"Building Our Future Today – Ensuring Liveable Spaces for Every Family."

UPSCALING INNOVATION AND TRANSFORMATIVE TECHNOLOGIES: BUILDING SMART COMMUNITIES

The focus of the Commission is to:

a) examine ways to upscale innovation and transformative technologies to build smart communities for connectivity, resilience, economy and dignity

b) harness innovation to address rapid urbanisation and technology gaps in human settlements

1. BACKGROUND AND PROBLEM STATEMENT

Urbanisation creates many opportunities for societies. However it also comes with a wide range of challenges. In response, cities are examining innovative, transformative or alternative technologies to address the multifaceted problems that they are experiencing. One of the challenges is the fact that not all investments in innovative technologies are smart or transformative and would build smart communities. **How do we balance the two i.e. up scaling the use of such technologies and build smart communities?**

In 2009 the Department of Human Settlements organised an indaba and exhibition for alternative building technologies. The indaba was prompted by two factors. Firstly, the Department was inundated with innovators' requests for space to present their products, indicating that perhaps the Innovation Hub was by itself no longer enough to showcase vast innovations that were available in the market and innovators often had limited understanding of the processes to follow in order to get their products into the market. Secondly, it wished to review the functioning of the low cost housing sector.

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The indaba developed recommendations. These included amongst others that:

- the National Department of Human Settlements (NDHS) must consider using procurement processes to upscale the use of alternative building technologies specifically highlighting that tenders must be open to accommodating alternative technology providers,

- the NDHS must procure alternative materials that have an Agrément Certificate and from companies that have human and financial capacity to produce at scale, that government must use house performance standards to advertise tenders instead of the subsidy amount,

- government must consider life-cycle costs such as maintenance costs, energy consumption, etc., of a building technology before the technology is procured,

- government must ensure that institutions such as Agrément South Africa, NHBRC, and Institute for Architects, etc. intensify their support to local authorities in the implementation of alternative technologies.

The challenge to date is that while a majority of these recommendations have since been implemented, the up scaling of such technology has not occurred.

Billions of rands have been invested in South Africa as part of donor or government funding, covering innovative and transforming technology in a number of cities, towns, and rural districts under the guise of smart innovative technology, however a number of challenges have arisen with the implementation of such technologies. Amongst the key challenges are the acceptance of such technologies by South African communities, and the availability of alternative material in the country to enable up scaling.

There is acknowledgement that South Africa has invested in massive infrastructure development in every city and province, which requires maintenance, renewal and refurbishment. However the resources available are not sufficient to enable refurbishment, maintenance, and renewal, and there is thus a need to invest in alternative solutions to deliver all these services for the citizenry in both urban and rural areas.

In 2015, the United Nations member States committed to Agenda 2030 and its seventeen Sustainable Development Goals, which are global goals and grant a universal call of action to end poverty, protect the planet and ensure that all people in the society enjoy peace and prosperity. In 2017, New Urban Agenda was adopted as a global commitment to addressing urbanisation while promoting basic services for all, ensuring that all inhabitants have access to equal opportunities and face no discrimination, promoting measures that support cleaner cities, strengthen resilience in cities to reduce the risk and impact of disasters, take action to address climate change by reducing their greenhouse gas emissions, improve connectivity and support innovative and green initiatives, promote safe , accessible and public spaces. The New Urban Agenda seeks to effect a paradigm shift in planning, financing, developing, governing and managing cities and human settlements.

The key question that the commission should answer is "How does South Africa respond to the New Urban Agenda through innovation and technology, with the support of communities"?

There is no doubt that innovative solutions are required and infrastructure and built environment will continue to be crucial for economic development, poverty alleviation and addressing unemployment in South Africa.

<table><tr><td>2.</td><td>WHAT ARE THE CAUSES OF THE PROBLEM?</td></tr></table>

The causes of the problem as identified in the National Development Plan (NDP) diagnostic report is the lack of capacity, a weak regulatory environment (which increases the cost of doing business and incidences of fraud and corruption in the implementation of infrastructure development projects), pressure on urban governance (with demand outstripping the supply of services), climate change.

Urban governance – Cities have been the recipients of a worldwide trend to devolve power from the national to the local level in support of the principle of decentralization. One of the consequences of the adoption of this principle is the provision of adequate legal and financial resources to provide services to their communities. However, in many instances, decentralization has not been supported by adequate resourcing either financial or human resulting in institutions unable to execute their devolved powers.

In South Africa the Treasury Capacity Building Report states that: "Within government, systems are chaotic, often impeding delivery. There is a lack of integration between human resource development and strategic and operational planning functions. Management capacity at all levels is a significant problem and this has a key impact on performance." This is particularly true in the infrastructure field with many of the built environment professions being on the national scarce skills list. In tough economic times there are also severe funding constraints associated with infrastructure investment.

Increased residency in slums and informal settlements – the widespread growth of slums or informal urban settlements has become a central policy issues during the last two decades. Slums represent part of the unfinished business of the MDGs or part of the "old" urban agenda that must be addressed by the new urban agenda. The enormous growth of cities, largely through rural-urban migration, and the challenge of providing adequate housing placed the emphasis on large-scale public housing schemes to build low-cost, affordable housing. It has become obvious now that these schemes could not keep up with demand, nor could they be managed in a manner that the neediest would be primary beneficiaries, and so in many instances the state has retreated from being a housing provider.

Challenges in providing urban services – closely linked to the issue of housing is the challenge of providing adequate basic services and infrastructure. Emerging trends include

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cities not being able to keep up with the demand for services, especially in poor countries; increasing number of attempts to find innovative ways of dealing with infrastructure challenges including PPPs and privatization; and the level of public service is very poor.

A significant portion of South Africa's infrastructure is old and in many instances crumbling, particularly at municipal level (waste water treatment plants and roads for example). The rapid expansion of urban settlements has placed severe stress on infrastructure requiring repeated upgrading on the one hand, and increased maintenance obligations on the other. South Africa is defined as a water scarce country, as mentioned in the Diagnostic Overview. Both water availability and water quality are major challenges, particularly due to climate change and municipal pollution (sewage disposal), industrial effluent, acid mine drainage and desalinization caused by irrigation. More than 10% of South Africans still do not have access to potable water. Water infrastructure in South Africa is rated of poor quality by South Africa Institute of Civil Engineers (SAICE), particularly waste water treatment systems and, in some cases, water reticulation leading to major losses and water quality problems. It is well known that infrastructure boosts economic growth. Government has set targets for infrastructure spend of 25% of GDP. However, according to the Diagnostic Overview South Africa has a "legacy of old, out-dated and unreliable infrastructure" and it specifically mentions transport infrastructure (road, rail, ports, and airports) and water infrastructure. In many instances maintenance of infrastructure is a significant problem.

Climate change – one of the emerging issues that cities have to deal with is climate change. Its adverse impacts are capable of undermining the ability of all cities to achieve sustainable development. Impacts will be most profoundly felt in urban areas: urban areas concentrate economic activity, households, industries and infrastructures which are also totally dependent on urban structures and services. Urbanization brings about changes in production and consumption patterns, which when associated with dysfunctional urban forms and structure of cities, contribute to higher levels of energy consumption and greenhouse gas emissions. Consequently the design and use of the built environment is a critical area for climate change mitigation and adaptation.

Climate change affects the performance of infrastructure greatly due to the fact that infrastructure is designed to last for 20 to 50 years. Particularly where flooding, rising sea levels and increased temperatures are concerned. Ports are particularly prone to problems associated with rising sea levels and buildings and roads are susceptible to increased temperature levels and precipitation. In addition, infrastructure in South African cities is based on a centralised system developed, managed, and maintained by various tiers of government. Centralised systems of infrastructure significantly increase the risk of failure from natural and man-made disasters.

Upsurge in international migration – the upsurge in forced migration across international borders is an emerging issue. Not all migrants are fleeing conflicts, wars or oppressive regimes; it has been a mixed-migration flow of refugees, asylum-seekers and economic migrants among others. The absence of integration policies can lead to the formation of

ghettos and marginalized communities, which could serve as breeding grounds for frustration, disenchantment, vulnerability and even radicalization.

Insecurity – a major emerging urban issue concerns insecurity and increasing risk. Over the past two decades, urban population growth and the effects of globalization have enhanced the complexities and manifestation or crime and violence in cities. New and pervasive risks affecting cities include terrorism, urban warfare, heightened securitization, and disease and pandemics. Insecurity and risk undermine the long-term sustainability of cities worldwide. Rapid urban growth and the globalized nature of cities have added new levels of urban health risks. The spread of disease in cities often occurs as a result of inadequate infrastructure and services. High incidence of traffic fatalities, air pollution related respiratory infections and premature deaths, and communicable, vector, and waterborne diseases can all be related to inadequate, poor, or inefficient urban infrastructure. Movement between global cities has significantly impacted the spread of viruses as well.

In light of the above, and the evolving definition of human settlements there is a need to change the South African approach. Human Settlements as defined by United Nations as an integrative concept that comprises of physical components of shelter, and physical services to which the physical elements provide support that is to say community services such as education, health, culture, welfare, recreation and nutrition. Such human settlements require technology transformation and new product development which are part of the fabric of urban and rural areas and such settlements must deliver on housing, sanitation, energy , waste management , transport etc.

3.   WHAT HAS BEEN DONE IN SOUTH AFRICA?

• A clear situational analysis has been done with diagnostic reports prepared for the National Planning Commission.

• A number of territorial solutions have been tried in South Africa   as part of implementing alternative or innovative solutions. e.g. Human settlements is forging ahead with densification through social housing programme and has through the support of National Homebuilders Registration Council (NHBRC) crafted guidelines to implementing alternative technology. Human Settlements has a Govan Mbeki awards programme that recognises Provinces and/ partners that implemented innovation and/or alternative technology in projects.

• Water and sanitation has also explored alternative transformative approaches to water conservation for human settlements and even crafted scenarios for future of water in South Africa.

• Department of Environment has also pursued approaches to alternative and transformative management for human settlements

- There are lessons from the field about barriers to up scaling IBTs.

- Some of the cities has installed Wi-Fi connections and tested some of the alternative technology solutions.

- Science, Technology and Innovation for Sustainable Human Settlements may provide a road map for government.

4.   WHAT SOLUTIONS ARE AVAILABLE?

There are a number of solutions available and some are based on international benchmarks:

- One of the solutions is forming strong partnerships with the private sector and government.

- One of the proposals is to create Intelligent Community Forums which would meet regularly and have a Smart City and IBT annual award ceremony. This has been applied in New York and consists of assessments in the application of broad band, knowledge workforce, innovation, digital inclusion and advocacy assessment. This works through an agreed framework that defines what the application process will look at and the transformation / innovation required by the community that has to be achieved through an effective collaboration between government and citizens. This uses an automation process that is not top down from government to people.

- Setting densification and clean city targets in cities and townships: Densification and cleaning activities would bring people in specific areas together and assist in ending social exclusion whilst developing smart solutions using technology as the only tool.

- Use of a variety of technology such as Wi-Fi, desalination plants, dry sanitation, solar water geysers, increasing broadband ,etc. in Provinces and cities. An opportunity exists of using technology as a tool for social and behavioural transformation in communities. This technology would make the life of citizens easier and safer.

- Development of disaster risk plans and creating connected smart city regions, including improvement on the quality of rural settlements. Efforts should be made to integrate physical, digital, and human systems to enable economically productive, inclusive and prosperous areas.

- The reducing the trust deficit between governance institutions and communities through dialogues and software applications. A majority of countries such as Brazil and India have created special technology that is used in smart cities which focuses on turning people's ideas into solutions. In some instances the focus of such labs is on hosting dialogue regarding innovative solutions. This can be used in South Africa to promote acceptance of alternative technologies.

5.   INDICATORS OF ACHIEVEMENT

- The South Africa's alternative technology and smart city policies consolidated with key areas of commonality, reinvention acknowledged and agreed.

- Consensus reached on crafting an implementation plan for the up scaling the IBT & Smart City Agenda.

- Working Groups established to prepare specific matrix areas, making use of, adapting, the SDG Indicators, NUA and crafting new MTSF priorities.

- Emphasis placed on collaboration and partnerships across government and with partners and actors.

6.   EXPECTED OUTCOMES

- To adopt a defined agenda and plan (road map) for the up-scaling of innovation and implementing alternative technology solutions and smart city and community approach for human settlements.

- To agree on key principles to enable up-scaling of alternative solutions and smart cities.

- Proposal on institutional arrangements (i.e. a multi-sector and multi-agency compact for innovation and alternative technologies for human settlements) to further the application of innovation, smart cities, and alternative technologies in the development of human settlements with specific reference to:

  o   Innovative Building Technologies

  o   Usage of Waste in Construction

  o   Water services

  o   Sanitation solutions

  o   Energy

  o   Transport and Mobility

  o   Communication (Broadband and connectivity) access

  o   Planning for disaster resilience and preparedness

  o   Planning for settlements that are cost and resource efficient

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7. Glossary

Appropriate technology	The sustainable application or operation of a technology (process, tool or device), which could be conventional, intermediate, alternative or innovative, to meet national imperatives within the local technological, legal, institutional, financial, social, cultural, ethical, economic and environmental requirements and constraints experienced by the authority, households and/or market best positioned to benefit from the technology.
Indigenous knowledge	Indigenous knowledge is the unique, traditional and local knowledge existing within and developed around specific conditions of women and men indigenous to a particular geographic area, the product of indigenous people's direct experience of the workings of nature and its relationships with the social world. Indigeous knowledge is embedded in a particular community or cultural grouping defined by their origins in a particular geographic geographical area, and as such it is both culturally and contextually bound.
Innovative technology	Novel technology not (yet) in general circulation or use.
Intermediate technology	Intermediate technologies are seen as technologies which fit more smoothly into the relatively unsophisticated environment in which it is to be utilised, are simple and therefore understandable, are suitable for maintenance and repair on the spot, are less dependent on raw materials and are much more adaptable to market fluctuations.
Mainstreaming	Generally accepted and successfully implemented technology.
Technology ecosystem	Processes, tools and devices and the political, economic, sociological, technological, legal and environmental (PESTLE) factors which support or frustrate their successful mainstreaming.
Urban Knowledge Exchange	The purpose of the Urban Knowledge Exchange South Africa is to improve the delivery of better quality human settlements, towns and cities by making reliable, evidence-based knowledge more widely accessible. The forthcoming broad-based South African urban knowledge hub will establish a high level platform for exchanging technically validated knowledge about practice to enhance sharing and learning between government, civil society organisations, private sector agencies, research organisations and tertiary institutions working in the urban and settlement development sector; improve access to, and use of, high quality knowledge and expertise; promote innovation, good practice, joint learning and knowledge sharing; deepen understanding of the key issues; improve trust between the stakeholders; and improve policy and programme formulation, and access to decision support.

The following list, adapted from Croxton (2013, p3), identifies common barriers for promising technologies to be developed from idea to maturity or to be successfully mainstreamed.

a.   **Technological factors.** The technology performs poorly, is unproven, or lacks **complementary technologies needed to make it effective.**

b.   **Demand.** Specifiers or end-users do not see the need or desirability of the technology (for example, loyalty to known technologies; technology is more expensive than existing solutions; the advantages are not appreciated or valued).

c.   **Cultural and perception factors**. End-users may reject technologies perceived to undermine values and preferences (for example, end-users may interpret substitution of familiar with unfamiliar products as an attempt to impose inferior products).

d.   **Skills and knowledge.** Specifiers and end-users may not know what the technology offers, or may not have the skills (or confidence) needed to specify or implement it.

e.   **Production factors**. Supply chains needed may be unformed or immature (risky). Raw materials and equipment may be unavailable, of insufficiently dependable quantity and quality. Specialised production skills may be lacking.

f.   **Investment factors.** Lack of access to capital, market uncertainty and risk aversion can lead to underinvestment in production capacity and scale up, so the technology cannot benefit from economies of scale and therefore cannot compete.

g.   **Infrastructure and maintenance factors.** The infrastructure for delivering the product and/or spare parts is inadequate; or a maintenance network does not exist (e.g. specialised maintenance skills are lacking).

h.   **Undesirable social and/or environmental effects.** Technologies intended to solve one problem may introduce new ones.

i.   **Policy and regulatory framework.** A new technology may not fit with existing regulations and policies; policies can be a disincentive to investment in new technology.

Table 1 Critical success factors for mainstreaming technological innovation (Croxton, 2013, p3

Key drivers	What has to happen
Resource mobilisation	Mobilise relevant human, financial capital and other resources, including identifying people with relevant skills and offering training
Prioritisation mechanisms	Produce incentives for stakeholders to set priorities; ensure there is capability within any particular sector to allow stakeholders to agree priorities across competing technologies, applications, markets, etc.
Capacity development and diffusion	Develop and expand the breadth and depth of stakeholders' knowledge in both technology and application sectors with an explicit focus on changing behaviour and perception
Entrepreneurial experimentation	Develop an institutional infrastructure that favours entrepreneurial activity, firm establishment and growth
Market formation	Develop market places, identify customers and users, develop viable business models, consider possibilities for exports and/or needs for imports
Legitimation and governance	Work to raise the social acceptance for technology, develop mechanisms for influencing such acceptance, and ensure compliance with requirements of relevant institutions and policies

Rapid advances in science, technology and innovation (STI) have significant implications for the design of human settlements and housing and the offer the potential for radical improvements in resource efficiency and quality of life. STIs also provide a structured way of addressing the significant risks for human settlements associated with climate change. It therefore important that STI developments are explored and developed as a means of achieving human settlements and housing targets as well as for achieving more sustainable and resilient development. Some examples of how STIs can be used to address human settlement and housing challenges are provided below.

• Climate change: Climate change impacts projected for South Africa include higher average temperatures, increased number of very hot days (days with a maximum of over 35oC), erratic rainfall and more extreme weather events (Engelbrecht, 2017). These changes have significant implications for housing and neighborhoods (Gibberd, 2017a). STI-based measures such as sustainable urban drainage systems (SUDS), rainwater harvesting, additional structure and insulation in roofs, increased provision of shade and drinking water and local climate change adaptation and disaster mitigation plans can be used to build resilience in communities and infrastructure and reduce negative impacts of climate change (Gibberd, 2017a; Gibberd, 2017b).

- Water: The Department of Water and Sanitation's Water Reconciliation All Town Study indicates that water resources in 30% of South Africa's towns are already in deficit. It indicates that water shortages are expected in at least another 15% of South Africa's towns in the next 5 years, with an additional 12% of towns also suffering shortages in the 5 years following this (Water Research Commission, 2017). STI solutions are being developed to help address this situation. Highly efficient water fittings can reduce water consumption in housing by 30%, compared to conventional fittings. Greywater systems have the potential to reduce water consumption in housing by a further 20%. In addition, rainwater harvesting systems can provide for 80-90% of the water requirements in housing (100% if filtration is included) (Gibberd, 2009; Gibberd, 2016).

- Energy: Residential buildings consume about 13% of South Africa's energy resulting in 25million tons of carbon dioxide emissions per year (UNEP, 2009). A range of STI developments within housing have been developed to improve energy efficiency and reduce carbon emissions. Solar water heaters in housing can reduce electricity consumption and association carbon emissions by 30-40% compared to conventional electrical geysers. A further 20% reduction can be achieved through more efficient cooking equipment relative to conventional electrical cookers. Highly efficient light fittings, appliances and controls reduce household electricity consumption by a further 10% compared to conventional systems (Gibberd, 2008).

- Recycling: Levels of waste generation in South Africa are high and figures show that 761 kg of waste per person are generated in Gauteng (DEA, 2012) In urban areas municipal bylaws combined within increasing recycling provision is enabling larger proportions of waste to be recycled. Recycling technologies enable small-scale local recycling and reuse of materials such as plastics and organic matter to create local recycling enterprises and it is estimated that recycling activities create employment for over 113 500 people (Matete and Trois, 2008; StatsSa, 2007).

- Building materials and components: Manufacture of building materials and components consume about 5% of South Africa's energy (UNEP, 2009). STI-based solutions can be used to reduce energy associated with building materials and create increased employment. For example, hybrid construction techniques which combine traditional materials, indigenous knowledge and passive environment control systems can be used to create high quality, comfortable, low energy buildings. Significant local economic impact can be created through this approach as construction techniques are labour-intensive and draw on local manufacturing and skills (Gibberd, 2005). Construction costs can be reduced by drawing on 'sweat-equity' and self-build techniques thereby increasing the affordability of housing (Kariyawasam and Jayasinghe, 2016).

- **Building design and construction:** Occupants of low cost housing in South African can spend as much as 20% of their income on heating in winter (Mathews and Van Wyk, 1996). Inappropriate heating methods can also lead to suspended particulates being over 12 times WHO guidelines and leading to a range of health problems (Mathews and Van Wyk, 1996). STI developments within the design and environmental modelling fields, such as Building Information Modelling (BIM), enable the development of designs that are optimized for air quality, energy and water efficiency, daylighting and thermal comfort. These techniques can also support 'future-proofing' of housing by drawing on climate change and other projections in modelling processes (Azhar, 2011). Advances in building technology are leading to a range of benefits including better thermal performance of the building envelope, improved indoor environmental quality, reduced environmental impacts and increased speed and quality of construction (Bribián, Capilla and Usón, 2011). Prefabrication of components can improve quality of construction and reduce construction waste by over 50% (Jaillon, Poon, and Chiang, 2009).

- **Urban agriculture:** Expenditure on food can account for up to 80% of total household income in low-income households (Baiphethi and Jacobs, 2009). Small-scale urban agriculture can therefore be an important strategy in reducing the vulnerability of these households (Baiphethi and Jacobs, 2009). In cities such as Newcastle and Mafikeng over 30% of households are involved in urban agriculture (StatSA, 2011). Urban agriculture projects carried out in Durban indicate that food and travel costs can be substantially reduced through urban agriculture (GBCSA, 2012). Additional benefits of urban agriculture are improved health, the development of local small enterprises and increased social cohesion (Olivier and Heinecken, 2017; Van Averbeke, 2007)

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