SECURE

SAVE

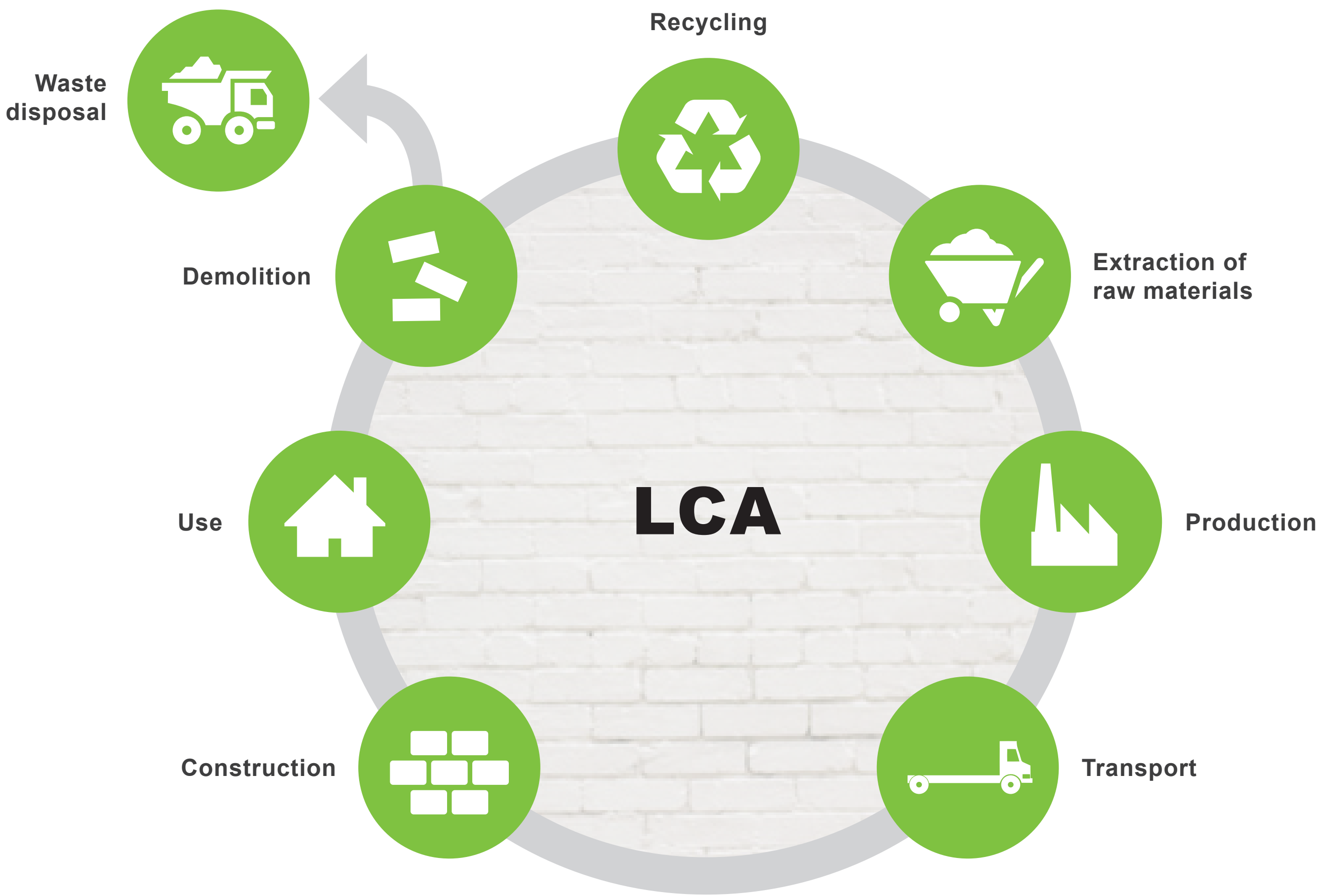
SUSTAIN

STYLE

THE ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACT OF CLAY BRICKS IN SOUTH AFRICA

THE CLAY BRICK ASSOCIATION (CBA) IS COMMITTED TO A SUSTAINABLE FUTURE

The building sector has been linked to high CO_2 emissions and global climate change, a concern that affects us all. A first step towards improving the sustainability of building materials is to understand the extent and source of the environmental and socio-economic impacts. In light of this, the CBA commissioned two detailed scientific assessments to understand the environmental impact of clay brick production and use in South Africa. The independent studies were conducted by The University of Pretoria. The CBA also commissioned a social LCA which was conducted by G1 Consulting & Associates and Equispectives Research & Consulting Services.



WHAT IS AN LCA?

Understanding a product's effect on the environment over its entire life span is a considerable undertaking. Leading academics and researchers are grappling with this, and the robust methodology of LCA has developed in response to this challenge.

An LCA is an internationally and scientifically recognised approach that measures the environmental impact of a product by analysing all the inputs (e.g. raw materials and energy) and outputs (e.g. emissions and waste) that occur as a result of that product being manufactured, transported, assembled, used, maintained, and eventually disposed of. An LCA quantifies the resources consumed and emissions produced over the product's entire life cycle and then assesses the impact of this on specific environmental aspects such as human health, climate change and damage to ecosystems.

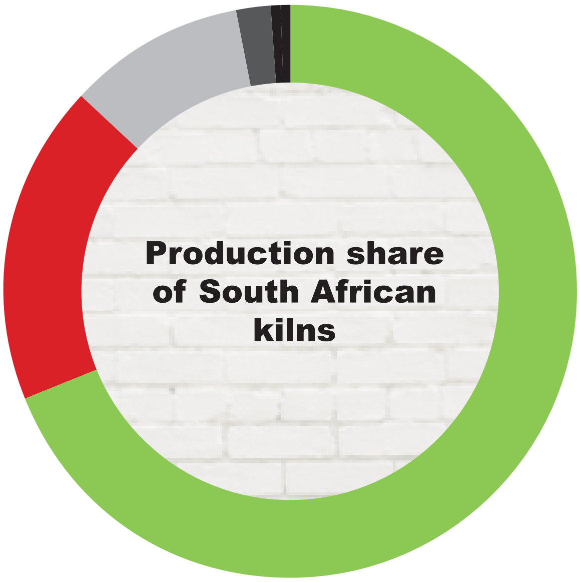
A social LCA uses a similar framework to an environmental LCA but assesses how a product affects workers, the community and the consumer in terms of socio-economic factors, such as human rights, working conditions, and health and safety.

THE CLAY BRICK LCA

The study commissioned by the CBA was conducted in accordance with the ISO 14040 and 14044 standards, with an external review by Quantis International, to assure the highest quality standards. The LCA is underpinned by specific production data from 86 out of the 102 clay brick production sites in South Africa, covering 95% of the bricks produced in South Africa. Data from the informal sector was not considered, as this is estimated to represent only 3% of the market.

Production data for each manufacturing site was collected for one year (2013), and takes into account raw materials, electricity and fuels input into each of the production steps, as well as all transport steps.

Brick firing technologies differ substantially in terms of their infrastructure requirements, fuel type and combustion procedure.
The study covered six different kiln types used in South Africa:



- **CLAMP KILN,** the most widely used in SA typically producing stock bricks. The kiln is fired with coal or fuel oil, and burns for up to two weeks.
- **TUNNEL KILN**, an advanced firing technique, with most face bricks produced in SA produced by this technology. Firing is with gas, fuel oil or coal of specific quality, and continues for 48 to 72 hours.
- **TRANSVERSE ARCH KILN (TVA)**, a continuously-fired kiln burning coal and/or gas, with the complete firing and vitrification process taking up to a week.
- **VERTICAL SHAFT BRICK KILN (VSBK)**, a continuous process in which bricks move down a vertical kiln through a central firing location. The firing process takes only 24 hours. VSBKs are typically coal-fired.
- **HOFFMAN KILN**, an old technology and the first type of continuous kiln in which coal is dropped from above into a tunnel constructed of refractory bricks.
- **ZIGZAG KILN**, the least used technology in South Africa, has a long fire zone and uses suction fans to draw the fire from one batch of bricks to the next batch. Internal fuel (coal) added to the clay mix fires the kiln.

The application of the brick considered in the study is in a brick wall of an average South African lived-in house. The second stage of the life cycle is thus the transport of the brick to where it will be used and the construction of the wall.

The use phase, which was assumed to last 50 years, considers the energy required for heating and cooling the house over its life span. A rigorous thermal performance study was commissioned to inform this influential stage of the brick life cycle. The thermal performance study looked at the heating and cooling requirements of typical buildings in South Africa over the six climatic zones of the country. Six wall construction methods were considered, including three clay brick wall types, each with different insulation characteristics, and consequently different heating and cooling requirements.

After the resources consumed and emissions produced over the clay brick wall's life cycle were quantified, the impact of these were assessed on specific environmental aspects such as human health, climate change, resources and ecosystem quality.

Study covers **95%** of bricks produced in South Africa

86 out of the **102** clay brick production sites

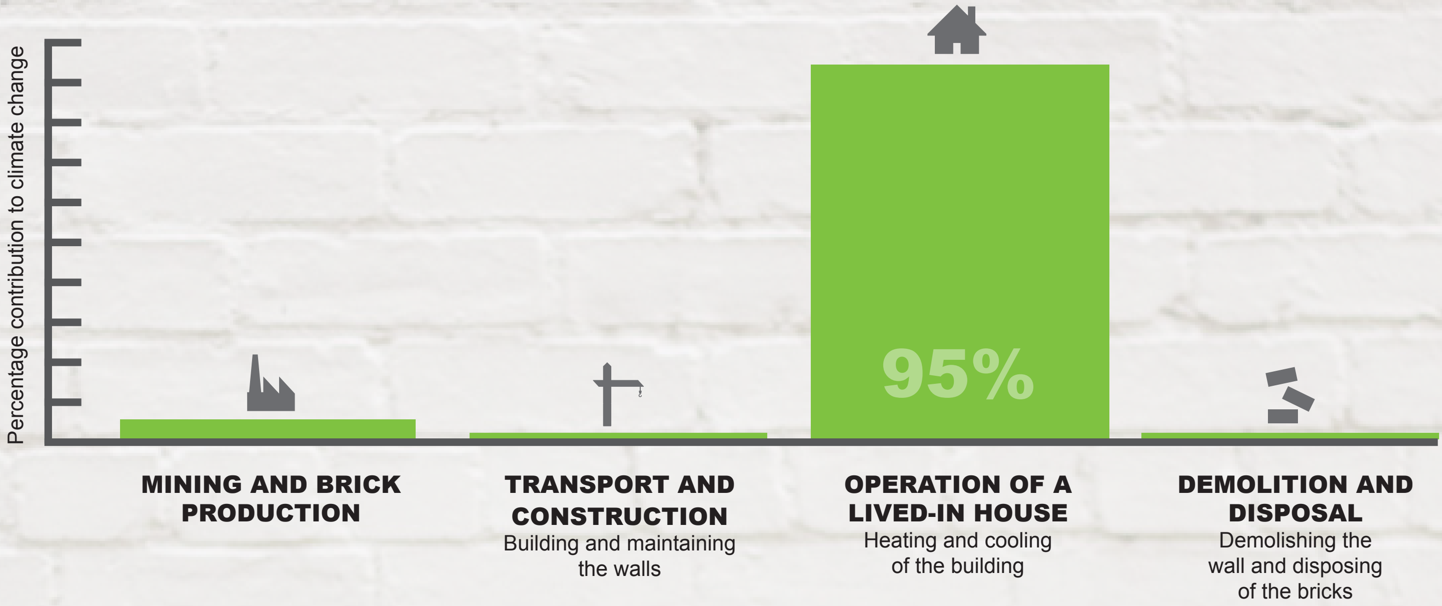
The environmental LCA looked at the impact of a clay brick over the **4 stages** of its life cycle:

- **MINING AND BRICK PRODUCTION**
- **TRANSPORT AND CONSTRUCTION**
- **OPERATION OF A LIVED-IN HOUSE**
- **DEMOLITION AND DISPOSAL**

The **social LCA** included all stakeholders in brick manufacturing – workers, local community, larger society and consumers. A future study is planned to look at the brick life cycle stages beyond manufacturing. The study looked at the clay brick industry's socio-economic impact in South Africa in the categories of human rights, working conditions, governance, health and safety, and socio-economic development. The study follows the United Nations Environment Programme Guidelines for the Social Life Cycle Assessment of Products, with data provided by an online survey of formal clay brick manufacturers. 89 manufacturers contributed data to the social LCA, representing a response rate to the survey of 78%.

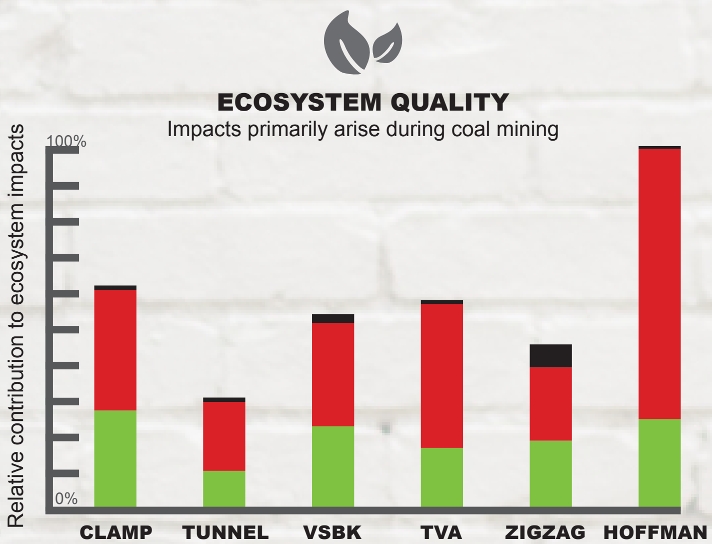
WHAT THE STUDIES FOUND

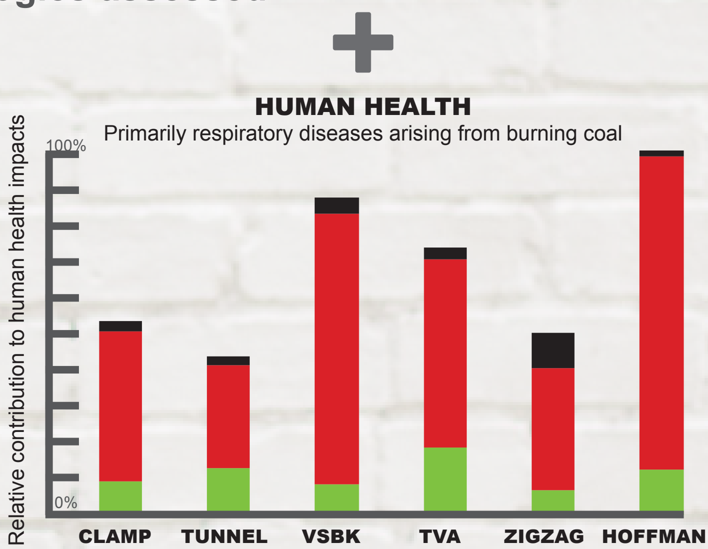
Contribution to climate change* of a 220mm double brick wall over its life cycle:

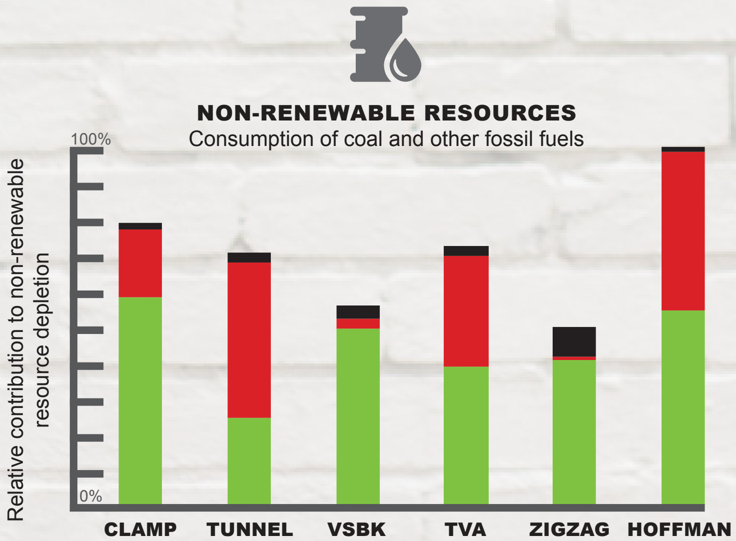


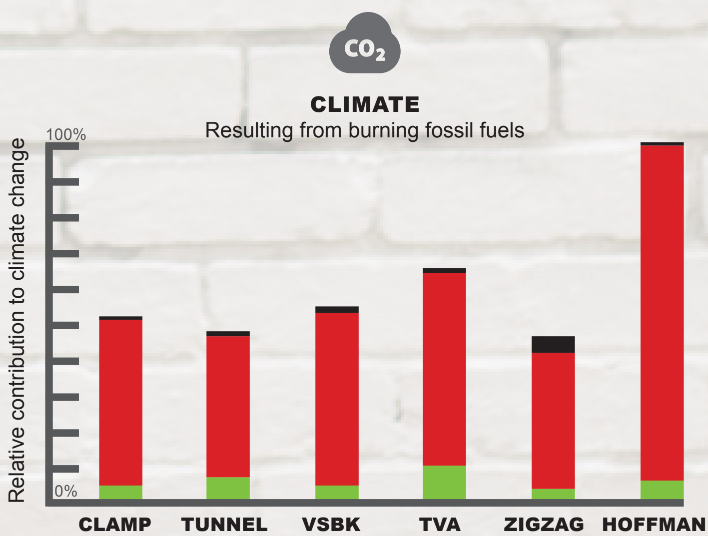
*Very similar relative trends were observed for human health and ecosystem impacts as they are also predominantly caused by coal use.

Relative contribution to brick production impacts of the six different kiln technologies assessed









■ Transports & Factory overheads ■ Brick drying & firing ■ Clay extraction, preparation & stockpiling

ENVIRONMENTAL IMPACTS DRIVEN BY DEPENDENCE ON FOSSIL FUELS

The most significant environmental impacts from the production and use of a brick are contribution to global climate change, consumption of non-renewable resources and emissions of substances that cause respiratory diseases. All three of these impacts are a consequence of the use of fossil fuels, primarily coal, either directly in the kilns or indirectly to produce electricity.

A BRICK'S BIGGEST IMPACT IS IN ITS USE

By far the greatest share of climate and health impacts occur in the use phase of the brick. The electricity used for heating and cooling houses in South Africa has a very high impact as it is predominantly produced from burning coal.

THE HIGHEST PRODUCTION IMPACTS OCCUR IN THE KILN

When looking at the life cycle up until the factory gate, the highest climate, health and ecosystem impacts occur during brick drying and firing. The impacts arise from the burning of coal added to the clay mixture as internal fuel, or from the burning of coal and other fossil fuels to fire the kiln. The highest resource consumption impacts occur either in clay preparation or in firing, depending on whether coal is added as an internal fuel or directly in the kiln.

KILN TECHNOLOGIES HAVE DIFFERING LIFE CYCLE IMPACTS

Of the six kiln types assessed, it is not possible to identify a single technology that performs best across all impacts. Kiln environmental performance is strongly linked to the kg coal used per kg brick produced, with the Hoffman kiln the poorest performer overall due to it having the highest coal use per kg brick produced. The tunnel kiln has the lowest coal use per kg brick produced and consequently the lowest human health and ecosystem impacts. This can be attributed to the use of cleaner-burning fuels, such as gas and fuel oil, in the tunnel kilns. The tunnel kiln is, however, not the best performer with respect to climate impact and non-renewable resource consumption as all fossil fuels contribute to these impacts. The tunnel and TVA kilns also have higher electricity use, primarily in clay preparation, which somewhat counters their low coal use in production. The VSBK profile is somewhat anomalous because even though its coal use per kg brick produced is very similar to the TVA kiln, its higher human health impact and lower climate and resource impacts are due to the use of a separate combustion process for the drying of bricks at one VSBK plant.

THE BIG PICTURE

Overall, the production of 1 standard clay brick in South Africa requires 9.5 MJ of fossil energy, resulting in the emission of 0.74 kg CO_2 equivalents. Annual brick production in South Africa leads to some 2.6 million tons of CO_2 equivalents per year - equivalent to the annual emissions of approximately half a million passenger vehicles on the road.

WHAT CAN THE INDUSTRY DO?

The clay brick sector can reduce its environmental impact in two ways. Firstly, by educating the building sector on the need for the design of energy-efficient buildings and the importance of choosing suitable building materials. Secondly, by becoming more energy efficient and adapting to the use of better performing kilns and cleaner-burning fuels. However the savings that can be achieved in the production phase are much smaller than those that can potentially be achieved in the use phase.

Over the life cycle of 1 m² of wall:

changing from the worst to best performing kiln has the potential to remove **38 passenger cars** off the road for a day.

changing from a solid wall to a double cavity wall with insulation has the potential to remove **5 x as many** cars off the road.

The greatest potential for the clay brick sector to reduce its environmental impact is by educating the building sector on the need for the design of energy-efficient buildings and the importance of choosing suitable building materials. The Thermal Performance Study carried out in conjunction with this LCA found residential buildings constructed with clay brick walls to have the lowest heating and cooling requirements of all commonly employed walling systems in South Africa. In the temperate climate zones of South Africa, potential energy savings of 30% were found for residential buildings built of 220mm solid brick walls relative to those built with 150mm hollow concrete blocks, whilst savings of 70% were found if walls were built with insulated cavity brick walls. Even higher savings are evident in the hotter regions of South Africa.

30% to 70% energy saving using clay brick relative to other typical building materials

= 3 to 7 passenger cars off the road for a month for every year the building is in use

FINDINGS OF THE SOCIAL LCA

A PREDOMINANTLY POSITIVE SOCIO-ECONOMIC IMPACT

The brick manufacturing sector provides employment, particularly in rural communities where it is most needed. It takes 26 man-hours to produce a thousand bricks, which results in four jobs created per million bricks produced. Brick producers are also actively engaged in community development programmes, with, on average, R6.50 spent on community development per thousand bricks produced. The brick manufacturing sector is also a significant supporter of SMMEs with 74% of supplies provided by small businesses. A particular strong-point of the industry is that there is transparency and communication about the industry's environmental and social performance. Areas for improvement include equal opportunities for employment at higher education levels, and equal remuneration across gender and race.

SOCIAL IMPACT CATEGORIES

- Human rights
- Working conditions
- Governance
- Health and safety of workers
- Socio-economic repercussions

SOCIAL IMPACT SUB-CATEGORIES

- Freedom of association and collective bargaining
- Fair salary
- Working hours
- Social benefits/social security
- Equal opportunities/discrimination
- Health and Safety
- Access to material resources
- Access to immaterial resources
- Safe and healthy living conditions
- Community engagement
- Local employment
- Cultural heritage
- Public commitments to sustainability issues
- Contributions to economic development
- Technology development
- Fair competition
- Promoting social responsibility
- Feedback mechanism
- Transparency

Fair / average
Good Performance
Areas for improvement

This study was undertaken by the Clay Brick Association representing the brickmakers that participated and contributed to the development of the study, published in February 2017.

The lead authors of the environmental and social LCA studies respectively are Prof Piet Vosloo and Greg Rice (University of Pretoria), and Michele Gilbert and San-Marié Aucamp. The studies were funded by the Clay Brick Association and the National Research Foundation

Full reports are available at www.claybrick.org/LCA

Produced by The Green House in association with Rothko Brand Partners