The Urban Research Town: An in–Field Tool for Testing, Adoption and Deployment of New Urban Energy Sources and Technologies

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Abstract

This article explores the possibility of developing the in-field urban research town that will perform the role of a research and development centre for the development, testing and adoption of new urban energy sources. From a desktop review of existing literature, it is clearly evident that there is a vast array of energy producing technologies available, globally. What has been missing in Zimbabwe is a platform where these technologies can be tested before large scale adoption. This, therefore, brings about the emerging need for an in-field urban energy research facility. This article critically explores this concept within the framework of survivability, sustainability and resilience. It is then concluded that for continued survivability, sustainability and resilience, a real-time in-field research and development facility, in this case, an urban research town, be a national priority.

Keywords: *research and development, diffusion of innovations, provocation, experiment, innovators*

INTRODUCTION

The article pivots on the importance of research and development facilities and their role in the delivery of urban products and services that solve existing

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energy mix challenges. The study proposes the development of the urban research town which can be an urban development experimentation site where diverse urban development solutions will be studied in a practical manner. For the purposes of this article, one of its key result areas will be the testing and adoption of alternative urban energy solutions. The study presents the potential benefits of developing field research sites within the area of urban planning. Urban Zimbabwe has been riddled with energy supply challenges with the majority of settlements experiencing energy rationing measures of up to 18 hours during winter seasons (reuters.com). Thus, the output of this research has the potential of developing long-term solutions to the energy supply shortage in the country.

The article bases its exploration upon the classic wisdom of the Garden City model (Howard, 1902), the theory of diffusion of innovations (Rogers, 2012) and the lateral-thinking concept of provocation (de Bono, 1985).

The Department of Rural and Urban Planning, University of Zimbabwe (DRUP-UZ) Urban Development Research Town will be a field-testing site which will be used to research and develop alternative urban products and services with the aim of solving contemporary urban challenges. The core thrust of this facility will be alternative urban energy mix solutions. Provocation is a lateral-thinking method aimed at stimulating alternate solutions through the deliberate statement of mental provocations which allow problem solving thinking to move beyond judgement and towards new solution scenarios. Existing Information Universe is the collection of existing historic information up to the present traditionally used to judge situations and come up with decisions. Future Information Universe is an alternative deliberate development of new information created through the lateral-thinking process. It is used to develop new direction of thinking targeted towards the development of new solutions. Historic decision loop is a decision-making process based on old traditional, and, thus, historic events. It is characterised by its close-looped nature that does not permit new pertinent information.

BACKGROUND

In 2017, the global energy supply was characterised by a number of components. Oil dominated the energy supply mix with 32%. Coal was second with 27.1%. Natural gas was third with 22.2%. Bio-fuels and waste-derived energy was fourth with 9.5%. Nuclear energy supplied 4.9% of the world's energy demand at fifth place. Hydro-electrical energy was sixth, supplying 2.5% of the global energy demand. Geothermal energy, solar, wind power, thermal energy, tide, wave and ocean energy combined supplied the remainder of the world's energy demand standing at 1.8% (Wang, 2020).

In 2009, Zimbabwe's dominant supplier of energy was biomass with 66%. This was followed by coal at 19%. Petroleum products were in third position with 6%. Electricity imports were in fourth position with 5% and hydro-electric energy at fifth with 4%. The private home market for solar energy has been steadily growing, with the government removing all duty on imports of solar technologies in July 2019. Access to electricity in rural areas is 19%, whilst that of urban areas is 80%. The main challenge to Zimbabwe's energy sector is capacity, with no new developments having been commissioned after the Hwange coal plant in 1988. In addition, all coal powered stations in the country are in need for upgrading and electricity imports are not enough to meet the demand.

In terms of policy and general energy strategy, the Zimbabwean government's intention is to build another coal-fired plant, increase capacity at the existing Hwange and Kariba power stations. These plans have been held back by lack of resources and in September 2011, a power conference was held in Harare with the aim of attracting potential funding sources (Energypedia.info, 2020). Energy consumption in the country may generally be split into three user categories, industrial, commercial and residential. In larger urban settlements, the industrial and commercial energy users are guaranteed electricity supply for their business purposes. In the event of power disruption, they will usually have backup systems powered by fossil fuel energy sources (diesel and petrol generators). The third category of users, the residential zones, primarily depend on electricity as an energy supply for cooking, lighting and general household chores and maintenance. These are the zones within urban and rural areas where grid-based electricity has become a challenge.

In developing sustainable urban energy mix models for the future, it is important to factor in the trending concept of resilience and also to clearly estimate the future role of the urban planner in terms of facilitating alternative urban energy mix models. Resilience is the ability of any urban system to maintain continuity through all shocks and stresses while positively adapting and transforming towards sustainability. Therefore, a resilient city is one that assesses, plans and acts to prepare for and respond to all hazards, either sudden or slow-onset, expected or unexpected. By doing so, cities are better able to protect and enhance people's lives, secure development gains, foster an investible environment to drive positive change (Unhabitat.org, 2020).

Urban planning has been responsible for developing the very settlements, demanding energy supply for their functioning. In Zimbabwe's case, these urban settlements have access to 80% of energy supplied (Energypedia, 2020). Thus, it can be extrapolated that the energy crisis in Zimbabwe, at its base is the resultant manifestation of the effectiveness or ineffectiveness of urban patterning strategies and this has a key impact on the degree of resilience that these settlements will have. Government strategies have been solely based on expanding the capacity of existing energy generation without paying attention to the consumption patterns as dictated by urban land-use patterns (Energypedia, 2020). What is required now is the presentation of alternative solutions and this is where key research institutions like the DRUP-UZ must come to the forefront and present alternative urban models that have alternative energy consumption dynamics. Thus, the proposed inception of the DRUP-UZ Urban Research Town.

LITERATURE REVIEW

Innovation has long been recognised as an important driver of economic growth. Empirical research and surveys of business activities show that innovation leads to new and improved products and services, higher productivity and lower prices. As a result, economies that have consistently high levels of innovation also tend to have high levels of growth (Atkinson and McKay, 2007). Innovation lies at the core of economic growth, job creation and quality of life improvements. Research and development (R&D) may be put into three broad categories. Basic research involves discovering a fuller base of knowledge without specific applications to products or

processes. Applied research uses new discoveries to determine what could be developed into products or techniques to meet specific needs. Development then seeks to put new discoveries into production, including the development of prototypes (Joint Economic Committee Democrats, 2014).

In terms of the total dollar amount, the United States spends more on research and development than any other country (*ibid.*). The results of this spending are clearly evident in products and services offered in its economic spectrum. One of the drivers of this level of innovation are the state and regional based innovation clusters. These clusters are built around the unique strengths of a region and comprise firms and industries that do business with each other and have common needs in terms of technology, talent and infrastructure. Such clusters draw on the expertise of local universities and related institutions, which serve as centres of innovation and drivers of regional growth. Examples include the life-sciences clusters found in the Raleigh-Durham and in the Pittsburgh/Akron/Cleveland regions and the information technology/aerospace cluster found in Seattle/Tacoma/Olympia region (National Science Board, 202020).

In commenting about the shortcomings of a report entitled "Our Cities", Lewis Mumford had the following to say:

> "Happily, it is not too late to make good this deficiency. Before too many billions of dollars are sunk in cramped misplaced housing, misconceived road systems funnelling into the metropolitan areas, extravagantly extended suburbs and mis-planned slum clearances and rebuilding's, it is well for those who have not read Howards book, or have not grappled with it, to go carefully over his thesis and to absorb all its implications. This is not merely a book for technicians: above all it is a book for citizens, for the people who actively expressed needs, desires and interests should guide the planner and administrator at every turn" (Mumford as cited in Howard, 1970:40).

Lewis Mumford, one of the most prolific contemporary urban planners gave serious credence to Howards work as one of the most insightful holistic urban planning theses of our time. Howard was an inventor. The inventor proceeds by first conceiving an idea of a possible new product or instrument, next by

evolving the design on paper with patient thought for the adaptation of the structure to the conditions it has to fulfil and finally by experimentation with models to test the design in practice (Osborn as cited in Howard, 1970:21). Howard attacked the whole problem of the city's development, not merely its physical growth but the inter-relationship of urban functions within the community and the integration of urban and rural patterns, for the vitalisation of urban life on one hand and the intellectual and social improvement of rural life on the other. He also saw that there was no solution to the city's problems within the existing framework of municipal administration, because one of its greatest problems was the lack of economic and social and political relation to the surrounding countryside. Here, his vision was far clearer than the vision of those municipal reformers and the housing experts who had been absorbed in some single aspect of urban development and forgotten the larger situation of which the narrow problem they have chosen to solve is part of (Mumford as cited in Howard, 1970:35-36). In developing the garden city concept, Howard did, in fact, develop and implement the first holistic urban planning applied research and development experiment of contemporary times. This experiment covered all aspects of urban planning. It involved the design of infrastructure, socio-economic patterning and also local governance structures. He made far-reaching assumptions which a cautious student would not immediately accept and he made no attempt to substantiate them by a parade of authorities and statistics. His assumptions were, in fact, almost wholly right, because they were based on a wide sympathy with the habits and desires of common people. It was by unselfconscious common sense and humane understanding, rather than by systematic fact-finding and analysis, that Howard got to the heart of the urban problem (Osborn as cited in Howard, 1970:10).

Very few people, including contemporary urban planners, can fully grapple with Howard's proposals and their implications. Osborn and Mumford, in their introduction to the 1970 edition of *Garden Cities of Tomorrow*, provide a profound exposition of the gravity and implication of focused independent applied urban research and development experimentation and its impact of future urban planning practice. The success of the proposed research town will be critically pivoted on the basis of viewing the development of alternative urban energy mix solutions within the context of the whole town and not as a

separate and isolated urban challenge. It is this holistic approach that made the garden city experiment a success.

The theory of diffusion of innovations states that the diffusion and adoption of any new technology or innovation spreads through five distinct groups (Rodgers, 2003). The first group to adopt any new technology are the innovators. These represent 2.5% of the population. The innovators represent that quota of a population that is always pushing the boundaries by testing out new ideas and products. The second group to adopt new technologies are the early adopters. This group represents 13.5% of the population. This group adopts technologies whilst they are still in their early maturity. The third group in the technology adoption trail are the early majority. This group is willing to adopt new technology as it becomes mainstream. The early majority represents 34% of the population. The late majority, that is the fourth group, adopts technologies, due to the fact that they have become mainstream and dominate the market. This group also represents 34% of the market. The fifth group, the laggards, is the last group to adopt technologies. This is primarily due to the fact that previous models of technology that they were using are out of the market or there is no more product or service back-up for them. This group constitutes 16% of the population (Rogers, 2012).

In developing the concept of the research town, it will be important to identify and work with the innovator group. This group will include researches and potential town residents. This group will be where the greatest benefit from urban experimentation will be derived. From a research perspective, this group will provide the bedrock for the latest technological adoptions and innovative urban development models. From a resident perspective, the development of the research town will attract a population that will engage in new models of lifestyle and urban enterprise. From a local population perspective of 14.44 million (World Bank, 2020), this research facility could attract a potential 361,000 participants.

The research town can also be explained and justified from a supply-demand perspective. From Rogers's theory of diffusion of innovations, 2.5% population market demand of innovators already exists. To meet this innovation demand, a supply of space upon which these innovations can be

experimented upon is required and this will be in the form of the proposed DRUP-UZ Research Town. Once such a facility has been developed using an appropriate model, the innovative community will by diffusion naturally gravitate to where their demand is satisfied.

In developing new urban energy mix models for the future, it is important to shift the existing frame of reference regarding urban energy supply. The great changes in science have all been not the result of a particular discovery but the result of a shifted frame of reference (Kline as cited in deBono, 1985: 139). Shifting the frame of reference is shifting the frame of perception (deBono, 1985). Therefore, moving into the future onwards, the perception of urban energy supply must shift. This is where the need for lateral-thinking steps in. Lateral thinking is a system of thinking that allows perception to move away from existing patterns of thinking. The key point about lateral thinking is that existing concepts, perceptions and structures are a summary of history, rather than a blueprint for the future. So, it may have to cut across and break out of patterns before putting things together in a new way (deBono, 1985).

In the existing information universe, past events inform decisions that have to be made in the present concerning the future. This then traps solutions into a decision loop based on historic events and consequently the assumption that "what worked, in the past, will work again today for the future". In essence, "judgement" is used to determine whether a solution fits a historic pattern. However, lateral thinking breaks away from historic information loops, allowing new ideas and solutions to begin to present themselves. One of the tools used for lateral thinking is provocation. The essential point of provocation is that there is creation of movement away from judgement to new ways of thinking that offer solutions (*ibid.*). This provocation (PO) is usually created by developing a scenario that requires non-conventional solutions. However, in this case, **PO** instructs and allows the thinker to move beyond existing frames of reference. This shift of frame of reference at its most fundamental base allows any situation to be viewed as an opportunity towards moving to an alternative way of doing things. With regard to developing a more viable energy mix for the country, two provocations are stated:

PO_ *Zimbabwe energy crisis is an opportunity to develop alternative urban models with new energy sources.*
PO_ *The pressure of climate shift is an opportunity to develop alternative future urban models that have higher resilience.*

To develop effective future energy solutions, it is critically important to move away from judgement and decision-making based on historic decision loops and adopt provocation as a strategy for lateral-thinking that gifts urban planning the tool of movement to arrive at new paradigms of thinking. This new level of thinking must be developed systematically. de Bono is one of the pioneers of modern-day systems that teach on lateral thinking. The training on "thinking to solve challenges" should be the first step in attempting to solve the challenge. Having developed the concept of lateral thinking, de Bono's work on how people think has been published in numerous books that have been translated into many languages. His programmes for the teaching of thinking have proven very popular for use in many countries across the globe, including Argentina, Venezuela, the USA, Canada, Singapore, Australia and New Zealand. Furthermore, he holds professorial positions at top universities in the world, including Oxford, London, Cambridge and Harvard University (Kivunja, 2015).

What is essential in Zimbabwe is a platform that has both the mental acumen and latitude to test out all the possibilities and potentials presented within the alternative energy arena with the intent of developing solutions that work for the country. Secondly, critical to this endeavour is the ability of researchers and scientists within the country to use lateral-thinking techniques to further broaden their solution perception horizon. In this regard, training in lateral-thinking techniques, as developed by modern psychological-based practices, is imperative.

METHODOLOGY

The data utilised included a desktop review of key global energy statistics, online publications and existing local spatial development literature. First, a background of global and local energy mix patterns was given. This was followed by literature review of the importance of research and development, lessons derived from Howards Garden City model (Howard, 1902), the

significance of the diffusion of innovations theory (Rogers, 2012) and finally provocation as a concept of lateral thinking (deBono, 1985). A case study of local attempts to develop alternative energy mix solutions is undertaken before the conceptual and theoretical framework for the DRUP-UZ Research Town is presented followed by the discussion.

The Zimbabwe Energy Regulatory Authority (ZERA) began work on solar energy generation with 39 approved projects of which 6 were operational in September 2019. This came at a time when power-cuts were the order of the day, due to obsolete equipment at thermal power plants and low water levels at the Kariba Dam. The Cabinet approved the implementation of a large-scale programme to promote the importation, local production of solar equipment and the use of solar power as an alternative energy source. Therefore, special incentives through duty waivers on imported solar equipment are currently in place whilst all new construction projects are to be solar-powered. A number of companies, such as Matshela Energy, Harava Solar and Centragrid, are working on solar projects to alleviate power shortages, that have impacted domestic and commercial power users. Centragrid, that is based in Nyabira, about 40km from central Harare, has started feeding 2.5MW into the national grid, which can provide power to 1,200 households. Harava Solar expects to commission its 20MW project in December 2020. The Zimbabwe's Energy and Power Development Minister Advocate Fortune former Chasi had indicated that airports across the country would soon be powered by solar to reduce pressure on grid electricity (esi-africa.com). In 2019, the Infrastructure Development Bank of Zimbabwe began seeking partners for the development of seven solar parks plus two mini hydro-electricity plants (pv-magazine.com, 2020).

The alternative energy solution direction that the Zimbabwean government has taken has been that of seeking to boost existing generation capacity (Energypedia.info, 2020), the commissioning of new solar projects and the seeking out of new partners in the energy sector. Thus, its focus has been on energy source generation with no attention of consumption patterns and investing in research and development of alternative energy sources. In a nutshell, there is an absence of looking at the current energy challenge from a

"total urban challenge" perspective that requires research and development into alternative urban models with new energy sources.

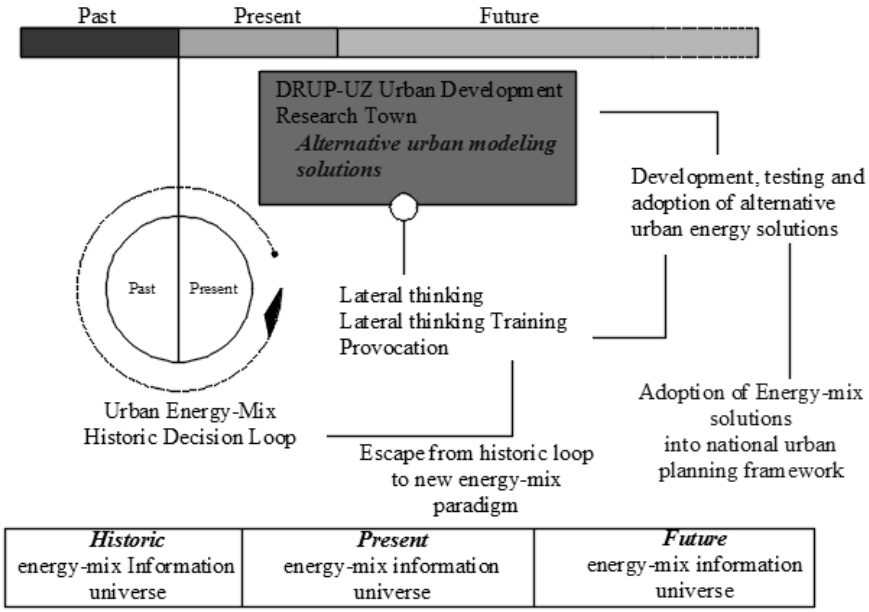

Figure 1: Role of research town in developing energy- mix solutions for Zimbabwe

The Research Town is proposed to be developed as a testing platform for possible urban challenge solutions with energy mix at the core. This will be a normal, practical real-time town that provides urban living, with the only proviso being that all activity within is an alternative to conventional urban life. With this in mind, the aim of the town will, thus, be to research and develop alternative solutions to challenges being faced by the existing conventional urban settlements. In this regard, it will accommodate all aspects of urban research but at its core will be the urban mix agenda as this is the powerhouse of the settlement. The simplistic and paradoxically complex vision of the research town can be encapsulated in the question. Why continue to expand existing settlements fully knowing that with each square kilometre of

urban expansion the challenges attributed to the existing urban model proportionally increase?

The core design and development strategy will be predicated on the thesis of innovation. Thus, from its design, development and management; the research town will be based on new development paradigms. This breaking away from convention will be visible throughout the entire design spectrum from innovative land tenure systems (based on use right, rather than ownership right) to municipal administration protocols. This strategy is aimed at attracting and facilitating the innovator population with special attention on private sector participation which invariably translates to a more focused approach towards public participation in terms of investment potential from groups and individuals. This approach will guarantee a unique profile of researchers, resident population and entrepreneurial interests. The success of Howard's Garden City Model was pivoted on its ability to attract strong benevolent private sector interest and offer affordable and innovative security of tenure. The proposed research town will replicate this approach to attract researchers, resident population, research entrepreneurs, philanthropists and financing.

Before delving into the theoretical design of the proposed DRUP-UZ Research Town, it is of the utmost importance to illuminate to the reader the futuristic energy mix trajectory of research and development agenda posited herein. Current global alternative energy development solutions are focusing on renewable sources, such as biomass, solar, geothermal, wind and marine potential (World Energy Council, 2016). However, the leading edge of renewable energy research is tapering towards perpetual free-energy sources and, a particularly interesting example, is the perpetual magnetic engine.

Published in the November 13 2017, article of the *Power Electronics Technology* e-magazine (Powerelectronics.com, 2020), the theoretical functioning of perpetual magnetic engines could soon become a reality. This technology, once perfected, will effectively render obsolete all previous models of power generation. The theoretical operation of this revolutionary engine is the use of the push-pull properties of magnetics to turn a shaft that would then be used to generate electricity. On a large scale, this would replace the need for steam, hydro-motion or nuclear energy to turn turbines that generate

electricity. This magnetic propulsion concept could be miniaturised to create engines small enough to power households and neighbourhoods and even vehicles. Figure 2 illustrates the theoretical operation of the magnetic engine.

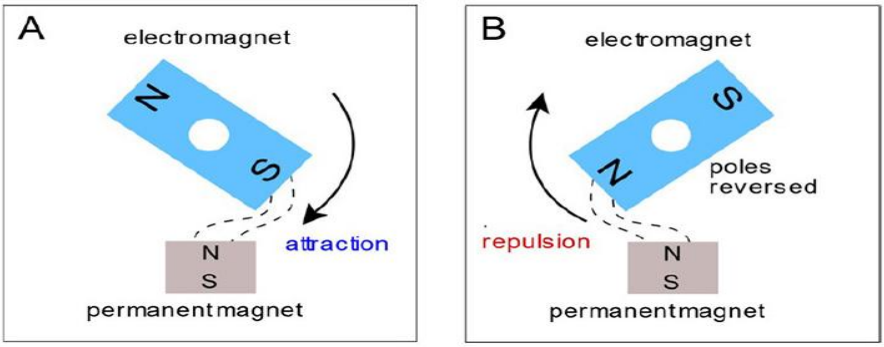

Figure 2: Theoretical Operational Principles of Perpetual Magnetic Engines. (Powerelectronics.com)

The testing and adoption of current alternative energy solutions (solar, geothermal, wind and marine) and facilitation of leading-edge energy research, such as the viability of the perpetual magnetic motor, will be the hallmark of this ground-breaking urban research facility. Thus, the core research agenda of the research town will be the development of alternative energy mix solutions.

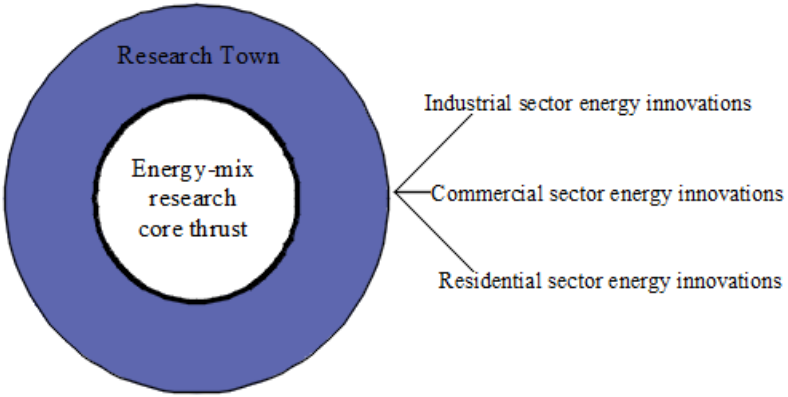

Figure 3: Energy Mix Research and Outputs

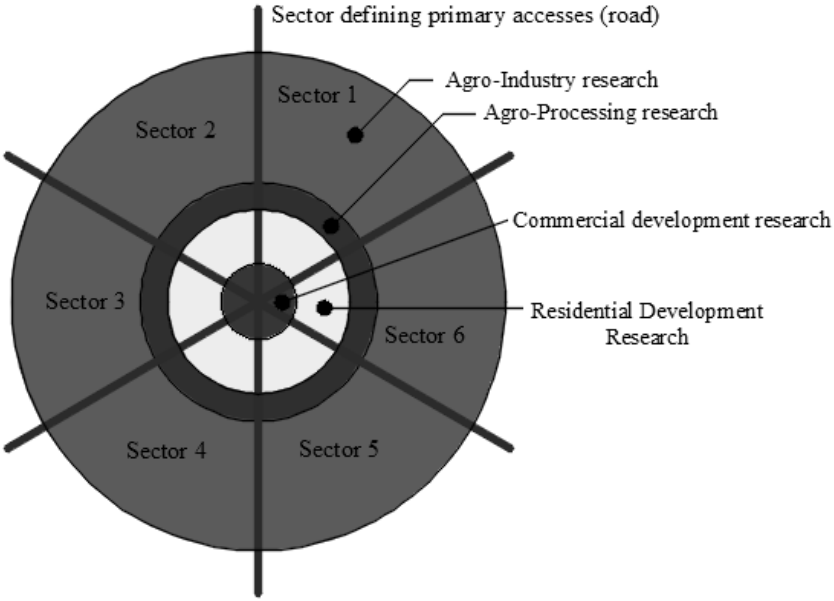

Figure 4: Theoretical Research Town Design

In terms of developing an urban research model, a strong precedence has already been set by Howard's Garden City Model. The proposed urban research town will replicate the garden city model by revolving around a sector-based design that creates zones for different energy mix research agendas. As with the garden city, the proposed size of the site will be 2,400ha with 2,000ha apportioned to agro- and agro-based industry energy mix research and the remaining 400ha designated for urban energy mix research (residential and commercial). The significantly larger proportion designation to agro-related industrial energy research creates opportunities for new industry development which will act as an urban magnet for the town.

An existing urban challenges inventory of towns and cities in the country will be used to develop the alternative models that will provide solutions. Furthermore, by identifying the Innovators population in the country and combining it with the towns' core development guidelines, the inception of this proposal will invariably create a scenario where high incidences of

innovation can occur with the key fact that innovations will be tested out on a real-time urban population. American research universities have been a model of innovation throughout the world, addressing complex economic, social, scientific and technological problems (Cole, 2010). Universities contribute to the quality of the economic infrastructure in a state or region by developing knowledge-linking activities that enhance the commercialisation of new technologies, support organisational and community change and assure the production of competent workers and professionals (Walshok, 1997). In this regard, local universities must follow suit by being at the front of developing not only solutions but equally acting as facilitators of innovation.

DISCUSSION

At first glance, it would seem that the magnitude of what is proposed here might seem eccentric and even unobtainable. However, considering the magnitude of the challenge that climate shift and urban energy deficit has presented to urban functionality, it is only courageous that present and future solutions must be equally magnanimous. The development of future urban energy mix solutions must in all attempts, eclipse the current challenge with their resolve. Key events of the past century have subtly colluded to the proposal contained herein the inception of Howard's Garden City Concept in 1903 (Howard, 1903). The fast-track land resettlement programme which began in 2000 which effectively shifted the majority of land ownership to the state; he onslaught of climate shift and its impacts and the beginning of the fourth industrial revolution in 2012 (World Economic Forum, 2017). Viewed in isolation, these events confound the mind and create the image of the worlds end. However, if viewed as integral pieces of a puzzle, pointing at the development of new urban models, a light of hope begins to shine across the mind. In continuing this discussion, the following provocation PO is presented:

PO_ *All cities are experiments!*

African history has been experimenting with various city models since the dawn of time with examples, such as Meroe 1069-350BC (ancient.eu), Timbuktu 1400-1600 AD, Gao 700AD (Encyclopaedia Britannica, 2020a,b0) and Great Zimbabwe 1300-1500AD (Andrews, 2018). Uniquely provocative to the Zimbabwean context is that we live in the shadow of one of the greatest ancient cities (Great Zimbabwe) in world history and yet today the country

finds itself in a quagmire of how to solve contemporary urban challenges. Urban design and development are intrinsically an African legacy and it is time to claim this rich heritage with a contemporary research town that will be at par with or eclipse the precedence left by ancient African civilisations. The proposed research town not only offers a platform for researching future energy mix solutions for local needs but also displays strong potential links for regional and global participation. In this new global age, the proposed research town can become an ultimate tool for diplomacy with its potential ability to bring together global resources with the aim of developing solutions for the world. This research facility will also function as a real-time record of the attempts, success and failures of the country on the road to developing alternative energy mix solutions. The acceptance, adoption and development of the research town proposal will require an unprecedented level of cooperation and commitment from all sectors of the country. If the country is to move towards providing solutions for future energy mix solutions, facilities, such as the DRUP-UZ Research Town must be considered a priority.

CONCLUSION

The true strength of urban planning as demonstrated by Howards Garden City Model is that it can facilitate the adoption of new ideas in an effort to solve existing challenges. Today, the challenge is one of devising alternative urban energy mix solutions. The DRUP-UZ Research Town will be a contribution towards this goal from a research institution perspective. The essential idea here is to experiment and to experiment boldly. Moving into the future, local urban planning practice must begin to use such research platforms to develop new and innovative urban packages that solve, in an all-inclusive way, not only housing and employment, but also prevailing and future energy needs.

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