

Creating resilient, inclusive, thriving *human settlements* through a more circular economy

Circular Economy Briefing Note No. 5 in a series of 8

The intention of this short think piece on the circular economy in human settlements is to initiate discussion on the sector opportunities for South Africa. These opportunities are framed within the context of the current challenges facing human settlements in South Africa.

Circularity in resource flows in cities can tackle the consumption of resources, such as energy, water, buildings and land. Systems integration, flexibility, intelligence, cooperative behaviour, localisation, recycling and renewable resources are the key concepts under-pinning the Circular City⁹.

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Introduction

Human settlements – whether cities, towns or villages – include the built environment (houses, engineering infrastructure etc.), the natural environment (vegetation, water bodies etc.), amenities (such as healthcare and recreation), and the residents (people)¹. Given their composition and purpose, settlements are resource-intensive nodes consuming vast quantities of construction material, food, energy, water, and other resources. Similarly, settlements generate various types of waste, such as wastewater, greenhouse gas (GHG) emissions, and associated pollution.

Cities occupy 3% of the earth's land surface, but they are responsible for 60-80% of energy consumption, and more than 75% of the world's natural resource consumption². It is estimated that cities contribute up to 75% of global carbon emissions, with transport and buildings being among the largest contributors³. This large footprint is primarily due to the vast extraction, transport and construction activities involved, as well as the energy used to light, heat and cool dwellings⁴.

Due to the nature of South Africa's energy system (electricity and liquid fuels), many human settlements are energy- and carbon-intensive centres. A study that tracked the energy use of 20 of South Africa's most energy-intensive cities and towns revealed that they accounted for 38% of the country's total energy consumption in 2017 and were responsible for 29% of the country's emissions⁵.

A large portion of South Africa's energy is consumed within human settlements. In 2019, 42% of the country's electricity was sold to redistributors, mainly municipalities. The distribution of electricity by sector in 2020 further underscores the extensive and inefficient use of electricity within settlements

(See *CSIR Energy Briefing Note*). Industry is the largest electricity consumer (52%), the residential sector consumes 8%, and the commerce and public services sector 14%. Activities linked to these sectors largely take place within human settlements⁶. In addition to electricity, settlements also use significant amounts of water. Municipalities supply 27% of South Africa's water allocations to residential, commercial, and industrial users⁷ (See *CSIR Water Briefing Note*).

Settlements do not function in isolation. They are interconnected and have symbiotic relationships with the regions within which they are located. There are various forms of links, or networks, within and between settlements to distribute goods, services, and people, such as roads, railways, and pipelines. For instance, various types of food are produced in rural areas and have to be transported to cities and towns. These networks contribute to the demands on energy and water, while they also increase pollution, carbon emissions and waste, including large quantities of food waste (see *CSIR Agriculture Briefing Note*).

When applied to human settlements (Fig. 1), circular economy principles – eliminating waste and pollution, closing resource loops, and regenerating natural systems – provide a promising framework for South Africa to transition to inclusive, resilient and sustainable cities⁸:

- **Design out waste**, e.g., green, energy-efficient buildings, more compact cities, pedestrian-friendly neighbourhoods.
- **Keep materials in use**, e.g., circular construction value chains, circular organics, waste management.
- **Regenerate natural systems**, e.g., urban agriculture, renewable energy, green roofs, green open spaces.



Figure 1. Circular and regenerative cities (adapted from UCL⁹)

Human settlements in South Africa

About two thirds of South Africa's population lives in urban areas¹⁰. While urban areas may provide opportunities, the country's socio-economic context affects cities and towns. Poverty, unemployment, inequality, crime and violence impact on the sustainability and liveability of human settlements. Many characteristics of South Africa's human settlements result from planning principles and approaches influenced by the apartheid ideology and the modernist approach to urban planning. The legacy is still visible in spatial patterns and the form and structure of South African cities and towns, including sprawl, and low-density and mono-functional neighbourhoods. This results in inefficiencies and the wasteful use of scarce resources, especially land and infrastructure networks¹¹.

Despite well-intended policies and strategies, many parts of South African cities and towns still face challenges such as a lack of adequate infrastructure, facilities and amenities, low levels of service and few or undesirable public spaces. South Africa's public infrastructure was graded D+ overall in 2017, indicating deterioration¹⁸. A key framework guiding the future growth and management of urban areas is the Integrated Urban Development Framework (IUDF). Its purpose is to steer urban growth towards a sustainable growth model of compact, connected and coordinated cities and towns¹¹. Another key document is the Comprehensive Plan for the Development of Sustainable Human Settlements (Breaking New Ground - BNG). It encourages higher densities, mixed land use, integrating land use and public transport planning and a more compact urban form to create more diverse and responsive environments and reduce travelling distances. The spirit of these, and other policies and strategies, clearly support the principles of the circular economy in developing and managing human settlements in South Africa – but they need to be implemented.

Prior to the BNG policy approach, government's housing subsidy programme has in the last 20 years contributed to the single-

house-on-a-plot model of development, perpetuating sprawl. These developments are often located on the periphery of cities and towns, and therefore residents generally have to travel long distances between their homes and their workplaces, shops, amenities, and facilities. This increases pollution and results in inefficient use of resources¹. Middle- to high-income lifestyle and security estates developed on the outskirts of cities and towns further contribute to the expansion of the urban edge with similar negative environmental consequences. This development model means that municipalities need more resources and infrastructure to render services such as water and electricity provision, and waste collection. It also requires more maintenance of infrastructure.

Informality manifests in South Africa's human settlements as informal settlements and the way income is generated. About 26% of urban dwellers live in informal settlements¹². The government has targeted programmes to support informal settlement upgrading. The informal economy supports many households and contributes to poverty alleviation and economic growth.

Many municipalities struggle to execute their mandates effectively. Challenges they face include poor service delivery; low levels of payment for municipal services; ageing infrastructure; and inadequate maintenance (resulting, for instance, in substantial water losses due to leaks). In South Africa, most buildings, especially houses, are constructed using conventional "bricks and mortar". Despite stated support for alternative or innovative building technologies from various government departments, academics, researchers and practitioners, such technologies have not been widely adopted. Government entities such as Agrément South Africa are responsible for testing and certifying construction industry products and methodologies to ensure quality and durability. However, factors such as perceptions of users, municipal regulatory restrictions and procurement challenges still inhibit mainstreaming some products and building systems.

The construction industry in South Africa has been under pressure for some time. Public sector spending on infrastructure has declined steadily since 2017¹³. A recent material flow analysis found that relatively little of South Africa's materials consumption goes into local stock-building, i.e., infrastructure, buildings, etc.¹⁴. However, some interventions have been put in place to stimulate the industry. For instance, only locally produced cement, made from locally sourced raw materials, may now be used on any government-funded project¹⁵. Furthermore, the government has developed a post-COVID Infrastructure Investment Plan aimed at increasing spending on infrastructure projects¹⁶. This will increase demand for resources, but it also creates an opportunity to integrate circular economy principles into the construction industry and economic development due to the focused investment in construction.

Opportunities for greater circularity in urban systems

With the substantial contribution settlements make to consuming resources and generating waste, pollution, and

carbon emissions, implementing the principles of the circular economy should make significant positive differences. The circular economy provides an opportunity to look at ways to decouple urban development from resource consumption, create circular cities, and contribute to improving the quality of life for all (Fig. 1).

A “circular city” is more than just the sum of various circular economy interventions¹⁹. To create circular cities, the principles of the circular economy need to be focused on more than just buildings, building components, economic or production systems. The entire complex urban system should be considered, particularly systems for providing services and infrastructure across multiple sectors (rather than the system of production). At a settlement level, land and infrastructure are also critical resources (in addition to natural and other resources). Land is scarce, providing the space where circular activities could occur. It is also essential for regenerating the urban ecosystem. Infrastructure plays a key role in the provision and consumption of resources. It could also be reused and or recycled, thereby enhancing circularity¹⁹.

The principles of circularity can be applied at various scales, including entire city-regions, municipal areas, cities or towns, neighbourhoods, and buildings (industrial, commercial, residential etc.). Opportunities for circular development are highlighted below according to the three interconnected principles. Many interventions could support more than one of the principles.

Design out waste and pollution

There are various ways in which human settlements could contribute to reducing waste and pollution (including carbon emissions). For instance, deficiencies in the construction, mobility, energy and water sectors could be addressed at settlement level to enhance circularity.

Because the construction industry consumes vast amounts of resources, it provides ample opportunities for circular economy interventions. Reducing construction waste involves more than re-using material – interventions should commence during the planning, design, specification and procurement stages of the manufacturing or building process to limit the generation of waste from the outset and reduce the use of virgin material. For instance, dimensional coordination and materials and components standardisation should reduce the waste generated. Standard sizes (steel and timber lengths, glass pane sizes, roof sheeting dimensions etc.) should be considered when specifying material, and quantities should be accurately calculated before materials are ordered. Other strategies include off-site construction, recovering unused materials from building sites, and re-using materials (e.g., concrete, bricks, roofing material), to extend the lifespan of materials. Furthermore, buildings could be designed to facilitate deconstruction, and to be flexible so they could be repurposed for different uses and functions to extend the lifespan of existing stock.

Building and infrastructure efficiency are fundamentally linked to their maintenance and management. Failing and poorly maintained infrastructure cause resource losses, in particular water wasted because of leaking pipes.

Waste and pollution could also be reduced through space sharing economy initiatives. This involves the sharing of underused physical spaces, e.g., as accommodation, kitchens, and coworking spaces. Business models of the sharing economy emphasise a shift from ownership of goods to using goods through services. This provides opportunities for job creation, and it provides those previously unable to afford them with access to quality goods and services. The disruption to traditional office workspace caused by the COVID-19 pandemic, presents an opportunity to fast-track the adoption of alternative work-space environments, including space-sharing¹⁷.

Applying sound planning, design, and management principles at city, town and neighbourhood level should contribute substantially to reducing pollution and carbon emissions. For instance, accommodating and encouraging the use of non-motorised transport (NMT) reduces the need for using private motor vehicles. Strategies and interventions include transport-oriented development (TOD), creating cycle- and pedestrian-friendly neighbourhoods, and providing affordable, efficient, safe and reliable public transport (See *CSIR Mobility Briefing Note*).

Keep products and materials in use

One of the aims of the circular economy is to reduce the consumption and wastage of resources, by closing the loop and productively returning resources back into the economy for use, rather than disposal. The loops are the flows of resources, materials, parts, goods, by-products and so on, within cities and neighbourhoods, and between them. To manage these loops, they need to be mapped and understood, and to be measured, monitored and improved.

The circular economy aims to move from linear processes to circular value chains, such as by sharing, leasing, repairing, refurbishing, repurposing, reducing, remanufacturing, upcycling or recycling as opposed to the traditional take-make-consume-dispose process. This also includes just-in-time procurement (reducing the need for excessive warehousing and parts that go unused) and reverse logistics, where the manufacturer aims to take back as much as possible, the packaging used and at the end of their life, the used goods. The built environment needs to be considered as a whole, not segmented by zoning types, because opportunities are likely to loop through different parts of a city.

Examples of the circular construction chain are brokers who facilitate sharing expensive equipment or selling unused materials from one building site to another, so they don't become waste; informal businesses repairing discarded equipment or recovering resources from waste; buildings that can be assembled and disassembled rapidly, to be moved to where needed; and re-occupying abandoned buildings.

Other ways of closing the resource loop involve organic waste. For instance, food waste, garden waste, etc. can be cycled back into the economy, e.g., as compost for urban parks, gardens, urban food systems and agricultural activities surrounding cities and towns; bio-energy generation; or returned to biorefinery processes for the recovery of high-value products. In South Africa to a limited extent, sewerage is already being processed to return clean water to the water distribution network and to provide fertilizer for application within the agricultural sector. A further use of sewerage sludge is for energy, by producing biogas through anaerobic digestion or by burning dry sludge.

Regenerate natural systems

Regenerating natural systems means more than merely protecting the natural environment. The concept of a regenerative settlement encompasses more than sustainability – it involves the active restoration of the natural environment and the regeneration of the natural resources it consumes. Regeneration incorporates the principles described above, namely the reduction of waste and the creation of closed loop systems that actively feed natural resources back into the ecosystem to improve the natural environment.

A key pillar of regenerative settlements is the need for a mutually beneficial relationship with the surrounding region. This means that cities and towns should source their resources locally and regionally (closing the loop) to create social, economic, and environmental value for the local communities. Similarly, local farmers could benefit from organic waste generated by settlements. Such waste could be a resource and could be used as compost or as livestock and poultry feed.

Regenerative initiatives could be implemented across various sectors such as energy, water, mobility, and waste. It could include interventions aimed at the generation of renewable energy, utilising rainwater and stormwater (e.g. by applying the principles of water-sensitive design¹¹), and creating walkable neighbourhoods. Organic waste could be used to provide bioenergy or support decentralised energy systems in cities and towns; for growing algae, mushrooms and insects for food and feed; and for fibres, bioplastics and bio-aromatics. Well-considered greening initiatives could improve the quality of the atmosphere, reduce urban heat islands, and have a positive impact on the wellbeing of the people living in the city or town.

Conclusions

The terms “circular economy” and “circular city” may be relatively new in South Africa, but the principles behind these concepts have been promoted by human settlement researchers and practitioners for many years. Various policies, strategies and frameworks guiding human settlement development in South Africa support and encourage the development of sustainable, resource efficient, liveable, and resilient cities, towns and neighbourhoods. However, many parts of South African cities and towns still face challenges such as a lack of adequate infrastructure, facilities and amenities, low levels of service and inadequate public spaces.

Since many of the circular city concepts are emerging from developed countries, there is more to be done in understanding their relevance and appropriateness in developing countries, often facing their own unique social and economic challenges. When implementing circular economy initiatives in South Africa, the local context should be carefully considered. This includes factors such as poverty, unemployment, the role of the informal economy, inequality, crime and violence. Furthermore, challenges related to service delivery at municipal level and the lack of infrastructure maintenance could jeopardise initiatives aimed at creating circular cities and towns.

To guide local circular economy initiatives, a thorough understanding of the challenges and opportunities is needed. Reliable data and evidence are required to develop appropriate initiatives that create a net benefit. In addition, to enhance circularity in any settlement, attention needs to be paid to the interaction between the systems of provision and the lifestyles of the residents, and also to the effect lifestyles may have on the residents’ willingness to adopt circular practices.

While much needs to be done to achieve circularity in human settlements in South Africa, the challenges are far from insurmountable. The concepts of circularity are starting to be included in the plans of some local governments and there are replicable projects that are already making a difference.

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References

1. DHS (2019). The Neighbourhood Planning and Design Guide: Creating Sustainable Human Settlements [\[online\]](#).
2. UN (2021). Sustainable Development Goal 11: Cities [\[online\]](#).
3. UNEP (2021). Cities and Climate Change [\[online\]](#).
4. Circle Economy (2021). The Circularity Gap Report 2021. Platform for Accelerating the Circular Economy (PACE) [\[online\]](#).
5. Urban Energy Support (2020). State of Energy in South African Cities 2020 [\[online\]](#).
6. DoE (2019). The South Africa Energy Sector Report [\[online\]](#).
7. GreenCape (2021). Water market intelligence report [\[online\]](#).
8. EMF (2021) Circular Economy Introduction [\[online\]](#).
9. UCL (2021). UCL Circular Cities Hub [\[online\]](#)
10. Statista (2021). South Africa: Urbanization from 2010 to 2020 [\[online\]](#).
11. CoGTA (2021). Integrated Urban Development Framework (IUDF) [\[online\]](#).
12. World Bank (2021). Population living in slums (% of urban population) - South Africa [\[online\]](#).
13. Stats SA (2020). Public-sector infrastructure investment falls for a third year [\[online\]](#).
14. von Blottnitz, H. *et al.* (2021). Challenging but promising: South Africa’s transition towards a circular economy [\[online\]](#).
15. Bulbulia, T. (2021). Use of imported cement on govt-funded projects to be prohibited from Nov 4. Eng. News [\[online\]](#).
16. PMG (2020). SA’s Infrastructure Investment Plan post COVID19, with Minister [\[online\]](#).
17. Klevnäs, P. *et al.* (2021). The circular economy and Covid-19 recovery [\[online\]](#)
18. SAICE (2017). 2017 Infrastructure Report Card for South Africa [\[online\]](#).
19. Williams J (2021). Circular Cities: A Revolution in Urban Sustainability. Routledge Studies in Sustainability. [\[online\]](#).