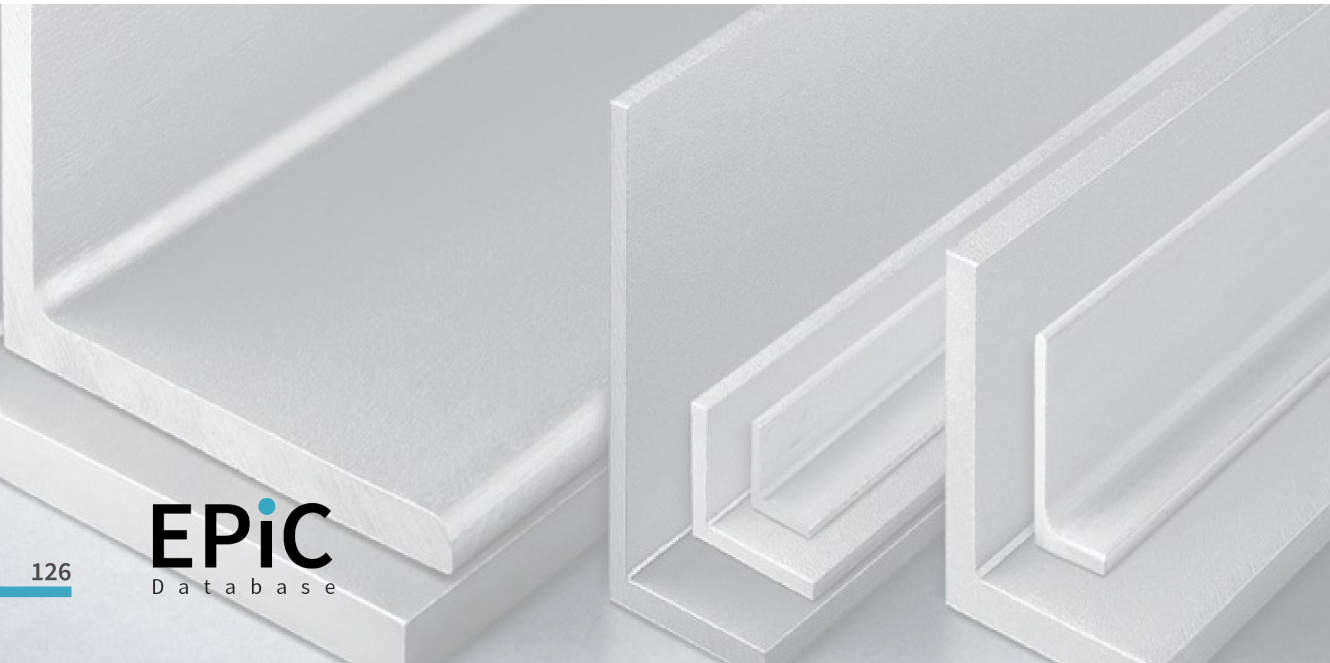
Category	*Metals*
Type	*Stainless steel*
Functional unit	*kg*
Specific heat	*456 J/(kg·K)*
Density	*7 740 kg/m^3*

Common uses
Exterior cladding, handrails, counter tops, interior surfaces

Process name
Stainless steel, cold rolled (custom)

Input-output sector
Iron and Steel Manufacturing

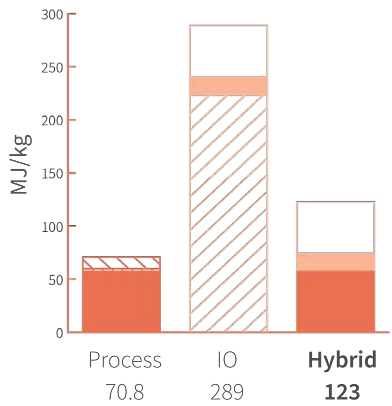
Further information
doi.org/10.26188/5da552cbb2e64



EPiC Database

TOP THREE INPUTS

- **40.2%** Steel, converter, chromium steel 18/8, at plant/RER U/AusSD U
- **6.5%** Sheet rolling, chromium steel/RER U/AusSD U
- **6.0%** Road Transport

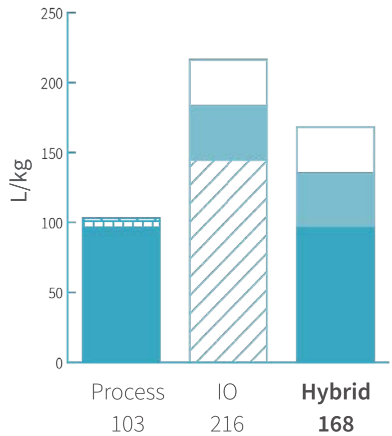


ENERGY

123
MJ/kg

TOP THREE INPUTS

- **34.3%** Sheet rolling, chromium steel/RER U/AusSD U
- **23.0%** Steel, converter, chromium steel 18/8, at plant/RER U/AusSD U
- **2.9%** Coal mining

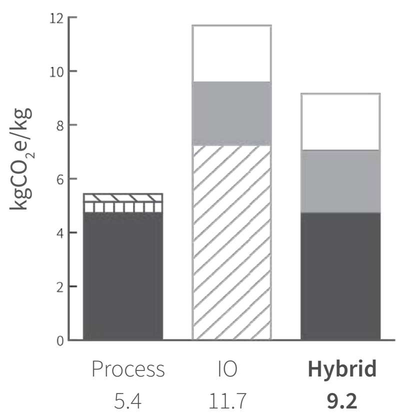


WATER

168
L/kg

TOP THREE INPUTS

- **44.0%** Steel, converter, chromium steel 18/8, at plant/RER U/AusSD U
- **7.6%** Coal mining
- **7.6%** Sheet rolling, chromium steel/RER U/AusSD U



GREENHOUSE GAS EMISSIONS

9.2
$kgCO_2e/kg$

kg Stainless steel extruded

Steel is a ferrous metal and is an alloy of iron and carbon, as well as potential other elements. It has a very high tensile strength. Steel has been used in the construction industry for over a century. Stainless steel is extremely resistant to corrosion.

The core material for making steel is iron, which is found in iron ore. Iron is extracted from iron ore in blast furnaces through the smelting process, while controlling for the content of carbon. To render the steel stainless, chromium is needed and is typically added as stainless steel scraps. The molten steel is usually further processed before being extruded into its final shape.

Steel is commonly used in the construction industry, mainly as a structural material. Extruded stainless steel can be used to produce a range of tubes for structural and finishing purposes as well as pipes.

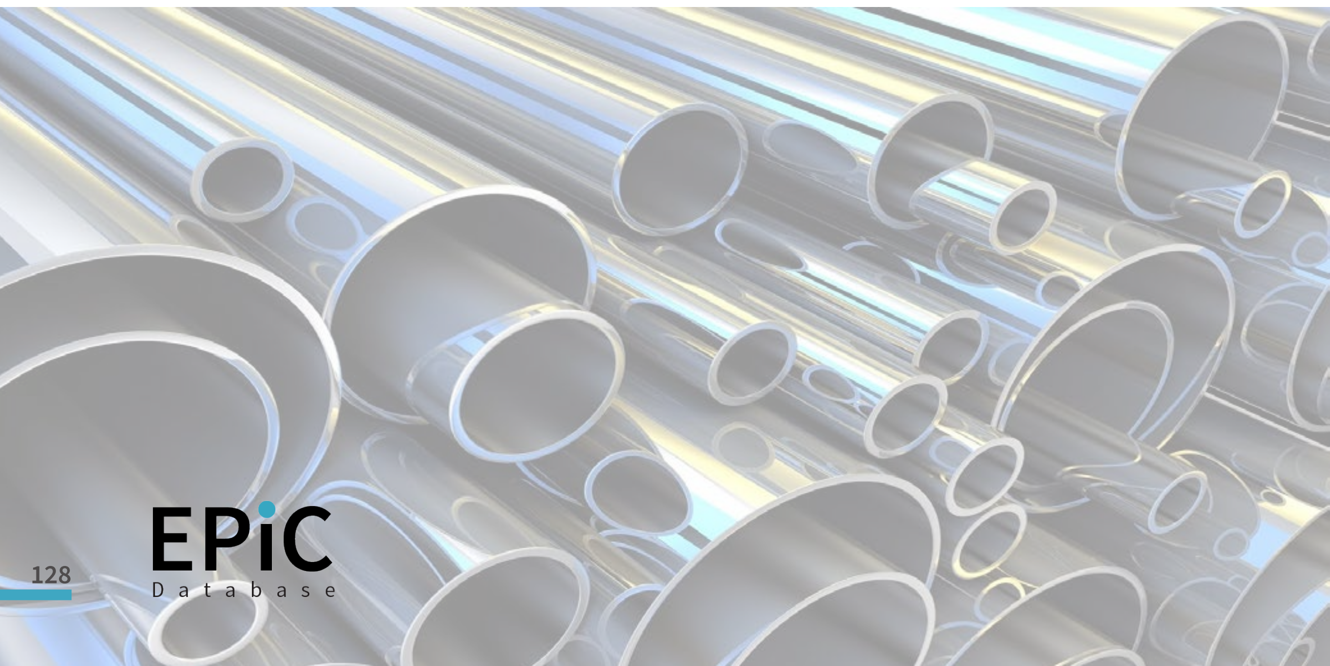
Category	*Metals*
Type	*Stainless steel*
Functional unit	*kg*
Specific heat	*456 J/(kg·K)*
Density	*7 740 kg/m^3*

Common uses
Tubes, pipes

Process name
Stainless steel, hot extruded (custom)

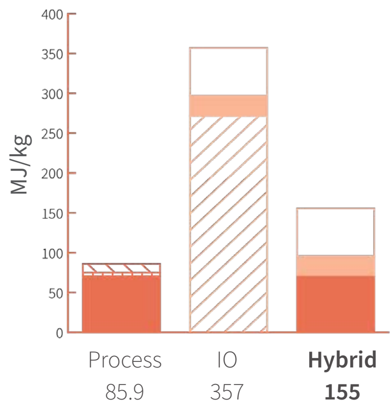
Input-output sector
Iron and Steel Manufacturing

Further information
doi.org/10.26188/5da557cc41ed8



TOP THREE INPUTS

- **31.5%** Steel, converter, chromium steel 18/8, at plant/RER U/ AusSD U
- **5.8%** Road Transport
- **2.5%** Non Ferrous Metal Ore Mining

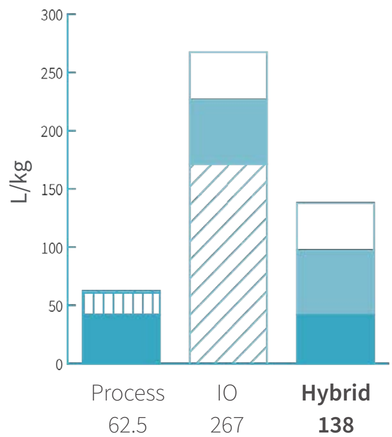


ENERGY

155
MJ/kg

TOP THREE INPUTS

- **28.1%** Steel, converter, chromium steel 18/8, at plant/RER U/ AusSD U
- **7.9%** Non Ferrous Metal Ore Mining
- **4.4%** Coal mining

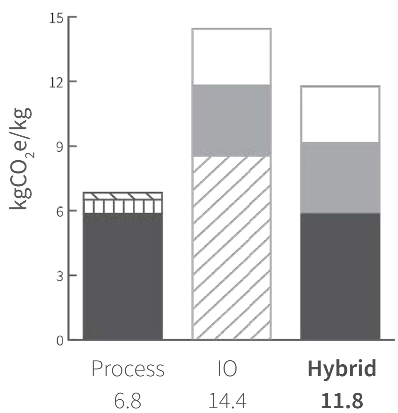


WATER

138
L/kg

TOP THREE INPUTS

- **34.2%** Steel, converter, chromium steel 18/8, at plant/RER U/ AusSD U
- **7.3%** Coal mining
- **4.0%** Non Ferrous Metal Ore Mining



GREENHOUSE GAS EMISSIONS

11.8
$kgCO_2e/kg$

kg Stainless steel sheet

Steel is a ferrous metal and is an alloy of iron and carbon, as well as potential other elements. It has a very high tensile strength. Steel has been used in the construction industry for over a century. Stainless steel is extremely resistant to corrosion.

The core material for making steel is iron, which is found in iron ore. Iron is extracted from iron ore in blast furnaces through the smelting process, while controlling for the content of carbon. To render the steel stainless, chromium is needed and is typically added as stainless steel scraps. The molten steel is usually further processed before being cast for its final use.

Steel is commonly used in the construction industry, mainly as a structural material. Stainless steel sheets are used to produce a range of finishing materials, such as high durability cladding, roofing (mainly for airports), and kitchen surfaces.

Category *Metals*

Type *Stainless steel*

Functional unit *kg*

Specific heat *456 J/(kg·K)*

Density *7 740 kg/m^3*

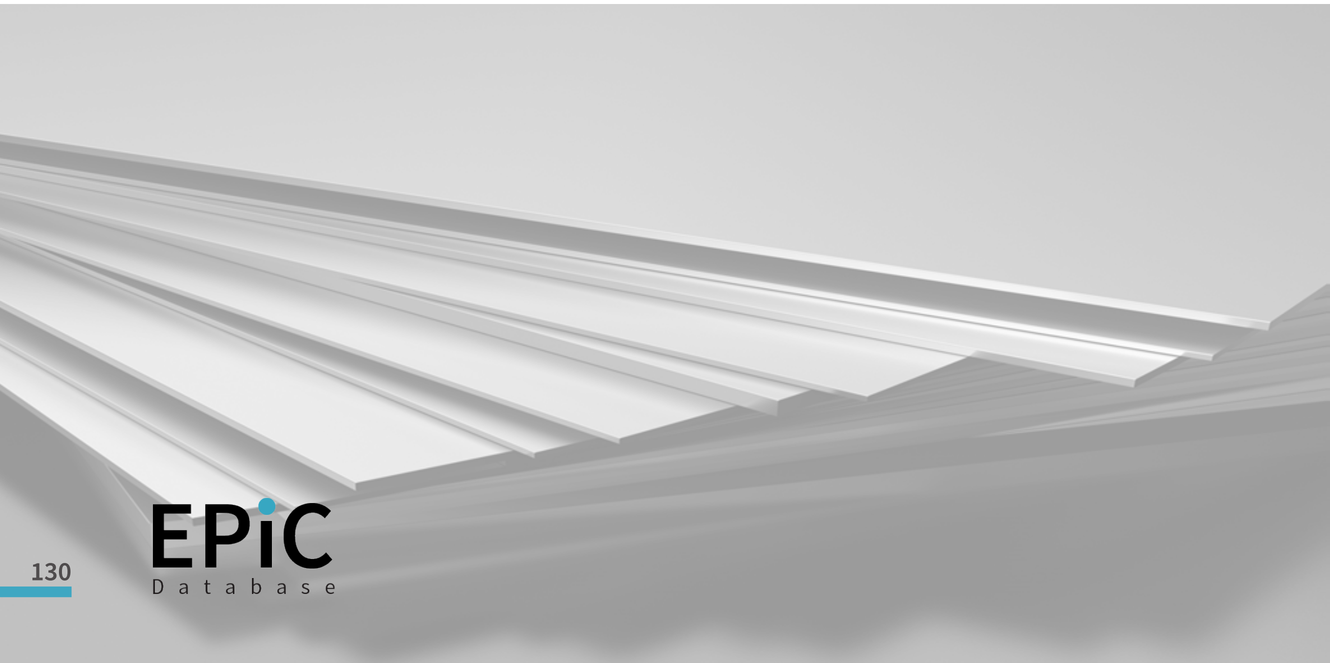
Common uses
High-durability cladding, tubes, roofing, kitchen surfaces

Process name
Stainless steel, sheet (custom)

Input-output sector
Iron and Steel Manufacturing

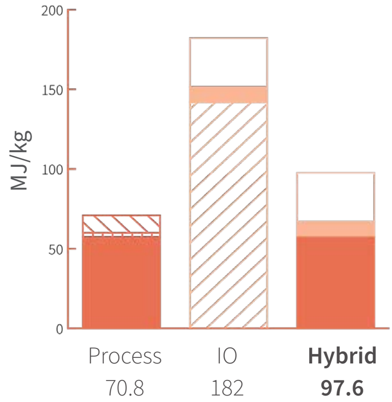
Further information
doi.org/10.26188/5da557de9ee33

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO$_2$e/unit)
Stainless steel sheet	*kg*	*97.6*	*140*	*7.2*
Stainless steel sheet products	kg	238	263	14.7



TOP THREE INPUTS

- **50.6%** Steel, converter, chromium steel 18/8, at plant/RER U/AusSD U
- **8.1%** Sheet rolling, chromium steel/RER U/AusSD U
- **4.7%** Road Transport

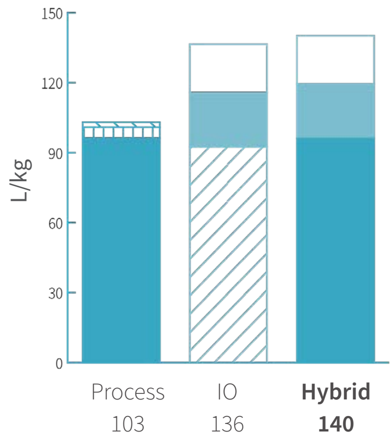


ENERGY

97.6 MJ/kg

TOP THREE INPUTS

- **41.2%** Sheet rolling, chromium steel/RER U/AusSD U
- **27.5%** Steel, converter, chromium steel 18/8, at plant/RER U/AusSD U
- **0.7%** Wholesale Trade

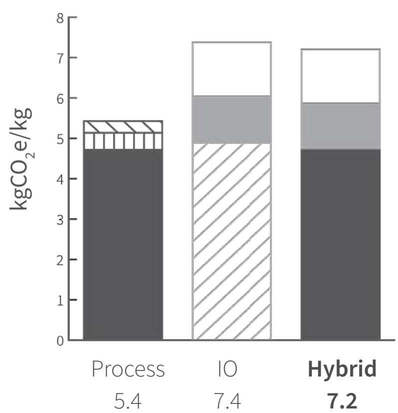


WATER

140 L/kg

TOP THREE INPUTS

- **55.9%** Steel, converter, chromium steel 18/8, at plant/RER U/AusSD U
- **9.7%** Sheet rolling, chromium steel/RER U/AusSD U
- **2.1%** Road Transport



GREENHOUSE GAS EMISSIONS

7.2 $kgCO_2e/kg$

kg Stainless steel wire

Steel is a ferrous metal and is an alloy of iron and carbon, as well as potential other elements. It has a very high tensile strength. Steel has been used in the construction industry for over a century. Stainless steel is extremely resistant to corrosion.

The core material for making steel is iron, which is found in iron ore. Iron is extracted from iron ore in blast furnaces through the smelting process, while controlling for the content of carbon. To render the steel stainless, chromium is needed and is typically added as stainless steel scraps. The molten steel is usually further processed before being thermoformed into its final shape.

Steel is commonly used in the construction industry, mainly as a structural material. Stainless steel wires are typically used as ropes and cables in multiple applications, including bridges, suspending structures, lighting and others.

Category	*Metals*
Type	*Stainless steel*
Functional unit	*kg*
Specific heat	*456 J/(kg·K)*
Density	*7 740 kg/m^3*

Common uses
Cables, ropes, structure, lighting

Process name
Stainless steel, wire (custom)

Input-output sector
Other Fabricated Metal Product manufacturing

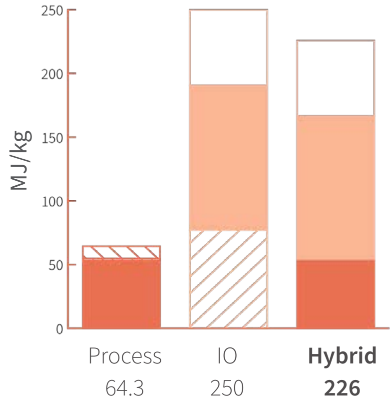
Further information
doi.org/10.26188/5da5580349dda

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO_2e/unit)
Stainless steel wire	*kg*	*226*	*253*	*13.9*
Bare wire - 2 mm dia.	m	5.5	6.2	0.3
Bare wire - 3.2 mm dia.	m	14.1	15.8	0.9
Wire Rope - 1.6 mm dia.	m	2.4	2.7	0.2
Wire Rope - 4 mm dia.	m	14.2	15.9	0.9
Wire Rope - 8 mm dia.	m	57.8	64.9	3.6
Wire Rope - 12 mm dia.	m	127	143	7.8

EPiC Database

TOP THREE INPUTS

- **25.9%** Basic Non-Ferrous Metal Manufacturing
- **22.3%** Steel, converter, chromium steel 18/8, at plant/RER U/AusSD U
- **5.0%** Road Transport

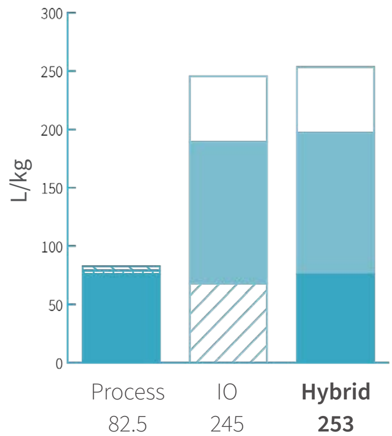


ENERGY

226
MJ/kg

TOP THREE INPUTS

- **15.3%** Steel, converter, chromium steel 18/8, at plant/RER U/AusSD U
- **14.6%** Wire drawing, steel/RER U/AusSD U
- **12.4%** Basic Non-Ferrous Metal Manufacturing

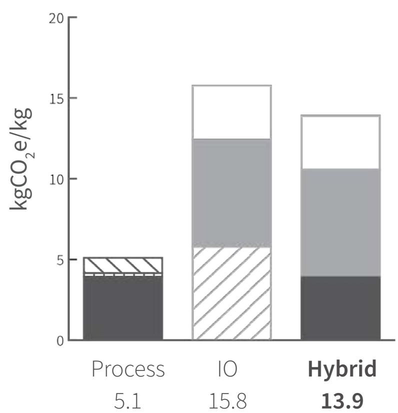


WATER

253
L/kg

TOP THREE INPUTS

- **26.9%** Steel, converter, chromium steel 18/8, at plant/RER U/AusSD U
- **20.6%** Basic Non-Ferrous Metal Manufacturing
- **3.5%** Other Fabricated Metal Product manufacturing



GREENHOUSE GAS EMISSIONS

13.9
$kgCO_2e/kg$

Cold rolled steel

Steel is a ferrous metal and is an alloy of iron and carbon, as well as potential other elements. It has a very high tensile strength. Steel has been used in the construction industry for over a century.

The core material for making steel is iron, which is found in iron ore. Iron is extracted from iron ore in blast furnaces through the smelting process, while controlling for the content of carbon. The molten steel is usually further processed before being cast for its final use. Cold rolled steel is cooled at room temperature and then annealed or tempered.

Steel is commonly used in the construction industry, mainly as a structural material. Cold rolled structural steel is used to produce a range of more precise structural elements compared to hot rolled structural steel. These include structural members for trusses and profiles for roof and wall systems.

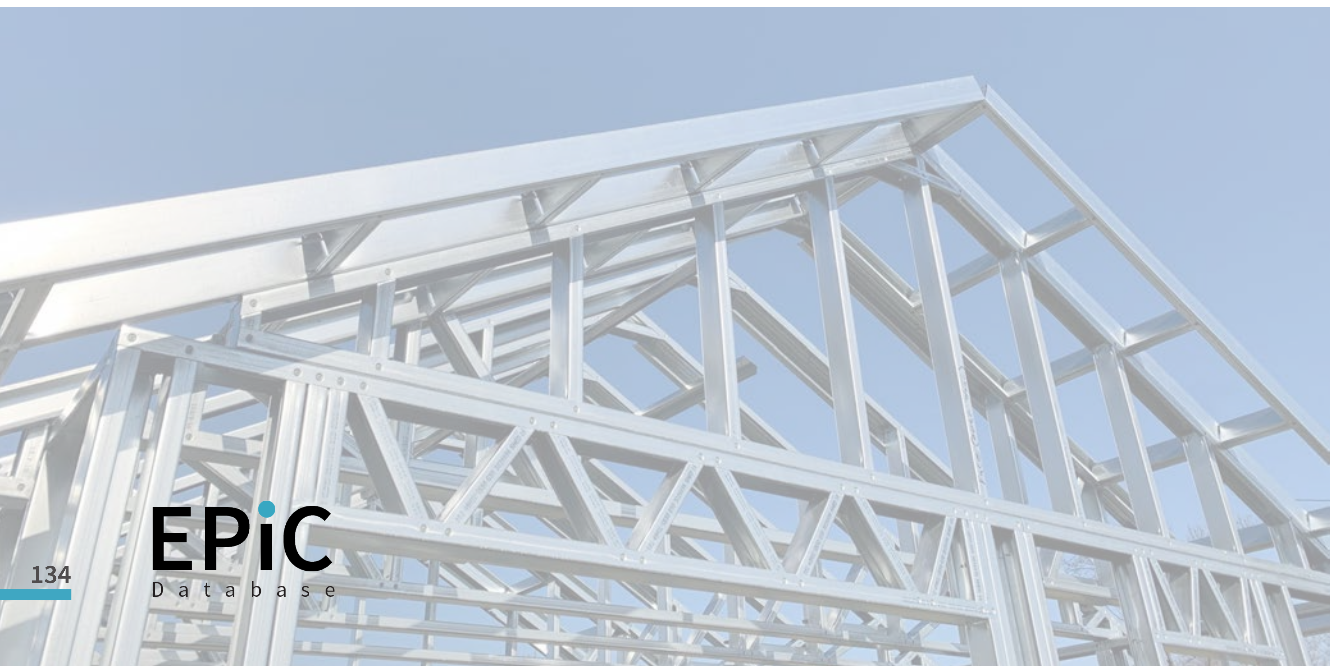
Category	*Metals*
Type	*Steel*
Functional unit	*kg*
Specific heat	*490 J/(kg·K)*
Density	*7 850 kg/m^3*

Common uses
Truss members, wall and roof systems

Process name
Steel cold rolled (custom)

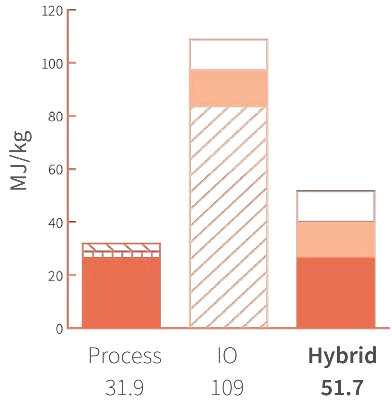
Input-output sector
Iron and Steel Manufacturing

Further information
doi.org/10.26188/5da552dadce9f



TOP THREE INPUTS

- **41.5%** Steel, converter, low-alloyed, at plant/RER U/AusSD U
- **9.9%** Sheet rolling, steel/RER U/ AusSD U
- **5.7%** Road Transport

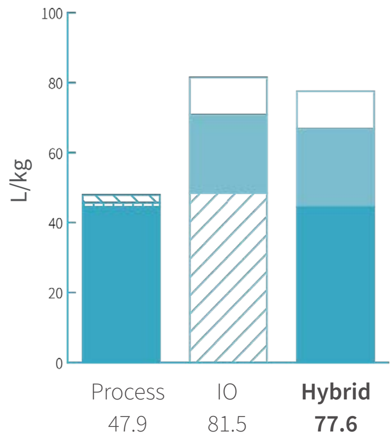


ENERGY

51.7 MJ/kg

TOP THREE INPUTS

- **36.8%** Sheet rolling, steel/RER U/ AusSD U
- **20.6%** Steel, converter, low-alloyed, at plant/RER U/AusSD U
- **5.9%** Water Supply, Sewerage and Drainage Services

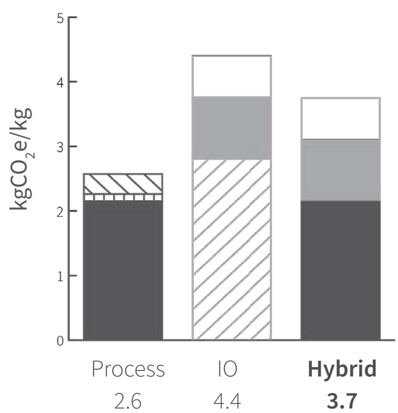


WATER

77.6 L/kg

TOP THREE INPUTS

- **46.9%** Steel, converter, low-alloyed, at plant/RER U/AusSD U
- **10.4%** Sheet rolling, steel/RER U/ AusSD U
- **4.0%** Non Ferrous Metal Ore Mining



GREENHOUSE GAS EMISSIONS

3.7 $kgCO_2e/kg$

Hot rolled galvanised structural steel

Steel is a ferrous metal and is an alloy of iron and carbon, as well as potential other elements. It has a very high tensile strength. Steel has been used in the construction industry for over a century.

The core material for making steel is iron, which is found in iron ore. Iron is extracted from iron ore in blast furnaces through the smelting process, while controlling for the content of carbon. The molten steel is usually further processed before being cast for its final use. Galvanisation can be used to apply a coat of zinc crystals on the surface of the steel to significantly improve its resistance to corrosion.

Steel is commonly used in the construction industry, mainly as a structural material. Hot rolled galvanised steel is used to produce elements for the outdoors, such as poles, pipes, and decking.

Category	*Metals*
Type	*Galvanised steel (zinc coated)*
Functional unit	*kg*
Specific heat	*456 J/(kg·K)*
Density	*7 850 kg/m^3*

Common uses
Beams, columns

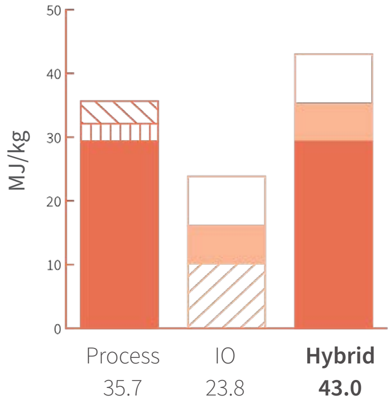
Process name
Galvanised hot rolled steel (custom)

Input-output sector
Structural Metal Product Manufacturing

Further information
doi.org/10.26188/5da5554017f41

TOP THREE INPUTS

- **49.8%** Steel, converter, low-alloyed, at plant/RER U/AusSD U
- **9.4%** Hot rolling, steel/RER U/AusSD U
- **9.1%** Zinc coating, coils/RER U/AusSD U

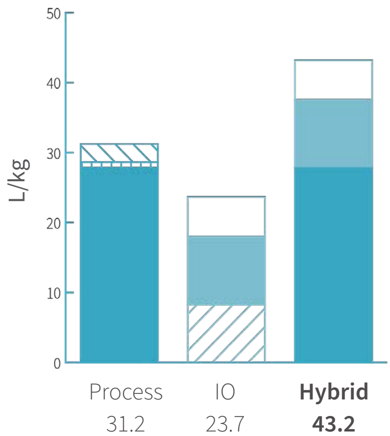


ENERGY

43.0
MJ/kg

TOP THREE INPUTS

- **37.3%** Steel, converter, low-alloyed, at plant/RER U/AusSD U
- **14.7%** Hot rolling, steel/RER U/AusSD U
- **12.5%** Zinc coating, coils/RER U/AusSD U

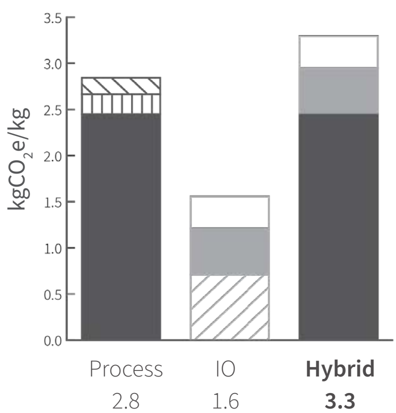


WATER

43.2
L/kg

TOP THREE INPUTS

- **55.2%** Steel, converter, low-alloyed, at plant/RER U/AusSD U
- **9.9%** Zinc coating, coils/RER U/AusSD U
- **9.2%** Hot rolling, steel/RER U/AusSD U



GREENHOUSE GAS EMISSIONS

3.3
$kgCO_2e/kg$

kg Hot rolled structural steel

Steel is a ferrous metal and is an alloy of iron and carbon, as well as potential other elements. It has a very high tensile strength. Steel has been used in the construction industry for over a century.

The core material for making steel is iron, which is found in iron ore. Iron is extracted from iron ore in blast furnaces through the smelting process, while controlling for the content of carbon. The molten steel is usually further processed before being cast for its final use.

Steel is commonly used in the construction industry, mainly as a structural material. Hot rolled structural steel is used to produce a range of structural elements, such as reinforcement bars, I-beams and railroad tracks.

Category *Metals*

Type *Steel*

Functional unit *kg*

Specific heat *490 J/(kg·K)*

Density *7 850 kg/m^3*

Common uses
Reinforcement bars, beams, railroad tracks

Process name
Steel hot rolled (custom)

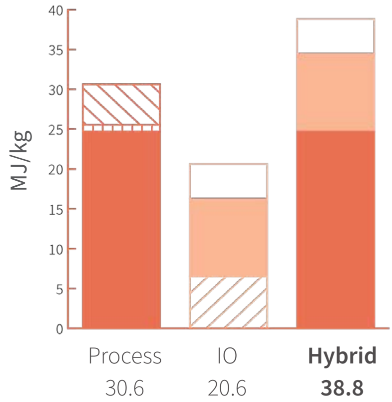
Input-output sector
Structural Metal Product Manufacturing

Further information
doi.org/10.26188/5da55550a40e9

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Hot rolled structural steel	*kg*	*38.8*	*37.1*	*2.9*
Steel reinforcement bar - 6 mm dia.	m	8.6	8.2	0.6
Steel reinforcement bar - 8 mm dia.	m	15.3	14.6	1.1
Steel reinforcement bar - 12 mm dia.	m	34.5	32.9	2.6

TOP THREE INPUTS

- **53.6%** Steel, converter, low-alloyed, at plant/RER U/AusSD U
- **10.0%** Hot rolling, steel/RER U/AusSD U
- **6.9%** Basic Non-Ferrous Metal Manufacturing

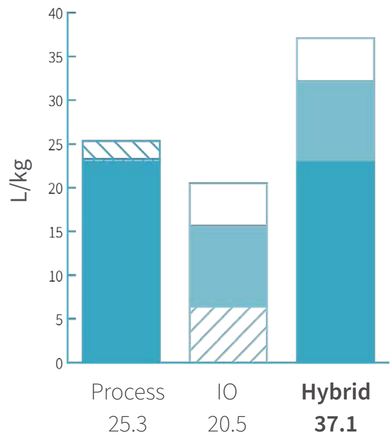


ENERGY

38.8 MJ/kg

TOP THREE INPUTS

- **44.8%** Steel, converter, low-alloyed, at plant/RER U/AusSD U
- **17.1%** Hot rolling, steel/RER U/AusSD U
- **3.8%** Basic Non-Ferrous Metal Manufacturing

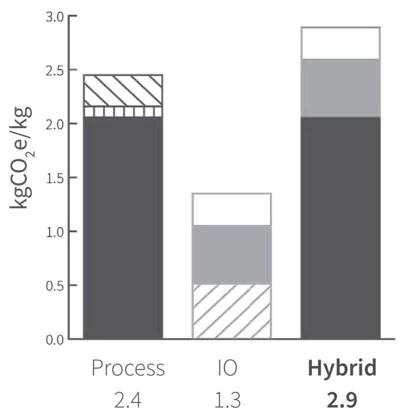


WATER

37.1 L/kg

TOP THREE INPUTS

- **60.9%** Steel, converter, low-alloyed, at plant/RER U/AusSD U
- **10.2%** Hot rolling, steel/RER U/AusSD U
- **4.4%** Basic Non-Ferrous Metal Manufacturing



GREENHOUSE GAS EMISSIONS

2.9 $kgCO_2e/kg$

kg Steel bar

Steel is a ferrous metal and is an alloy of iron and carbon, as well as potential other elements. It has a very high tensile strength. Steel has been used in the construction industry for over a century.

The core material for making steel is iron, which is found in iron ore. Iron is extracted from iron ore in blast furnaces through the smelting process, while controlling for the content of carbon. The molten steel is usually further processed before being cast for its final use.

Steel is commonly used in the construction industry, mainly as a structural material. Steel (flat) bars are used as frames and cut and welded into steel plates.

Category	*Metals*
Type	*Steel*
Functional unit	*kg*
Specific heat	*490 J/(kg·K)*
Density	*7 850 kg/m^3*

Common uses
Framing, plates

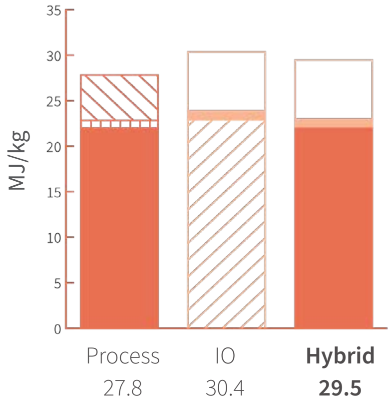
Process name
Steel bar (custom)

Input-output sector
Iron and Steel Manufacturing

Further information
doi.org/10.26188/5da55814c051c

TOP THREE INPUTS

- **70.6%** Steel, converter, low-alloyed, at plant/RER U/AusSD U
- **2.3%** Road Transport
- **0.5%** Non Ferrous Metal Ore Mining

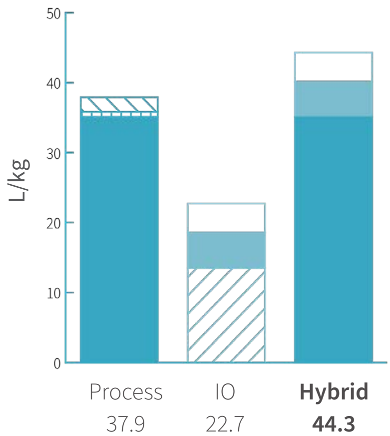


ENERGY

29.5
MJ/kg

TOP THREE INPUTS

- **37.5%** Non Ferrous Metal Ore Mining
- **2.9%** Water Supply, Sewerage and Drainage Services
- **1.9%** Non Ferrous Metal Ore Mining

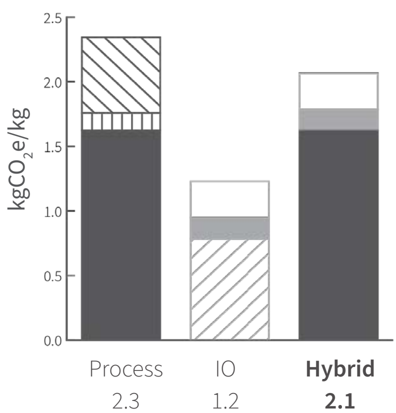


WATER

44.3
L/kg

TOP THREE INPUTS

- **74.5%** Steel, converter, low-alloyed, at plant/RER U/AusSD U
- **1.6%** Non Ferrous Metal Ore Mining
- **1.1%** Road Transport



GREENHOUSE GAS EMISSIONS

2.1
$kgCO_2e/kg$

kg Steel hollow section extruded

Steel is a ferrous metal and is an alloy of iron and carbon, as well as potential other elements. It has a very high tensile strength. Steel has been used in the construction industry for over a century.

The core material for making steel is iron, which is found in iron ore. Iron is extracted from iron ore in blast furnaces through the smelting process, while controlling for the content of carbon. The molten steel is usually further processed before being extruded into hollow sections.

Hollow sections of steel are commonly used in the construction industry, mainly for structural purposes.

Category *Metals*

Type *Steel*

Functional unit *kg*

Specific heat *490 J/(kg·K)*

Density *7 850 kg/m^3*

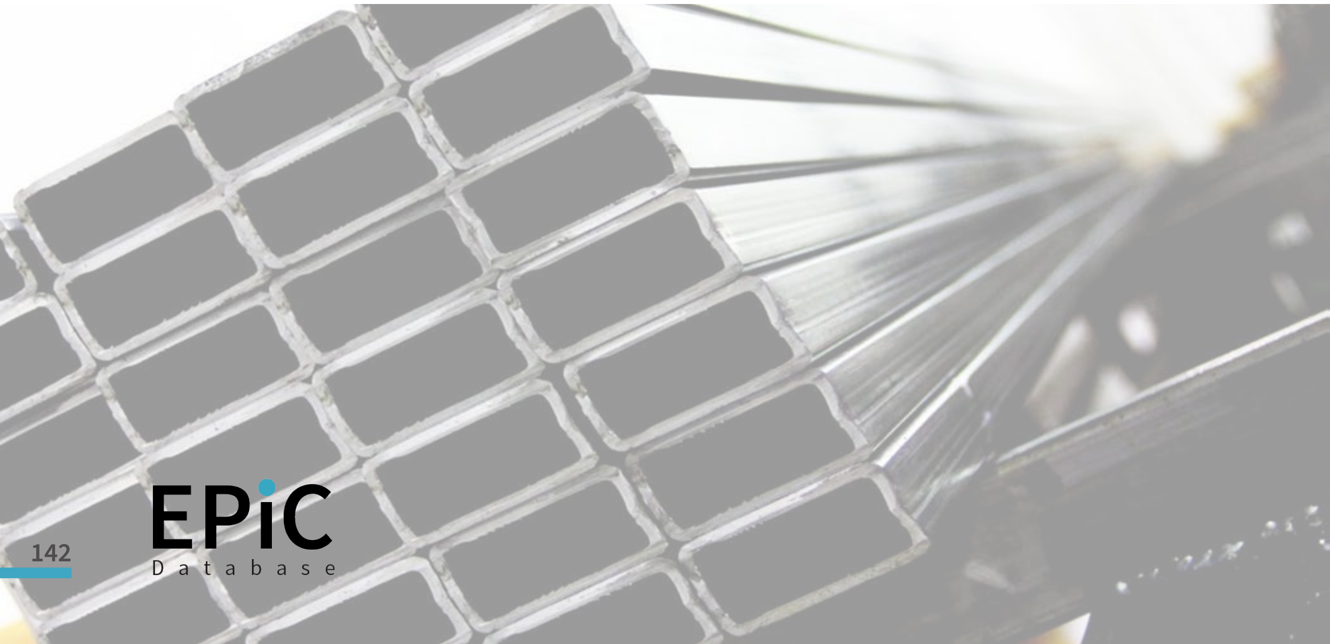
Common uses
Structural profiles

Process name
Steel, extruded (custom)

Input-output sector
Iron and Steel Manufacturing

Further information
doi.org/10.26188/5da558259be14

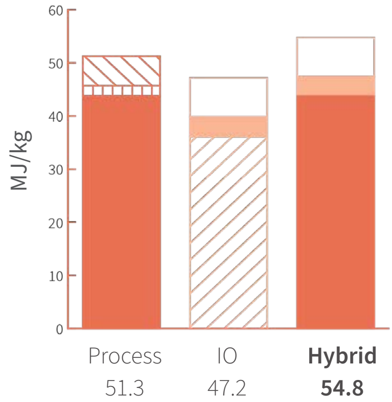
Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Steel hollow section extruded	*kg*	*54.8*	*45.2*	*4.6*
Square tube - 20 mm, 1.6 mm thick	m	55	45.4	4.6
Square tube - 50 mm, 2 mm thick	m	172	142	14.5
Square tube - 100 mm, 4 mm thick	m	688	568	57.8



EPiC Database

TOP THREE INPUTS

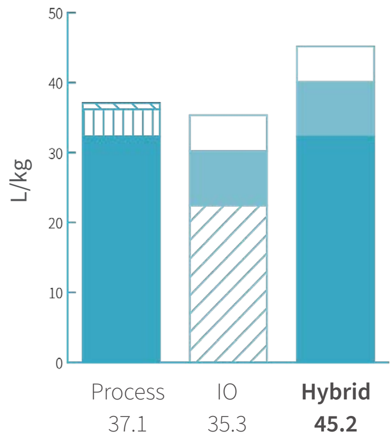
- **37.8%** Steel, converter, low-alloyed, at plant/RER U/AusSD U
- **2.2%** Road Transport
- **1.0%** Non Ferrous Metal Ore Mining



ENERGY

TOP THREE INPUTS

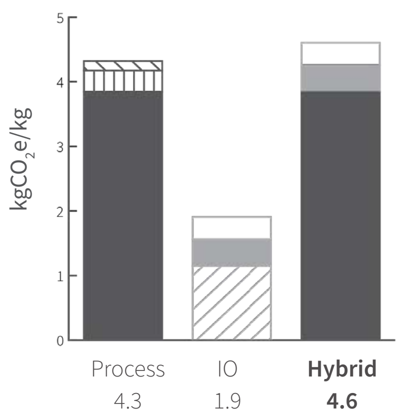
- **36.5%** Steel, converter, low-alloyed, at plant/RER U/AusSD U
- **3.2%** Non Ferrous Metal Ore Mining
- **1.8%** Coal mining



WATER

TOP THREE INPUTS

- **39.1%** Steel, converter, low-alloyed, at plant/RER U/AusSD U
- **2.2%** Coal mining
- **1.3%** Non Ferrous Metal Ore Mining



GREENHOUSE GAS EMISSIONS

kg Steel pipe

Steel is a ferrous metal and is an alloy of iron and carbon, as well as potential other elements. It has a very high tensile strength. Steel has been used in the construction industry for over a century.

The core material for making steel is iron, which is found in iron ore. Iron is extracted from iron ore in blast furnaces through the smelting process, while controlling for the content of carbon. The molten steel is usually further processed before being extruded into circular pipes.

Steel pipes are often used in pile foundations, plumbing and as columns (usually filled with concrete).

Category *Metals*

Type *Steel*

Functional unit *kg*

Specific heat *490 J/(kg·K)*

Density *7 850 kg/m³*

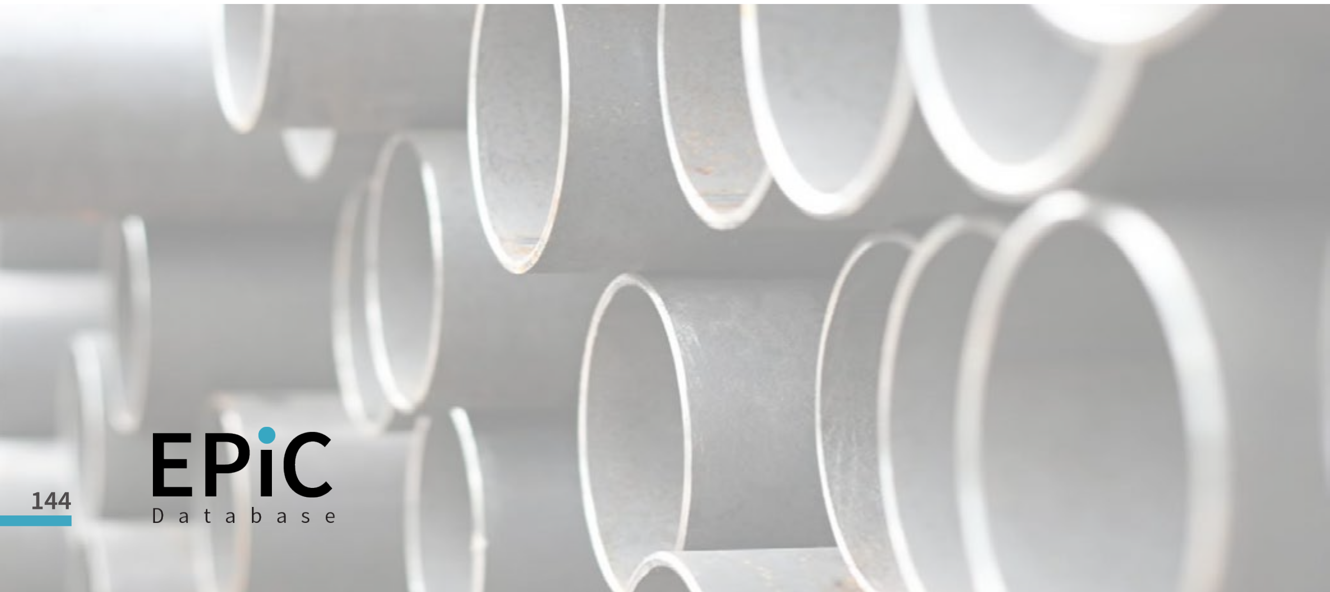
Common uses
Piles, pipes, structural profiles

Process name
Steel pipe (custom)

Input-output sector
Iron and Steel Manufacturing

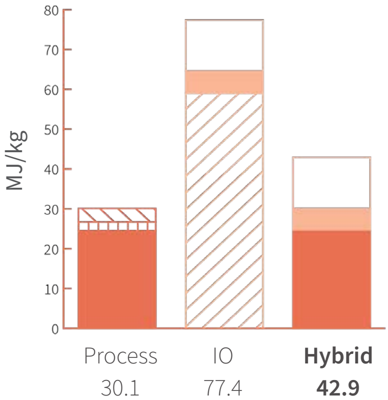
Further information
doi.org/10.26188/5da5583906307

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Steel pipe	*kg*	*42.9*	*78.1*	*3.5*
Steel pipe - 21.3 mm outer dia., 2.6 mm thick	m	51.4	93.7	4.2
Steel pipe - 42.4 mm outer dia., 2.6 mm thick	m	109	199	9.0
Steel pipe - 88.9 mm outer dia., 4 mm thick	m	359	654	29.6
Steel pipe - 165.1 mm outer dia., 4.9 mm thick	m	831	1 512	68.5



TOP THREE INPUTS

- **49.5%** Steel, converter, low-alloyed, at plant/RER U/AusSD U
- **4.6%** Road Transport
- **2.0%** Non Ferrous Metal Ore Mining

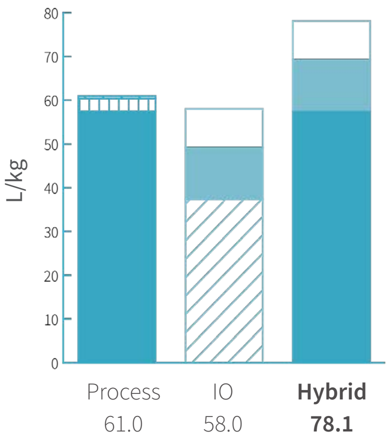


ENERGY

42.9
MJ/kg

TOP THREE INPUTS

- **20.2%** Steel, converter, low-alloyed, at plant/RER U/AusSD U
- **3.0%** Non Ferrous Metal Ore Mining
- **1.7%** Coal mining

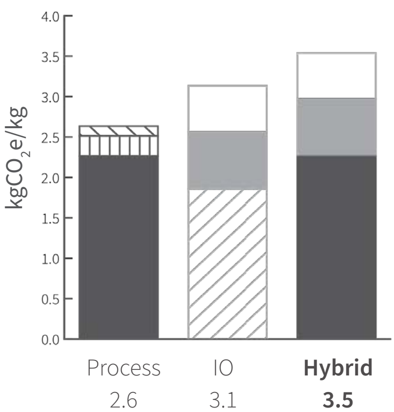


WATER

78.1
L/kg

TOP THREE INPUTS

- **50.8%** Steel, converter, low-alloyed, at plant/RER U/AusSD U
- **5.3%** Coal mining
- **2.8%** Non Ferrous Metal Ore Mining



GREENHOUSE GAS EMISSIONS

3.5
$kgCO_2e/kg$

kg Steel sheet corrugated

Steel is a ferrous metal and is an alloy of iron and carbon, as well as potential other elements. It has a very high tensile strength. Steel has been used in the construction industry for over a century.

The core material for making steel is iron, which is found in iron ore. Iron is extracted from iron ore in blast furnaces through the smelting process, while controlling for the content of carbon. The molten steel is usually further processed before being cast into sheet. These steel sheets are then corrugated using roll forming. The corrugated steel sheets are finally galvanised by applying a coat of zinc crystals on their surface to significantly improve their resistance to corrosion.

Corrugated steel sheets are widely used in the construction industry, mainly as roofing, cladding, separations and permanent formwork.

Category *Metals*

Type *Steel*

Functional unit *kg*

Specific heat *490 J/(kg·K)*

Density *7 850 kg/m^3*

Common uses
Roofing, cladding, separations, permanent formwork

Process name
Steel sheet corrugated (custom)

Input-output sector
Iron and Steel Manufacturing

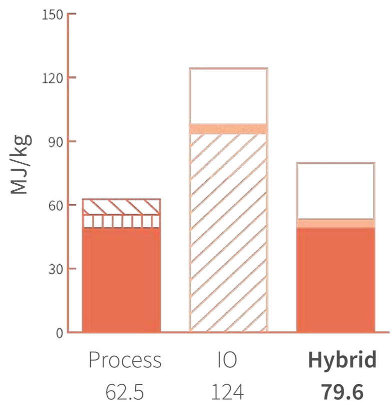
Further information
doi.org/10.26188/5da5584b06f9b

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Steel sheet corrugated	*kg*	*79.6*	*73.4*	*5.5*
Steel sheet corrugated - per m^2	m^2	259	239	17.9
Steel sheet corrugated - pre-painted	m^2	293	286	24.9

EPiC Database

TOP THREE INPUTS

- **26.2%** Steel, converter, low-alloyed, at plant/RER U/AusSD U
- **4.9%** Hot rolling, steel/RER U/AusSD U
- **3.5%** Road Transport

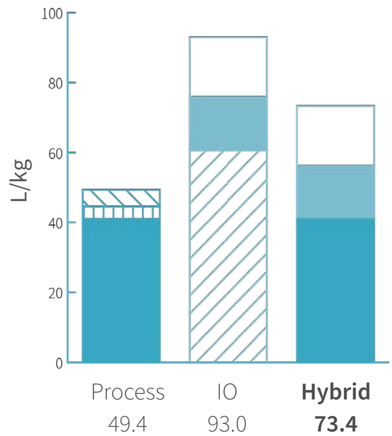


ENERGY

79.6 MJ/kg

TOP THREE INPUTS

- **22.6%** Steel, converter, low-alloyed, at plant/RER U/AusSD U
- **8.6%** Hot rolling, steel/RER U/AusSD U
- **4.8%** Non Ferrous Metal Ore Mining

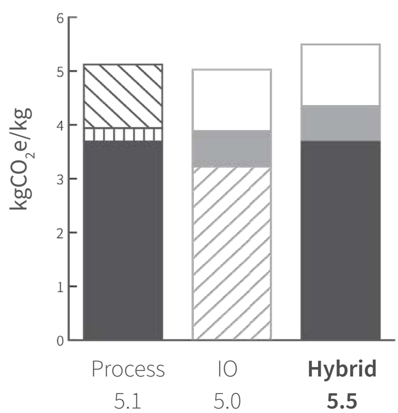


WATER

73.4 L/kg

TOP THREE INPUTS

- **28.0%** Steel, converter, low-alloyed, at plant/RER U/AusSD U
- **4.5%** Hot rolling, steel/RER U/AusSD U
- **2.5%** Non Ferrous Metal Ore Mining



GREENHOUSE GAS EMISSIONS

5.5 $kgCO_2e/kg$

kg Asphalt

Asphalt is made by combining bitumen and aggregates. It is also commonly known as asphaltic concrete or bituminous concrete. Bitumen is a petroleum-based product made by extracting components of crude oil. Crude bitumen obtained from oil sands can also be used, which is a naturally occurring bitumen. Bitumen is used as a binder and generally represents around 5% of the asphalt mix.

Typical aggregates used are crushed rock, sand or gravel and these make up approximately 95% of the volume of asphalt. The maximum aggregate size is generally 10 mm. Polymers and other additives are often added to control the properties of asphalt. Due to its high viscosity, asphalt is heated prior to being mixed with the aggregate materials.

Asphalt is used mainly as a road construction material, but also commonly used for path and carpark surfacing as well as waterproofing of roofs.

Category	*Miscellaneous*
Type	*Bitumen*
Functional unit	*kg*
Specific heat	*837 J/(kg·K)*
Density	*2 649 kg/m^3*

Common uses
Roads, carparks, pathways, roofs

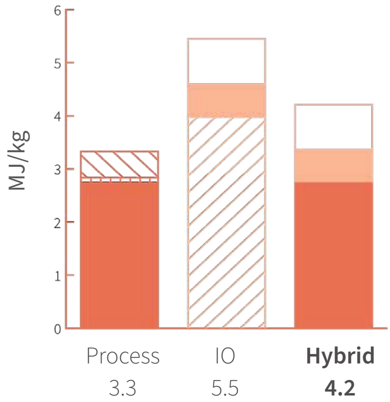
Process name
Asphalt, standard mix, 5.5% virgin bitumen, at plant/AU U

Input-output sector
Petroleum and Coal Product Manufacturing

Further information
doi.org/10.26188/5da551ed753b9

TOP THREE INPUTS

- **55.8%** Bitumen, at refinery/RER U/AusSD U
- **12.9%** Oil and gas extraction
- **1.4%** Gravel, crushed, at mine/CH U/AusSD U

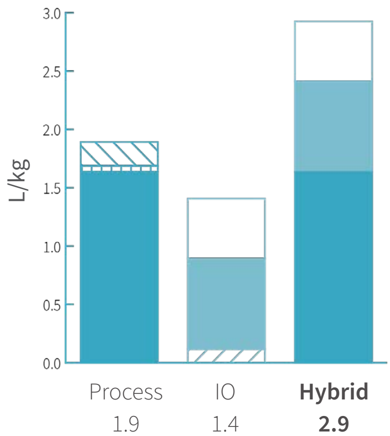


ENERGY

4.2
MJ/kg

TOP THREE INPUTS

- **34.4%** Gravel, crushed, at mine/CH U/AusSD U
- **15.1%** Oil and gas extraction
- **12.0%** Bitumen, at refinery/RER U/AusSD U

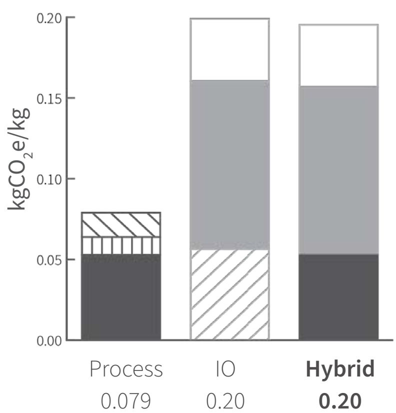


WATER

2.9
L/kg

TOP THREE INPUTS

- **48.1%** Oil and gas extraction
- **9.4%** Bitumen, at refinery/RER U/AusSD U
- **3.8%** Gravel, crushed, at mine/CH U/AusSD U



GREENHOUSE GAS EMISSIONS

0.20
$kgCO_2e/kg$

Nylon carpet

Carpet is a common flooring material, widely used for residential and commercial flooring applications. It has good insulative properties and medium - high durability. It is typically graded using surface pile mass (g/m²), with a higher g/m² generally indicating a higher quality and more durable product.

Tufted carpet is available in three standard styles: 'cut pile', 'loop pile' and 'cut & loop pile'. Within these styles, there are significant variations in durability, aesthetic qualities and cost. During production, carpet fibre is sewn directly onto a primary backing fabric and then bonded (commonly using latex) onto a secondary backing layer (hessian, or similar). Common carpet fibres include: Nylon, Polypropylene, Wool, Wool-blends, Polyester and Acrylic.

Nylon carpet is generally cheaper than wool alternatives. It is stain resistant and holds its colour well. High durability and toughness make it ideal for use in high-traffic areas.

Category *Miscellaneous*

Type *Nylon*

Functional unit *m^2*

Specific heat *2 500 J/(kg·K)*

Density *350 kg/m^3*

Common uses
Residential and commercial flooring

Process name
Carpet, tufted, 100% nylon, 600-700g/m2 (custom)

Input-output sector
Polymer Product Manufacturing

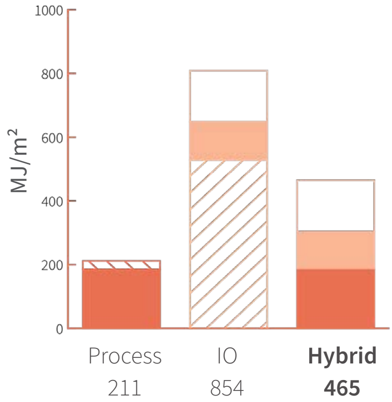
Further information
doi.org/10.26188/5da5521a352db

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Tufted carpet, nylon - average	*m^2*	*465*	*1 149*	*31.2*
Tufted carpet, nylon - quality	m^2	484	1 161	33.3
Tufted carpet, nylon - prestige	m^2	785	1 866	55.3
Woven carpet, nylon - average	m^2	364	908	23.9
Woven carpet, nylon - quality	m^2	376	911	24.8

EPiC Database

TOP THREE INPUTS

- **16.9%** Nylon 6, at plant/RER U/AusSD U
- **8.4%** Thermoforming, with calendering/RER U/AusSD U
- **8.2%** Latex, at plant/RER S/AusSD U

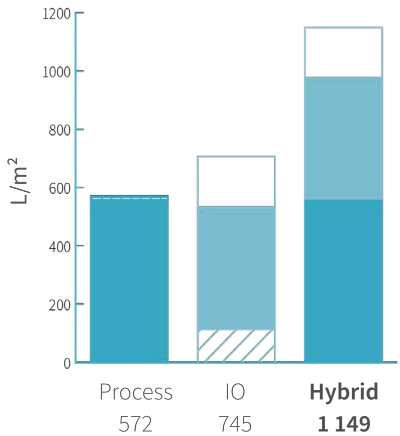


ENERGY

465 MJ/m²

TOP THREE INPUTS

- **24.2%** Thermoforming, with calendering/RER U/AusSD U
- **17.9%** Other Agriculture
- **11.8%** Nylon 6, at plant/RER U/AusSD U

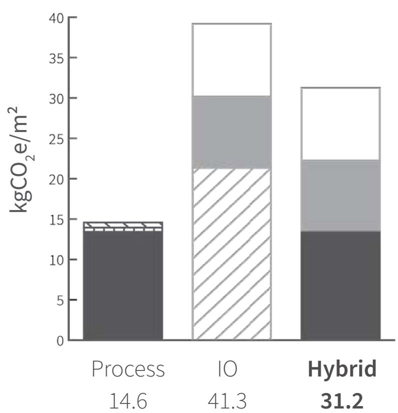


WATER

1 149 L/m²

TOP THREE INPUTS

- **21.6%** Nylon 6, at plant/RER U/AusSD U
- **9.9%** Thermoforming, with calendering/RER U/AusSD U
- **4.0%** Latex, at plant/RER S/AusSD U



GREENHOUSE GAS EMISSIONS

31.2 $kgCO_2e/m^2$

m² Wool carpet

Carpet is a common flooring material, widely used for residential and commercial flooring applications. It has good insulative properties and medium - high durability. It is typically graded using surface pile mass (g/m²), with a higher g/m² generally indicating a higher quality and more durable product.

Tufted carpet is available in three standard styles: 'cut pile', 'loop pile' and 'cut & loop pile'. Within these styles, there are significant variations in durability, aesthetic qualities and cost. During production, carpet fibre is sewn directly onto a primary backing fabric and then bonded (commonly using latex) onto a secondary backing layer (hessian, or similar). Common carpet fibres include: Nylon, Polypropylene, Wool, Wool-blends, Polyester and Acrylic.

Wool carpet is generally more expensive than nylon alternatives. It is often blended with nylon to reduce cost of production and increase durability and toughness. Wool is easy to maintain and is naturally stain resistant, although is highly absorbent making it more prone to stains from spillages.

Category *Miscellaneous*

Type *Wool*

Functional unit *m²*

Specific heat *1 360 J/(kg·K)*

Density *530 kg/m³*

Common uses
Residential and commercial flooring

Process name
Carpet, tufted, 80% wool 20% nylon, 1000-1100g/m2 (custom)

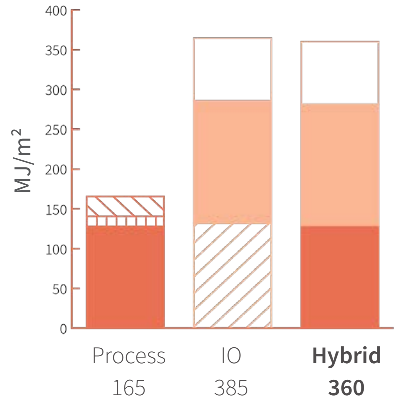
Input-output sector
Textile Product Manufacturing

Further information
doi.org/10.26188/5da55236c5619

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Tufted carpet, wool - average	*m²*	*360*	*1 343*	*41.0*
Tufted carpet, wool - quality	m²	407	1 545	49.1
Tufted carpet, wool - prestige	m²	509	1 945	64.2

TOP THREE INPUTS

- **11.3%** Thermoforming, with calendering/RER U/AusSD U
- **8.8%** Road Transport
- **6.2%** Nylon 6, at plant/RER U/AusSD U

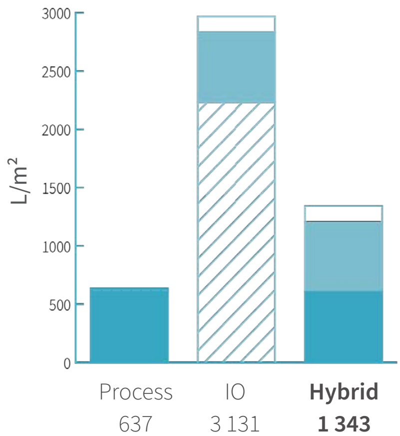


ENERGY

360 MJ/m²

TOP THREE INPUTS

- **20.9%** Thermoforming, with calendering/RER U/AusSD U
- **12.4%** Wool, sheep, at farm/US U/ AusSD U
- **6.6%** Textile Product Manufacturing

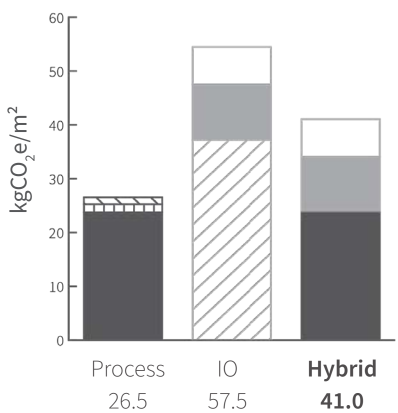


WATER

1 343 L/m²

TOP THREE INPUTS

- **38.0%** Wool, sheep, at farm/US U/ AusSD U
- **7.5%** Thermoforming, with calendering/RER U/AusSD U
- **4.7%** Nylon 6, at plant/RER U/AusSD U



GREENHOUSE GAS EMISSIONS

41.0 $kgCO_2e/m^2$

kg Silicone

Silicone is a synthetic polymer compound, with a molecular chain consisting of alternating silicon and oxygen atoms. Depending on the production process, it can take the form of a liquid, gel, elastomer or resin. It is widely used for plumbing applications, due to its adhesive properties, ability to repel water, flexibility, stability in high/low temperatures and antimicrobial properties.

Silicone is derived from silicon, which is extracted from quartz, sand or other sources. To produce silicone, the base material (silicon) goes through several chemical and distillation processes.

In construction, silicone is used as a sealant, adhesive or electrical insulation amongst other uses. It is also widely used in manufacturing, for production of gaskets, moulds, coatings, caulks, household goods and plumbing hardware.

Category	*Miscellaneous*
Type	*Other polymers*
Functional unit	*kg*
Specific heat	*1 460 J/(kg·K)*
Density	*0.96 kg/m^3*

Common uses
Sealant, adhesive, electrical insulation, fittings, coatings

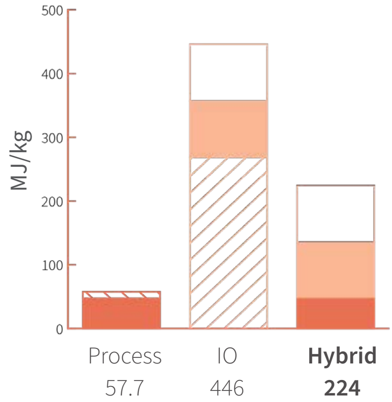
Process name
Silicone product, at plant/RER U/ AusSD U

Input-output sector
Polymer Product Manufacturing

Further information
doi.org/10.26188/5da55771ca8cf

TOP THREE INPUTS

- **8.7%** Polymer Product Manufacturing
- **5.6%** Road Transport
- **5.2%** Natural gas, burned in industrial furnace low-NOx >100kW/RER U/AusSD U

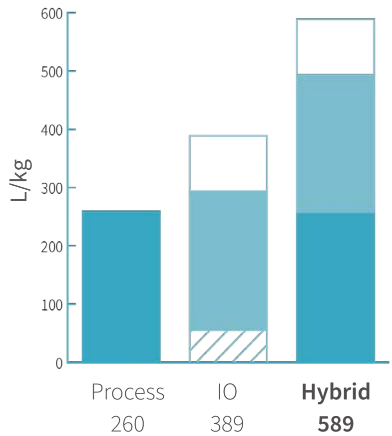


ENERGY

224
MJ/kg

TOP THREE INPUTS

- **18.2%** Other Agriculture
- **2.7%** Polymer Product Manufacturing
- **1.4%** Wholesale Trade

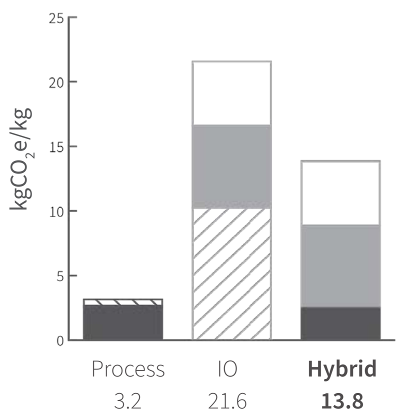


WATER

589
L/kg

TOP THREE INPUTS

- **6.5%** Polymer Product Manufacturing
- **5.4%** Natural gas, burned in industrial furnace low-NOx >100kW/RER U/AusSD U
- **2.8%** Road Transport



GREENHOUSE GAS EMISSIONS

13.8
$kgCO_2e/kg$

kg Water

Water is used in significant quantities for construction activities, site preparation and as a material additive/solvent. It is also essential for all known forms of life on earth.

Although water covers approximately 70% of the earth's surface, only a small proportion is readily available for use in construction projects. With a growing population, and increasing demand for housing, construction and infrastructure projects, water is becoming an increasingly scarce resource.

Category	*Miscellaneous*
Type	*Other chemicals*
Functional unit	*kg*
Specific heat	*4 200 J/(kg·K)*
Density	*1 000 kg/m^3*

Common uses
Site preparation, construction activities, material additive, solvent

Process name
Tap water, at user, Australia/AU U

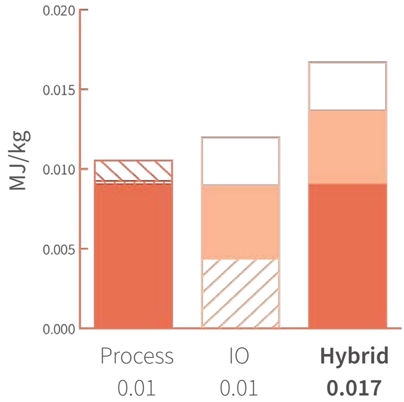
Input-output sector
Water Supply, Sewerage and Drainage Services

Further information
doi.org/10.26188/5da558d1e3aa6

EPiC Database

TOP THREE INPUTS

- **1.9%** Construction Services
- **1.4%** Water Supply, Sewerage and Drainage Services
- **1.4%** Diesel, burned in building machine/GLO U/AusSD U

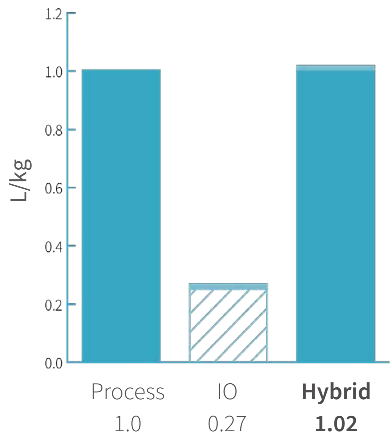


ENERGY

0.017
MJ/kg

TOP THREE INPUTS

- **0.8%** Water Supply, Sewerage and Drainage Services
- **0.0%** Other Agriculture
- **0.0%** Construction Services

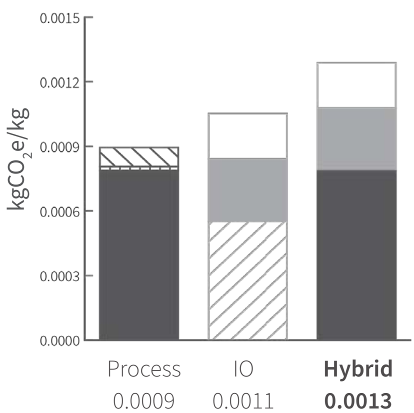


WATER

1.02
L/kg

TOP THREE INPUTS

- **1.8%** Water Supply, Sewerage and Drainage Services
- **1.4%** Diesel, burned in building machine/GLO U/AusSD U
- **1.2%** Construction Services



GREENHOUSE GAS EMISSIONS

0.0013
$kgCO_2e/kg$

kg Wood glue (PVA)

Polyvinyl acetate (PVA), also known as wood glue, is clear drying, non-toxic, water-based adhesive commonly used as a binding agent for timber, paper, cloth and other natural fibres. It provides a flexible and strong bond that dries quickly at room temperature.

There are different grades of PVA glue, used for different purposes. ‘White glue’ or ‘craft glue’ is used for interior applications only. ‘Yellow glue’ or ‘carpenters glue’ is water-resistant, but not suitable for full exterior use. There are also exterior grade, fully waterproof variations, that are suitable for not-structural exterior purposes. These are generally slower drying, and cure at a lower temperature.

In addition to being used as a wood binding agent, PVA can also be used as a sealer, primer and filler.

Category	*Miscellaneous*
Type	*Adhesive*
Functional unit	*kg*
Specific heat	*1 546 J/(kg·K)*
Density	*1 191 kg/m^3*

Common uses
Adhesive, sealer, primer, filler

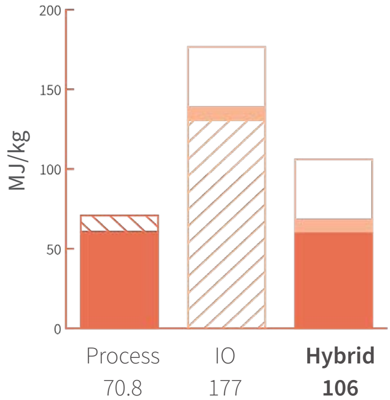
Process name
Vinyl acetate, at plant/RER U/AusSD U

Input-output sector
Basic Chemical Manufacturing

Further information
doi.org/10.26188/5da558f73d913

TOP THREE INPUTS

- **28.2%** Acetic acid, 98% in H2O, at plant/RER U/AusSD U
- **4.5%** Road Transport
- **1.2%** Oxygen, liquid, at plant/RER U/AusSD U

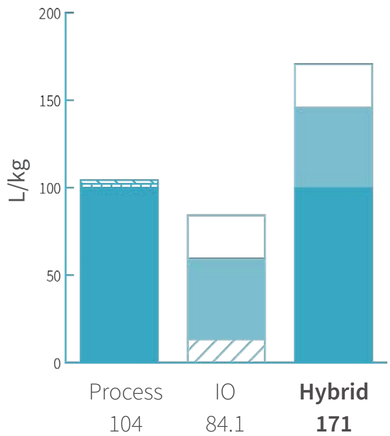


ENERGY

106
MJ/kg

TOP THREE INPUTS

- **35.3%** Acetic acid, 98% in H2O, at plant/RER U/AusSD U
- **4.1%** Sheep, Grains, Beef and Dairy Cattle
- **3.8%** Meat and Meat product Manufacturing

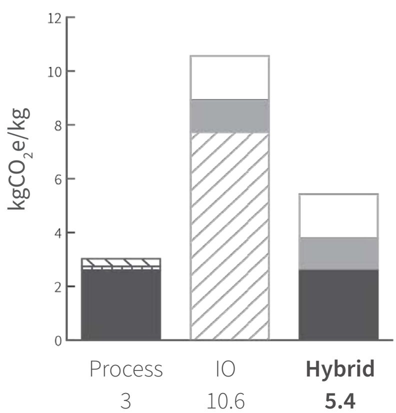


WATER

171
L/kg

TOP THREE INPUTS

- **24.3%** Acetic acid, 98% in H2O, at plant/RER U/AusSD U
- **3.0%** Road Transport
- **2.7%** Oxygen, liquid, at plant/RER U/AusSD U



GREENHOUSE GAS EMISSIONS

5.4
$kgCO_2e/kg$

no. Solar hot water system

Solar hot water systems are used as an alternative to more conventional electric or gas storage systems. They use energy from the sun to heat water that is used for a range of purposes within buildings.

The system consists of two flat plate collectors, a storage tank, and associated plumbing and electrical components, suitable for a one-family dwelling. The water is pumped from the storage tank to the collectors, where it is passed through thin tubes to be heated by direct solar radiation. Heated water is then stored in the storage tank until it is needed.

The flat plate collectors consist of an insulated steel absorber plate, encased in an aluminium frame and toughened glass. The storage tank is manufactured from steel and aluminium alloy and is insulated with polyurethane foam.

Category *Miscellaneous*

Type *Other ferrous metals*

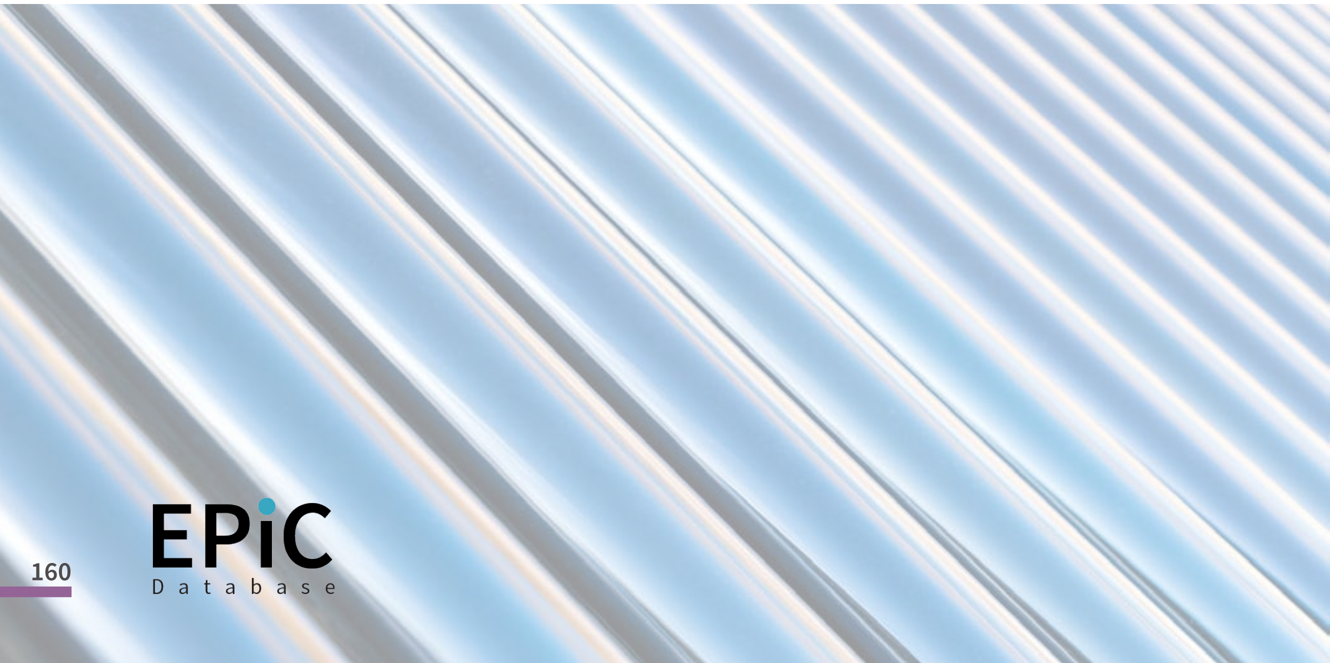
Functional unit *no.*

Common uses
Water heating

Process name
Solar system, flat plate collector, one-family house, hot water/CH/I U/AusSD U

Input-output sector
Domestic Appliance Manufacturing

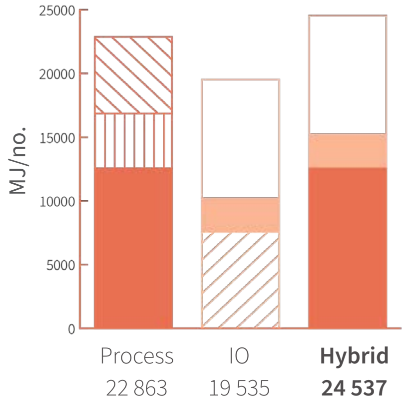
Further information
doi.org/10.26188/5da557a8720ed



EPiC Database

TOP THREE INPUTS

- **4.5%** Propylene glycol, liquid, at plant/RER U/AusSD U
- **4.1%** Road Transport
- **2.2%** Wholesale Trade

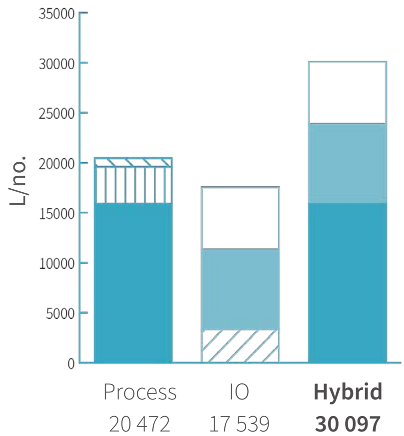


ENERGY

24 537 MJ/no.

TOP THREE INPUTS

- **10.4%** Propylene glycol, liquid, at plant/RER U/AusSD U
- **3.0%** Wholesale Trade
- **1.7%** Tube insulation, elastomere, at plant/DE U/AusSD U

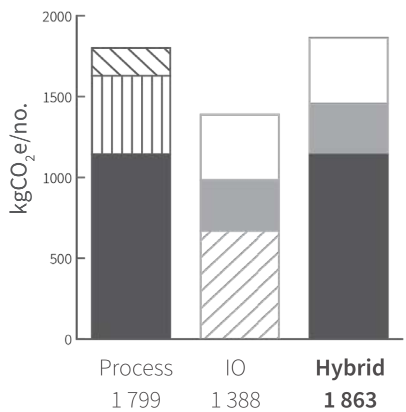


WATER

30 097 L/no.

TOP THREE INPUTS

- **3.7%** Propylene glycol, liquid, at plant/RER U/AusSD U
- **1.9%** Wholesale Trade
- **1.7%** Road Transport



GREENHOUSE GAS EMISSIONS

1 863 $kgCO_2e/no.$

kg Solvent-based paint

Paint is used to protect surfaces from moisture, UV and wear. It can protective coating for timber, metals, plastics and plaster products. There are two main types of paint: water-based paint (including waterborne acrylics, and acrylic latex paints) and solvent-based paint (also known as alkyd or oil-based enamel paints).

Paint is produced by combining resin, solvents, pigment, and additives. Resins are used to bind together the ingredients. For solvent-based paint these include: dammar, mastic, copal and alkyd resin. Pigments are added to create colour and sheen, and can include calcium carbonate, talc, oxides and mica amongst others. Solvents such as mineral spirits or turpentine are used to dilute and thin the paint. Other additives are included to reduce drying time and give the paint particular properties.

Solvent-based paints are becoming less common, due to the high levels of volatile organic compounds (VOCs) present. Paints with high levels of VOCs are toxic to the environment, have a harsh odour and can be dangerous to inhale. Solvent-based paints are cheaper and tougher than the water-based alternative, and are commonly used in high-traffic areas (although they are more susceptible to UV deterioration). They are more abrasion resistant and have a more brilliant gloss, with a smooth finish. They are difficult to clean, and require mineral turpentine, rather than water.

Category	*Miscellaneous*
Type	*Paint*
Functional unit	*kg*
Density	*1 200 kg/m^3*

Common uses
Exterior and internal finishes, sealant, weatherproofing

Process name
Alkyd paint, white, 60% in solvent, at plant/RER U/AusSD U

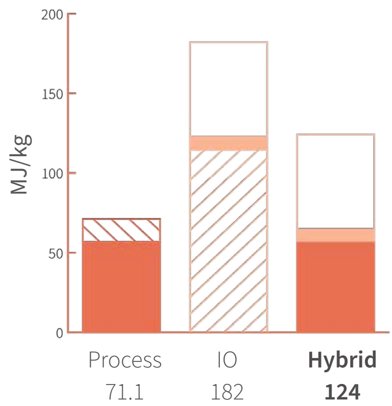
Input-output sector
Polymer Product Manufacturing

Further information
doi.org/10.26188/5da557baa95ce

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO$_2$e/unit)
Solvent-based paint	*kg*	*124*	*197*	*6.3*
Solvent-based paint - per m^2	m^2	9.3	14.7	0.5

TOP THREE INPUTS

- **3.5%** Road Transport
- **1.0%** Wholesale Trade
- **0.9%** Air and Space Transport

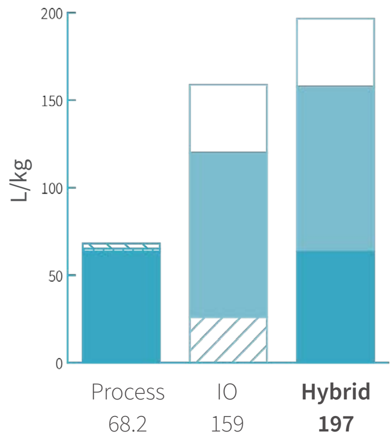


ENERGY

124
MJ/kg

TOP THREE INPUTS

- **22.3%** Other Agriculture
- **1.7%** Wholesale Trade
- **1.3%** Textile Product Manufacturing

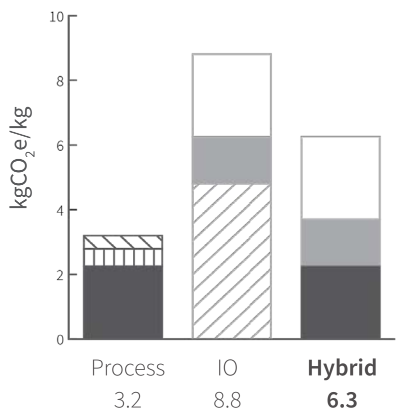


WATER

197
L/kg

TOP THREE INPUTS

- **2.4%** Road Transport
- **1.8%** Wholesale Trade
- **1.1%** Other Agriculture



GREENHOUSE GAS EMISSIONS

6.3
$kgCO_2e/kg$

kg Water-based paint

Paint is used to protect surfaces from moisture, UV and wear. It can protective coating for timber, metals, plastics and plaster products. There are two main types of paint: water-based paint (including waterborne acrylics, and acrylic latex paints) and solvent-based paint (also known as alkyd or oil-based enamel paints).

Paint is produced by combining resin, solvents, pigment, and additives. Resins are used to bind together the ingredients. For water-based paint these include: poly vinyl acetate, butyl methacrylate and methyl. Solvents such as water and mineral turpentine are used to dilute and thin the paint. Pigments are added to create colour and sheen, and can include calcium carbonate, talc, oxides and mica amongst others. Other additives are included to reduce drying time and give the paint particular properties.

Water-based paints have several advantages over oil-based alternatives. They are excellent for external applications, and have high tolerance to UV. They have a low odour, are easy to clean, and are less hazardous to dispose of. They also have better flexibility, dry faster, and are generally more environmentally friendly due to the low amounts of volatile organic compounds (VOCs), which are commonly found in solvent-based paints. Paints with high levels of VOCs are toxic to the environment, have a harsh odour and can be dangerous to inhale.

Category	*Miscellaneous*
Type	*Paint*
Functional unit	*kg*
Density	*1 250 kg/m³*

Common uses
Exterior and internal finishes, sealant, weatherproofing

Process name
Alkyd paint, white, 60% in H2O, at plant/RER U/AusSD U

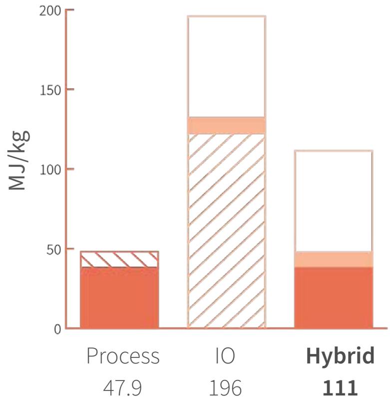
Input-output sector
Polymer Product Manufacturing

Further information
doi.org/10.26188/5da558e47158f

Material variations	**Unit**	**Energy (MJ/unit)**	**Water (L/unit)**	**GHG emissions ($kgCO_2e$/unit)**
Water-based paint	*kg*	*111*	*206*	*6.8*
Water-based paint - per m^2	m^2	8.7	16.1	0.5

TOP THREE INPUTS

- **4.3%** Penta-erythritol, at plant/RER U/AusSD U
- **4.2%** Road Transport
- **1.2%** Wholesale Trade

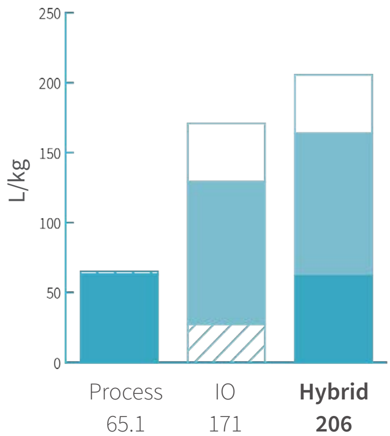


ENERGY

111
MJ/kg

TOP THREE INPUTS

- **22.9%** Other Agriculture
- **4.4%** Penta-erythritol, at plant/RER U/AusSD U
- **1.8%** Wholesale Trade

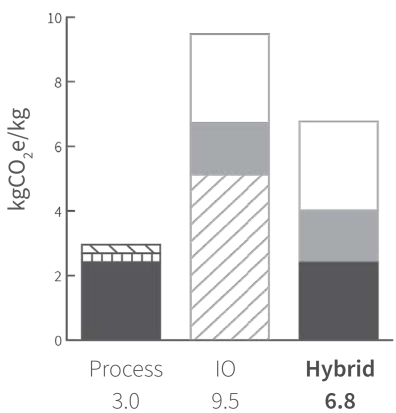


WATER

206
L/kg

TOP THREE INPUTS

- **4.2%** Penta-erythritol, at plant/RER U/AusSD U
- **2.3%** Road Transport
- **1.8%** Wholesale Trade



GREENHOUSE GAS EMISSIONS

6.8
$kgCO_2e/kg$

kg Wallpaper

Wallpaper is a decorative wall finish that gained popularity as early as the 16th Century. There are two main types of wallpaper - woven and non-woven. Both include a decorative colour or print on the front and an adhesive paste to fix it to the wall.

Woven wallpapers are typically made from fabric, or heavy cotton, which is coated (often with an acrylic or polyvinyl coating). Non-woven wallpaper is made from paper, natural fibres, or synthetic materials. A backing adhesive is either applied manually, or included as a precoated layer. The backing paste is typically made from starch, wheat-derived, or a vinyl-based adhesive. Patterns are printed using a variety of printing techniques depending on the aesthetic style, and backing material used.

Wallpaper is predominantly used for decorative purposes. It varies significantly in cost, depending on the production quality and materials used.

Category *Miscellaneous*

Type *Paper*

Functional unit *kg*

Specific heat *1 336 J/(kg·K)*

Density *920 kg/m³*

Common uses
Interior decoration

Process name
Kraft paper, bleached, at plant/RER U/AusSD U

Input-output sector
Paper Stationery and Other Converted Paper Product Manufacturing

Further information
doi.org/10.26188/5da558bf3c7d7

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Wallpaper	*kg*	*263*	*448*	*16.0*
Wallpaper - per m^2	m^2	45.5	77.5	2.8

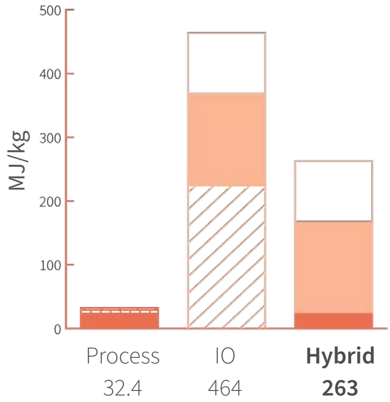
EPiC Database

TOP THREE INPUTS

11.4% Road Transport

10.8% Paper Stationery and Other Converted Paper Product Manufacturing

6.2% Polymer Product Manufacturing



ENERGY

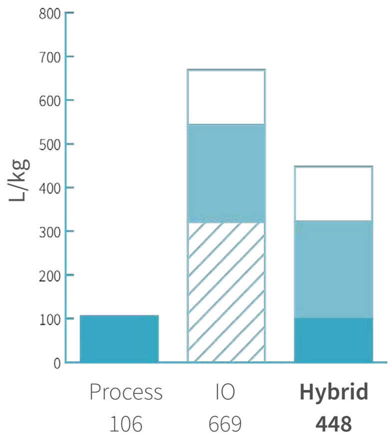
263
MJ/kg

TOP THREE INPUTS

11.6% Water Supply, Sewerage and Drainage Services

9.4% Paper Stationery and Other Converted Paper Product Manufacturing

3.4% Professional, Scientific and Technical Services



WATER

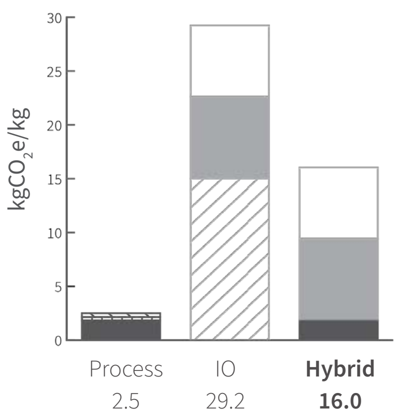
448
L/kg

TOP THREE INPUTS

10.7% Paper Stationery and Other Converted Paper Product Manufacturing

5.7% Road Transport

4.3% Polymer Product Manufacturing



GREENHOUSE GAS EMISSIONS

16.0
$kgCO_2e/kg$

kg Natural rubber

Rubber is a highly elastic polymer (elastomer) that can be obtained naturally, or produced synthetically using oil-based production methods. It has a high tensile strength, resistance to fatigue and tearing, abrasion resistance and a high resilience/ability to return to its original shape and size. In addition to this, it has good insulative qualities and adheres well to itself and other materials.

Natural rubber is harvested in the form of latex from the sap of rubber trees, which is refined and converted into rubber. Variations in quality can be observed in natural rubber, due to the geographical area, weather and soil conditions.

In comparison with natural rubber, synthetic rubber is generally tolerant to a broader range of temperatures, is resistant to oil and grease, and ages well against weathering. Natural rubber is favoured for its high performance and low cost, which is not directly tied to the price of petroleum.

Category	*Miscellaneous*
Type	*Rubber*
Functional unit	*kg*
Specific heat	*2 010 J/(kg·K)*
Density	*1 100 kg/m^3*

Common uses
Expansion joints, window and building seals, flooring, fittings

Process name
Natural rubber based sealing, at plant/DE U/AusSD U

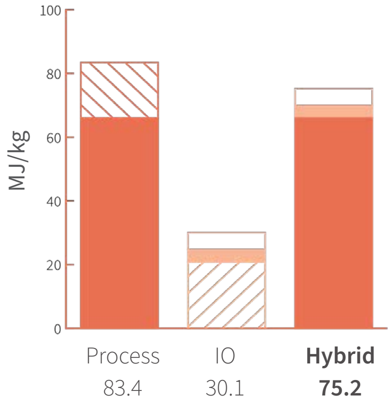
Input-output sector
Natural Rubber Product Manufacturing

Further information
doi.org/10.26188/5da555f8c2b02

EPiC Database

TOP THREE INPUTS

- **0.7%** Road Transport
- **0.5%** Other Agriculture
- **0.5%** Electricity Transmission, Distribution, On Selling and Electricity Market Operation

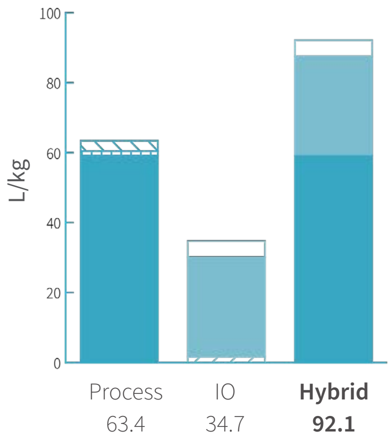


ENERGY

75.2
MJ/kg

TOP THREE INPUTS

- **21.4%** Other Agriculture
- **0.8%** Electricity Transmission, Distribution, On Selling and Electricity Market Operation
- **0.5%** Professional, Scientific and Technical Services

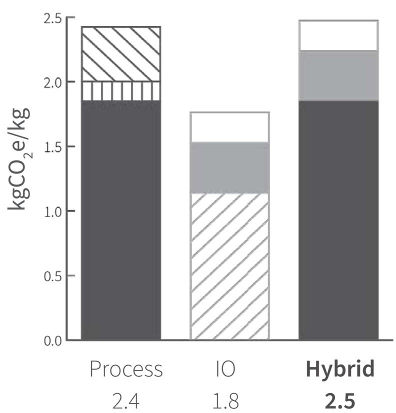


WATER

92.1
L/kg

TOP THREE INPUTS

- **1.6%** Other Agriculture
- **1.2%** Oil and gas extraction
- **1.1%** Electricity Transmission, Distribution, On Selling and Electricity Market Operation



GREENHOUSE GAS EMISSIONS

2.5
$kgCO_2e/kg$

kg Synthetic rubber

Rubber is a highly elastic polymer (elastomer) that can be obtained naturally, or produced synthetically using oil-based production methods. It has a high tensile strength, resistance to fatigue and tearing, abrasion resistance and a high resilience/ability to return to its original shape and size. In addition to this, it has good insulative qualities and adheres well to itself and other materials.

There are many different types of synthetic rubber. Most are synthesised from petroleum by-products. Some are produced with distinctive properties or qualities for specific products.

In comparison with natural rubber, synthetic rubber is generally tolerant to a broader range of temperatures, is resistant to oil and grease, and ages well against weathering. Natural rubber is favoured for its high performance and low cost, which is not directly tied to the price of petroleum.

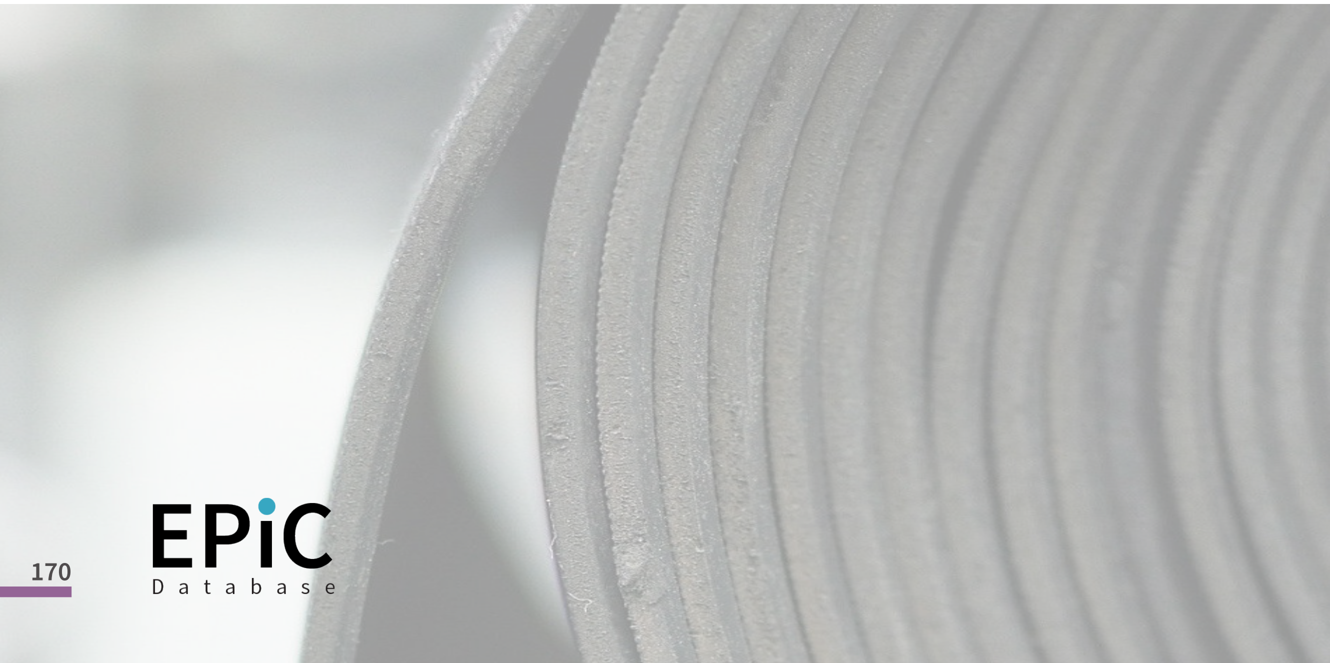
Category	*Miscellaneous*
Type	*Rubber*
Functional unit	*kg*
Specific heat	*2 010 J/(kg·K)*
Density	*1 100 kg/m^3*

Common uses
Expansion joints, window and building seals, flooring, fittings

Process name
Synthetic rubber, at plant/RER U/AusSD U

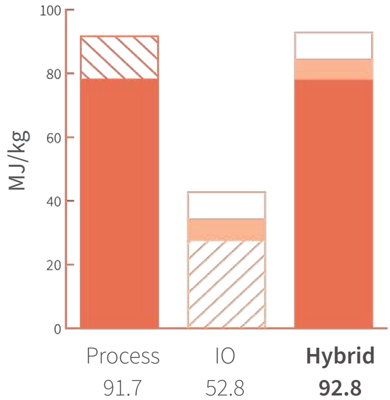
Input-output sector
Polymer Product Manufacturing

Further information
doi.org/10.26188/5da558867e249



TOP THREE INPUTS

- **30.2%** Carbon black, at plant/GLO U/ AusSD U
- **6.4%** Extrusion, plastic pipes/RER U/ AusSD U
- **1.6%** Road Transport

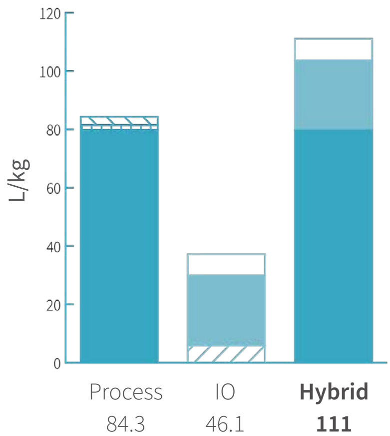


ENERGY

92.8
MJ/kg

TOP THREE INPUTS

- **18.6%** Extrusion, plastic pipes/RER U/ AusSD U
- **11.5%** Other Agriculture
- **2.5%** Carbon black, at plant/GLO U/ AusSD U

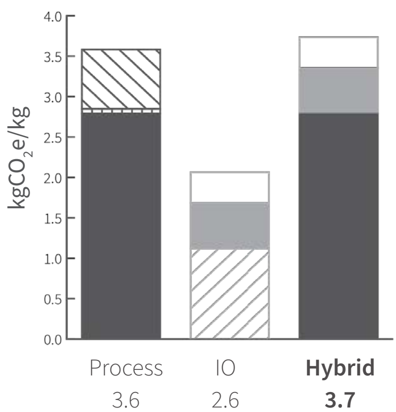


WATER

111
L/kg

TOP THREE INPUTS

- **19.5%** Carbon black, at plant/GLO U/ AusSD U
- **14.2%** Extrusion, plastic pipes/RER U/ AusSD U
- **1.5%** Wholesale Trade



GREENHOUSE GAS EMISSIONS

3.7
$kgCO_2e/kg$

kg High-density polyethylene (HDPE) film

Polyethylene (PE) is the most common plastic and is a thermoplastic polymer. It has low strength and rigidity but high impact strength and ductility and low friction. It is highly waterproof.

PE is produced by polymerising ethylene monomers using different catalysts (typically metal chlorides or metal oxides). Different densities can be obtained with different properties. Multiple additives are also used to obtain different grades and properties of PE. PE is thermoformed into moulds or extruded.

High-density polyethylene (HDPE) has improved strength and durability compared to LDPE. HDPE films are usually used as geomembranes.

Category *Plastics*

Type *High Density Polyethylene*

Functional unit *kg*

Specific heat *1 555 J/(kg·K)*

Density *940 kg/m^3*

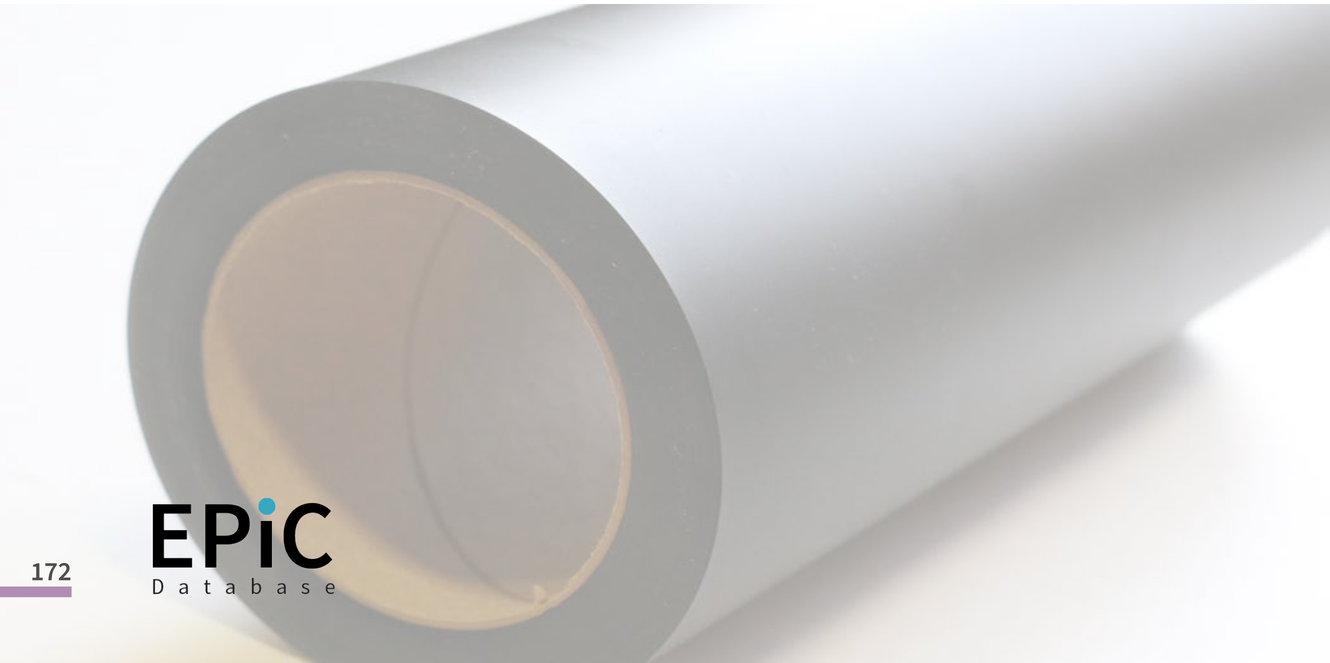
Common uses
Geomembranes

Process name
HDPE, extruded film (custom)

Input-output sector
Polymer Product Manufacturing

Further information
doi.org/10.26188/5da5551da9cb9

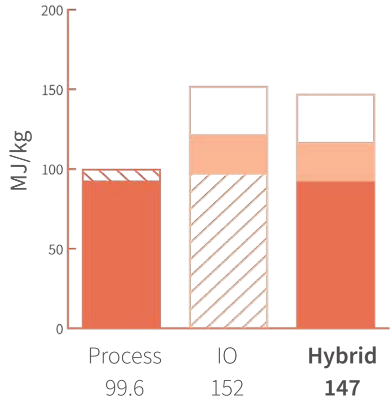
Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
High-density polyethylene (HDPE) film	*kg*	*147*	*172*	*6.4*
HDPE film - 100 µm	m^2	13.8	16.2	0.6
HDPE film - 200 µm	m^2	27.6	32.4	1.2



EPiC Database

TOP THREE INPUTS

- **5.4%** Extrusion, plastic film/RER U/ AusSD U
- **2.9%** Road Transport
- **1.6%** Wholesale Trade

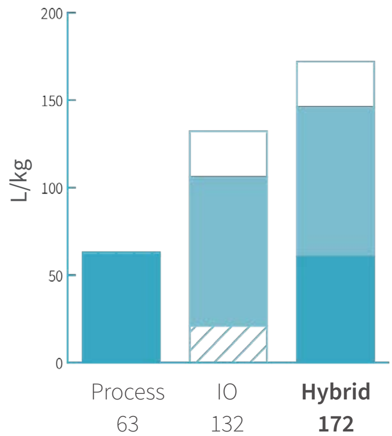


ENERGY

147 MJ/kg

TOP THREE INPUTS

- **26.1%** Extrusion, plastic film/RER U/ AusSD U
- **21.2%** Other Agriculture
- **2.0%** Wholesale Trade

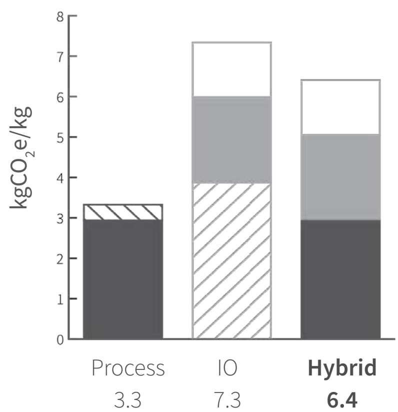


WATER

172 L/kg

TOP THREE INPUTS

- **11.4%** Extrusion, plastic film/RER U/ AusSD U
- **2.4%** Wholesale Trade
- **2.2%** Road Transport



GREENHOUSE GAS EMISSIONS

6.4 $kgCO_2e/kg$

kg High-density polyethylene (HDPE) pipe

Polyethylene (PE) is the most common plastic and is a thermoplastic polymer. It has low strength and rigidity but high impact strength and ductility and low friction. It is highly waterproof.

PE is produced by polymerising ethylene monomers using different catalysts (typically metal chlorides or metal oxides). Different densities can be obtained with different properties. Multiple additives are also used to obtain different grades and properties of PE. PE is thermoformed into moulds or extruded.

High-density polyethylene (HDPE) has improved strength and durability. HDPE pipes are usually used for high pressure systems and are typically larger than LDPE pipes.

Category *Plastics*

Type *High Density Polyethylene*

Functional unit *kg*

Specific heat *1 555 J/(kg·K)*

Density *940 kg/m^3*

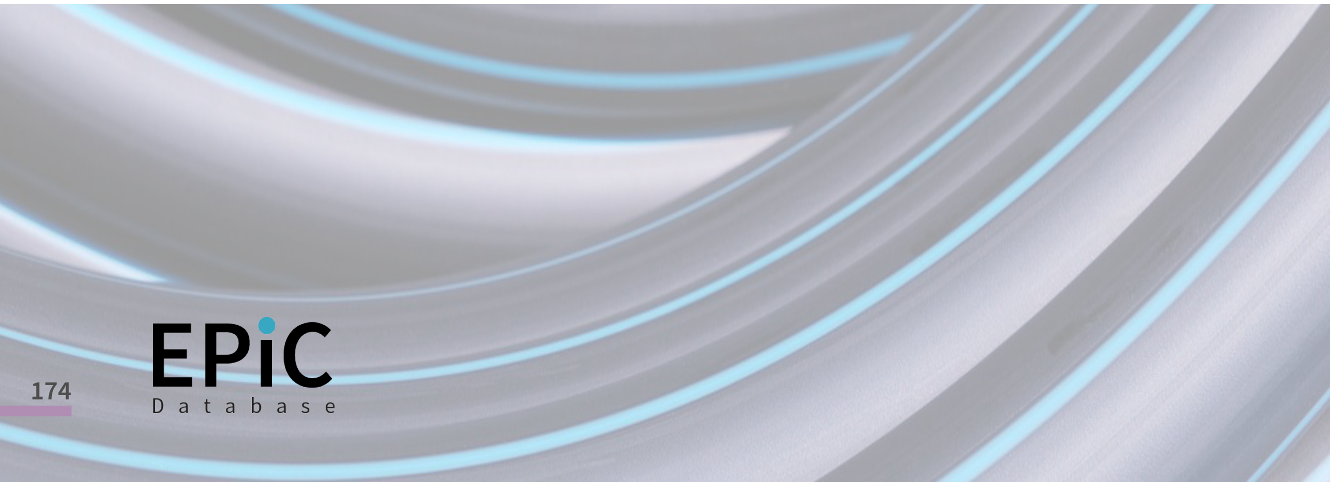
Common uses
High-pressure pipes

Process name
HDPE, extruded pipe (custom)

Input-output sector
Polymer Product Manufacturing

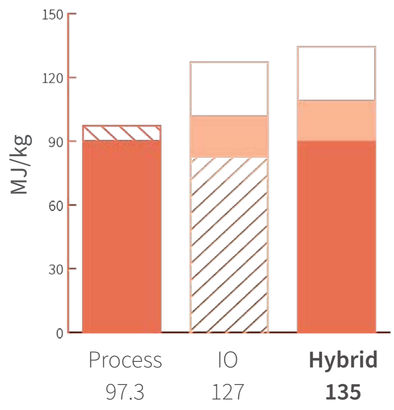
Further information
doi.org/10.26188/5da5552ee9ccf

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO$_2$e/unit)
High-density polyethylene (HDPE) pipe	*kg*	*135*	*130*	*5.6*
HDPE pipe - 32 mm inner dia., 1.88 mm thickness	m	12.3	11.9	0.5
HDPE pipe - 63 mm inner dia., 3.75 mm thickness	m	47.7	46.1	2.0
HDPE pipe - 125 mm inner dia., 7.35 mm thickness	m	188	181	7.8
HDPE pipe - 250 mm inner dia., 14.71 mm thickness	m	752	726	31
HDPE pipe - 500 mm inner dia., 29.41 mm thickness	m	3 007	2 903	124
HDPE pipe - 800 mm inner dia., 47.06 mm thickness	m	7 698	7 433	318



TOP THREE INPUTS

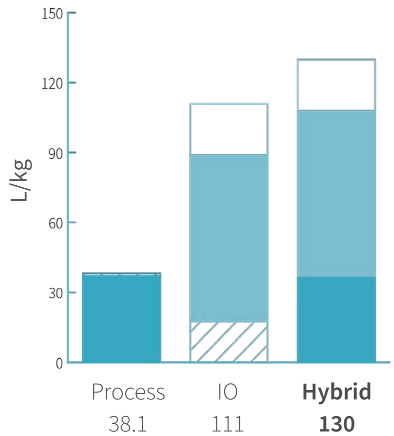
- 4.4% Extrusion, plastic pipes/RER U/ AusSD U
- 2.7% Road Transport
- 1.5% Wholesale Trade



ENERGY

TOP THREE INPUTS

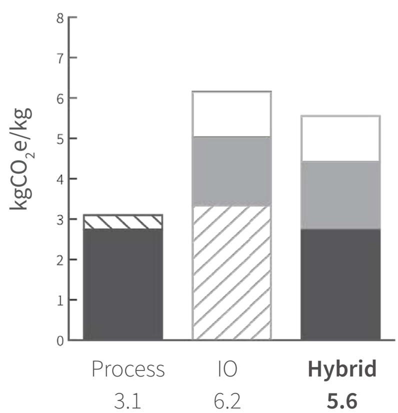
- 23.6% Other Agriculture
- 15.9% Extrusion, plastic pipes/RER U/ AusSD U
- 2.2% Wholesale Trade



WATER

TOP THREE INPUTS

- 9.6% Extrusion, plastic pipes/RER U/ AusSD U
- 2.4% Wholesale Trade
- 2.1% Road Transport



GREENHOUSE GAS EMISSIONS

kg Low-density polyethylene (LDPE) film

Polyethylene (PE) is the most common plastic and is a thermoplastic polymer. It has low strength and rigidity but high impact strength and ductility and low friction. It is highly waterproof.

PE is produced by polymerising ethylene monomers using different catalysts (typically metal chlorides or metal oxides). Different densities can be obtained with different properties. Multiple additives are also used to obtain different grades and properties of PE. PE is thermoformed into moulds or extruded.

Low-density polyethylene (LDPE) is cheaper than HDPE. LDPE films are usually used as vapour barriers, geomembranes and as general purpose membranes on site.

Category *Plastics*

Type *Low Density Polyethylene*

Functional unit *kg*

Specific heat *1 555 J/(kg·K)*

Density *910 kg/m^3*

Common uses
Vapour barrier, geomembrane, general purpose membrane

Process name
LDPE, extruded film (custom)

Input-output sector
Polymer Product Manufacturing

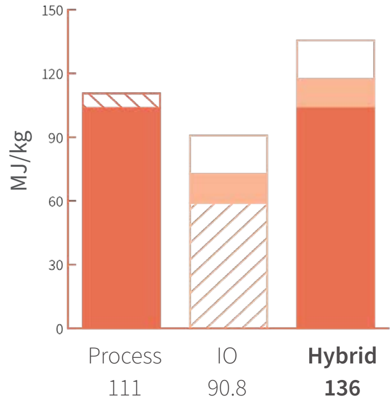
Further information
doi.org/10.26188/5da55582e7c62

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO_2e/unit)
Low-density polyethylene (LDPE) film	*kg*	*136*	*122*	*6.4*
LDPE film - 100 µm	m^2	12.3	11.1	0.6
LDPE film - 200 µm	m^2	24.7	22.2	1.2

EPiC Database

TOP THREE INPUTS

- **70.7%** low density polyethylene, at plant/AU U
- **5.8%** Extrusion, plastic film/RER U/ AusSD U
- **1.9%** Road Transport

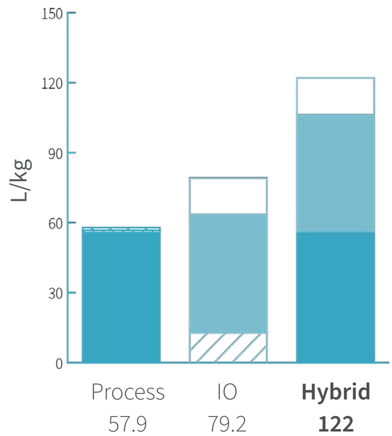


ENERGY

136 MJ/kg

TOP THREE INPUTS

- **36.9%** Extrusion, plastic film/RER U/ AusSD U
- **17.9%** Other Agriculture
- **8.8%** Low density polyethylene, at plant/AU U

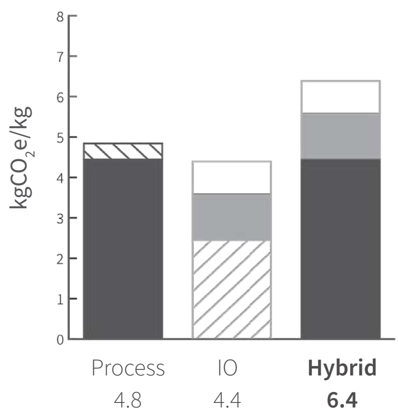


WATER

122 L/kg

TOP THREE INPUTS

- **58.1%** Low density polyethylene, at plant/AU U
- **11.4%** Extrusion, plastic film/RER U/ AusSD U
- **1.5%** Wholesale Trade



GREENHOUSE GAS EMISSIONS

6.4 $kgCO_2e/kg$

kg Low-density polyethylene (LDPE) pipe

Polyethylene (PE) is the most common plastic and is a thermoplastic polymer. It has low strength and rigidity buy high impact strength and ductility and low friction. It is highly waterproof.

PE is produced by polymerising ethylene monomers using different catalysts (typically metal chlorides or metal oxides). Different densities can be obtained with different properties. Multiple additives are also used to obtain different grades and properties of PE. PE is thermoformed into moulds or extruded.

Low-density polyethylene (LDPE) is generally cheaper than HDPE. LDPE pipes are usually used for lower pressure systems and are typically smaller than HDPE pipes.

Category *Plastics*

Type *Low Density Polyethylene*

Functional unit *kg*

Specific heat *1 555 J/(kg·K)*

Density *910 kg/m^3*

Common uses
Low-pressure pipes

Process name
LDPE, extruded pipe (custom)

Input-output sector
Polymer Product Manufacturing

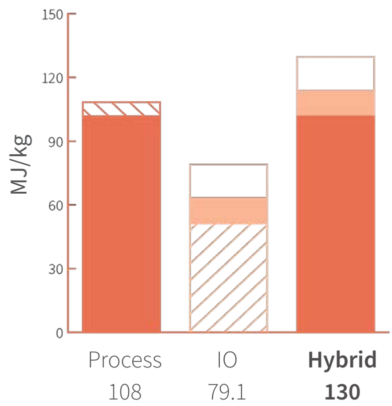
Further information
doi.org/10.26188/5da5559330846

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO$_2$e/unit)
Low-density polyethylene (LDPE) pipe	*kg*	*130*	*89.6*	*6.0*
LDPE pipe - 13 mm inner dia., 3.95 mm thickness	m	11	7.6	0.5
LDPE pipe - 19 mm inner dia., 4.4 mm thickness	m	17.3	11.9	0.8
LDPE pipe - 25 mm inner dia., 5.2 mm thickness	m	26.6	18.4	1.2
LDPE pipe - 32 mm inner dia., 6.7 mm thickness	m	43.9	30.3	2.0

EPiC Database

TOP THREE INPUTS

- **74.0%** low density polyethylene, at plant/AU U
- **4.6%** Extrusion, plastic pipes/RER U/ AusSD U
- **1.7%** Road Transport

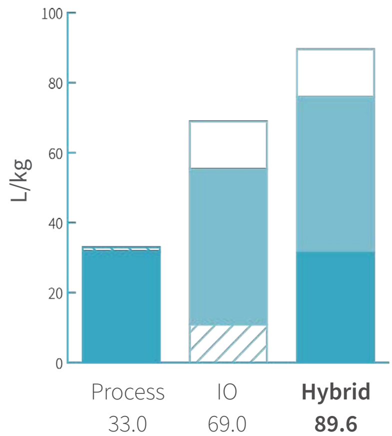


ENERGY

130 MJ/kg

TOP THREE INPUTS

- **23.1%** Extrusion, plastic pipes/RER U/ AusSD U
- **21.3%** Other Agriculture
- **12.0%** Low density polyethylene, at plant/AU U

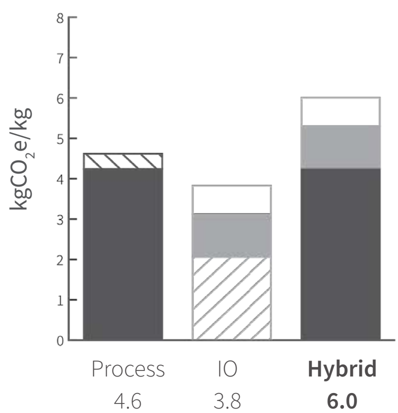


WATER

89.6 L/kg

TOP THREE INPUTS

- **61.7%** Low density polyethylene, at plant/AU U
- **8.9%** Extrusion, plastic pipes/RER U/ AusSD U
- **1.4%** Wholesale Trade



GREENHOUSE GAS EMISSIONS

6.0 $kgCO_2e/kg$

kg Nylon 66

Nylon 66 (nylon 6-6, nylon 6/6, or nylon 6,6) is a polyamide made from two monomers with six carbon atoms each. It has high mechanical strength, rigidity, good stability under heat and chemical resistance.

Nylon 66 is synthesised by polycondensating hexamethylenediamine and adipic acid. The same amount of each monomere are mixed with water and crystallised to produce a nylon salt. The salt is polymerised and nylon 66 is formed. It can be extruded, granulated or spun into fibres.

Nylon 66 is mostly used as a sheet in construction, but also in rods, tubes, screws, washers, ropes and spacers.

Category *Plastics*

Type *Nylon*

Functional unit *kg*

Specific heat *1 464 J/(kg·K)*

Density *1 140 kg/m^3*

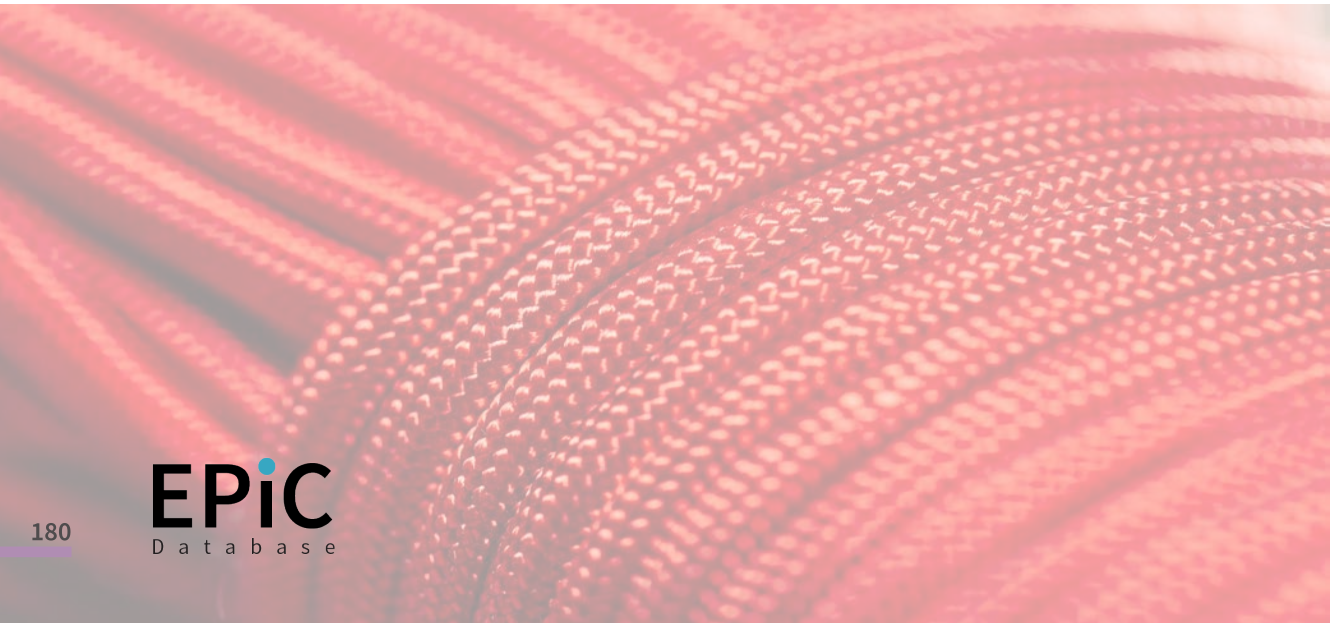
Common uses
Membrane, rods, tubes, screws, washers, spacers, rope

Process name
Nylon 66, at plant/RER U/AusSD U

Input-output sector
Polymer Product Manufacturing

Further information
doi.org/10.26188/5da55609d0f6f

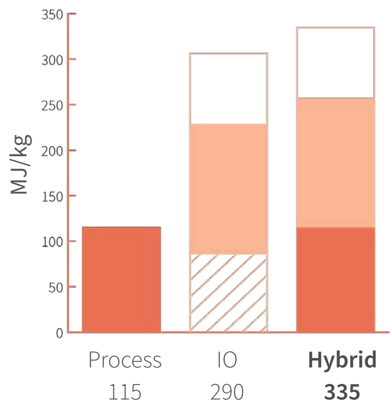
Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO$_2$e/unit)
Nylon 66	*kg*	*335*	*910*	*22.2*
Nylon 66 sheet - 1.5 mm	m^2	572	1 556	37.9
Nylon 66 sheet - 3 mm	m^2	1 145	3 113	75.8
Nylon 66 sheet - 5 mm	m^2	1 908	5 188	126



EPiC Database

TOP THREE INPUTS

- **21.2%** Basic Chemical Manufacturing
- **4.8%** Electricity Generation
- **3.8%** Petroleum and Coal Product Manufacturing

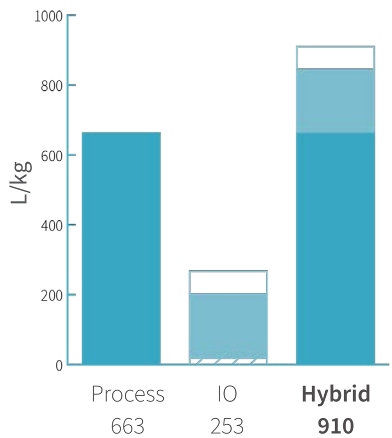


ENERGY

335
MJ/kg

TOP THREE INPUTS

- **7.7%** Other Agriculture
- **3.0%** Basic Chemical Manufacturing
- **1.2%** Water Supply, Sewerage and Drainage Services

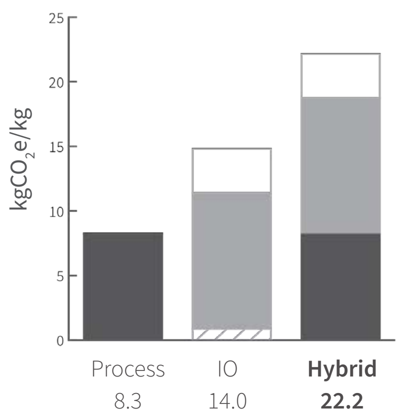


WATER

910
L/kg

TOP THREE INPUTS

- **20.3%** Basic Chemical Manufacturing
- **8.7%** Electricity Generation
- **2.6%** Polymer Product Manufacturing



GREENHOUSE GAS EMISSIONS

22.2
$kgCO_2e/kg$

kg Acrylonitrile butadiene styrene (ABS)

Acrylonitrile butadiene styrene (ABS) is a thermoplastic with high mechanical strength. It is tough, resistant to impacts, offers a good surface quality and is a good electrical insulator.

ABS is derived from three polymers, namely acrylonitrile, butadiene and styrene, mostly through emulsion. It can be moulded or extruded.

ABS is generally used for pipes and fittings and sometimes for general purpose panels within the construction industry.

Category *Plastics*

Type *Other polymers*

Functional unit *kg*

Specific heat *1 423 J/(kg·K)*

Density *1.07 kg/m^3*

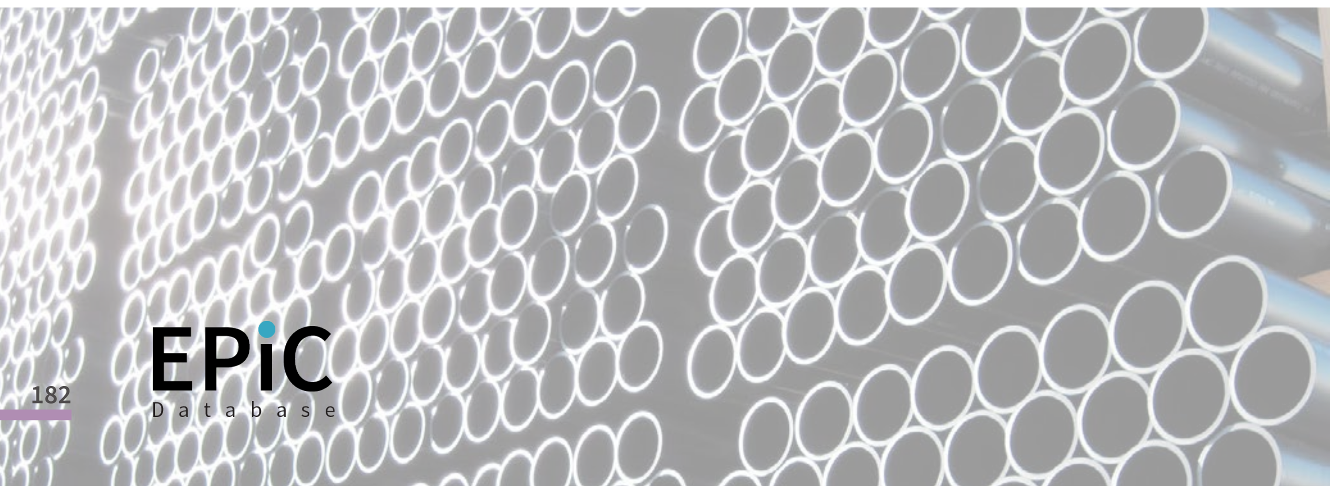
Common uses
Pipes, fittings, general purpose panels

Process name
Acrylonitrile-butadiene-styrene copolymer, ABS, at plant/RER U/AusSD U

Input-output sector
Polymer Product Manufacturing

Further information
doi.org/10.26188/5da55178a8ecb

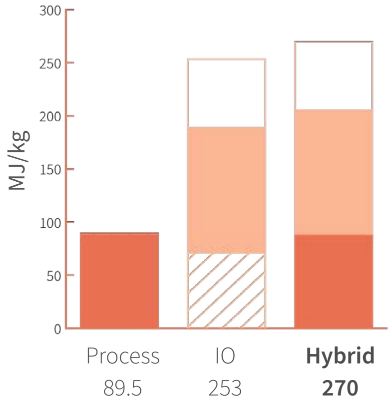
Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Acrylonitrile butadiene styrene (ABS)	*kg*	*270*	*359*	*16.0*
ABS panel - 2mm	m^2	577	767	34.3
ABS panel - 3mm	m^2	866	1 151	51.4
ABS pipe - 21.4 mm outer dia., 2.1 mm thick	m	36.8	48.9	2.2
ABS pipe - 48.3 mm outer dia., 3.6 mm thick	m	146	194	8.7
ABS pipe - 168.3 mm outer dia., 7.7 mm thick	m	1 122	1 491	66.6



EPiC Database

TOP THREE INPUTS

- **23.0%** Basic Chemical Manufacturing
- **5.2%** Electricity Generation
- **4.1%** Petroleum and Coal Product Manufacturing

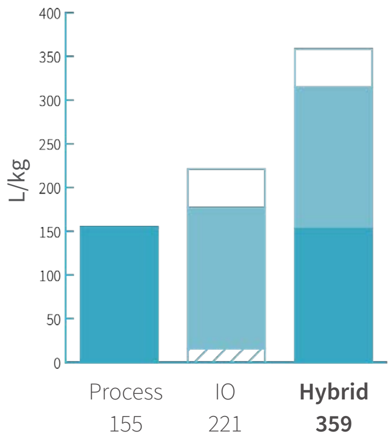


ENERGY

270
MJ/kg

TOP THREE INPUTS

- **17.0%** Other Agriculture
- **7.2%** Basic Chemical Manufacturing
- **2.7%** Polymer Product Manufacturing

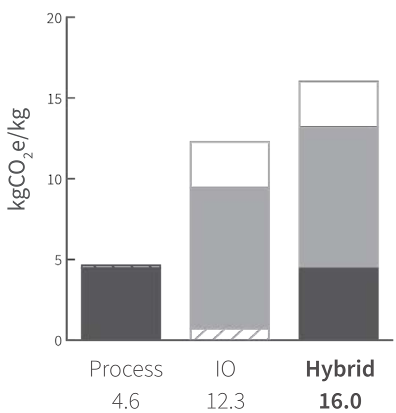


WATER

359
L/kg

TOP THREE INPUTS

- **24.6%** Basic Chemical Manufacturing
- **10.5%** Electricity Generation
- **3.2%** Polymer Product Manufacturing



GREENHOUSE GAS EMISSIONS

16.0
$kgCO_2e/kg$

Ethylene tetrafluoroethylene (ETFE)

Ethylene tetrafluoroethylene (ETFE) is a fluorine-based plastic with high corrosion resistance, self-cleaning properties, ultraviolet resistance and resistant to a broad range of temperatures.

ETFE is produced by polymerising tetrafluoroethylene using water. ETFE is then extruded to the required thickness and welded into large sheets.

Due to its high resistance to the outdoor environment, ETFE is used in tensile architecture as a membrane and can also be used in inflated cushions.

Category *Plastics*

Type *Other polymers*

Functional unit *kg*

Specific heat *1 950 J/(kg·K)*

Density *1 700 kg/m^3*

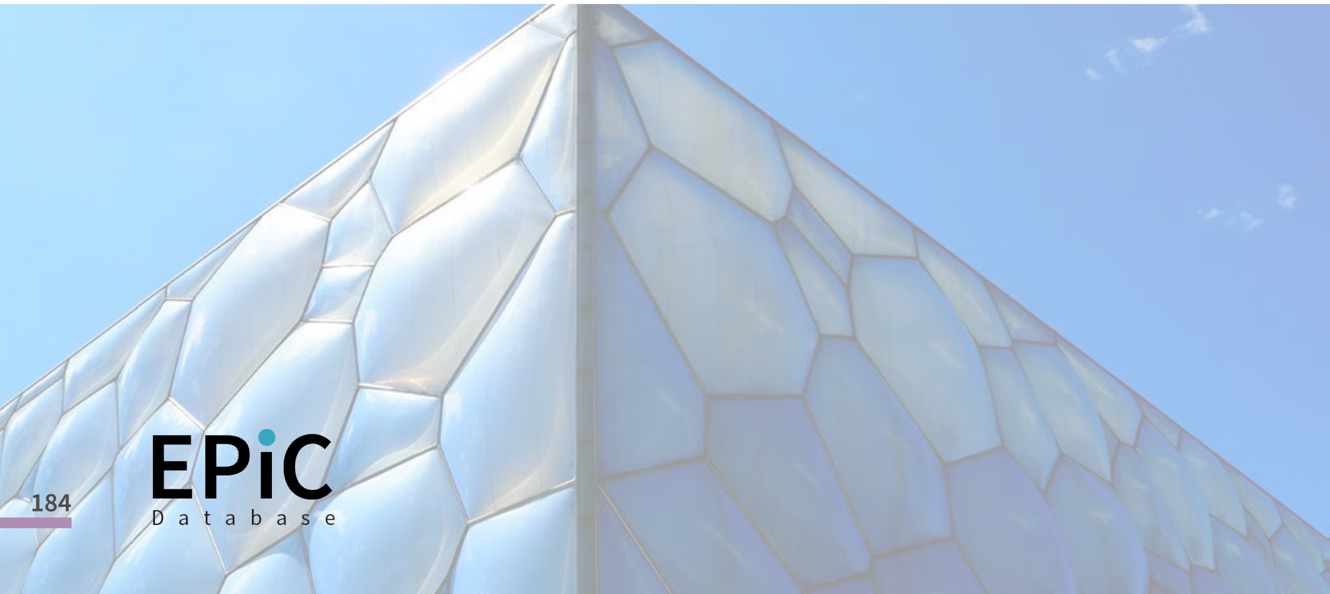
Common uses
Tensile architecture, inflatable cushions

Process name
Ethylene Tetrafluoroethylene (ETFE), film

Input-output sector
Polymer Product Manufacturing

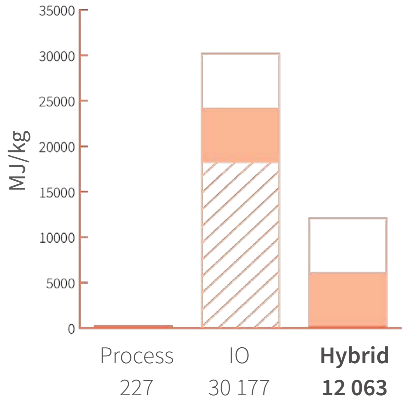
Further information
doi.org/10.26188/5da554446a581

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Ethylene tetrafluoroethylene (ETFE)	*kg*	*12 063*	*22 606*	*798*
ETFE film - 25.4 µm (0.001”)	m^2	306	574	20.3
ETFE film - 50.8 µm (0.002”)	m^2	613	1 148	40.5
ETFE film - 127 µm (0.005”)	m^2	1 532	2 871	101



TOP THREE INPUTS

- **11.6%** Petroleum and Coal Product Manufacturing
- **7.1%** Road Transport
- **3.9%** Wholesale Trade

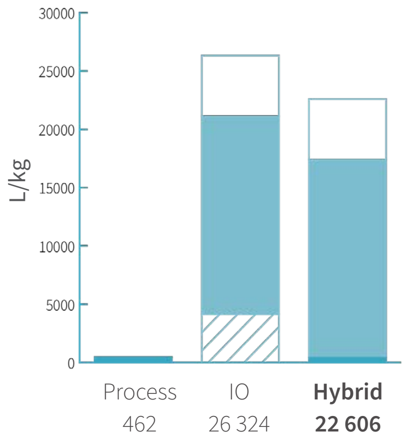


ENERGY

12 063 MJ/kg

TOP THREE INPUTS

- **32.2%** Other Agriculture
- **3.0%** Wholesale Trade
- **2.0%** Textile Product Manufacturing

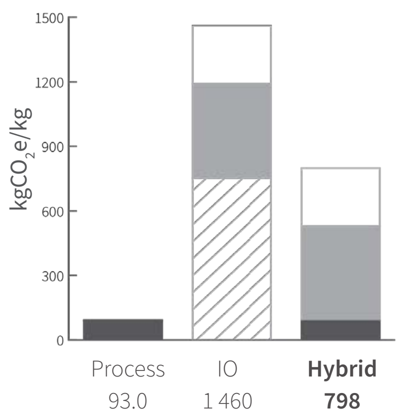


WATER

22 606 L/kg

TOP THREE INPUTS

- **6.1%** Petroleum and Coal Product Manufacturing
- **3.9%** Wholesale Trade
- **3.5%** Road Transport



GREENHOUSE GAS EMISSIONS

798 $kgCO_2e/kg$

kg Glass reinforced plastic (GRP)

Glass reinforced plastic (GRP) is a composite laminate material including glass fibres to reinforce a plastic, typically a polyethylene (PE) resin. GRP is strong, lightweight, weather-resistant and heat resistant. It is also commonly referred to as glass reinforced polyester, glass-fibre reinforced plastic (GFRP), fibre reinforced plastic (FRP) or fibre reinforced polymer (FRP).

GRP is made by laying the glass fibres in two or three dimensions and embedding them into the plastic resin. This is typically done through moulding. GRP is thus available in multiple shapes, including flat sheets and curved objects.

GRP can be used for roofing, storage tanks, door and window surrounds, piping and cladding.

Category	*Plastics*
Type	*Other polymers*
Functional unit	*kg*
Specific heat	*700 J/(kg·K)*
Density	*1 350 kg/m³*

Common uses
Roofing, storage tanks, door and window surrounds, piping, cladding

Process name
Glass fibre reinforced plastic, polyester resin, hand lay-up, at plant/RER U/AusSD U

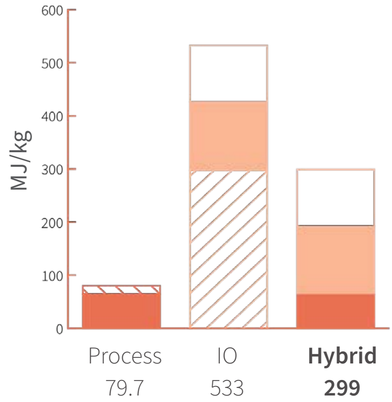
Input-output sector
Polymer Product Manufacturing

Further information
doi.org/10.26188/5da55484429d7

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Glass reinforced plastic (GRP)	*kg*	*299*	*529*	*18.8*
GRP panel - 10 mm	m^2	4 037	7 144	254
GRP panel - 20 mm	m^2	8 075	14 288	509
GRP panel - 50 mm	m^2	20 187	35 719	1 271

TOP THREE INPUTS

- **12.5%** Polyester resin, unsaturated, at plant/RER U/AusSD U
- **8.4%** Glass fibre, at plant/RER U/AusSD U
- **8.3%** Petroleum and Coal Product Manufacturing

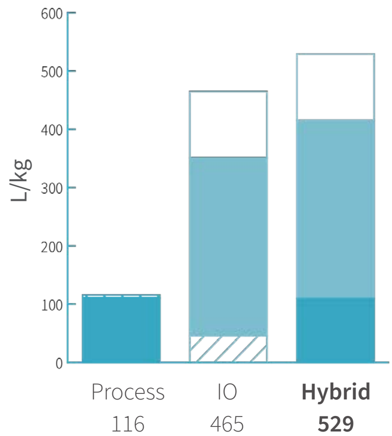


ENERGY

299 MJ/kg

TOP THREE INPUTS

- **24.2%** Other Agriculture
- **16.5%** Polyester resin, unsaturated, at plant/RER U/AusSD U
- **4.0%** Glass fibre, at plant/RER U/AusSD U

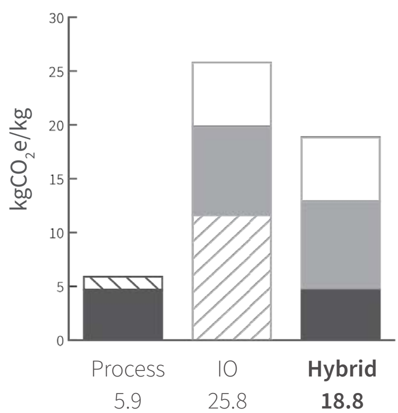


WATER

529 L/kg

TOP THREE INPUTS

- **14.7%** Polyester resin, unsaturated, at plant/RER U/AusSD U
- **10.2%** Glass fibre, at plant/RER U/AusSD U
- **5.7%** Polymer Product Manufacturing



GREENHOUSE GAS EMISSIONS

18.8 $kgCO_2e/kg$

kg Linoleum

Linoleum is a composite material used for floor covering or underlay that is durable and shock-absorbing.

Linoleum is made from a mixture of oxidised linseed oil, gums, resin and other additives, which are applied to a felt or canvas backing. The oil is heated in kettles, oxidises and increases in viscosity. It is blended with resin to produce a plastic material that is in turn mixed with wood flour. Additives are added and the mixture is calendered into a sheet and applied to the backing. The sheets are hardened before being sent to market.

Category *Plastics*

Type *Other polymers*

Functional unit *kg*

Specific heat *1 260 J/(kg·K)*

Density *1 200 kg/m^3*

Common uses
Flooring

Process name
Linoleum, average on mass basis, from EPDs

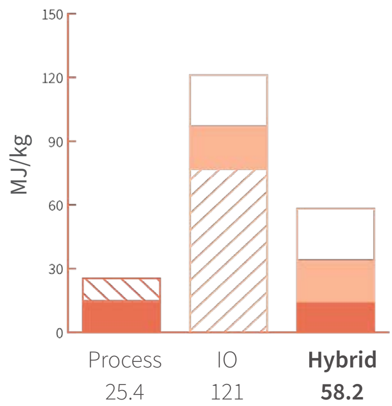
Input-output sector
Polymer Product Manufacturing

Further information
doi.org/10.26188/5da555a381ad3

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Linoleum	*kg*	*58.2*	*195*	*4.4*
Linoleum sheet - 2 mm	m^2	140	469	10.6
Linoleum sheet - 2.5 mm	m^2	175	586	13.3
Linoleum sheet - 3.2 mm	m^2	223	750	17.0
Linoleum sheet - 4 mm	m^2	279	937	21.2

TOP THREE INPUTS

- **5.9%** Road Transport
- **3.2%** Wholesale Trade
- **1.7%** Air and Space Transport

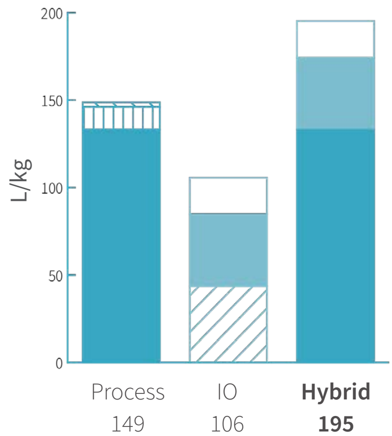


ENERGY

58.2
MJ/kg

TOP THREE INPUTS

- **1.4%** Wholesale Trade
- **0.7%** Professional, Scientific and Technical Services
- **0.7%** Forestry and Logging

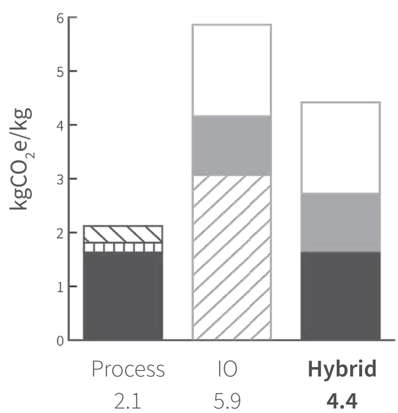


WATER

195
L/kg

TOP THREE INPUTS

- **2.2%** Road Transport
- **2.2%** Oil and gas extraction
- **1.7%** Wholesale Trade



GREENHOUSE GAS EMISSIONS

4.4
$kgCO_2e/kg$

kg Polycarbonate

Polycarbonate represents a family of thermoplastic polymers. Polycarbonate is a strong material and the grade used for construction is most often transparent. Polycarbonate has high mechanical strength and can withstand temperature fluctuations without cracking.

Polycarbonate is made by mixing bisphenol A and phosgene through multiple chemical reactions. The resulting polycarbonate can be extruded or moulded, like other thermoplastics.

Polycarbonate is mostly used in construction to replace glass in glazing, for skylights, flat or curved glazing and for sound walls.

Category *Plastics*

Type *Other polymers*

Functional unit *kg*

Specific heat *1 J/(kg·K)*

Density *1 200 kg/m^3*

Common uses
Skylights, flat glazing, curved glazing, sound walls

Process name
Polycarbonate, at plant/RER U/AusSD U

Input-output sector
Polymer Product Manufacturing

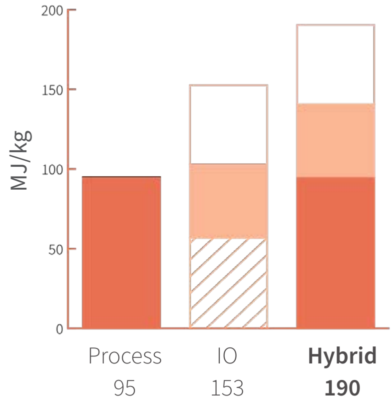
Further information
doi.org/10.26188/5da556966a461

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Polycarbonate	*kg*	*190*	*265*	*14.0*
Polycarbonate roofing sheet - 1 mm	m^2	228	318	16.7
Polycarbonate roofing sheet - 2 mm	m^2	457	635	33.5
Polycarbonate roofing sheet - 3 mm	m^2	685	953	50.2
Polycarbonate roofing sheet - 6 mm	m^2	1 371	1 905	100

EPiC Database

TOP THREE INPUTS

- **17.9%** Basic Chemical Manufacturing
- **2.2%** Polymer Product Manufacturing
- **1.9%** Road Transport

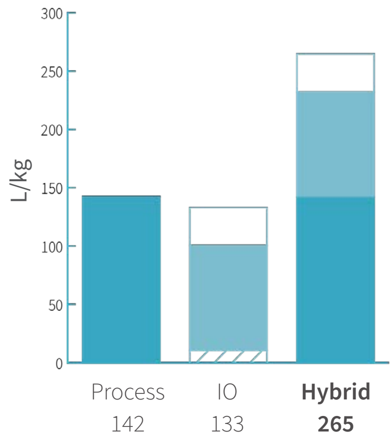


ENERGY

190
MJ/kg

TOP THREE INPUTS

- **13.9%** Other Agriculture
- **5.4%** Basic Chemical Manufacturing
- **2.1%** Water Supply, Sewerage and Drainage Services

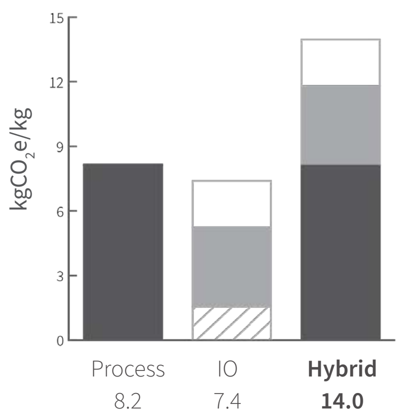


WATER

265
L/kg

TOP THREE INPUTS

- **16.2%** Basic Chemical Manufacturing
- **1.9%** Polymer Product Manufacturing
- **0.9%** Road Transport



GREENHOUSE GAS EMISSIONS

14.0
$kgCO_2e/kg$

kg Polymethyl methacrylate (PMMA)

Polymethyl methacrylate (PMMA) is a transparent thermoplastic that is light-weight has a good tensile strength, flexural strength and UV tolerance. It is commonly known as plexiglass, acrylic or acrylic glass.

PMMA is made by polymerising monomers of methyl-methacrylate. It is moulded or extruded into its final shape, which is often flat sheets. Common additives include acrylate monomers for heat processing, butyl acrylate for impact strength, dyes for colouring and ultraviolet resistance and fillers to reduce cost.

PMMA is most often used in construction as a substitute to glass.

Category *Plastics*

Type *Other polymers*

Functional unit *kg*

Specific heat *1.5 J/(kg·K)*

Density *1 190 kg/m³*

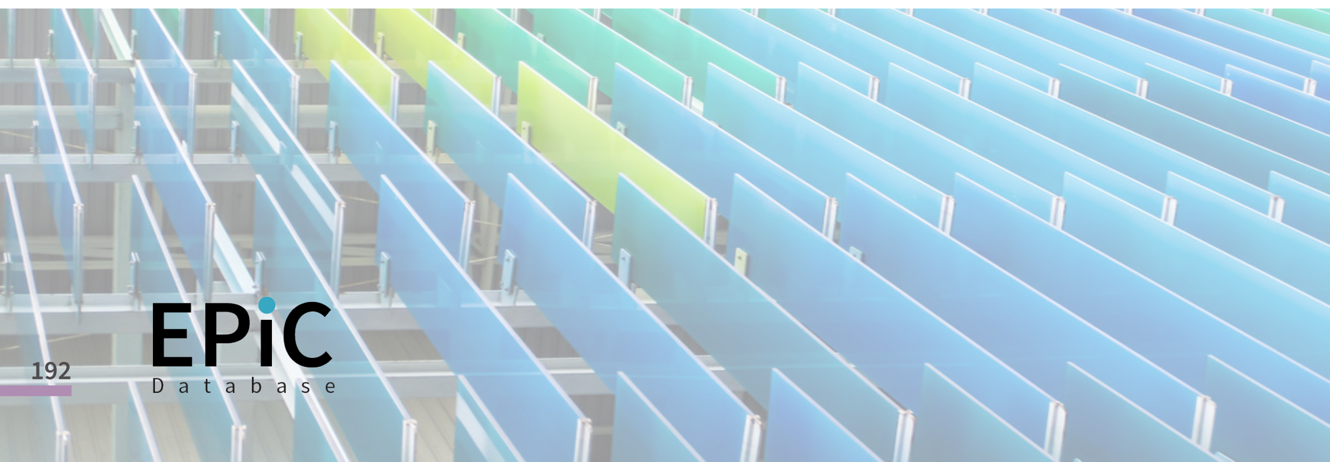
Common uses
Skylights, flat glazing, sound walls, bathtubs

Process name
Polymethyl methacrylate, sheet, at plant/RER U/AusSD U

Input-output sector
Polymer Product Manufacturing

Further information
doi.org/10.26188/5da556a82dd9d

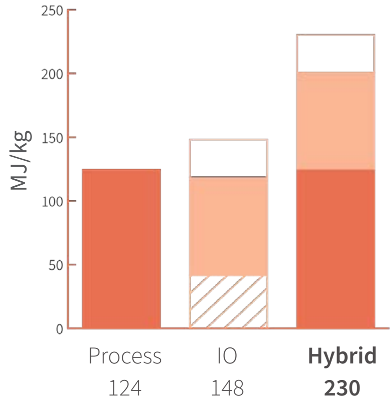
Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Polymethyl methacrylate (PMMA)	*kg*	*230*	*215*	*15.4*
PMMA sheet - 3 mm	m^2	822	768	54.9
PMMA sheet - 4 mm	m^2	1 096	1 023	73.2
PMMA sheet - 5 mm	m^2	1 370	1 279	91.4
PMMA sheet - 6 mm	m^2	1 644	1 535	110
PMMA sheet - 8 mm	m^2	2 192	2 047	146
PMMA sheet - 10 mm	m^2	2 740	2 558	183



EPiC Database

TOP THREE INPUTS

- **16.5%** Basic Chemical Manufacturing
- **3.6%** Electricity Generation
- **3.0%** Petroleum and Coal Product Manufacturing

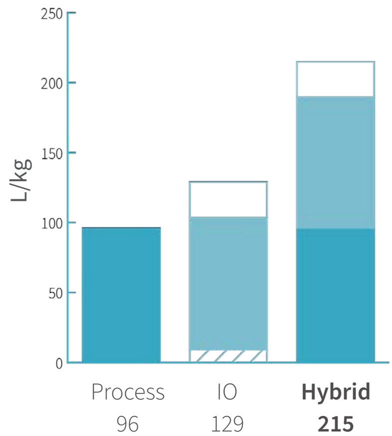


ENERGY

230
MJ/kg

TOP THREE INPUTS

- **16.6%** Other Agriculture
- **7.0%** Basic Chemical Manufacturing
- **2.7%** Polymer Product Manufacturing

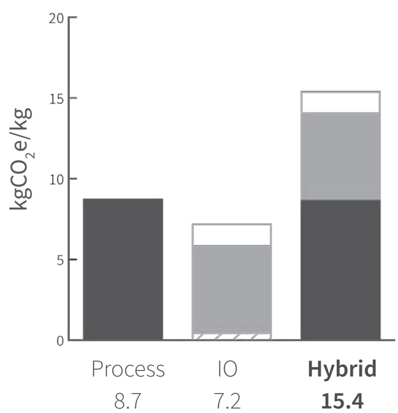


WATER

215
L/kg

TOP THREE INPUTS

- **15.4%** Basic Chemical Manufacturing
- **6.4%** Electricity Generation
- **2.1%** Polymer Product Manufacturing



GREENHOUSE GAS EMISSIONS

15.4
$kgCO_2e/kg$

kg Polypropylene (PP) sheet

Polypropylene (PP) is a thermoplastic polymer and second most produced plastic. It has similar properties to polyethylene (PE), including high impact strength and ductility, but is harder and more resistant to heat.

PP is produced by polymerising chains of propylene monomers through different catalysts. Different catalysts can result in different PP properties. PP is then moulded or extruded. Different additives can enhance the properties of PP, e.g. antistatic, dust resistant, and colouring.

PP is mostly used in construction as a membrane (including as a water vapour membrane).

Category *Plastics*

Type *Polypropylene*

Functional unit *kg*

Specific heat *1 622 J/(kg·K)*

Density *900 kg/m^3*

Common uses
Vapour barrier, general purpose membrane

Process name
Polypropylene, extruded film (custom)

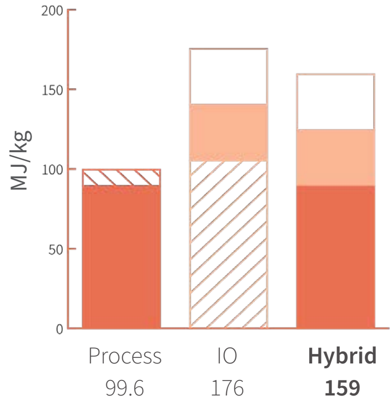
Input-output sector
Polymer Product Manufacturing

Further information
doi.org/10.26188/5da556bad2165

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO$_2$e/unit)
Polypropylene (PP) sheet	*kg*	*159*	*186*	*7.4*
PP sheet - 2 mm	m^2	287	335	13.4
PP sheet - 3 mm	m^2	431	502	20.0
PP sheet - 4 mm	m^2	574	670	26.7
PP sheet - 6 mm	m^2	861	1 005	40.1
PP sheet - 10 mm	m^2	1 435	1 675	66.8
PP sheet - 12 mm	m^2	1 722	2 010	80.2
PP sheet - 15 mm	m^2	2 153	2 512	100

TOP THREE INPUTS

- **50.9%** polypropylene, PP, at factory gate/AU U
- **5.1%** Petroleum and Coal Product Manufacturing
- **5.0%** Extrusion, plastic film/RER U/AusSD U

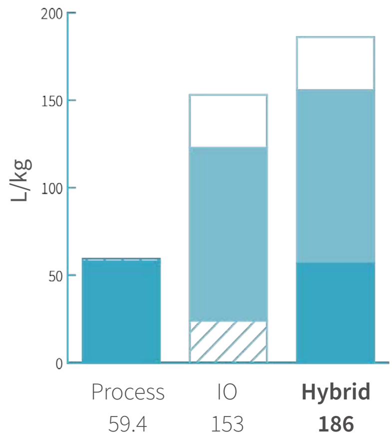


ENERGY

159 MJ/kg

TOP THREE INPUTS

- **24.1%** Extrusion, plastic film/RER U/AusSD U
- **22.7%** Other Agriculture
- **6.4%** Polypropylene, PP, at factory gate/AU U

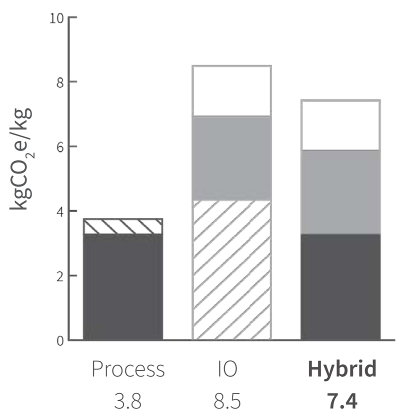


WATER

186 L/kg

TOP THREE INPUTS

- **34.2%** Polypropylene, PP, at factory gate/AU U
- **9.8%** Extrusion, plastic film/RER U/AusSD U
- **3.8%** Petroleum and Coal Product Manufacturing



GREENHOUSE GAS EMISSIONS

7.4 $kgCO_2e/kg$

kg Polyurethane (PU) flexible foam

Polyurethane (PU) is a polymer with a low density, low thermal conductivity and high durability.

PU is produced by mixing a stream of isocyanate and a stream of polyol, including any other additives. The proportion of each stream in the mix is often used to alter the material properties. The resulting mixture is poured into a mould or onto a surface. Once cured, the PU is demoulded.

In construction, flexible PU foam consists of thin flexible foam rolls that are typically used as floor underlay.

Category *Plastics*

Type *Polyurethane*

Functional unit *kg*

Specific heat *1 800 J/(kg·K)*

Density *69 kg/m³*

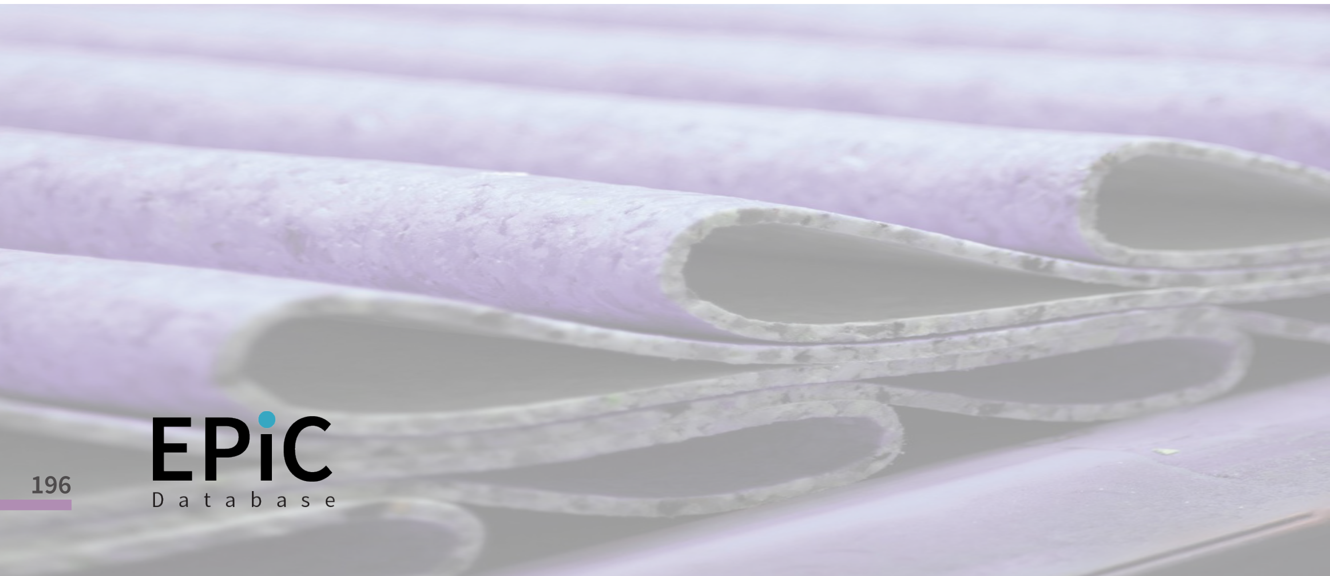
Common uses
Floor underlay

Process name
Polyurethane, flexible foam, at plant/RER U/AusSD U

Input-output sector
Polymer Product Manufacturing

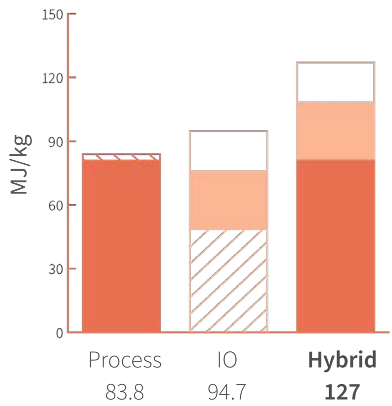
Further information
doi.org/10.26188/5da556dde71cd

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Polyurethane (PU) flexible foam	*kg*	*127*	*443*	*7.7*
PU foam underlay - 7 mm, 64 kg/m^3	m^2	56.8	198	3.4
PU foam underlay - 7 mm, 69 kg/m^3	m^2	61.4	214	3.7
PU foam underlay - 10 mm, 73 kg/m^3	m^2	92.5	323	5.6
PU foam underlay - 10 mm, 123 kg/m^3	m^2	156	543	9.4



TOP THREE INPUTS

- **41.0%** Polyols, at plant/RER U/AusSD U
- **19.3%** Toluene diisocyanate, at plant/ RER U/AusSD U
- **3.5%** Petroleum and Coal Product Manufacturing

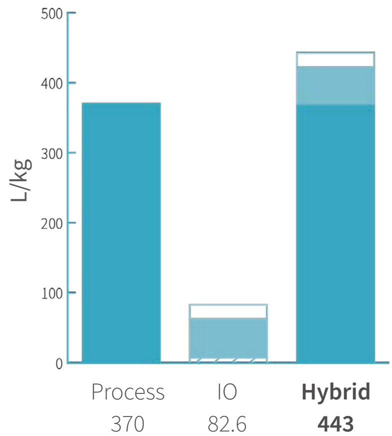


ENERGY

127 MJ/kg

TOP THREE INPUTS

- **56.6%** Polyols, at plant/RER U/AusSD U
- **21.5%** Toluene diisocyanate, at plant/ RER U/AusSD U
- **5.1%** Other Agriculture

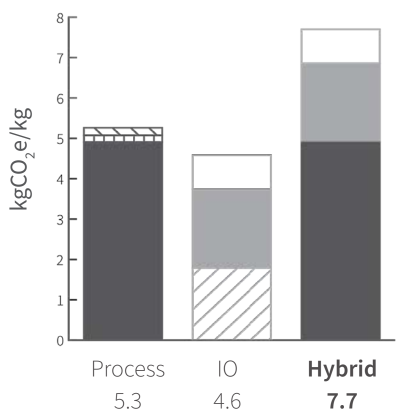


WATER

443 L/kg

TOP THREE INPUTS

- **33.8%** Polyols, at plant/RER U/AusSD U
- **24.3%** Toluene diisocyanate, at plant/ RER U/AusSD U
- **2.7%** Polymer Product Manufacturing



GREENHOUSE GAS EMISSIONS

7.7 $kgCO_2e/kg$

kg Polyvinyl chloride (PVC) film

Polyvinyl chloride (PVC) is a plastic polymer characterised by good thermal and electrical insulation properties. PVC can be rigid (see uPVC) or soft. PVC is the third most produced plastic, globally.

PVC is produced by polymerising vinyl chloride monomers, mostly through suspension polymerisation, followed by emulsion and bulk polymerisation. This generates heat and requires cooling and water. The resulting sludge is filtered, centrifuged, and dried, before being converted to pellets. These can be molten for moulding or extrusion. Multiple additives can be added to PVC to enhance its properties, most importantly phthalate to soften the PVC.

PVC film is used in construction for flooring and electrical cable insulation.

Category *Plastics*

Type *Polyvinyl Chloride*

Functional unit *kg*

Specific heat *950 J/(kg·K)*

Density *1 390 kg/m^3*

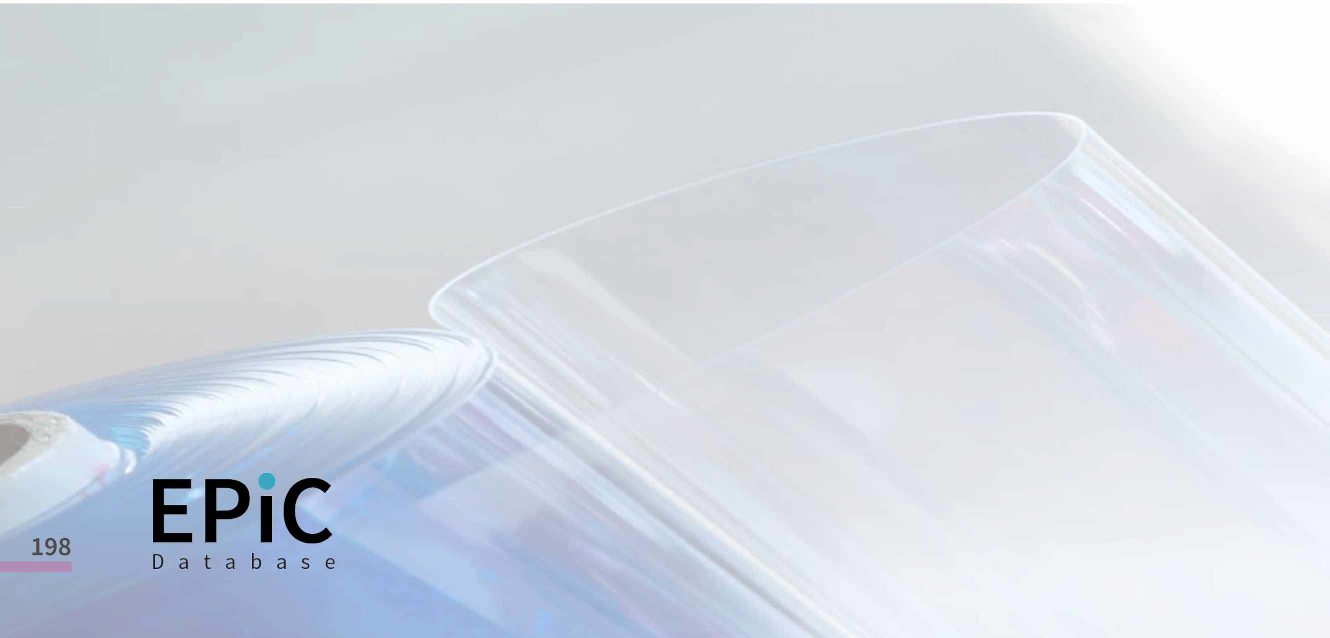
Common uses
Electrical cable insulation, flooring, cladding

Process name
PVC, calendered (custom)

Input-output sector
Polymer Product Manufacturing

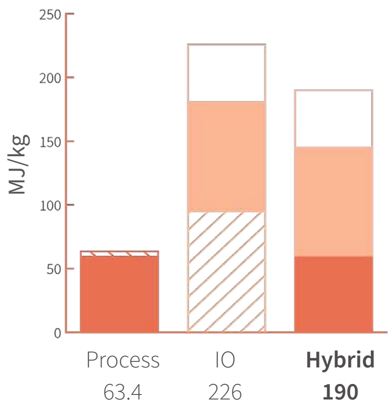
Further information
doi.org/10.26188/5da5571457bf1

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO$_2$e/unit)
Polyvinyl chloride (PVC) film	*kg*	*190*	*758*	*11.2*
PVC film - 19 µm	m^2	5.0	20	0.3
PVC film - 25 µm	m^2	6.6	26.3	0.4



TOP THREE INPUTS

- **30.5%** Basic Chemical Manufacturing
- **5.9%** Thermoforming, with calendering/RER U/AusSD U
- **3.4%** Road Transport

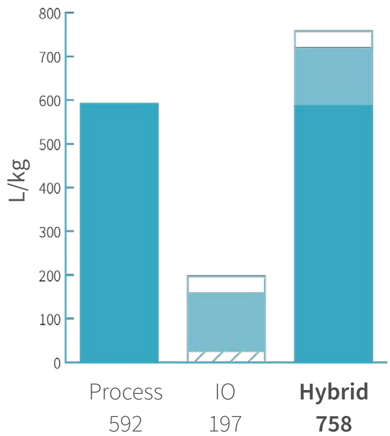


ENERGY

190
MJ/kg

TOP THREE INPUTS

- **13.7%** Thermoforming, with calendering/RER U/AusSD U
- **7.2%** Other Agriculture
- **3.0%** Basic Chemical Manufacturing

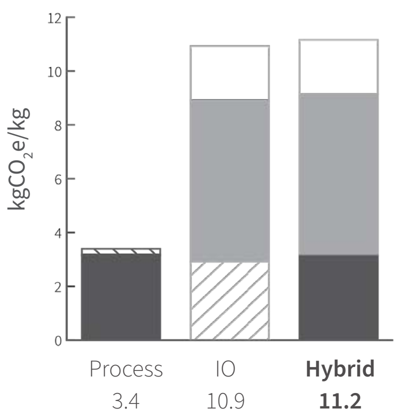


WATER

758
L/kg

TOP THREE INPUTS

- **32.4%** Basic Chemical Manufacturing
- **9.5%** Thermoforming, with calendering/RER U/AusSD U
- **2.1%** Wholesale Trade



GREENHOUSE GAS EMISSIONS

11.2
$kgCO_2e/kg$

PLASTICS

Unplasticised polyvinyl chloride (uPVC)

Polyvinyl chloride (PVC) is a plastic polymer characterised by good thermal and electrical insulation properties. Unplasticised PVC is rigid. PVC is the third most produced plastic, globally.

PVC is produced by polymerising vinyl chloride monomers, mostly through suspension polymerisation, followed by emulsion and bulk polymerisation. This generates heat and requires cooling and water. The resulting sludge is filtered, centrifuged, and dried, before being converted to pellets. These can be molten for moulding or extrusion. Multiple additives can be added to PVC to enhance its properties, notably chloride to enhance its resistance to ultraviolet light.

uPVC is widely used in the construction industry. Its main uses include window frames, doors, pipes, and gutters.

Category *Plastics*

Type *Polyvinyl Chloride*

Functional unit *kg*

Specific heat *950 J/(kg·K)*

Density *1 390 kg/m^3*

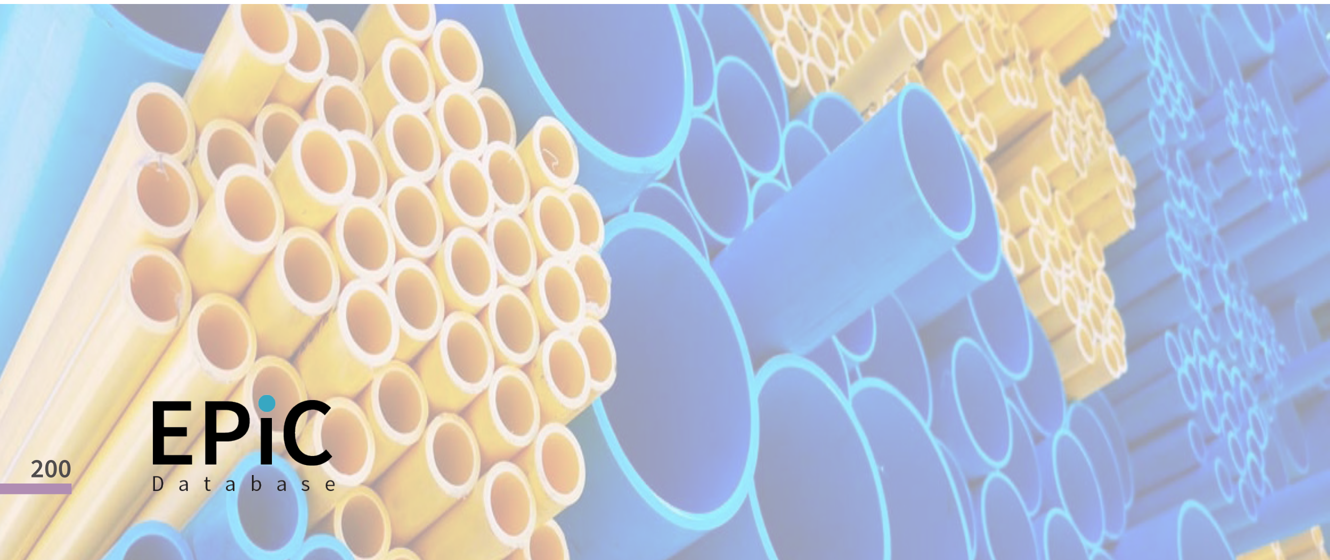
Common uses
Window frames, doors, pipes, gutters

Process name
PVC, extruded pipe (custom)

Input-output sector
Polymer Product Manufacturing

Further information
doi.org/10.26188/5da558ad914dc

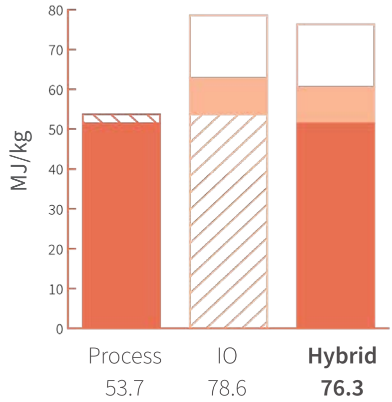
Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO$_2$e/unit)
Unplasticised polyvinyl chloride (uPVC)	*kg*	*76.3*	*561*	*4.2*
uPVC pipe - 21.35 mm outer dia., 1.8 mm thick	m	11.7	86.2	0.6
uPVC pipe - 60.25 mm outer dia., 2.6 mm thick	m	50	367	2.7
uPVC pipe - 11.43 mm outer dia., 4.85 mm thick	m	177	1 301	9.7
uPVC pipe - 22.53 mm outer dia., 11.1 mm thick	m	792	5 826	43.2



EPiC Database

TOP THREE INPUTS

- **7.8%** Extrusion, plastic pipes/RER U/ AusSD U
- **1.6%** Wholesale Trade
- **0.8%** Air and Space Transport

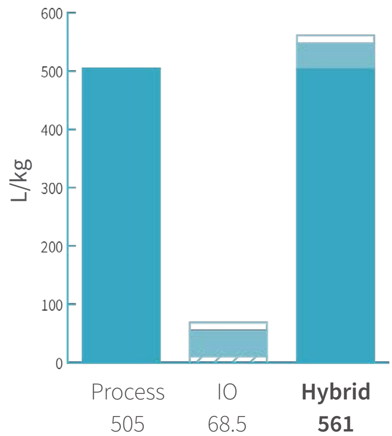


ENERGY

76.3 MJ/kg

TOP THREE INPUTS

- **3.7%** Extrusion, plastic pipes/RER U/ AusSD U
- **3.4%** Other Agriculture
- **0.3%** Wholesale Trade

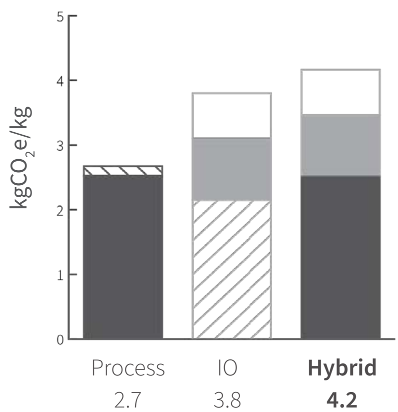


WATER

561 L/kg

TOP THREE INPUTS

- **12.8%** Extrusion, plastic pipes/RER U/ AusSD U
- **1.9%** Wholesale Trade
- **0.9%** Other Agriculture



GREENHOUSE GAS EMISSIONS

4.2 $kgCO_2e/kg$

kg Clay brick

Clay bricks are widely used in the construction industry for their strength, affordability and ease of construction. They have high durability, weather and fire resistance, compressive strength, and good thermal/sound insulative properties. The strength of a brick wall is also largely dependent on the quality of the mortar and workmanship.

Bricks are made from clay, which is an abundant resource across most of the world. Clay is prepared and mixed to ensure consistent particle size and mineral content. The clay is then extruded, soft moulded or dry pressed into brick shaped forms. The bricks are dried in a temperature and humidity controlled environment, and fired in a high temperature oven/kiln. Coatings, glazing or textures are applied to give the brick its final appearance. The colour of a brick largely depends on the mineral content of the clay and final firing temperature.

Bricks are commonly used for external cladding, loadbearing walls, flooring, and other construction elements. Face bricks usually have a decorative or smooth finish, while building/common bricks are used for internal structure. Bricks can also be hollowed, to reduce the volume of the brick and materials needed per unit.

Category	*Sand, stone and ceramics*
Type	*Clay*
Functional unit	*kg*
Specific heat	*835 J/(kg·K)*
Density	*2 403 kg/m^3*

Common uses
Cladding, loadbearing walls, landscaping, decorative features

Process name
Brick, at plant/RER U/AusSD U

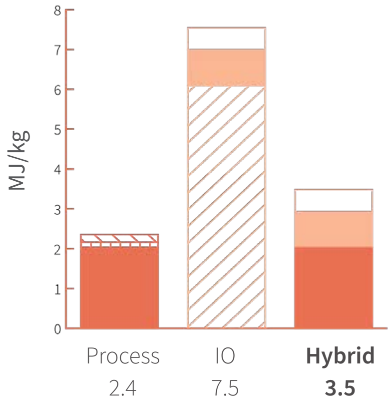
Input-output sector
Ceramic Product Manufacturing

Further information
doi.org/10.26188/5da552ad307a9

EPiC Database

TOP THREE INPUTS

- **5.6%** Other Non-Metallic Mineral Product Manufacturing
- **5.0%** Road Transport
- **1.9%** Cement, Lime and Ready-Mixed Concrete Manufacturing

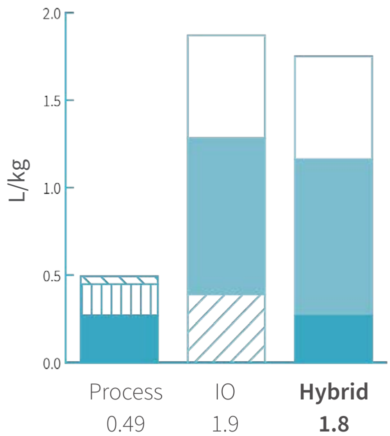


ENERGY

3.5
MJ/kg

TOP THREE INPUTS

- **6.1%** Other Non-Metallic Mineral Product Manufacturing
- **3.1%** Professional, Scientific and Technical Services
- **2.7%** Food and Beverage Services

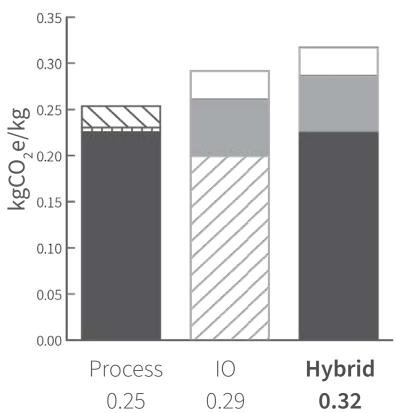


WATER

1.8
L/kg

TOP THREE INPUTS

- **4.6%** Other Non-Metallic Mineral Product Manufacturing
- **1.9%** Cement, Lime and Ready-Mixed Concrete Manufacturing
- **1.8%** Road Transport



GREENHOUSE GAS EMISSIONS

0.32
$kgCO_2e/kg$

kg Gravel

Gravel is a course aggregate, comprised of hard, durable and weather resistant rocks. It has excellent drainage properties, and is commonly used in construction. There are different sizes and grades of gravel available, ranging from small smooth rounded rock, to large angular crushed rock.

Gravel is produced in quarries or extracted from gravel pits. It is found naturally, in the form of eroded rock and minerals, or created by crushing rock such as limestone, basalt or sandstone.

It is commonly used for construction and landscaping purposes, including: as a base layer for walkways and roads, as bulk fill, as a drainage substrate, or as an aggregate for concrete.

Category	*Sand, stone and ceramics*
Type	*Other minerals*
Functional unit	*kg*
Specific heat	*840 J/(kg·K)*
Density	*1 840 kg/m^3*

Common uses
Landscaping, bulk fill, material additive

Process name
Gravel, crushed, at mine/CH U/AusSD U

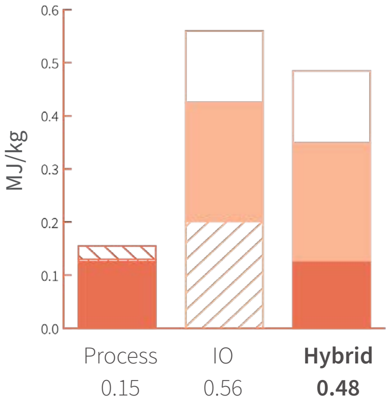
Input-output sector
Non Metallic Mineral Mining

Further information
doi.org/10.26188/5da554c7241e7

EPiC Database

TOP THREE INPUTS

- **5.9%** Exploration and Mining Support Services
- **3.1%** Diesel, burned in building machine/GLO U/AusSD U
- **1.7%** Coal mining

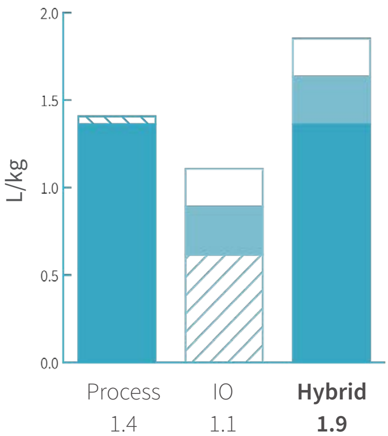


ENERGY

0.48 MJ/kg

TOP THREE INPUTS

- **1.8%** Exploration and Mining Support Services
- **0.7%** Agriculture, Forestry and Fishing Support Services
- **0.5%** Electricity Transmission, Distribution, On Selling and Electricity Market Operation

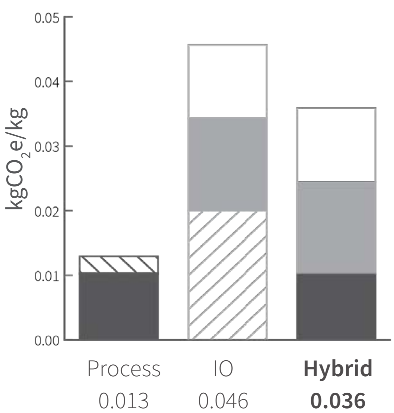


WATER

1.9 L/kg

TOP THREE INPUTS

- **8.9%** Exploration and Mining Support Services
- **3.3%** Coal mining
- **2.9%** Diesel, burned in building machine/GLO U/AusSD U



GREENHOUSE GAS EMISSIONS

0.036 $kgCO_2e/kg$

kg Recycled aggregate

Recycled aggregate is a cheap and readily available product made from recycled construction materials. It is strong and durable with excellent drainage properties.

It is typically comprised of concrete, stone, brick, ceramics, mortar and other common construction materials. It is produced using the waste materials collected from the demolition of building and infrastructure projects. Impurities such as metal, wood and timber are removed via magnets and other sorting techniques. The remaining materials are sorted by size, and crushed into a coarse aggregate.

Recycled aggregate is becoming increasingly popular as a replacement for natural aggregates. It is commonly used for: bulk fill, road construction, gravel, and as an aggregate in concrete. When used in concrete, it is typically combined with fly ash or other additives to ensure improved strength and reliability.

Category	*Sand, stone and ceramics*
Type	*Other minerals*
Functional unit	*kg*
Specific heat	*837 J/(kg·K)*
Density	*1 320 kg/m^3*

Common uses
Landscaping, bulk fill, material additive

Process name
Recycled aggregate, at plant/AU U

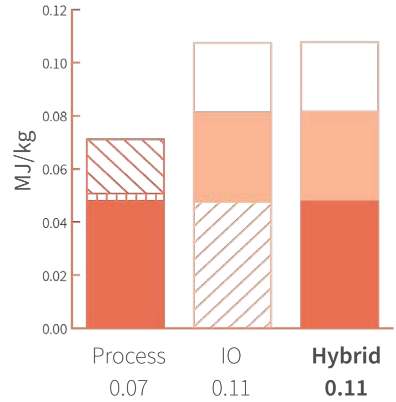
Input-output sector
Waste Collection, Treatment and Disposal Services

Further information
doi.org/10.26188/5da557263ad43

EPiC Database

TOP THREE INPUTS

- **1.6%** Road Transport
- **1.3%** Auxiliary Finance and Insurance Services
- **1.0%** Wholesale Trade

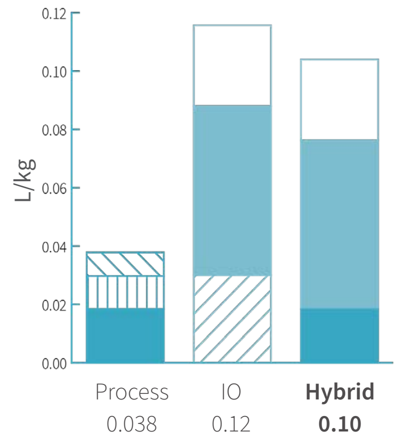


ENERGY

0.11 MJ/kg

TOP THREE INPUTS

- **3.6%** Employment, Travel Agency and Other Administrative Services
- **2.3%** Auxiliary Finance and Insurance Services
- **2.1%** Dairy Product Manufacturing

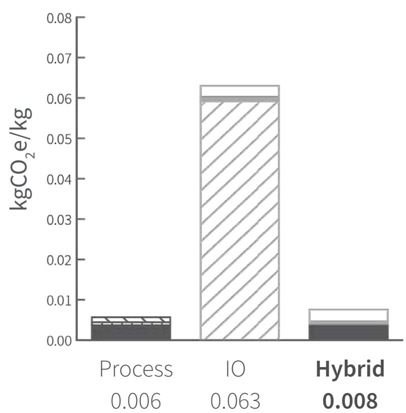


WATER

0.10 L/kg

TOP THREE INPUTS

- **0.6%** Road Transport
- **0.5%** Auxiliary Finance and Insurance Services
- **0.4%** Employment, Travel Agency and Other Administrative Services



GREENHOUSE GAS EMISSIONS

0.008 $kgCO_2e/kg$

kg Sand

Sand is comprised of small particles of quartz (silica), feldspar and calcium carbonate from various forms of life that have been eroded down over thousands of years. It is strong, durable, chemically inert and has excellent drainage characteristics.

It is commonly extracted through open pit mining and is available in many different grades and levels of purity. Due to the extended period of time required to create sand, it is considered a non-renewable resource.

Sand can be used as a substrate for footings, pathways, and concrete slabs. It is also used as an additive in concrete, mortar, asphalt, and various exterior finishes. It is one of the primary materials used in the production of silicon for various construction products.

Category	*Sand, stone and ceramics*
Type	*Other minerals*
Functional unit	*kg*
Specific heat	*830 J/(kg·K)*
Density	*1 500 kg/m^3*

Common uses
Landscaping, concrete slabs, material additive, external finishes

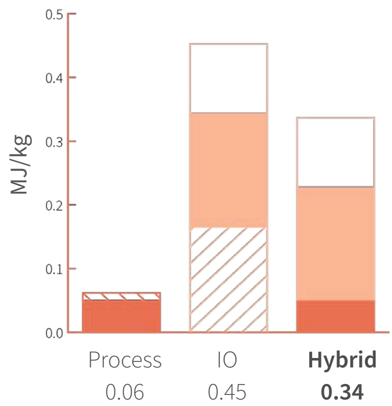
Process name
Sand, at mine/CH U/AusSD U

Input-output sector
Non Metallic Mineral Mining

Further information
doi.org/10.26188/5da5574945e6e

TOP THREE INPUTS

- **6.8%** Exploration and Mining Support Services
- **4.5%** Diesel, burned in building machine/GLO U/AusSD U
- **1.9%** Coal mining

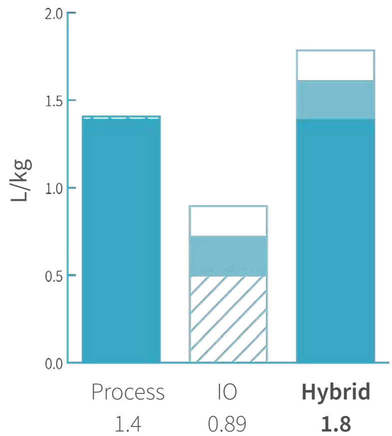


ENERGY

0.34 MJ/kg

TOP THREE INPUTS

- **1.5%** Exploration and Mining Support Services
- **0.6%** Agriculture, Forestry and Fishing Support Services
- **0.4%** Electricity Transmission, Distribution, On Selling and Electricity Market Operation

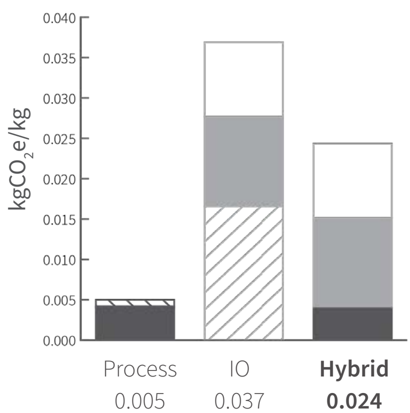


WATER

1.8 L/kg

TOP THREE INPUTS

- **10.6%** Exploration and Mining Support Services
- **4.7%** Diesel, burned in building machine/GLO U/AusSD U
- **4.0%** Coal mining



GREENHOUSE GAS EMISSIONS

0.024 $kgCO_2e/kg$

kg Sanitary ceramic

Sanitary ceramics are a high quality ceramic product that is durable, water proof, stain and mould resistant. Materials used in sanitary ceramics are generally denser and less porous than other ceramic products.

Sanitary ceramics are commonly made from silica, sand, feldspar and clays such as kaolinite that are used to make china and porcelain. The raw materials are pulverised into fine particles and mixed together, before being formed into the desired size and shape. The product is then dried, glazed with a waterproof coating and fired in a high temperature oven/kiln.

Sanitary ceramics are commonly used for washbasins, toilets, bathroom accessories and sanitary ware. They are generally more expensive than other ceramic products, due to their high-quality waterproof and stain resistant finish.

Category	*Sand, stone and ceramics*
Type	*Ceramic*
Functional unit	*kg*
Specific heat	*1 070 J/(kg·K)*
Density	*2 700 kg/m^3*

Common uses
Washbasins, toilets, bathroom accessories, sanitary ware

Process name
Sanitary ceramics, at regional storage/CH U/AusSD U

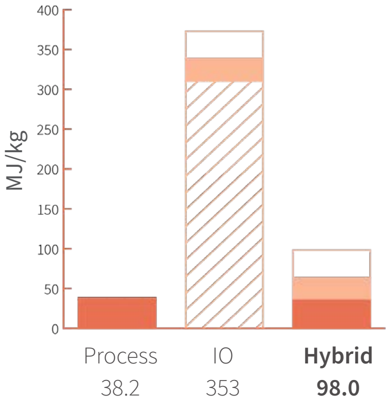
Input-output sector
Ceramic Product Manufacturing

Further information
doi.org/10.26188/5da5575bb1595

EPiC Database

TOP THREE INPUTS

- **24.4%** Natural gas, burned in industrial furnace >100kW/RER U/AusSD U
- **8.1%** Road Transport
- **2.9%** Cement, Lime and Ready-Mixed Concrete Manufacturing

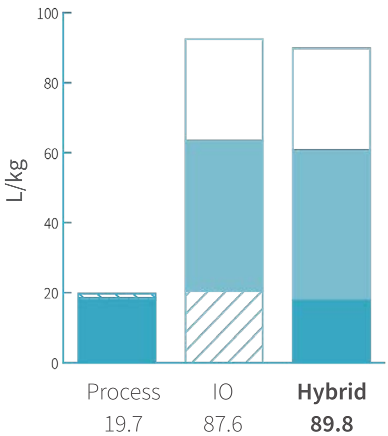


ENERGY

98.0 MJ/kg

TOP THREE INPUTS

- **4.5%** Kaolin, at plant/RER U/AusSD U
- **2.8%** Professional, Scientific and Technical Services
- **2.5%** Food and Beverage Services

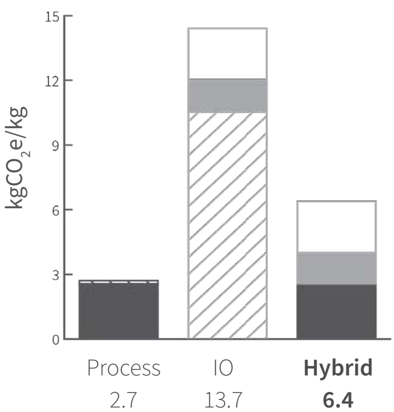


WATER

89.8 L/kg

TOP THREE INPUTS

- **23.6%** Natural gas, burned in industrial furnace >100kW/RER U/AusSD U
- **3.9%** Cement, Lime and Ready-Mixed Concrete Manufacturing
- **3.6%** Road Transport



GREENHOUSE GAS EMISSIONS

6.4 $kgCO_2e/kg$

kg Dimension stone

Dimension stone is the common term used for finished blocks or slabs of stone used in construction. There are a variety of rock types used to create dimension stone, including: marble, granite, slate, travertine and others. These have different properties, and can vary in strength, hardness, durability, texture, colour, size and cost.

Dimension stone is mined from quarries, using precision saws, burners and blasting. Slabs are then graded, cut to size, and finished using a variety of techniques, including: sandblasting, polishing, honing, and saw cutting; each technique providing a different finish and texture. Resin can be used to fill imperfections in the stone.

Dimension stones are commonly used for bathroom vanities, countertops, flooring and cladding. Granite is used for external and flooring applications due to its hardness, and ability to withstand weathering. Marble and travertine is commonly used for benchtops and interior applications.

Category	*Sand, stone and ceramics*
Type	*Other minerals*
Functional unit	*kg*
Specific heat	*837 J/(kg·K)*
Density	*2 243 kg/m^3*

Common uses
Countertops, flooring, walling, cladding, interior decorations

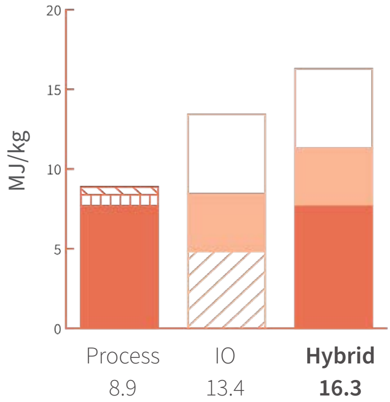
Process name
Natural stone plate, cut, at regional storage/CH U/AusSD U

Input-output sector
Non Metallic Mineral Mining

Further information
doi.org/10.26188/5da553562c7fa

TOP THREE INPUTS

- **7.1%** Diesel, burned in building machine/GLO U/AusSD U
- **3.1%** Exploration and Mining Support Services
- **0.9%** Road Transport

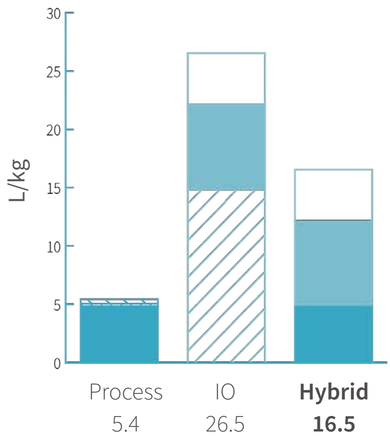


ENERGY

16.3 MJ/kg

TOP THREE INPUTS

- **5.3%** Exploration and Mining Support Services
- **1.9%** Agriculture, Forestry and Fishing Support Services
- **1.3%** Electricity Transmission, Distribution, On Selling and Electricity Market Operation

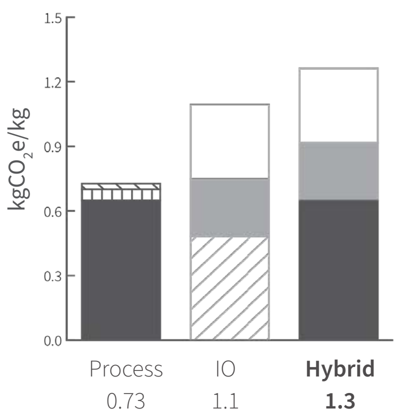


WATER

16.5 L/kg

TOP THREE INPUTS

- **7.0%** Diesel, burned in building machine/GLO U/AusSD U
- **5.5%** Exploration and Mining Support Services
- **2.1%** Coal mining



GREENHOUSE GAS EMISSIONS

1.3 $kgCO_2e/kg$

kg Ceramic tile

Ceramic tiles are popular for their decorative, hard wearing, stain resistant, and water resistant qualities. Glazed tiles provide a more water and stain resistant finish, while unglazed tiles have a rougher, more natural appearance and texture. A surface coating is often applied to unglazed tiles, to provided additional water proofing.

Ceramic tiles are made from natural clays, feldspar, silica and other materials. Clays and additives are sorted and pulverised to ensure a consistent texture and consistency. The mixture is then formed into tile shaped elements, dried, and fired in a high temperature oven/kiln. Glazing and surface treatments are applied for waterproofing, and aesthetic purposes.

Ceramic tiles are used for interior and exterior non-structural purposes including flooring, cladding and decorative elements. They are commonly used in kitchens, bathrooms and wet areas.

Category	*Sand, stone and ceramics*
Type	*Ceramic*
Functional unit	*kg*
Specific heat	*1 070 J/(kg·K)*
Density	*2 900 kg/m^3*

Common uses
Interior and exterior finishes, bathrooms, kitchens, flooring, walling

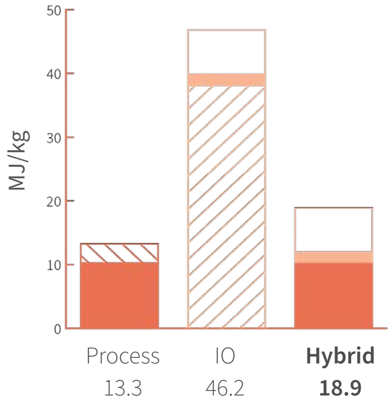
Process name
Ceramic tiles, at regional storage/CH U/AusSD U

Input-output sector
Ceramic Product Manufacturing

Further information
doi.org/10.26188/5da5529e3a6be

TOP THREE INPUTS

- **29.4%** Natural gas, burned in industrial furnace >100kW/RER U/AusSD U
- **4.7%** Road Transport
- **1.4%** Basic Chemical Manufacturing

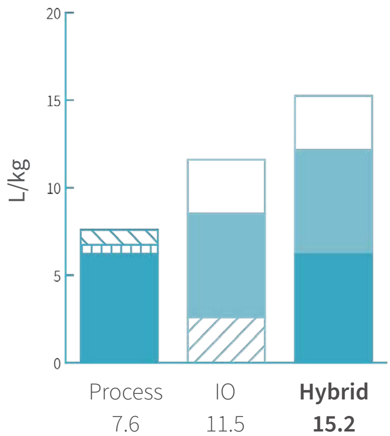


ENERGY

18.9 MJ/kg

TOP THREE INPUTS

- **5.5%** Sodium perborate, tetrahydrate, powder, at plant/RER S/AusSD U
- **4.7%** Feldspar, at plant/RER S/AusSD U
- **2.4%** Professional, Scientific and Technical Services

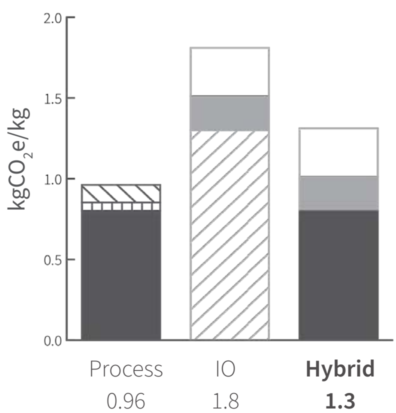


WATER

15.2 L/kg

TOP THREE INPUTS

- **27.8%** Natural gas, burned in industrial furnace >100kW/RER U/AusSD U
- **2.5%** Cement, Lime and Ready-Mixed Concrete Manufacturing
- **2.3%** Road Transport



GREENHOUSE GAS EMISSIONS

1.3 $kgCO_2e/kg$

kg Clay roof tile

Clay roof tiles, also known as terracotta tiles are a common roofing option. They are durable, weather resistant, fire resistant, and have a high thermal mass compared with other roofing materials. Tiles are interlocking, to ensure a consistent weatherproof roof covering, and require ongoing maintenance to ensure they remain weatherproof. Tiles can be brittle, and crack easily if not handled/treated correctly.

The manufacturing process for clay tiles is similar to the production of other ceramic products. Clay is prepared and mixed to ensure consistent particle size and mineral content. The clay is then moulded or extruded into tile shaped elements. These are dried in a temperature and humidity controlled environment, and fired in a high temperature oven/kiln. Coatings or glazing can be applied to ensure the tiles are waterproof, or provide other construction or aesthetic qualities. The colour of the tile largely depends on the mineral content of the clay, the final firing temperature, or the coating/glazing applied.

Clay roof tiles are available in a wide range of shapes and sizes, including specific regional styles which are influenced by roof pitch, weather conditions, availability of raw materials and aesthetic qualities.

Category	*Sand, stone and ceramics*
Type	*Clay*
Functional unit	*kg*
Specific heat	*800 J/(kg·K)*
Density	*1 860 kg/m^3*

Common uses
Roof cladding

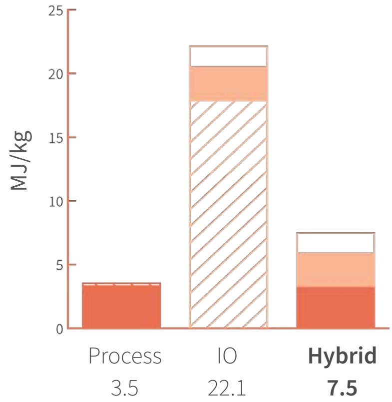
Process name
Roof tile, at plant/RER U/AusSD U

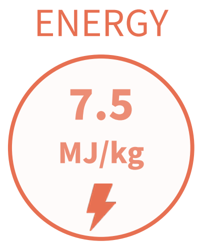
Input-output sector
Ceramic Product Manufacturing

Further information
doi.org/10.26188/5da552bc24123

TOP THREE INPUTS

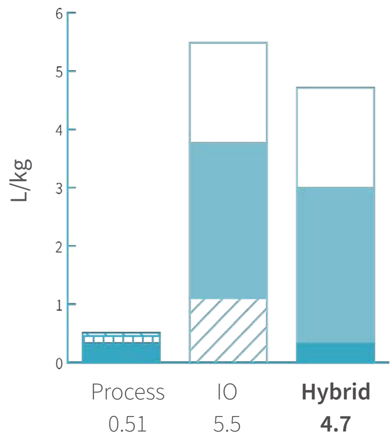
- **7.7%** Other Non-Metallic Mineral Product Manufacturing
- **6.9%** Road Transport
- **2.6%** Cement, Lime and Ready-Mixed Concrete Manufacturing

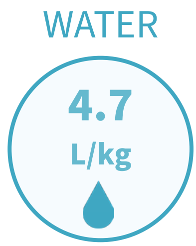




TOP THREE INPUTS

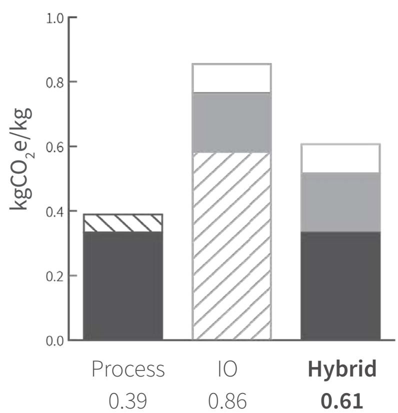
- **6.7%** Other Non-Metallic Mineral Product Manufacturing
- **3.4%** Professional, Scientific and Technical Services
- **3.0%** Food and Beverage Services

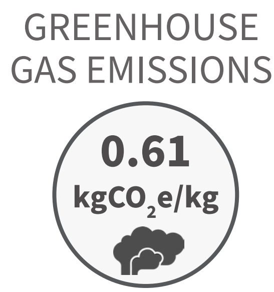




TOP THREE INPUTS

- **7.1%** Other Non-Metallic Mineral Product Manufacturing
- **2.9%** Cement, Lime and Ready-Mixed Concrete Manufacturing
- **2.7%** Road Transport





kg Cork slab

Cork slab is manufactured from cork material obtained from the bark layer of cork oak trees. Cork slab is often made as a by-product of wine stopper production or from recycled cork. It is often made by combining ground granulated cork with a binding agent.

Cork slab is lightweight, rot resistant, fire resistant and termite resistant. It is available in a variety of thicknesses, from 6 mm and used for a range of purposes, including floor and wall tiles, thermal insulation, benchtops and exterior cladding.

Cork slab products are typically available as rolls up to 25 m long, as 600 or 900 mm wide sheets and 300 or 600 mm square tiles.

Category *Timber products*

Type *Cork*

Functional unit *kg*

Specific heat *2 000 J/(kg·K)*

Density *120 kg/m³*

Common uses
Insulation, floor tiles, wall tiles, exterior cladding, floor finish, benchtops

Process name
Cork slab, at plant/RER U/AusSD U

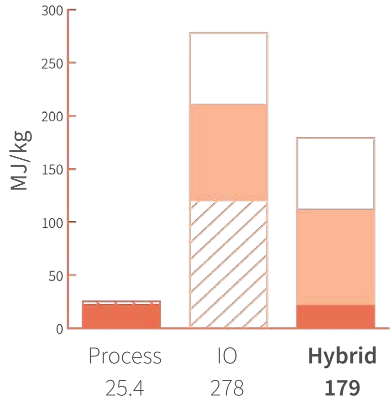
Input-output sector
Other Wood Product Manufacturing

Further information
doi.org/10.26188/5da55336dce12

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Cork slab	*kg*	*179*	*199*	*9.5*
Cork slab - 6 mm	m^2	129	143	6.8
Cork slab - 10 mm	m^2	215	238	11.4
Cork slab - 12 mm	m^2	258	286	13.6
Cork slab - 20 mm	m^2	430	477	22.7
Cork slab - 50 mm	m^2	1 074	1 191	56.8

TOP THREE INPUTS

- **25.1%** Road Transport
- **2.5%** Polymer Product Manufacturing
- **2.5%** Wholesale Trade

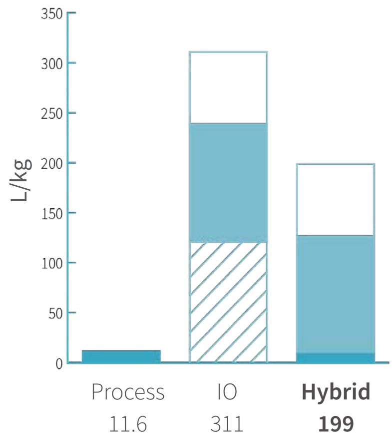


ENERGY

179 MJ/kg

TOP THREE INPUTS

- **3.8%** Water Supply, Sewerage and Drainage Services
- **2.7%** Phenolic resin, at plant/RER U/AusSD U
- **2.7%** Wholesale Trade

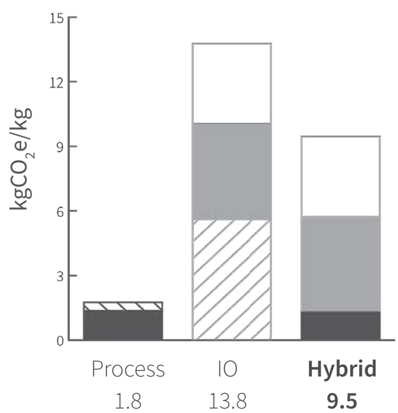


WATER

199 L/kg

TOP THREE INPUTS

- **15.0%** Road Transport
- **2.5%** Wholesale Trade
- **2.3%** Other Fabricated Metal Product manufacturing



GREENHOUSE GAS EMISSIONS

9.5 $kgCO_2e/kg$

m³ Hardwood

Timber comes in a wide range of varieties and sizes. It is used for structural and non-structural purposes, and can vary significantly in density, grain texture, workability, usage and cost. It is lightweight, easy to handle and transport, and has a good strength to weight ratio. It is typically divided into softwood varieties, such as Pine, Cypress and Spruce and hardwood varieties such as Victorian Ash, Blackbutt and Oak. The term hardwood and softwood is a botanical distinction, and not an indication of timber strength or density. The density of timber is highly dependent on the species, varying from 120 kg/m^3 to 1 300 kg/m^3 or higher.

Hardwood is generally more dense and durable than softwood varieties, with better longevity. Some hardwoods are naturally resistant to termites and pests and more fire resistant. It is commonly used for high traffic areas, quality furnishings and interior joinery, structural members, cladding and flooring.

Commercial timber products are typically kiln, or air-dried. Kiln/oven drying is done in a controlled environment over a relatively short time period. It produces a uniformly dried, high quality product that generally kills any fungi and insects in the wood. Air-drying is done over extended periods of time, and does not require any fuel inputs. It is cost effective, but needs to be carefully managed to reduce cracking and ensure consistent drying.

Category *Timber products*

Type *Hardwood*

Functional unit *m^3*

Specific heat *1 255 J/(kg·K)*

Density *720 kg/m^3*

Common uses
Beams, columns, framing, joinery, flooring, walling, furniture, cladding, doors, windows

Process name
Sawn timber, hardwood, planed, air / kiln dried, u=10%, at plant/RER U/ AusSD U

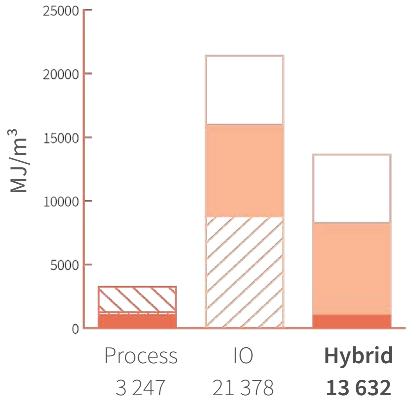
Input-output sector
Sawmill Product Manufacturing

Further information
doi.org/10.26188/5da554ea370a5

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO_2e/unit)
Hardwood air-dried	*m^3*	*13 632*	*19 110*	*944*
Hardwood kiln-dried - dressed	m^3	41 597	58 411	2 269
Hardwood kiln-dried - structural	m^3	19 389	25 332	1 178

TOP THREE INPUTS

- **45.9%** Road Transport
- **1.1%** Wholesale Trade
- **0.8%** Construction Services

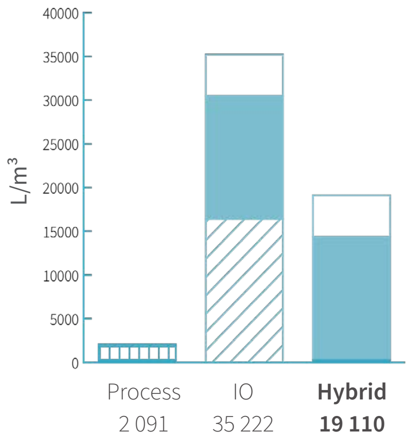


ENERGY

13 632 MJ/m³

TOP THREE INPUTS

- **3.7%** Road Transport
- **1.9%** Construction Services
- **1.2%** Wholesale Trade

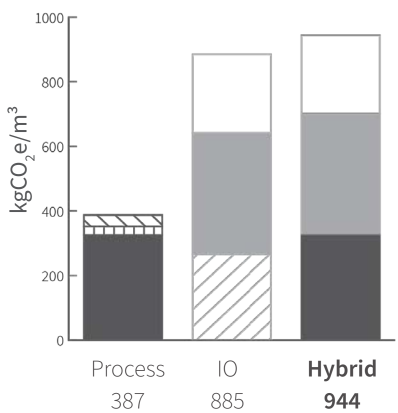


WATER

19 110 L/m³

TOP THREE INPUTS

- **21.7%** Road Transport
- **1.6%** Construction Services
- **1.1%** Wholesale Trade



GREENHOUSE GAS EMISSIONS

944 $kgCO_2e/m^3$

m^3 Cross laminated timber (CLT)

Cross laminated timber (CLT) is a manufactured timber product, similar to plywood. Solid timber members are bonded together, with the grain alternating by 90 degrees for each lamination. CLT is much thicker than traditional plywood and has superior structural capabilities. It has excellent dimensional stability, strength and rigidity.

CLT is fabricated using a range of different timber varieties. It is typically bonded together using melamine urea formaldehyde, polyurethane or other adhesives.

CLT has different structural capabilities when compared with conventional timber, and acts as a sheet product, rather than a framing product. It can be used as a complete floor, wall or roof system, without the need for additional supporting members.

Category *Timber products*

Type *Manufactured timber product*

Functional unit *m^3*

Specific heat *1 300 J/(kg·K)*

Density *490 kg/m^3*

Common uses
Flooring and walling system, structural panels, timber sheets

Process name
Glued laminated timber, indoor use, at plant/RER U/AusSD U

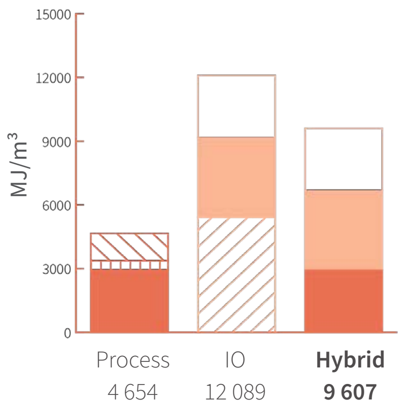
Input-output sector
Other Wood Product Manufacturing

Further information
doi.org/10.26188/5da55346af5dc

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Cross laminated timber (CLT)	*m^3*	*9 607*	*8 608*	*645*
CLT - 60 mm	m^3	576	516	38.7
CLT - 105 mm	m^3	1 009	904	67.7
CLT - 175 mm	m^3	1 681	1 506	113

TOP THREE INPUTS

- **20.3%** Road Transport
- **6.5%** Sawn timber, softwood, raw, air dried, u=20%, at plant/RER U/AusSD U
- **2.0%** Wholesale Trade

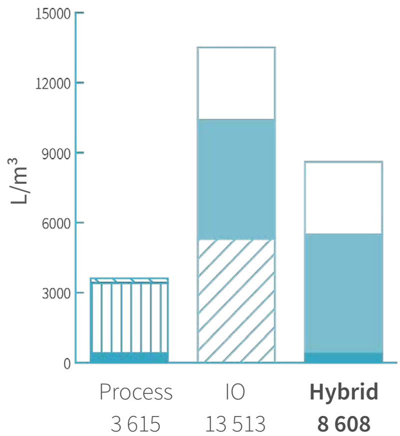


ENERGY

9 607 MJ/m³

TOP THREE INPUTS

- **3.8%** Water Supply, Sewerage and Drainage Services
- **2.7%** Wholesale Trade
- **2.3%** Road Transport

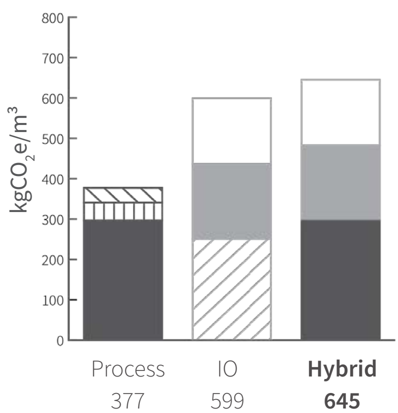


WATER

8 608 L/m³

TOP THREE INPUTS

- **18.3%** Sawn timber, softwood, raw, air dried, u=20%, at plant/RER U/AusSD U
- **9.6%** Road Transport
- **2.6%** Wood chips, from industry, softwood, burned in furnace 300kW/CH U/AusSD U



GREENHOUSE GAS EMISSIONS

645 $kgCO_2e/m^3$

m³ Glued laminated timber (glulam)

Glued laminated timber or glulam is a structurally engineered timber product produced from large strips of graded timber that are bonded together. Glulam has a high degree of dimensional stability, and a high strength to weight ratio compared to steel.

Timber members are individually selected for lamination, to maximise strength and performance. Because of this, glulam can be manufactured with increased strength in particular areas, to compensate for areas of high stress in a structure. Synthetic resin glues are typically used as a binding agent, commonly in conjunction with finger joints to increase joint performance.

Glulam can be used for long structural members, which exceed the capabilities of standard timber. It is also used for columns, rafters, trusses and curved beams.

Category	*Timber products*
Type	*Manufactured timber product*
Functional unit	*m^3*
Specific heat	*1 300 J/(kg·K)*
Density	*430 kg/m^3*

Common uses
Structural members, columns, rafters, trusses, curved beams

Process name
Glued laminated timber, indoor use, at plant/RER U/AusSD U

Input-output sector
Other Wood Product Manufacturing

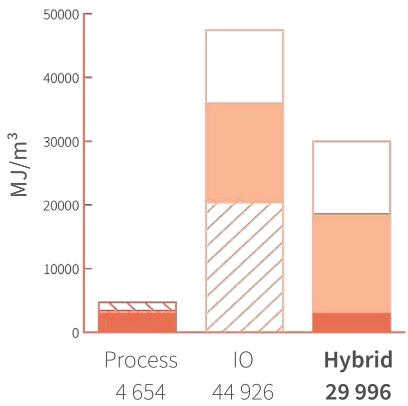
Further information
doi.org/10.26188/5da554a55f5a5

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions (kgCO_2e/unit)
Glulam indoor	*m^3*	*29 996*	*35 813*	*1 718*
Glulam outdoor	m^3	28 279	31 246	1 605

EPiC Database

TOP THREE INPUTS

- **24.2%** Road Transport
- **2.4%** Polymer Product Manufacturing
- **2.4%** Wholesale Trade

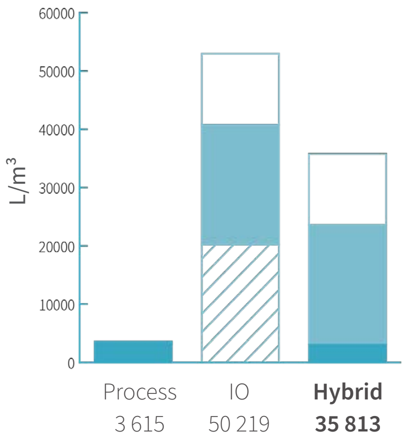


ENERGY

29 996
MJ/m^3

TOP THREE INPUTS

- **3.4%** Water Supply, Sewerage and Drainage Services
- **2.4%** Wholesale Trade
- **2.0%** Road Transport

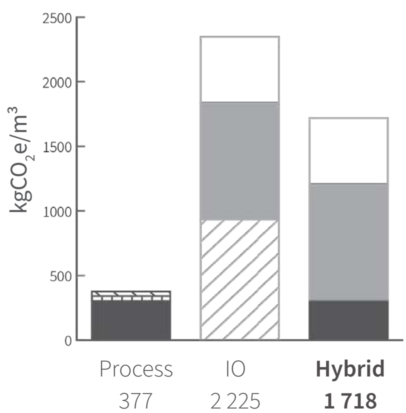


WATER

35 813
L/m^3

TOP THREE INPUTS

- **14.0%** Road Transport
- **2.7%** Wholesale Trade
- **2.3%** Other Fabricated Metal Product manufacturing



GREENHOUSE GAS EMISSIONS

1 718
$kgCO_2e/m^3$

m^3 Laminated veneer lumber (LVL)

Laminated veneer lumber (LVL) is a manufactured timber product made from thin veneers of timber bonded together under heat and pressure. Unlike plywood, the grain is oriented in the same direction. LVL is stronger and can span further than traditional timber members. It has excellent dimensional stability, reliability and strength.

LVL can be made from smaller varieties of trees, usually unsuitable for large structural members. Veneers are bonded together using bonding agents that cure at high temperatures, such as phenol formaldehyde.

LVL members are excellent for long spanning structural purposes, and are commonly used for lintels, beams, purlins and trusses.

Category	*Timber products*
Type	*Manufactured timber product*
Functional unit	*m^3*
Specific heat	*1 800 J/(kg·K)*
Density	*510 kg/m^3*

Common uses
Long spanning structural members, lintels, beams, purlins, trusses

Process name
Glued laminated timber, indoor use, at plant/RER U/AusSD U

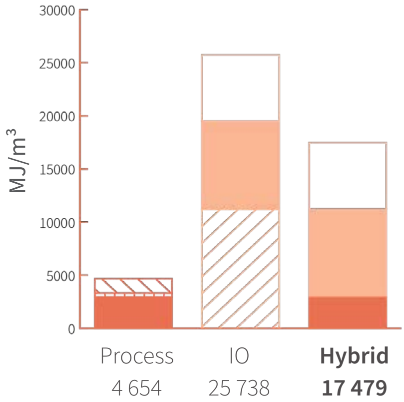
Input-output sector
Other Wood Product Manufacturing

Further information
doi.org/10.26188/5da55571d9d31

EPiC Database

TOP THREE INPUTS

- **23.8%** Road Transport
- **2.4%** Polymer Product Manufacturing
- **2.3%** Wholesale Trade

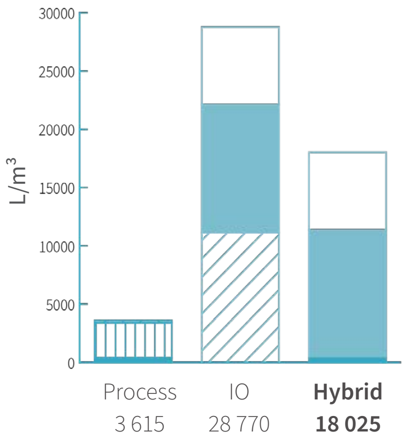


ENERGY

17 479
MJ/m³

TOP THREE INPUTS

- **3.8%** Water Supply, Sewerage and Drainage Services
- **2.7%** Wholesale Trade
- **2.3%** Road Transport

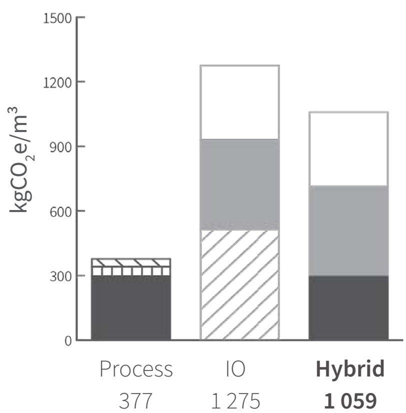


WATER

18 025
L/m³

TOP THREE INPUTS

- **12.4%** Road Transport
- **2.1%** Wholesale Trade
- **1.9%** Other Fabricated Metal Product manufacturing



GREENHOUSE GAS EMISSIONS

1 059
$kgCO_2e/m^3$

m³ MDF sheet

Medium density fibreboard (MDF), is a manufactured timber product made from reconstituted wood fibres. It is denser than particleboard or plywood, and has a smooth finish. MDF is commonly covered with timber veneer, vinyl, or a melamine paper coating, providing increased durability, water resistance and aesthetic qualities. MDF is cost-effective when compared with other sheet materials, and is typically stronger than particleboard.

MDF is created by combining residual wood fibres with a resin binder and wax, and pressing at a high temperature. Urea-formaldehyde is commonly used for non-waterproof applications, and melamine urea formaldehyde for increased water resistance.

MDF is commonly used for joinery and interior purposes. Depending on the resin used, it can have a moderate resistance to water, and is generally not suited to exterior applications.

Category	*Timber products*
Type	*Manufactured timber product*
Functional unit	*m^3*
Specific heat	*1 300 J/(kg·K)*
Density	*684 kg/m^3*

Common uses
Interior joinery, walling, flooring

Process name
Medium density fibreboard, at plant/RER U/AusSD U

Input-output sector
Other Wood Product Manufacturing

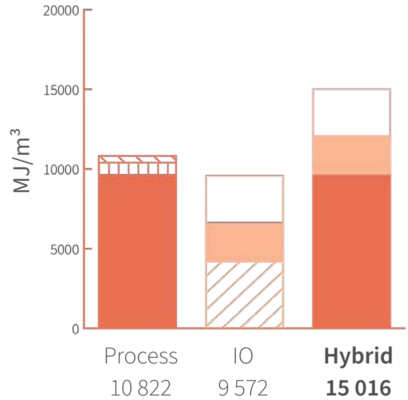
Further information
doi.org/10.26188/5da555b3e3bf9

Material variations	**Unit**	**Energy (MJ/unit)**	**Water (L/unit)**	**GHG emissions ($kgCO_2e$/unit)**
MDF sheet	*m^3*	*15 016*	*8 471*	*899*
Melamine-coated MDF board - 16 mm	m^2	344	283	18.7
Melamine-coated MDF board - 18 mm	m^2	390	323	21.3
Melamine-coated MDF board - 25 mm	m^2	557	453	30.5

EPiC Database

TOP THREE INPUTS

- **11.0%** Natural gas, burned in industrial furnace >100kW/RER U/AusSD U
- **9.9%** Road Transport
- **7.6%** Paraffin, at plant/RER U/AusSD U

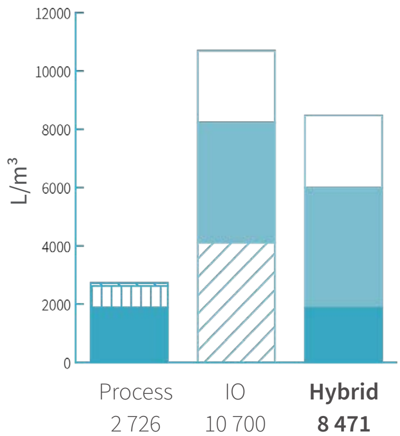


ENERGY

15 016
MJ/m³

TOP THREE INPUTS

- **8.1%** Paraffin, at plant/RER U/AusSD U
- **3.0%** Water Supply, Sewerage and Drainage Services
- **2.1%** Wholesale Trade

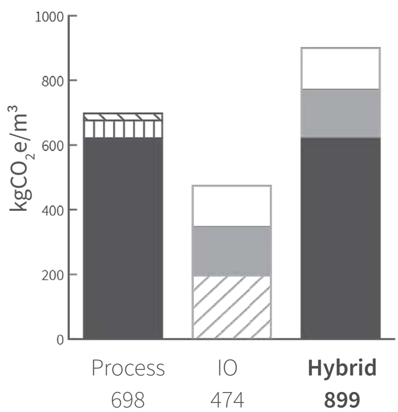


WATER

8 471
L/m³

TOP THREE INPUTS

- **11.6%** Natural gas, burned in industrial furnace >100kW/RER U/AusSD U
- **5.4%** Road Transport
- **1.9%** Wood chips, from industry, softwood, burned in furnace 300kW/CH U/AusSD U



GREENHOUSE GAS EMISSIONS

899
$kgCO_2e/m^3$

m³ OSB sheet

Oriented strand board (OSB) is a manufactured timber product similar to particleboard. It is made from timber fibres that are bonded together in a particular orientation. The orientation varies across the inner and outer layers, to provide increased dimensional stability. It has superior structural capabilities compared with particleboard, and is more cost-effective than plywood. Boards can be manufactured to have a high strength and rigidity, depending on the required application.

Strands of timber are bonded together using thermal compression. Adhesive resins such as urea-formaldehyde (non-waterproof) or melamine-formaldehyde (water resistant) are used to bond the strands together, often combined with wax. OSB boards can utilise timber offcuts and have very low timber wastage.

OSB boards are commonly used as an alternative for plywood sheet products.

Category	*Timber products*
Type	*Manufactured timber product*
Functional unit	*m^3*
Specific heat	*1 880 J/(kg·K)*
Density	*607 kg/m^3*

Common uses
Timber sheets, walling, roofing

Process name
Oriented strand board, at plant/RER U/AusSD U

Input-output sector
Other Wood Product Manufacturing

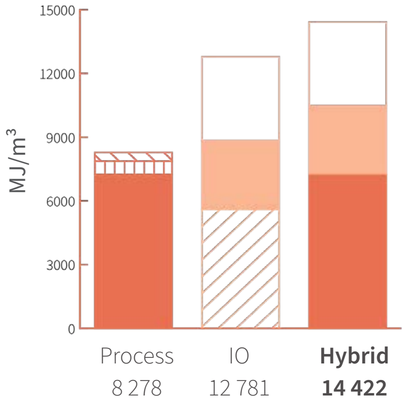
Further information
doi.org/10.26188/5da5561c22195

TOP THREE INPUTS

35.0% Phenolic resin, at plant/RER U/AusSD U

13.8% Road Transport

1.8% Paraffin, at plant/RER U/AusSD U



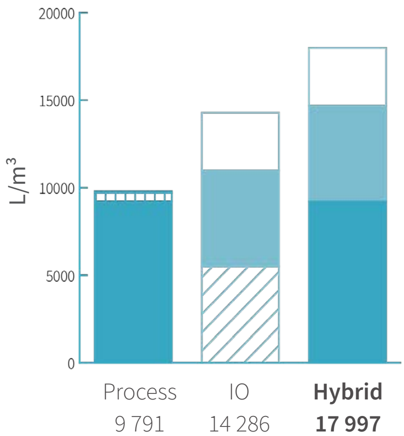
ENERGY

TOP THREE INPUTS

48.4% Phenolic resin, at plant/RER U/AusSD U

1.9% Water Supply, Sewerage and Drainage Services

1.3% Wholesale Trade



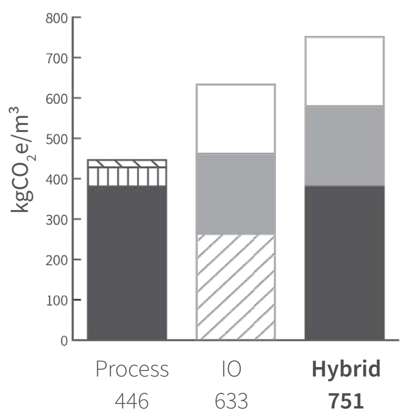
WATER

TOP THREE INPUTS

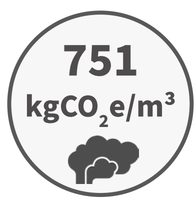
28.3% Phenolic resin, at plant/RER U/AusSD U

8.7% Road Transport

2.5% Wood chips, from industry, softwood, burned in furnace 300kW/CH U/AusSD U



GREENHOUSE GAS EMISSIONS



m³ Particleboard

Particleboard, also known as chipboard, is a manufactured timber product made from reconstituted wood particles. Unlike OSB, the particles are randomly orientated, and the board has uniform properties in each direction. Due to this, it is a relatively stable product, and offers a cheaper alternative to other timber sheet products. It is typically weaker than plywood and highly susceptible to water damage, warping and expansion, and is generally not situatable for outdoor applications.

Small wood particles are layered with a formaldehyde-based resin, or melamine-based resin (for increased water resistance). Other additives are commonly included to increase resistance to insect damage, fire, and water.

Particleboard is commonly used for low cost joinery and dry area construction. It is often painted, or covered with a timber veneer or melamine coating to increase water resistance, durability and aesthetic qualities.

Category *Timber products*

Type *Manufactured timber product*

Functional unit *m^3*

Specific heat *1 300 J/(kg·K)*

Density *680 kg/m^3*

Common uses
Interior joinery, walling, flooring

Process name
Particle board, indoor use, at plant/RER U/AusSD U

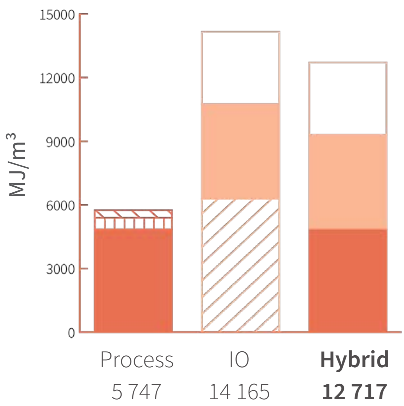
Input-output sector
Other Wood Product Manufacturing

Further information
doi.org/10.26188/5da5562dbfbf9

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Particleboard - indoor	*m^3*	*12 717*	*10 720*	*696*
Particleboard outdoor	m^3	15 879	20 491	813

TOP THREE INPUTS

- **18.0%** Road Transport
- **4.3%** Paraffin, at plant/RER U/AusSD U
- **1.8%** Wholesale Trade

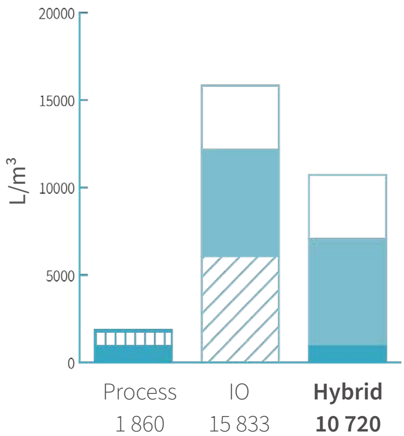


ENERGY

12 717 MJ/m³

TOP THREE INPUTS

- **3.6%** Water Supply, Sewerage and Drainage Services
- **3.1%** Paraffin, at plant/RER U/AusSD U
- **2.5%** Wholesale Trade

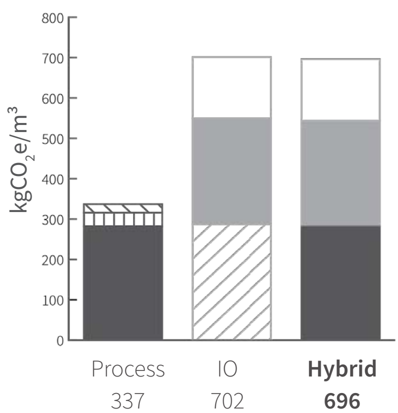


WATER

10 720 L/m³

TOP THREE INPUTS

- **10.9%** Road Transport
- **2.1%** Wholesale Trade
- **1.8%** Other Fabricated Metal Product manufacturing



GREENHOUSE GAS EMISSIONS

696 $kgCO_2e/m^3$

m³ Plywood

Plywood is a manufactured timber product made from thin veneers of timber bonded together under heat and pressure. Typically the outer layers (face timbers) are a higher grade with superior aesthetic qualities. Plywood is a high-strength, high quality sheet material, with good dimensional stability and resistance to cracking and warping.

Veneers are 'peeled' off a timber log to a precise thickness, and laminated together with other veneers, typically at different orientations to provide increased strength and stability. They are bonded with urea formaldehyde or a water-resistant glue such as phenol formaldehyde.

Plywood is available in a variety of grades, and timber species. These include high grade interior plywood, formply, exterior/marine grade plywood, and structural plywood.

Category *Timber products*

Type *Manufactured timber product*

Functional unit *m^3*

Specific heat *1 215 J/(kg·K)*

Density *625 kg/m^3*

Common uses
Timber sheets, interior joinery, walling, flooring, formwork, furniture, cladding

Process name
Plywood, indoor use, at plant/RER U/AusSD U

Input-output sector
Other Wood Product Manufacturing

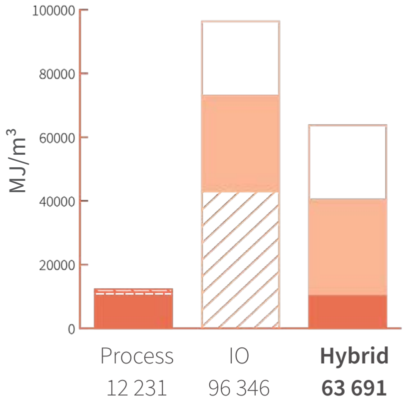
Further information
doi.org/10.26188/5da556748c57f

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Plywood - indoor decorative	*m^3*	*63 691*	*69 363*	*3 680*
Plywood outdoor	m^3	26 790	23 083	1 777

EPiC Database

TOP THREE INPUTS

- **24.4%** Road Transport
- **2.4%** Wholesale Trade
- **1.7%** Other Fabricated Metal Product manufacturing

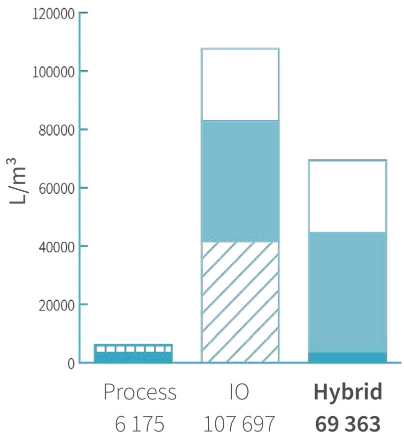


ENERGY

63 691
MJ/m^3

TOP THREE INPUTS

- **3.7%** Water Supply, Sewerage and Drainage Services
- **2.6%** Wholesale Trade
- **2.2%** Road Transport

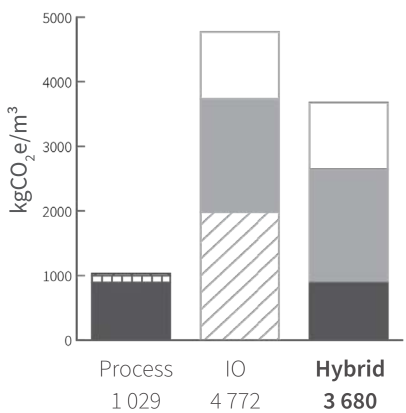


WATER

69 363
L/m^3

TOP THREE INPUTS

- **14.0%** Road Transport
- **2.7%** Wholesale Trade
- **2.3%** Other Fabricated Metal Product manufacturing



GREENHOUSE GAS EMISSIONS

3 680
kgCO_2e/m^3

Structural insulated panel (SIP)

Structural insulated panels, often referred to as SIPs, are a composite product containing an outer skin and inner core. As their name suggest, they are typically used as a structural element for low-rise buildings.

Outer layers of oriented strand board (OSB) are glued to an insulating core made from expanded polystyrene (EPS). The core gives the panels good thermal properties while the outer skins provide a durable, aesthetic finish. Alternative core materials, such as extruded polystyrene (XPS) or rigid polyurethane (PU) foam and outer skin materials, such as plywood or fibre cement sheet can also be used.

SIPs can be used as wall or roof panels and are mainly used in domestic construction. They are very lightweight and thus easy to move. The panels come in a range of thicknesses ranging from 100 to 300 mm. Typical panel dimensions are 300, 600, 900 and 1 200 mm wide and 2.4, 2.7 and 3 m long. Openings for windows and doors are cut out of panels during manufacture. Panels are connected onsite using splines with cavities cut into the core for electrical and plumbing services.

Category *Timber products*

Type *Other timber*

Functional unit *m^2*

Density *139 kg/m^3*

Common uses
Floor structure, external walls, internal walls, roof structure

Process name
SIPS

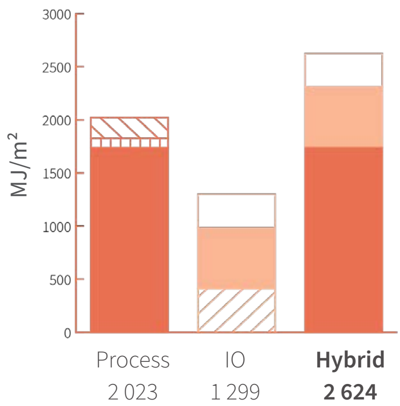
Input-output sector
Other Wood Product Manufacturing

Further information
doi.org/10.26188/5da5586fec593

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
SIP - 112 mm	*m^2*	*2 624*	*4 219*	*135*
SIP - 142 mm	m^2	3 327	5 349	171
SIP - 162 mm	m^2	3 795	6 103	195

TOP THREE INPUTS

- 8.0% Road Transport
- 4.7% Sawmill Product Manufacturing
- 3.6% Forestry and Logging

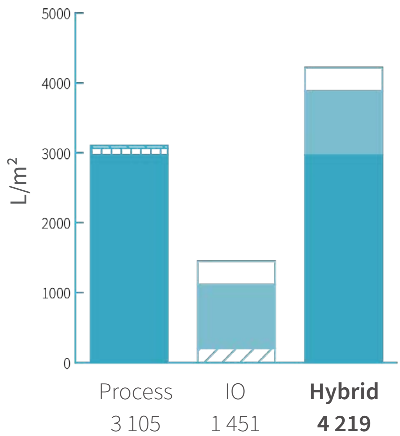


ENERGY

2 624 MJ/m²

TOP THREE INPUTS

- 9.3% Forestry and Logging
- 5.3% Sawmill Product Manufacturing
- 0.8% Water Supply, Sewerage and Drainage Services

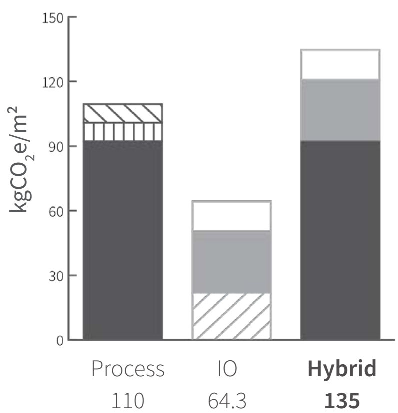


WATER

4 219 L/m²

TOP THREE INPUTS

- 5.2% Road Transport
- 3.6% Sawmill Product Manufacturing
- 2.5% Forestry and Logging



GREENHOUSE GAS EMISSIONS

135 $kgCO_2e/m^2$

m^3 Softwood

Timber comes in a wide range of varieties and sizes. It is used for structural and non-structural purposes, and can vary significantly in density, grain texture, workability, usage and cost. It is lightweight, easy to handle and transport, and has a good strength to weight ratio. It is typically divided into softwood varieties, such as Pine, Cypress and Spruce and hardwood varieties such as Victorian Ash, Blackbutt and Oak. The term hardwood and softwood is a botanical distinction, and not an indication of timber strength or density. The density of timber is highly dependent on the species, varying from 120 kg/m^3 to 1 300 kg/m^3 or higher.

Softwood generally has a lower density and better workability than hardwood varieties. It is comparably cheap due to the fast growing nature of many softwood plantation varieties. It is widely used for timber framing purposes, feature walls, door and windows.

Commercial timber products are typically kiln, or air-dried. Kiln/oven drying is done in a controlled environment over a relatively short time period. It produces a uniformly dried, high quality product that generally kills any fungi and insects in the wood. Air-drying is done over extended periods of time, and does not require any fuel inputs. It is cost effective, but needs to be carefully managed to reduce cracking and ensure consistent drying.

Category	*Timber products*
Type	*Softwood*
Functional unit	*m^3*
Specific heat	*1 380 J/(kg·K)*
Density	*510 kg/m^3*

Common uses
Beams, columns, framing, joinery, flooring, walling, furniture, cladding, doors, windows

Process name
Sawn timber, softwood, planed, air dried, at plant/RER U/AusSD U

Input-output sector
Sawmill Product Manufacturing

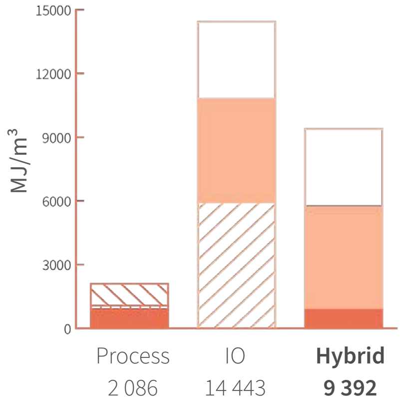
Further information
doi.org/10.26188/5da5578416cc9

Material variations	Unit	Energy (MJ/unit)	Water (L/unit)	GHG emissions ($kgCO_2e$/unit)
Softwood air-dried	*m^3*	*9 392*	*13 091*	*549*
Softwood kiln-dried	m^3	9 704	13 181	583

EPiC Database

TOP THREE INPUTS

- **45.0%** Road Transport
- **1.0%** Wholesale Trade
- **0.8%** Construction Services

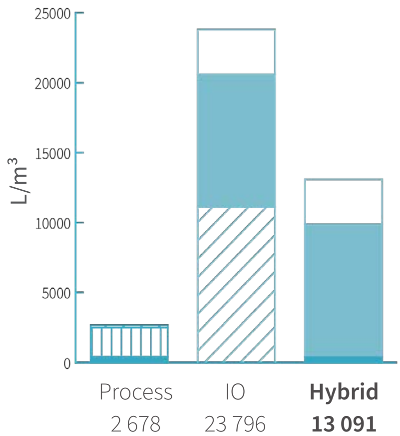


ENERGY

9 392
MJ/m³

TOP THREE INPUTS

- **3.6%** Road Transport
- **1.9%** Construction Services
- **1.2%** Wholesale Trade

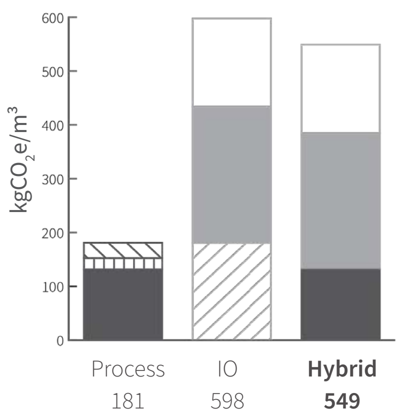


WATER

13 091
L/m³

TOP THREE INPUTS

- **25.2%** Road Transport
- **18.1%** Sawn timber, softwood, raw, air dried, u=20%, at plant/RER U/AusSD U
- **1.9%** Construction Services



GREENHOUSE GAS EMISSIONS

549
$kgCO_2e/m^3$

6

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Image credits: doi.org/10.26188/5dc1e272cbedc

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Appendices

Appendix A: List of economic sectors (industry/product groups)

0	Sheep, Grains, Beef and Dairy Cattle
1	Poultry and Other Livestock
2	Other Agriculture
3	Aquaculture
4	Forestry and Logging
5	Fishing, hunting and trapping
6	Agriculture, Forestry and Fishing Support Services
7	Coal mining
8	Oil and gas extraction
9	Iron Ore Mining
10	Non Ferrous Metal Ore Mining
11	Non Metallic Mineral Mining
12	Exploration and Mining Support Services
13	Meat and Meat product Manufacturing
14	Processed Seafood Manufacturing
15	Dairy Product Manufacturing
16	Fruit and Vegetable Product Manufacturing
17	Oils and Fats Manufacturing
18	Grain Mill and Cereal Product Manufacturing
19	Bakery Product Manufacturing
20	Sugar and Confectionery Manufacturing
21	Other Food Product Manufacturing
22	Soft Drinks, Cordials and Syrup Manufacturing
23	Beer Manufacturing
24	Wine, Spirits and Tobacco
25	Textile Manufacturing

26 Tanned Leather, Dressed Fur and Leather Product Manufacturing
27 Textile Product Manufacturing
28 Knitted Product Manufacturing
29 Clothing Manufacturing
30 Footwear Manufacturing
31 Sawmill Product Manufacturing
32 Other Wood Product Manufacturing
33 Pulp, Paper and Paperboard Manufacturing
34 Paper Stationery and Other Converted Paper Product Manufacturing
35 Printing (including the reproduction of recorded media)
36 Petroleum and Coal Product Manufacturing
37 Human Pharmaceutical and Medicinal Product Manufacturing
38 Veterinary Pharmaceutical and Medicinal Product Manufacturing
39 Basic Chemical Manufacturing
40 Cleaning Compounds and Toiletry Preparation Manufacturing
41 Polymer Product Manufacturing
42 Natural Rubber Product Manufacturing
43 Glass and Glass Product Manufacturing
44 Ceramic Product Manufacturing
45 Cement, Lime and Ready-Mixed Concrete Manufacturing
46 Plaster and Concrete Product Manufacturing
47 Other Non-Metallic Mineral Product Manufacturing
48 Iron and Steel Manufacturing
49 Basic Non-Ferrous Metal Manufacturing
50 Forged Iron and Steel Product Manufacturing
51 Structural Metal Product Manufacturing
52 Metal Containers and Other Sheet Metal Product manufacturing
53 Other Fabricated Metal Product manufacturing
54 Motor Vehicles and Parts; Other Transport Equipment manufacturing
55 Ships and Boat Manufacturing
56 Railway Rolling Stock Manufacturing
57 Aircraft Manufacturing

58 Professional, Scientific, Computer and Electronic Equipment Manufacturing

59 Electrical Equipment Manufacturing

60 Domestic Appliance Manufacturing

61 Specialised and other Machinery and Equipment Manufacturing

62 Furniture Manufacturing

63 Other Manufactured Products

64 Electricity Generation

65 Electricity Transmission, Distribution, On Selling and Electricity Market Operation

66 Gas Supply

67 Water Supply, Sewerage and Drainage Services

68 Waste Collection, Treatment and Disposal Services

69 Residential Building Construction

70 Non-Residential Building Construction

71 Heavy and Civil Engineering Construction

72 Construction Services

73 Wholesale Trade

74 Retail Trade

75 Accommodation

76 Food and Beverage Services

77 Road Transport

78 Rail Transport

79 Water, Pipeline and Other Transport

80 Air and Space Transport

81 Postal and Courier Pick-up and Delivery Service

82 Transport Support services and storage

83 Publishing (except Internet and Music Publishing)

84 Motion Picture and Sound Recording

85 Broadcasting (except Internet)

86 Internet Service Providers, Internet Publishing, Websearch Portals & Data Processing

87 Telecommunication Services

88 Library and Other Information Services

89 Finance

90	Insurance and Superannuation Funds
91	Auxiliary Finance and Insurance Services
92	Rental and Hiring Services (except Real Estate)
93	Ownership of Dwellings
94	Non-Residential Property Operators and Real Estate Services
95	Professional, Scientific and Technical Services
96	Computer Systems Design and Related Services
97	Employment, Travel Agency and Other Administrative Services
98	Building Cleaning, Pest Control and Other Support Services
99	Public Administration and Regulatory Services
100	Defence
101	Public Order and Safety
102	Primary and Secondary Education Services (incl Pre-Schools and Special Schools)
103	Technical, Vocational & Tertiary Education Services (incl undergraduate & postgraduate)
104	Arts, Sports, Adult and Other Education Services (incl community education)
105	Health Care Services
106	Residential Care and Social Assistance Services
107	Heritage, Creative and Performing Arts
108	Sports and Recreation
109	Gambling
110	Automotive Repair and Maintenance
111	Other Repair and Maintenance
112	Personal Services
113	Other Services
114	Capital - Biological resources
115	Capital - Construction
116	Capital - Machinery and weapons
117	Capital - IP Products

Source: Input-Output Industry/Product Groups (IOIG/IOPG) are based on ABS (2017a). Additional information about goods or services produced by each group is available as Input-Output Product Categories (IOPC) from ABS (2017b).

Appendix B: Total environmental flow requirements for economic sectors

Sector number	Energy (MJ/A$)	Water (L/A$)	Greenhouse gas emissions (kg CO_2-e/A$)
0	7.54	175.68	2.37
1	5.72	46.27	0.82
2	7.11	221.82	0.57
3	12.93	16.98	0.59
4	14.13	49.60	0.54
5	9.11	17.31	0.47
6	6.74	98.53	0.57
7	11.96	13.53	1.51
8	11.10	8.05	1.26
9	7.70	10.59	0.54
10	12.71	19.67	0.95
11	10.77	21.29	0.88
12	9.15	11.85	0.93
13	8.21	93.46	1.42
14	8.52	13.50	0.48
15	9.66	101.75	1.59
16	7.79	64.66	0.55
17	13.21	77.18	1.39
18	9.13	78.42	1.25
19	7.50	37.76	0.61
20	9.90	72.14	0.84
21	8.52	51.42	0.72
22	7.62	19.81	0.46
23	6.87	44.21	0.72
24	7.01	48.39	0.52
25	8.16	56.27	1.06
26	6.26	39.49	0.75

Sector number	Energy (MJ/A$)	Water (L/A$)	Greenhouse gas emissions (kg CO_2-e/A$)
27	5.51	44.86	0.82
28	7.22	9.58	0.75
29	4.66	8.38	0.41
30	28.09	6.31	0.52
31	11.85	19.53	0.49
32	9.92	11.09	0.49
33	17.33	29.07	1.01
34	9.85	14.21	0.62
35	6.55	6.20	0.43
36	32.85	8.48	1.20
37	6.75	13.54	0.50
38	4.97	48.51	0.83
39	20.49	9.76	1.22
40	7.23	10.81	0.47
41	12.20	10.64	0.59
42	12.02	13.89	0.71
43	9.95	7.00	0.64
44	28.47	7.06	1.10
45	11.79	8.46	0.98
46	14.49	9.52	0.97
47	13.56	9.01	0.96
48	23.15	17.34	0.94
49	25.00	16.13	1.27
50	10.21	11.34	0.68
51	7.81	7.75	0.51
52	7.24	6.21	0.47
53	9.70	9.52	0.61
54	6.44	8.11	0.43
55	5.87	6.67	0.39
56	7.44	7.37	0.47
57	6.52	6.09	0.43

Sector number	Energy (MJ/A$)	Water (L/A$)	Greenhouse gas emissions (kg CO_2-e/A$)
58	3.67	4.02	0.24
59	6.54	5.90	0.47
60	6.03	5.42	0.43
61	5.26	5.75	0.35
62	7.29	9.35	0.48
63	7.50	7.60	0.50
64	99.00	16.56	11.32
65	6.85	10.05	0.43
66	6.53	9.56	1.86
67	5.06	113.42	0.44
68	3.78	4.07	2.22
69	**6.26**	**9.32**	**0.36**
70	**5.67**	**6.59**	**0.35**
71	**4.66**	**5.42**	**0.29**
72	5.36	6.72	0.31
73	4.72	5.41	0.26
74	3.37	7.12	0.27
75	4.49	12.95	0.38
76	4.45	21.43	0.43
77	29.10	6.29	1.00
78	10.34	5.98	0.66
79	11.16	5.13	0.65
80	21.62	6.62	0.80
81	7.19	6.15	0.56
82	4.38	4.89	0.29
83	3.86	5.33	0.25
84	5.25	8.89	0.36
85	3.43	4.92	0.23
86	3.50	4.57	0.25
87	4.69	5.85	0.30
88	1.90	3.00	0.13

Sector number	Energy (MJ/A$)	Water (L/A$)	Greenhouse gas emissions (kg CO_2-e/A$)
89	0.90	1.19	0.06
90	1.91	2.91	0.13
91	2.57	3.47	0.17
92	5.70	10.07	0.47
93	3.39	4.88	0.28
94	3.21	6.03	0.24
95	2.91	6.11	0.20
96	2.31	3.03	0.16
97	2.24	5.02	0.16
98	3.36	8.16	0.23
99	4.23	4.82	0.33
100	3.90	4.05	0.19
101	4.13	6.66	0.23
102	2.07	3.22	0.14
103	2.35	3.92	0.16
104	2.78	4.29	0.20
105	2.66	5.16	0.18
106	2.07	4.51	0.14
107	3.33	6.84	0.23
108	5.21	16.96	0.37
109	5.24	11.58	0.36
110	4.94	5.93	0.29
111	4.40	5.53	0.27
112	4.19	8.47	0.27
113	1.22	3.91	0.10
114	7.09	84.96	0.97
115	5.81	8.47	0.38
116	6.23	6.66	0.39
117	4.46	6.48	0.33

Appendix C: Total environmental flow requirements of inputs to main construction sectors

69 Residential Building Construction

		Total Environmental Flow Requirement		
Economic Sector		Energy (MJ/A$)	Water (L/A$)	Emissions (kg CO_2-e/A$)
0	Sheep, Grains, Beef and Dairy Cattle	0.0009557	0.0222731	0.0003005
1	Poultry and Other Livestock	0.0001341	0.0010840	0.0000192
2	Other Agriculture	0.0083667	0.2611329	0.0006691
3	Aquaculture	0.0000195	0.0000256	0.0000009
4	Forestry and Logging	0.0012818	0.0044988	0.0000486
5	Fishing, hunting and trapping	0.0005505	0.0010459	0.0000282
6	Agriculture, Forestry and Fishing Support Services	0.0004410	0.0064513	0.0000371
7	Coal mining	0.0148600	0.0168155	0.0018824
8	Oil and gas extraction	0.0212028	0.0153792	0.0024106
9	Iron Ore Mining	0.0064172	0.0088336	0.0004507
10	Non Ferrous Metal Ore Mining	0.0175363	0.0271426	0.0013170
11	Non Metallic Mineral Mining	0.0162908	0.0322026	0.0013287
12	Exploration and Mining Support Services	0.0105149	0.0136210	0.0010733
13	Meat and Meat product Manufacturing	0.0017187	0.0195732	0.0002984
14	Processed Seafood Manufacturing	0.0003612	0.0005726	0.0000204
15	Dairy Product Manufacturing	0.0022296	0.0234910	0.0003673
16	Fruit and Vegetable Product Manufacturing	0.0006154	0.0051079	0.0000436
17	Oils and Fats Manufacturing	0.0000326	0.0001906	0.0000034
18	Grain Mill and Cereal Product Manufacturing	0.0006765	0.0058096	0.0000923
19	Bakery Product Manufacturing	0.0005170	0.0026044	0.0000422
20	Sugar and Confectionery Manufacturing	0.0013192	0.0096090	0.0001122
21	Other Food Product Manufacturing	0.0020135	0.0121494	0.0001692
22	Soft Drinks, Cordials and Syrup Manufacturing	0.0002822	0.0007334	0.0000171

Economic Sector		Total Environmental Flow Requirement		
		Energy (MJ/A$)	Water (L/A$)	Emissions (kg CO_2-e/A$)
23	Beer Manufacturing	0.0001574	0.0010124	0.0000164
24	Wine, Spirits and Tobacco	0.0005998	0.0041433	0.0000447
25	Textile Manufacturing	0.0009216	0.0063584	0.0001196
26	Tanned Leather, Dressed Fur and Leather Product Manufacturing	0.0027707	0.0174885	0.0003328
27	Textile Product Manufacturing	0.0112277	0.0914226	0.0016778
28	Knitted Product Manufacturing	0.0000927	0.0001231	0.0000097
29	Clothing Manufacturing	0.0029206	0.0052568	0.0002592
30	Footwear Manufacturing	0.0186447	0.0041893	0.0003441
31	Sawmill Product Manufacturing	0.1181311	0.1946299	0.0048887
32	Other Wood Product Manufacturing	0.5893566	0.6587864	0.0291935
33	Pulp, Paper and Paperboard Manufacturing	0.0218631	0.0366707	0.0012704
34	Paper Stationery and Other Converted Paper Product Manufacturing	0.0358786	0.0517695	0.0022618
35	Printing (including the reproduction of recorded media)	0.0090106	0.0085371	0.0005877
36	Petroleum and Coal Product Manufacturing	0.3139447	0.0810361	0.0114674
37	Human Pharmaceutical and Medicinal Product Manufacturing	0.0021586	0.0043301	0.0001606
38	Veterinary Pharmaceutical and Medicinal Product Manufacturing	0.0000562	0.0005486	0.0000093
39	Basic Chemical Manufacturing	0.0678030	0.0323065	0.0040514
40	Cleaning Compounds and Toiletry Preparation Manufacturing	0.0031757	0.0047484	0.0002061
41	Polymer Product Manufacturing	0.1378117	0.1202162	0.0066684
42	Natural Rubber Product Manufacturing	0.0012516	0.0014455	0.0000734
43	Glass and Glass Product Manufacturing	0.0647663	0.0456143	0.0041907
44	Ceramic Product Manufacturing	0.1132646	0.0280761	0.0043780
45	Cement, Lime and Ready-Mixed Concrete Manufacturing	0.2724145	0.1954092	0.0225287
46	Plaster and Concrete Product Manufacturing	0.1206845	0.0792807	0.0081029
47	Other Non-Metallic Mineral Product Manufacturing	0.0544483	0.0361929	0.0038423
48	Iron and Steel Manufacturing	0.2331234	0.1746250	0.0094326
49	Basic Non-Ferrous Metal Manufacturing	0.0454729	0.0293306	0.0023140
50	Forged Iron and Steel Product Manufacturing	0.0014933	0.0016594	0.0000999
51	Structural Metal Product Manufacturing	0.3045755	0.3024790	0.0198991
52	Metal Containers and Other Sheet Metal Product manufacturing	0.0412651	0.0354225	0.0027069

Economic Sector		Total Environmental Flow Requirement		
		Energy (MJ/A$)	Water (L/A$)	Emissions (kg CO_2-e/A$)
53	Other Fabricated Metal Product manufacturing	0.1095553	0.1076212	0.0069157
54	Motor Vehicles and Parts; Other Transport Equipment manufacturing	0.0095718	0.0120555	0.0006375
55	Ships and Boat Manufacturing	0.0032976	0.0037485	0.0002167
56	Railway Rolling Stock Manufacturing	0.0008821	0.0008736	0.0000555
57	Aircraft Manufacturing	0.0009992	0.0009342	0.0000653
58	Professional, Scientific, Computer and Electronic Equipment Manufacturing	0.0109168	0.0119717	0.0007063
59	Electrical Equipment Manufacturing	0.0421445	0.0380720	0.0030283
60	Domestic Appliance Manufacturing	0.0029536	0.0026518	0.0002099
61	Specialised and other Machinery and Equipment Manufacturing	0.0139677	0.0152615	0.0009190
62	Furniture Manufacturing	0.0407768	0.0522756	0.0026604
63	Other Manufactured Products	0.0105764	0.0107157	0.0007031
64	Electricity Generation	0.0482962	0.0080791	0.0055218
65	Electricity Transmission, Distribution, On Selling and Electricity Market Operation	0.0039271	0.0057575	0.0002443
66	Gas Supply	0.0000668	0.0000977	0.0000190
67	Water Supply, Sewerage and Drainage Services	0.0498208	1.1165677	0.0043698
68	Waste Collection, Treatment and Disposal Services	0.0041877	0.0045099	0.0024568
69	Residential Building Construction	0.1946543	0.2896918	0.0113046
70	Non-Residential Building Construction	0.0678650	0.0789833	0.0041749
71	Heavy and Civil Engineering Construction	0.0560663	0.0651827	0.0034558
72	Construction Services	1.5659312	1.9625026	0.0919260
73	Wholesale Trade	0.1503792	0.1721175	0.0083571
74	Retail Trade	0.0301791	0.0637228	0.0024561
75	Accommodation	0.0020710	0.0059760	0.0001760
76	Food and Beverage Services	0.0045678	0.0219969	0.0004380
77	Road Transport	0.4550750	0.0983441	0.0157130
78	Rail Transport	0.0047050	0.0027222	0.0002980
79	Water, Pipeline and Other Transport	0.0118417	0.0054470	0.0006902
80	Air and Space Transport	0.0406952	0.0124557	0.0015111
81	Postal and Courier Pick-up and Delivery Service	0.0171183	0.0146495	0.0013242
82	Transport Support services and storage	0.0322240	0.0359641	0.0021175
83	Publishing (except Internet and Music Publishing)	0.0021243	0.0029313	0.0001366

Economic Sector		Total Environmental Flow Requirement		
		Energy (MJ/A$)	Water (L/A$)	Emissions (kg CO_2-e/A$)
84	Motion Picture and Sound Recording	0.0000531	0.0000899	0.0000036
85	Broadcasting (except Internet)	0.0009387	0.0013451	0.0000636
86	Internet Service Providers, Internet Publishing, Websearch Portals & Data Processing	0.0064128	0.0083750	0.0004531
87	Telecommunication Services	0.0325219	0.0405260	0.0020666
88	Library and Other Information Services	0.0000082	0.0000130	0.0000006
89	Finance	0.0120425	0.0160663	0.0008276
90	Insurance and Superannuation Funds	0.0053715	0.0081694	0.0003713
91	Auxiliary Finance and Insurance Services	0.0284881	0.0384547	0.0018418
93	Ownership of Dwellings	Negligible	Negligible	Negligible
92	Rental and Hiring Services (except Real Estate)	0.0585431	0.1034641	0.0047873
94	Non-Residential Property Operators and Real Estate Services	0.0288659	0.0542319	0.0021709
95	Professional, Scientific and Technical Services	0.1003310	0.2105216	0.0069340
96	Computer Systems Design and Related Services	0.0028737	0.0037565	0.0002009
97	Employment, Travel Agency and Other Administrative Services	0.0131038	0.0293824	0.0009131
98	Building Cleaning, Pest Control and Other Support Services	0.0100651	0.0244221	0.0007021
99	Public Administration and Regulatory Services	0.0265776	0.0302545	0.0020831
100	Defence	0.0006204	0.0006440	0.0000306
101	Public Order and Safety	0.0064367	0.0103837	0.0003579
102	Primary and Secondary Education Services (incl Pre-Schools and Special Schools)	0.0000018	0.0000028	0.0000001
103	Technical, Vocational & Tertiary Education Services (incl undergraduate & postgraduate)	0.0016684	0.0027816	0.0001134
104	Arts, Sports, Adult and Other Education Services (incl community education)	0.0003477	0.0005354	0.0000251
105	Health Care Services	0.0001348	0.0002617	0.0000092
106	Residential Care and Social Assistance Services	0.0000656	0.0001434	0.0000045
107	Heritage, Creative and Performing Arts	0.0004775	0.0009809	0.0000331
108	Sports and Recreation	0.0025837	0.0084072	0.0001818
109	Gambling	0.0003182	0.0007031	0.0000221
110	Automotive Repair and Maintenance	0.0080253	0.0096298	0.0004733
111	Other Repair and Maintenance	0.0185704	0.0233443	0.0011591
112	Personal Services	0.0007105	0.0014359	0.0000455
113	Other Services	Negligible	0.0082897	0.0002070

70 Non-Residential Building Construction

	Economic Sector	Total Environmental Flow Requirement		
		Energy (MJ/A$)	Water (L/A$)	Emissions (kg CO_2-e/A$)
0	Sheep, Grains, Beef and Dairy Cattle	0.0004873	0.0113578	0.0001532
1	Poultry and Other Livestock	0.0000661	0.0005340	0.0000095
2	Other Agriculture	0.0069956	0.2183394	0.0005595
3	Aquaculture	0.0000170	0.0000223	0.0000008
4	Forestry and Logging	0.0010836	0.0038031	0.0000411
5	Fishing, hunting and trapping	0.0004771	0.0009064	0.0000244
6	Agriculture, Forestry and Fishing Support Services	0.0004048	0.0059220	0.0000340
7	Coal mining	0.0178723	0.0202242	0.0022640
8	Oil and gas extraction	0.0324900	0.0235662	0.0036938
9	Iron Ore Mining	0.0070918	0.0097623	0.0004981
10	Non Ferrous Metal Ore Mining	0.0210733	0.0326172	0.0015827
11	Non Metallic Mineral Mining	0.0244910	0.0484122	0.0019975
12	Exploration and Mining Support Services	0.0129630	0.0167923	0.0013232
13	Meat and Meat product Manufacturing	0.0022528	0.0256558	0.0003911
14	Processed Seafood Manufacturing	0.0003874	0.0006141	0.0000219
15	Dairy Product Manufacturing	0.0026722	0.0281539	0.0004402
16	Fruit and Vegetable Product Manufacturing	0.0005262	0.0043673	0.0000373
17	Oils and Fats Manufacturing	0.0000378	0.0002207	0.0000040
18	Grain Mill and Cereal Product Manufacturing	0.0005472	0.0046992	0.0000746
19	Bakery Product Manufacturing	0.0004331	0.0021815	0.0000354
20	Sugar and Confectionery Manufacturing	0.0014672	0.0106873	0.0001248
21	Other Food Product Manufacturing	0.0015679	0.0094608	0.0001318
22	Soft Drinks, Cordials and Syrup Manufacturing	0.0002372	0.0006162	0.0000144
23	Beer Manufacturing	0.0000321	0.0002062	0.0000033
24	Wine, Spirits and Tobacco	0.0011512	0.0079519	0.0000858
25	Textile Manufacturing	0.0014185	0.0097865	0.0001840
26	Tanned Leather, Dressed Fur and Leather Product Manufacturing	0.0009219	0.0058189	0.0001107

Economic Sector		Total Environmental Flow Requirement		
		Energy (MJ/A$)	Water (L/A$)	Emissions (kg CO_2-e/A$)
27	Textile Product Manufacturing	0.0143388	0.1167550	0.0021427
28	Knitted Product Manufacturing	0.0000349	0.0000464	0.0000036
29	Clothing Manufacturing	0.0018792	0.0033824	0.0001668
30	Footwear Manufacturing	0.0006681	0.0001501	0.0000123
31	Sawmill Product Manufacturing	0.0276655	0.0455810	0.0011449
32	Other Wood Product Manufacturing	0.1282198	0.1433249	0.0063513
33	Pulp, Paper and Paperboard Manufacturing	0.0052401	0.0087892	0.0003045
34	Paper Stationery and Other Converted Paper Product Manufacturing	0.0119079	0.0171820	0.0007507
35	Printing (including the reproduction of recorded media)	0.0078026	0.0073926	0.0005089
36	Petroleum and Coal Product Manufacturing	0.2055839	0.0530658	0.0075093
37	Human Pharmaceutical and Medicinal Product Manufacturing	0.0065450	0.0131290	0.0004869
38	Veterinary Pharmaceutical and Medicinal Product Manufacturing	0.0001858	0.0018127	0.0000308
39	Basic Chemical Manufacturing	0.3137791	0.1495081	0.0187492
40	Cleaning Compounds and Toiletry Preparation Manufacturing	0.0038269	0.0057220	0.0002483
41	Polymer Product Manufacturing	0.1120875	0.0977764	0.0054236
42	Natural Rubber Product Manufacturing	0.0083021	0.0095879	0.0004872
43	Glass and Glass Product Manufacturing	0.0514569	0.0362406	0.0033295
44	Ceramic Product Manufacturing	0.0164479	0.0040771	0.0006358
45	Cement, Lime and Ready-Mixed Concrete Manufacturing	0.3008264	0.2157897	0.0248784
46	Plaster and Concrete Product Manufacturing	0.1389437	0.0912756	0.0093289
47	Other Non-Metallic Mineral Product Manufacturing	0.0407421	0.0270821	0.0028751
48	Iron and Steel Manufacturing	0.1664847	0.1247082	0.0067363
49	Basic Non-Ferrous Metal Manufacturing	0.0420792	0.0271416	0.0021413
50	Forged Iron and Steel Product Manufacturing	0.0028138	0.0031267	0.0001882
51	Structural Metal Product Manufacturing	0.1787552	0.1775248	0.0116788
52	Metal Containers and Other Sheet Metal Product manufacturing	0.0223201	0.0191598	0.0014641
53	Other Fabricated Metal Product manufacturing	0.0541454	0.0531895	0.0034179
54	Motor Vehicles and Parts; Other Transport Equipment manufacturing	0.0116787	0.0147091	0.0007778
55	Ships and Boat Manufacturing	0.0023652	0.0026887	0.0001555
56	Railway Rolling Stock Manufacturing	0.0007013	0.0006946	0.0000441

		Total Environmental Flow Requirement		
Economic Sector		Energy (MJ/A$)	Water (L/A$)	Emissions (kg CO_2-e/A$)
57	Aircraft Manufacturing	0.0007336	0.0006858	0.0000480
58	Professional, Scientific, Computer and Electronic Equipment Manufacturing	0.0153180	0.0167982	0.0009911
59	Electrical Equipment Manufacturing	0.0864290	0.0780772	0.0062104
60	Domestic Appliance Manufacturing	0.0021963	0.0019719	0.0001561
61	Specialised and other Machinery and Equipment Manufacturing	0.0294103	0.0321347	0.0019350
62	Furniture Manufacturing	0.0215544	0.0276326	0.0014063
63	Other Manufactured Products	0.0079362	0.0080407	0.0005276
64	Electricity Generation	0.1169736	0.0195677	0.0133738
65	Electricity Transmission, Distribution, On Selling and Electricity Market Operation	0.0096651	0.0141698	0.0006013
66	Gas Supply	0.0000497	0.0000727	0.0000141
67	Water Supply, Sewerage and Drainage Services	0.0082714	0.1853764	0.0007255
68	Waste Collection, Treatment and Disposal Services	0.0024343	0.0026216	0.0014281
69	Residential Building Construction	0.2359910	0.3512105	0.0137052
70	Non-Residential Building Construction	0.0812253	0.0945324	0.0049968
71	Heavy and Civil Engineering Construction	0.0669122	0.0777920	0.0041243
72	Construction Services	1.9057583	2.3883906	0.1118752
73	Wholesale Trade	0.1307750	0.1496794	0.0072676
74	Retail Trade	0.0211339	0.0446240	0.0017200
75	Accommodation	0.0007566	0.0021833	0.0000643
76	Food and Beverage Services	0.0029131	0.0140284	0.0002793
77	Road Transport	0.2960703	0.0639823	0.0102228
78	Rail Transport	0.0042141	0.0024382	0.0002669
79	Water, Pipeline and Other Transport	0.0084707	0.0038964	0.0004937
80	Air and Space Transport	0.0268909	0.0082306	0.0009985
81	Postal and Courier Pick-up and Delivery Service	0.0092651	0.0079289	0.0007167
82	Transport Support services and storage	0.0539004	0.0601564	0.0035419
83	Publishing (except Internet and Music Publishing)	0.0024044	0.0033178	0.0001547
84	Motion Picture and Sound Recording	0.0000446	0.0000755	0.0000030
85	Broadcasting (except Internet)	0.0004355	0.0006241	0.0000295
86	Internet Service Providers, Internet Publishing, Websearch Portals & Data Processing	0.0032536	0.0042492	0.0002299

		Total Environmental Flow Requirement		
Economic Sector		Energy (MJ/A$)	Water (L/A$)	Emissions (kg CO_2-e/A$)
87	Telecommunication Services	0.0325393	0.0405476	0.0020677
88	Library and Other Information Services	0.0000078	0.0000123	0.0000005
89	Finance	0.0102832	0.0137191	0.0007067
90	Insurance and Superannuation Funds	0.0055122	0.0083834	0.0003810
91	Auxiliary Finance and Insurance Services	0.0204037	0.0275421	0.0013191
92	Rental and Hiring Services (except Real Estate)	0.0511099	0.0903273	0.0041794
93	Ownership of Dwellings	Negligible	Negligible	Negligible
94	Non-Residential Property Operators and Real Estate Services	0.0106668	0.0200403	0.0008022
95	Professional, Scientific and Technical Services	0.1126087	0.2362835	0.0077825
96	Computer Systems Design and Related Services	0.0020956	0.0027393	0.0001465
97	Employment, Travel Agency and Other Administrative Services	0.0074504	0.0167059	0.0005192
98	Building Cleaning, Pest Control and Other Support Services	0.0086661	0.0210275	0.0006045
99	Public Administration and Regulatory Services	0.0224448	0.0255499	0.0017592
100	Defence	0.0006849	0.0007110	0.0000338
101	Public Order and Safety	0.0079395	0.0128079	0.0004414
102	Primary and Secondary Education Services (incl Pre-Schools and Special Schools)	Negligible	Negligible	Negligible
103	Technical, Vocational & Tertiary Education Services (incl undergraduate & postgraduate)	0.0010766	0.0017949	0.0000732
104	Arts, Sports, Adult and Other Education Services (incl community education)	0.0004293	0.0006609	0.0000310
105	Health Care Services	0.0003265	0.0006342	0.0000223
106	Residential Care and Social Assistance Services	0.0000726	0.0001585	0.0000050
107	Heritage, Creative and Performing Arts	0.0000524	0.0001076	0.0000036
108	Sports and Recreation	0.0020961	0.0068204	0.0001475
109	Gambling	0.0002676	0.0005913	0.0000185
110	Automotive Repair and Maintenance	0.0022753	0.0027302	0.0001342
111	Other Repair and Maintenance	0.0041709	0.0052432	0.0002603
112	Personal Services	0.0014186	0.0028669	0.0000908
113	Other Services	0.0021552	0.0069184	0.0001728

71 Heavy and Civil Engineering Construction

	Economic Sector	Total Environmental Flow Requirement		
		Energy (MJ/A$)	Water (L/A$)	Emissions (kg CO_2-e/A$)
0	Sheep, Grains, Beef and Dairy Cattle	0.0002625	0.0061181	0.0000826
1	Poultry and Other Livestock	0.0000429	0.0003466	0.0000061
2	Other Agriculture	0.0024952	0.0778789	0.0001996
3	Aquaculture	0.0000321	0.0000422	0.0000015
4	Forestry and Logging	0.0019402	0.0068095	0.0000735
5	Fishing, hunting and trapping	0.0008853	0.0016820	0.0000454
6	Agriculture, Forestry and Fishing Support Services	0.0008263	0.0120868	0.0000694
7	Coal mining	0.0187255	0.0211896	0.0023720
8	Oil and gas extraction	0.0163074	0.0118284	0.0018540
9	Iron Ore Mining	0.0153758	0.0211655	0.0010798
10	Non Ferrous Metal Ore Mining	0.0155784	0.0241122	0.0011700
11	Non Metallic Mineral Mining	0.0197967	0.0391328	0.0016146
12	Exploration and Mining Support Services	0.0110720	0.0143427	0.0011302
13	Meat and Meat product Manufacturing	0.0028851	0.0328573	0.0005009
14	Processed Seafood Manufacturing	0.0002845	0.0004509	0.0000161
15	Dairy Product Manufacturing	0.0026038	0.0274336	0.0004289
16	Fruit and Vegetable Product Manufacturing	0.0005769	0.0047883	0.0000409
17	Oils and Fats Manufacturing	0.0000892	0.0005212	0.0000094
18	Grain Mill and Cereal Product Manufacturing	0.0005903	0.0050686	0.0000805
19	Bakery Product Manufacturing	0.0005634	0.0028377	0.0000460
20	Sugar and Confectionery Manufacturing	0.0012065	0.0087883	0.0001027
21	Other Food Product Manufacturing	0.0015685	0.0094643	0.0001318
22	Soft Drinks, Cordials and Syrup Manufacturing	0.0003821	0.0009928	0.0000232
23	Beer Manufacturing	0.0001750	0.0011257	0.0000183
24	Wine, Spirits and Tobacco	0.0010483	0.0072409	0.0000782
25	Textile Manufacturing	0.0010322	0.0071216	0.0001339
26	Tanned Leather, Dressed Fur and Leather Product Manufacturing	0.0016641	0.0105038	0.0001999

Economic Sector		Total Environmental Flow Requirement		
		Energy (MJ/A$)	Water (L/A$)	Emissions (kg CO_2-e/A$)
27	Textile Product Manufacturing	0.0062084	0.0505526	0.0009278
28	Knitted Product Manufacturing	0.0000331	0.0000440	0.0000035
29	Clothing Manufacturing	0.0014560	0.0026207	0.0001292
30	Footwear Manufacturing	0.0006890	0.0001548	0.0000127
31	Sawmill Product Manufacturing	0.0274332	0.0451982	0.0011353
32	Other Wood Product Manufacturing	0.0544346	0.0608474	0.0026964
33	Pulp, Paper and Paperboard Manufacturing	0.0164330	0.0275629	0.0009549
34	Paper Stationery and Other Converted Paper Product Manufacturing	0.0277997	0.0401123	0.0017525
35	Printing (including the reproduction of recorded media)	0.0194450	0.0184233	0.0012683
36	Petroleum and Coal Product Manufacturing	0.3026101	0.0781104	0.0110534
37	Human Pharmaceutical and Medicinal Product Manufacturing	0.0055552	0.0111436	0.0004133
38	Veterinary Pharmaceutical and Medicinal Product Manufacturing	0.0001608	0.0015681	0.0000267
39	Basic Chemical Manufacturing	0.1635320	0.0779190	0.0097715
40	Cleaning Compounds and Toiletry Preparation Manufacturing	0.0027992	0.0041855	0.0001817
41	Polymer Product Manufacturing	0.1410815	0.1230685	0.0068266
42	Natural Rubber Product Manufacturing	0.0073905	0.0085352	0.0004337
43	Glass and Glass Product Manufacturing	0.0309353	0.0217874	0.0020017
44	Ceramic Product Manufacturing	0.0169710	0.0042068	0.0006560
45	Cement, Lime and Ready-Mixed Concrete Manufacturing	0.1644909	0.1179931	0.0136034
46	Plaster and Concrete Product Manufacturing	0.0400779	0.0263282	0.0026909
47	Other Non-Metallic Mineral Product Manufacturing	0.0452099	0.0300519	0.0031904
48	Iron and Steel Manufacturing	0.2403768	0.1800582	0.0097261
49	Basic Non-Ferrous Metal Manufacturing	0.0601173	0.0387764	0.0030592
50	Forged Iron and Steel Product Manufacturing	0.0029620	0.0032915	0.0001981
51	Structural Metal Product Manufacturing	0.2385798	0.2369377	0.0155874
52	Metal Containers and Other Sheet Metal Product manufacturing	0.0217554	0.0186751	0.0014271
53	Other Fabricated Metal Product manufacturing	0.0940808	0.0924199	0.0059388
54	Motor Vehicles and Parts; Other Transport Equipment manufacturing	0.0146842	0.0184946	0.0009780
55	Ships and Boat Manufacturing	0.0049115	0.0055832	0.0003228
56	Railway Rolling Stock Manufacturing	0.0119605	0.0118455	0.0007526

Economic Sector		Total Environmental Flow Requirement		
		Energy (MJ/A$)	Water (L/A$)	Emissions (kg CO_2-e/A$)
57	Aircraft Manufacturing	0.0014440	0.0013500	0.0000944
58	Professional, Scientific, Computer and Electronic Equipment Manufacturing	0.0160889	0.0176436	0.0010409
59	Electrical Equipment Manufacturing	0.0615905	0.0556389	0.0044256
60	Domestic Appliance Manufacturing	0.0019628	0.0017623	0.0001395
61	Specialised and other Machinery and Equipment Manufacturing	0.0278210	0.0303980	0.0018305
62	Furniture Manufacturing	0.0048606	0.0062312	0.0003171
63	Other Manufactured Products	0.0075622	0.0076617	0.0005028
64	Electricity Generation	0.1569214	0.0262503	0.0179411
65	Electricity Transmission, Distribution, On Selling and Electricity Market Operation	0.0068307	0.0100144	0.0004250
66	Gas Supply	0.0000568	0.0000831	0.0000162
67	Water Supply, Sewerage and Drainage Services	0.0085325	0.1912274	0.0007484
68	Waste Collection, Treatment and Disposal Services	0.0063133	0.0067990	0.0037038
69	Residential Building Construction	0.1255584	0.1868606	0.0072918
70	Non-Residential Building Construction	0.0481626	0.0560531	0.0029628
71	Heavy and Civil Engineering Construction	0.0442160	0.0514055	0.0027254
72	Construction Services	0.9736347	1.2202072	0.0571560
73	Wholesale Trade	0.1180308	0.1350929	0.0065594
74	Retail Trade	0.0222198	0.0469167	0.0018084
75	Accommodation	0.0008550	0.0024671	0.0000727
76	Food and Beverage Services	0.0039397	0.0189724	0.0003778
77	Road Transport	0.2457934	0.0531172	0.0084869
78	Rail Transport	0.0069640	0.0040292	0.0004411
79	Water, Pipeline and Other Transport	0.0105942	0.0048731	0.0006175
80	Air and Space Transport	0.0339154	0.0103806	0.0012594
81	Postal and Courier Pick-up and Delivery Service	0.0101478	0.0086843	0.0007850
82	Transport Support services and storage	0.0733821	0.0818992	0.0048221
83	Publishing (except Internet and Music Publishing)	0.0031091	0.0042902	0.0002000
84	Motion Picture and Sound Recording	0.0000835	0.0001413	0.0000057
85	Broadcasting (except Internet)	0.0004337	0.0006215	0.0000294
86	Internet Service Providers, Internet Publishing, Websearch Portals & Data Processing	0.0035342	0.0046156	0.0002497

		Total Environmental Flow Requirement		
Economic Sector		Energy (MJ/A$)	Water (L/A$)	Emissions (kg CO_2-e/A$)
87	Telecommunication Services	0.0254721	0.0317411	0.0016186
88	Library and Other Information Services	0.0000167	0.0000264	0.0000011
89	Finance	0.0041714	0.0055652	0.0002867
90	Insurance and Superannuation Funds	0.0023590	0.0035878	0.0001631
91	Auxiliary Finance and Insurance Services	0.0093316	0.0125963	0.0006033
92	Rental and Hiring Services (except Real Estate)	0.0963159	0.1702206	0.0078761
93	Ownership of Dwellings	Negligible	Negligible	Negligible
94	Non-Residential Property Operators and Real Estate Services	0.0053527	0.0100564	0.0004026
95	Professional, Scientific and Technical Services	0.2947441	0.6184527	0.0203702
96	Computer Systems Design and Related Services	0.0036841	0.0048158	0.0002576
97	Employment, Travel Agency and Other Administrative Services	0.0305001	0.0683898	0.0021254
98	Building Cleaning, Pest Control and Other Support Services	0.0103930	0.0252177	0.0007250
99	Public Administration and Regulatory Services	0.0220452	0.0250951	0.0017279
100	Defence	0.0017773	0.0018452	0.0000876
101	Public Order and Safety	0.0071849	0.0115906	0.0003995
102	Primary and Secondary Education Services (incl Pre-Schools and Special Schools)	Negligible	Negligible	Negligible
103	Technical, Vocational & Tertiary Education Services (incl undergraduate & postgraduate)	0.0022212	0.0037032	0.0001509
104	Arts, Sports, Adult and Other Education Services (incl community education)	0.0005501	0.0008469	0.0000397
105	Health Care Services	0.0006065	0.0011780	0.0000415
106	Residential Care and Social Assistance Services	0.0001884	0.0004116	0.0000130
107	Heritage, Creative and Performing Arts	0.0000579	0.0001189	0.0000040
108	Sports and Recreation	0.0022939	0.0074641	0.0001614
109	Gambling	0.0005221	0.0011537	0.0000362
110	Automotive Repair and Maintenance	0.0068692	0.0082425	0.0004052
111	Other Repair and Maintenance	0.0123512	0.0155263	0.0007709
112	Personal Services	0.0026264	0.0053080	0.0001682
113	Other Services	0.0020449	0.0065641	0.0001639

Improving Environmental Performance in Construction

The EPiC Database contains environmental flow coefficients for over 250 common construction materials and products. Developed using complete, transparent and consistent methods, the EPiC coefficients can be used to assess the embodied energy, water and greenhouse gas emissions of construction projects, assisting with design, construction and whole of life decision-making.

The EPiC database is the result of a four-year multi-institutional research project, led by internationally recognised experts in modelling embodied environmental flows. Their combined 30+ years of experience in the field is testimony to their commitment to improving the environmental performance of construction.

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