An eco-efficient and sustainable Urban Unit in Africa

"Design for an eco-efficient and sustainable town of the future"

Niels J. Kropman

A sustainable outcome of the world's urbanization process is largely dependent on what happens in cities in the developing world. Developing countries will triple their entire built-up urban area by 2030, at astounding speeds and with significant resource constraints. According to the World Bank, developing countries' newly constructed urban areas in the next thirty years will be equal to the world's total built area as of 2000. At the same time the climate is undergoing changes we are only just beginning to understand and comprehend. There is more and more proof we are on the verge of a big change in climate on a global scale. Rising temperatures because of the increasing level of carbon dioxide and other less familiar greenhouse gasses in the atmosphere and because of that more intense rainfall in some area's, intensive droughts in others and rising sea levels worldwide, add to the intensity of the call for increased carbon neutrality. Next to the changes in climate we slowly but surely start to acknowledge that the worlds resources are not infinite in their supply and with over 6,5 billion people inhabiting the world today, all aiming to achieve more material and immaterial wealth, the resources in the world could be finished much quicker than expected. The average ecological footprint of the inhabitants of the more developed nations is much higher than on average is available for every member of the world population. The knowledge the world's resources are definitely not infinite, adds to the call for a more eco-efficient urban society. The effects of climate change combined with the predicted population growth will have a greater effect on the African continent than anywhere else.

The world as we know today is divided in a more developed and richer part of the world and the so called developing countries, the lesser developed and not so wealthy part of the world. Lots of countries in the continent of Africa are so-called developing countries and are showing above average economical growth. But climate change is a major threat to sustainable growth and development in Africa. Although Africa is the continent least responsible for climate change, it is particularly vulnerable to the effects of climate change, including reduced agricultural production, worsening food security, the increased incidence of both flooding and drought, spreading disease and an increase risk of conflict over scarce land and water resources. The effects of climate change threaten the development of the continent both economically as socially. In order to deal with the imminent problems caused by climate change and to reduce carbon emissions as part of the world effort there is a call for more carbon neutral and sustainable urban development.

The continent of Africa houses at the moment about 14,5% of the world population, about 973 million people. The population on the African continent will continue to grow and the predictions are that by 2050, 19,8% of the world population will be living in Africa amounting to about 1.766 million people. All those people will, of course, be aiming to achieve more material and immaterial wealth and cities on the continent will be growing immensely because of the increased urbanization. To indicate the increased process of urbanization: in 1950 only about 14,5% of the population in for instance sub-Saharan Africa lived in a city. In 1980, this percentage increased to 28% and in 1990 to 34%. It is expected that by 2020, 50% of the population in sub-Saharan Africa will be urbanized and in 2025, this figure will be at 60%. This process is indicative for the whole of the developing world. Developing countries will triple their entire built-up area by 2030.

This process of rapid urbanization will increase demand for resources immensely, if combined with the world's demand for resources and the fact that the continent is a big exporter of resources to other countries. Secondly this process will increase the amount of greenhouse gases pumped in the air significantly and this will speed up the imminent climate change. To summarize the before mentioned trends will increase the ecological footprint of the average inhabitant of Africa immensely and combined with the fact our resources are not infinite and the effects of climate change will be very problematic for the African continent, adds to the call for a more eco-efficient society and urban environment with extra attention on social sustainability.

The paper will first introduce and present a fictional design of a new urban settlement solely based on the principles of eco-efficiency and carbon neutrality. The future urban settlement will, next to using "green" energy, utilise the landscape, local environment and climate and pay special attention to available services, infrastructure and networks and community development, in order to achieve its main goal: being a fully sustainable city for the future, both ecologically and socially. Next the paper will describe the implementation of this fictional new urban unit in Africa and which choices are to be made.

The Urban Unit, eco-efficiency and CO2-neutrality are the framework of the design.

In order to design an urban settlement ready for the future, which is eco-efficient and carbon-neutral, we have to first identify the main flows which define the location of a city. Since early mankind started to live in cities they settled at and around focal points of transportation. Crossroads and waterways where common locations where the cities of old emerged. In itself a city is a focal point or hub, it's a hub of all the different flows needed by the inhabitants of a city to maintain themselves. With this knowledge we have identified the framework for the future city or Urban Unit. In modern times you can identify three different flows, which together form the framework for a city. The framework consists of transportation, energy and information. In order to design the new Urban Unit of the future we first need to apply the concepts of eco-efficiency and carbon-neutrality to the elements which form the framework. This combination of theory and framework will provide the basic design principles to design the Urban Unit ready for the future.

A more sustainable society needs to be more eco-efficient. When you think for instance of a city as having an industrial metabolism, it could be compared to a large animal grazing in its pasture. Just like the animal, the city consumes resources and all this energy and matter eventually passes through to the environment again. Then the ecological footprint becomes: "how large a pasture is needed to support the city indefinitely to produce all its food and to assimilate all its wastes sustainable". The average footprint (pasture) of the human world population is bigger than the available productive land (in 1st world countries significantly higher than in 3rd world countries). In order not to deplete the world's resources we need to be more eco-efficient to balance the cycle of resources and waste again. This is especially the case if you take into account the rapid urbanization in the 3th world countries, this will put even more pressure on the world resources. And the effects of climate change will reduce the availability of agricultural land, of course this will effect 3rd world countries, with their huge population increase, greatly. Secondly, the waste people produce at the moment cannot be assimilated into the natural cycle and is instead toxic or damaging to the environment.

In short there is a sustainability gap and ecological deficit. In order to close the gap and reduce the deficit, we should reduce the amount of resources used by society and also produce waste that can be part of the natural ecological cycle. Using local available resources, locally produced food, reducing transportation distances and manufacturing

goods with sustainable production methods will reduce the sustainability gap or ecological deficit. The Urban Unit will be designed with maximum eco-efficiency in mind.

Carbon is the backbone of our modern economy. Energy consumption and production have been the motors of material wealth in the world and have enabled our current lifestyles. But carbon is also the main reason for one of mankind's challenging problems: the imminent climate change because of the emission of greenhouse gasses. The economic dependency and the expected serious environmental impacts of climate change put our quality of life at risk. Fundamental reforms to build a low-energy and low-carbon economy are, therefore urgently needed. If we look at the problem of carbon emissions we could conclude that urbanization is a threat. Cities, although just 2% of the world surface, are responsible for two thirds of the global energy use and are thus the major contributor to the emissions of greenhouse gasses and climate change. The increased and rapid urbanization, combined with the population growth in 3rd world countries will increase the carbon emissions greatly if we don't take steps to reduce the effect.

But on the other hand the urban environment offers great opportunities in order to reduce the amount of greenhouse gasses en lower the energy use in the world. Because of the higher density of people the net effect of energy consumption reducing measures will be higher per capita of city resident. By limiting energy usage and emissions from transportation (walking, using bicycles or public transport, avoiding flying, using low-energy vehicles), as well as from buildings, equipment, animals and processes and by obtaining electricity and other energy from a renewable energy source (solar energy, wind energy or sustainable biofuels) we could achieve carbon neutrality. When applied to the urban environment we could achieve remarkable results. The Urban Unit will therefore be designed with carbon neutrality in mind.

The idea was to create and plan an innovative and communal Urban Unit for the future, capable of housing 20.000 inhabitants. This poses the first question: "how to design a city for 20.000 people? The design is based on short distances between the different functions and high densities. Another design principle is to recreate the link between the town and its surrounding landscape. And in order to reach carbon neutrality the Urban Unit is designed with reducing energy use in mind. By reducing the distances people, goods and information need to travel, lower energy use and by changing the modus of transport we can lower carbon emissions. The Urban Unit will be designed in a grid structure where the grid is not meant for streets but for slow traffic, public space and water. This grid will then be adapted to fit the surrounding landscape and a more organic city will emerge. The plentiful open spaces are available for different utilities such as sport fields, playgrounds, urban farming and community gardens. The centre of the Urban Unit will be the central park with its underground infrastructure hub and railway station. The park also offers room for space demanding (public)services like schools or a library. There will also be a marketplace, which is mainly supplied with goods from the surrounding area. The surrounding landscape will not only provide local (food)products but also the building materials and energy. Furthermore the landscape will provide the blueprint for the design in order to re-establish the link between city and its surroundings. Connections with the outside world are vital for a town of 20.000, therefore the Urban Unit will always be developed alongside an existing or newly build transport corridor. To transport goods to the Urban Unit a logistics system will be realized in which goods from the surrounding area are favoured, through financial incentives, over goods from further away. But carbon-neutrality and eco-efficiency cannot be reached by implementing measures in the physical environment alone, it also needs to be a way of life. Therefore the collective conscience and mind of society also needs to change and the future inhabitants of the Urban Unit need to be educated and stimulated to participate in order

to increase awareness. Stimulating participation will also increase the community-feeling and this will in turn increase the urban cohesion and identity. A sustainable city is a place with a good urban cohesion and a strong identity on every level of the city, in short this means a safe and liveable city for every inhabitant. A strong urban cohesion is strongly related to the available services and public services. Therefore it is vital that during the realisation of the Urban Unit, during every stage of development, enough and the right kind of services are provided. A second important element of cohesion and identity is the public environment. The environmental friendly principle will be expressed in the design of the public space, which is aimed at creating a park-like character with gardens. These gardens will partly be used by the inhabitants as extensions of their garden. Furthermore decentralised management of the remainder of public space, shared ownership and shared responsibility will guarantee commitment to maintain good quality and will increase awareness and participation even further. The design will ensure there is room for meeting each other on every level of the Urban Unit. As stated before the Urban Unit of the future will utilise the landscape, environment and climate in order to fully achieve its main goal: being a sustainable city for the future. The shape and form of the landscape will for instance determine the exact form and shape of the Urban Unit. Natural boundaries like roads, hills, valleys and waterways together form the blueprint of the Urban Unit. Lastly but not lastly we need to take the climate into consideration. The amount of sun or the average velocity of wind will determine which method of generating energy will be preferred. Average rainfall a year and the number of times there is peak rainfall will determine the area needed for water retention and water reservoirs. Some water elements in the Urban Unit will help to clean the runoff of roads and roofs by reserving space for helophyte filters. In order to achieve a carbon neutral, eco/efficient and fully sustainable city the landscape, environment and climate will influence the design greatly.

The earth and the sun generate more than enough power for everybody to use.

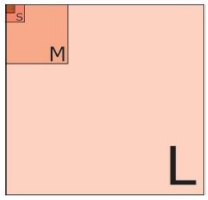
The energy system used in the Urban Unit will be a fully electrical system. The earth and the sun generate theoretically more than enough power for everybody to use. At the moment the most efficient methods of harnessing this power generates electricity. The energy system itself consists of two important elements: the part generating the energy and the part transporting this energy to its users. To distribute the energy the Urban Unit will develop a smart grid. A smart grid includes an intelligent monitoring system that keeps track of all electricity flowing in the system. It incorporates the use of superconductive transmission lines for less power loss. When power is least requested, for instance at night, a smart grid can turn on selected home appliances such as washing machines or factory processes that can run at arbitrary hours. When there is peak demand for electricity it can turn off selected appliances to reduce the overall demand. To further flatten the peaks in energy use, the energy still stored in the batteries of electric cars when people come home after work can be used to power electric appliances. Later in the night, the available excess power will be used to charge the car batteries again. The energy will be generated with the use of renewable energy sources such as solar energy, wind energy and biogas. Methane biogas made from manure, also known as “cow power”, can be produced in the landscape in which the Urban Unit is located. Cow Power tackles more than one problem at a time, it uses the not needed excess manure for generating energy. The cows needed to produce the manure can also be used as food and as a source of resources (like leather) and lastly the farmers have an extra source of income. Manure from different animals can be used to generate energy but also “normal” waste can be used to generate energy. Cow manure though has the best energy value and the availability of “normal” waste will reduce in the future because society will be recycling and upcycling more and more products. Solar power will be used in a conventional way, by putting solar panels on buildings. Dependent on how many

hours of sun the Urban Unit yearly receives this could supply a lot of energy. The amount of available solar energy depends greatly on the local climate. Apart from harnessing the power from the sun through the use of solar panels the Urban Unit will also use the available road space and harness its potential power.

Design phase 1

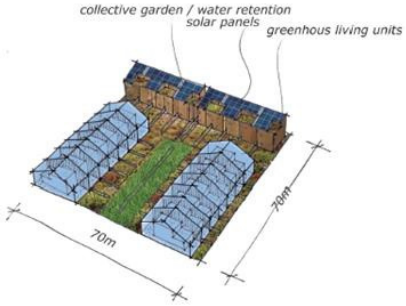
A modern city needs to be build around a framework consisting of the energy, (public) transportation network and information network. In order to guarantee a liveable and enjoyable city from the start, the new town needs to be connected to these networks right from the start of development. Therefore when building the Urban Unit the development will start with building the local energy network and connecting it to the national grid, realizing connection with the data-highway in order to supply every future inhabitant with high-speed internet and implementing the public transport in several stages (for instance start with adequate fast bustransport ending with the realisation of the railwayconnection).

The basic building blocks for the Urban Unit consist of four different building blocks called XS units. Each block focuses on a different type of building or function and corresponding density. The following types are used: apartments, rows of houses, single houses or workplaces & light industries. One single building block measures 70 x 70 metres and as such forms the basic and smallest part of the designed Urban Unit. On average the apartment block will house approximately 150 people, the row of houses 50 people and the single houses will house 25 people. By combining different basic blocks we can create different neighbourhood types which vary in density and building typology and maximize mixed-use .

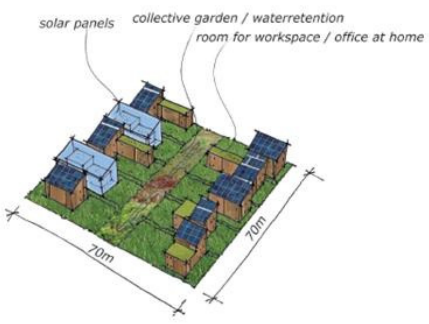


concept: XS/S/M/L

appartments / lofts (50%)



rows of houses (25%)



single houses (10%)

workplaces & light industries (15%)

Urban Unit 1st design phase, XS building blocks

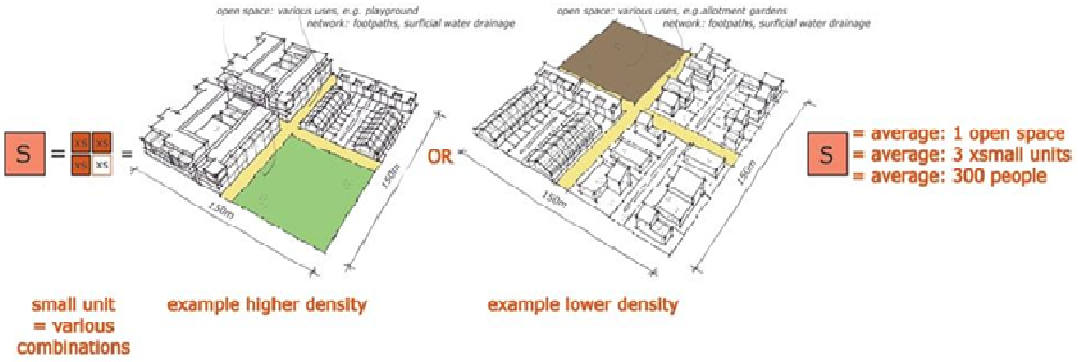
The bike and walk ways in the Urban Unit will be constructed with a new kind of solar cells specifically designed for use in roads. This technique has enormous potential if you consider all the roads available in the Urban Unit. Furthermore the highway, which will be located beneath the Urban Unit, will be constructed with the newly developed electricity generating asphalt. The system works by embedding tiny piezoelectric crystals into the road. When cars drive over the crystals, they are 'squeezed' and thus generate a small electrical charge. A 1km stretch of the power-generating asphalt can in theory generate upwards to 400kWh. The power from the wind will be harvested by using large and small windmills. Because the public is much against the big and powerful windmills, because of aesthetic reasons, they will be located in the landscape surrounding the Urban Unit. The landscape will be used to lessen the visual impact from the big windmills. The bigger mills can easily generate 5 MW electricity each. Inside the Urban Unit the power of the wind will be harvested by placing smaller windmills on top of the buildings. These smaller versions are specifically designed to be used in urban environments. Just like with the power of the sun the climate will determine the potential usage of the energy of the wind. The benefit of wind energy is that it consumes no fuel and emits no air pollution unlike fossil fuel power sources. The energy consumed to manufacture and transport the materials used to build a wind power plant is equal to the new energy produced by the plant within a few months of operation.

Most important and basic functions in the Urban Unit of the future are housing, work areas, services and recreation.

In the Urban Unit we identified four different functions, namely housing, work areas, services and recreation. These functions are mixed throughout the Urban Unit. Every building in the Urban Unit will have an extra function, namely energy production. The rooftops of the buildings will be covered in solar panels and on strategic places small windmills will be installed. This way every building will produce energy for its inhabitants and users, they are all small energy plants. This will greatly reduce the carbon footprint of the inhabitants. The Urban Unit will have three main types of housing, apartments, rows of houses and single homes. The basic apartments will be around four stories high and the three upper levels will accommodate around 60 lofts or apartments. The ground floor will accommodate shops, services and office space. The ground floor will be designed with maximum flexibility, in layout and construction, in mind in order to accommodate more apartments in the ground floor when needed. Of course this also works the other way around. The apartments on the south side of the building will make extensive use of glass in order to maximize the power of the sun. The balconies will be like small gardens to be used by the inhabitants of the apartment of loft. A bigger collective garden will be located in the middle of the building, a perfect place for the children to play for instance. The rows of houses will be a mix of normal houses and greenhouse living houses. In the centre between these housing types there will again be a collective garden for the inhabitants to use. The gardens will also be part of the water system and are designed with water retention in mind in order to deal with the increasing amount of peak rainfall. The last typology of housing is the more traditional single home. Just like the rows of houses there will be a collective garden for the inhabitants to use, which also serves as water retention element. The houses itself are designed to accommodate mixed use and promote working at home. Therefore each house will have a dedicated space designed as a office at home. In the Urban Unit there will be specialized areas for workplaces and light industries. Because some businesses should not be located in areas with lots of housing they have their own area. This will still be inside the city easily reachable for the employees. The buildings in these areas are designed to be flexible, possible room for expansion has already bin taken into account. The private space around each building is again connected to the water system of the town and will be designed with water retention in mind. Furthermore the availability of high-speed internet connections will

stimulate working at home, this way there will be less need for the inhabitants to commute. The more people work from their own home, the less carbon they generate by commuting to work. Every single-house in the Urban Unit will therefore have a dedicated area for working. Furthermore offices, businesses and (public) services will be housed in the ground floor of the apartment building. Because of the small scale of the basic building blocks, mixed use will be maximized. Inside the Urban Unit there will be no room for the more heavier industries, those kind of workplaces will have their own dedicated space outside the city. From the start of developing the Urban Unit there will be enough room for the needed (public)services, businesses and shops. Design of the buildings has maximum flexibility in mind, if needed apartments can be joined or separated or transformed in extra office space or shops. The other way around is also possible. Design of the workplaces and light industry buildings also has maximum flexibility in mind, if needed they can be expanded easily and this of course works also the other way around. The design of the Urban Unit offers enough open spaces where there is room to realize services like schools, libraries, city-hall and for instance a swimming pool. The number and types of services will grow over time parallel to the growth of the Urban Unit. The Urban Unit is almost completely car free so it will be perfect for people to enjoy biking, inline skating, jogging or other recreational activities. There will be enough parks, bike paths and walking paths connecting the Urban Unit with the surrounding landscape. Also some open spaces in the design are dedicated for playgrounds for children, sport facilities and parks for relaxing.

Design Phase 2
By combining three XS building blocks together with a dedicated open space we have created the small building unit. One quarter of the small unit will be dedicated for the realization of public space and/or dedicated for extra (public) services. By combining the different basic blocks we can create different neighborhoods with different density's and typology's. Near the railway station the most dominant typology will be dominated by apartments. One single building unit measures about 150 x 150 meters. On average the small building unit will be able to accommodate between 75 and 450 people depending on the choice of type of basic building block. The open space can for instance be used for public/private gardens, playgrounds or maybe schools.



Urban Unit 2nd design phase, S building blocks.

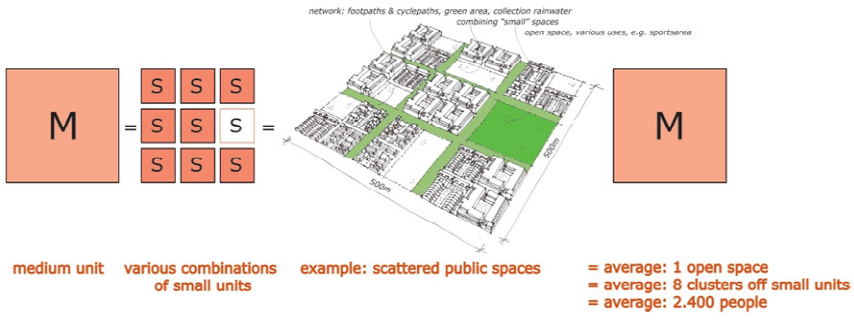
Good urban cohesion, strong identity and sense of community contribute to a sustainable city.

A sustainable city is also a place with a good urban cohesion and a strong identity and sense of community on every level of the town, in short this means a safe, livable town and enjoyable for every inhabitant. A strong urban cohesion is strongly related to the available services, public services and public spaces, off course in close relationship with the quality. Therefore it is absolutely vital that during the realization of the Urban Unit, during every stage of development, enough and the right kind of services are provided. The staging of the elements of the Urban Unit will therefore guarantee there will always be the right amount of public space and room for the needed (public) services available. Services can be located on the ground level of the apartments, in the workplaces or in the bigger public spaces. A second important element is the public environment. The environmental friendly principle will be expressed in the design of the outer space, which is aimed at creating a park-like character with lots of gardens and green public spaces. These gardens will partly be used by the inhabitants as extensions of their garden. Furthermore decentralized management of the remainder of public space, shared ownership and shared responsibility will guarantee commitment to maintain good quality and will increase awareness and participation even further. Furthermore the design will ensure there is room for meeting each other on every level of the Urban Unit. In order to achieve this every element of the Urban Unit will have room dedicated for public space, where people can meet each other, enjoy their gardens, where children can play and (public) services can be realized.

Carbon-neutrality and eco-efficiency cannot be reached by implementing measures in the build environment alone. The collective conscience and mind of society also needs to change. In order to successfully implement both concepts, the needed change in our way of living needs to be accepted by everyday people. Awareness needs to be improved in order to improve the acceptance and participation. The goal is to make eco-efficiency and carbon-neutrality an integral part of normal day life. The future inhabitants of the Urban Unit will therefore be educated and stimulated to participate through the design of the public space and shared responsibility for the environmentally designed public spaces. Lastly participation will increase the contact between inhabitants and therefore increase the community-feeling and through this urban cohesion.

Design Phase 3
By combining the area of nine small building blocks we are able to create the medium building unit. On average the medium unit will consist of 1 open space and 8 clusters of small building units. By using different setups in XS and Small building blocks we can again create different neighborhoods or we can create different setups in open space. The open space in the medium building block can for instance be used for parks, sport accommodations or (public) services on a larger scale like high schools or libraries. On average the medium building unit can theoretically house between 1.800 and 3.600 inhabitants, depending on the chosen mix of XS building blocks.

Urban Unit 3rd design phase, M building blocks



Daily activity is mostly shaped by the available mobility

Mobility is an essential factor which people take into account when they shape their daily activity patterns. The activity pattern expresses the use of time for different purposes at various places. A change in the transportation opportunities of an individual (e.g., getting or losing access to a car) is managed through changes in the time used for different activities and/or where they are performed. Not only do people shape their own activity pattern but they also shape a pattern of goods and services delivered to them. This pattern does not express the use of time but is economy based. Here we also see the effect of change in the transportation opportunity of goods and services which leads to higher or lower prices for goods and services. The availability of high speed travel to a lot of people has led to a widening of the activity space of individuals. At the same time, both the number of out-of-home contacts and the amount of time spent on daily travel in general remained remarkably unaffected. This high speed travel consumes a lot of energy which mostly comes from fuels that generate a lot of CO2. The subject of transport is dividable in two different subjects, traffic inside the urban unit and traffic to and from the urban unit. As we are designing an Urban Unit for 20.000 people in a reasonably high density the distances within the Urban Unit are limited. The total unit will measure approximately 1.600 by 1.600 meters, the distance from the edge of the Urban Unit to the central park-railway station will be about 800 meters. This is about 13 'walking minutes' or less if one uses a bike. There is almost no need for public transport in such a 'small' town. To stimulate walking and biking, the public areas will be reserved for these modes of transport. The car won't be visible in the streets. Parking of cars will be centralized in parking garages, which are situated underneath the main 'streets' of the Urban Unit and thus create a almost car-free town.

Because of the larger distance between the house and the car, people will be easier persuaded to walk of bike. Parking space near the central facilities will be limited, sustainable delivery services will be promoted, delivery can take place by delivery by bike, electric car or lorry. The central market place is not just a place where you can buy locally produced food, but also a place where you can find a lot of normally not available goods inside a town. By letting these goods travel to the Urban Unit, instead of letting people travel from the Urban Unit to the shops in other towns will save a lot of transport. Trying to limit the need for travel to and from the Urban Unit is possible, but it should not be conceived by people as limiting their possibilities. Commuting from the town to surrounding towns can be lessened by providing 'working on a distance' office buildings and providing work inside the Urban Unit. To facilitate the travel it is wise to make the most use of existing highways and railroads. A new urban unit should be placed at least along a railroad, preferably combined with highway access. Along such existing corridors there could be more Urban Units placed as on a string. It would even be possible to start a new corridor with urban units. To travel between Urban Units or the larger cities in the area people should be persuaded to make use of public transport or electric car instead of taking the conventional car. This persuasion can be realized with financial stimulus and with creating a competitive public transport system. This is also applicable on transport of goods to the Urban Unit. Goods that are produced in the general area of the Urban Unit get easier and cheaper access to the town, goods that are produced in conventional ways or are transported from far should have more difficulty getting into the town.

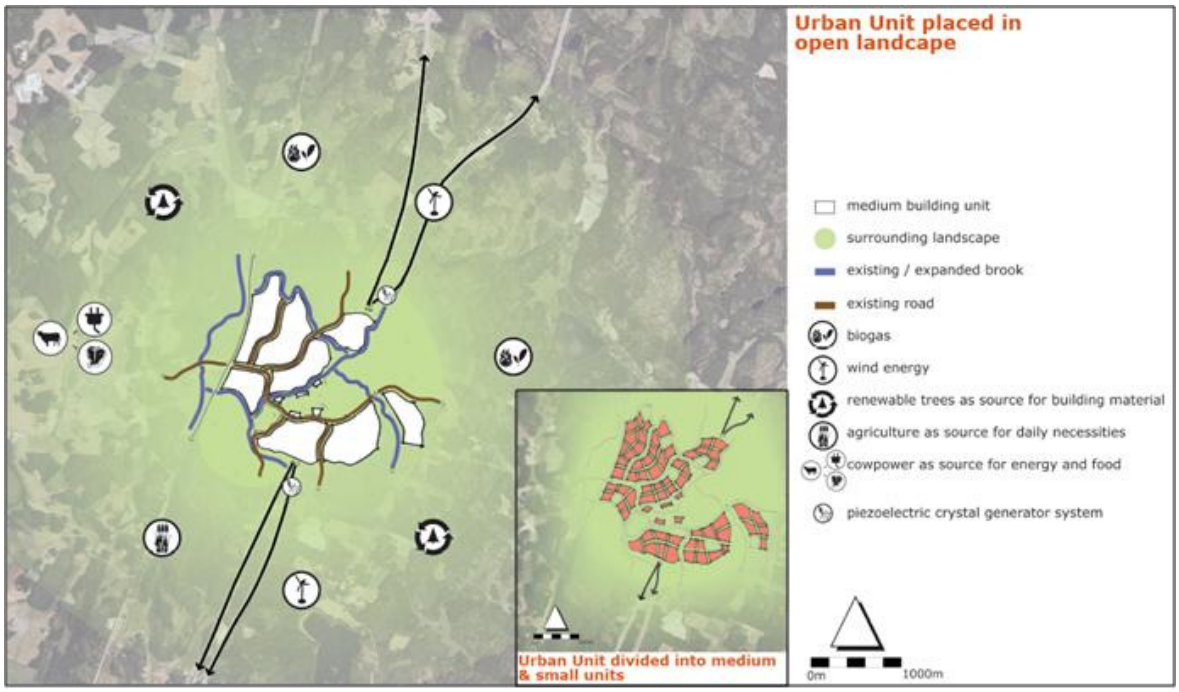
Design Phase 4
The final and last phase consists of eight various medium building blocks and one dedicated open space which can approximately house 20.000 people, depending on the chosen configuration of XSmall building blocks. The open area in the centre will be the central public transport hub and can for instance also house a town hall, the marketplace, a central park or small central business district.

Urban Unit 4th design phase, L building blocks.

A sustainable city uses the landscape as blueprint for urban development.

The design of the Urban Unit will use the landscape as a blueprint for the design of the city by using the already available natural borders like roads, waterways and hills and valleys. The landscapes height differences through hills and valleys, rivers and ponds and local roads will determine where to build and where not. In the Urban Unit the higher grounds will be better suited for building, partly because generating wind energy on top of these building will be more efficient. The lower parts of the landscape, like river valleys can be connected to the parks and other water elements in the Urban Unit and this way the Unit and its surroundings will have one water system. The increase in hard surfaces will inevitably reduce the ability for rainwater to penetrate the ground. But by connecting the water retention ponds, wadi's and other waterways of the Urban Unit with nearby rivers we can create a water system capable of dealing with increased runoff and more frequent peak rainfall. By using the landscape as a blueprint we create a visibly connection with the surrounding landscape, the landscape and the city merge into one unit. The landscape is also the most important provider (if possible) of building materials. The available building materials in the immediate surroundings will be used to build the Urban Unit itself. Of course every building material should be obtained according to the rules of eco-efficiency and carbon-neutrality. The main goal for the Urban Unit, in relation with the landscape, is to connect both separated entities, The goal is to connect the Urban Unit with the landscape, both physically and in the minds of the inhabitants and visitors. By moving the infrastructure, that connects the Urban Unit with the world, underground the problem with noise pollution, air pollution and particle matters will be much less. This will improve the local environment greatly and increases the possibilities

for mixed-use development. The local climate will determine to what extend water retention measures should be implemented. The amount of rainfall during specific periods in time and the risk for peak rainfall will determine the extent of water retention measures. The number of days with sunshine and the intensity of the sun during the year will determine to what extend the Urban Unit can use solar energy. The same goes for the number of wind days and the force of the wind. The less windy days and the less powerful the wind blows the less possibilities there are to harness wind power. The climate, landscape and environment will determine agriculture and the used livestock and therefore the availability of high quality of manure in order to develop an energy system running on biogas.



End result: Urban Unit random application of building blocks

Sustainable and eco-efficient urban development not only a necessity but also an enormous chance for sustainable economic development.

The predicted population growth and as a result of this process the increasing urbanization of the continent Africa combined with the imminent change of the climate results in an enormous challenge for Africa. On the one hand population growth and urbanization will place huge demands on the natural available resources in the continent. As a result the average ecological footprint of its inhabitants will increase massively. On the other hand the effects of the imminent climate change can have disastrous effects for the African population. This places Africa for a huge dilemma: how to accommodate all those people who are moving into the city and at the same time make sure there are enough economic opportunities without letting the emissions of greenhouse gasses spiral out of control. Developing sustainable, eco-efficient and preferably carbon-free new towns will limit the increase in the individual ecological footprint and at the same time reduce the amount of green house gasses being pumped in the air. But how can the principles of the Urban Unit be implemented in Africa?

One of the challenges Africa is facing is accommodate the urbanization and at the same time limit the amount of greenhouse gasses pumped in the air. As shown with the design of the Urban Unit of the future the solution can be the development of smart-grids powered by reusable and green energy. Its energy transport system will be a intelligent monitoring system that keeps track op all the electricity flowing in the system and if needed the system will intervene. Furthermore, Africa has huge amounts of new and renewable energy resources, most of which are under-exploited. There are still enormous amounts of electricity resources to be utilized, like hydropower, wind and solar power and other alternative energy sources. The use of solar and wind-power offers the extra opportunity of supplying more remote areas with electricity without the need for the realization of an extensive electricity network. Water pumps operating on solar energy or villages powered by wind energy will help to limit the ecological footprint as a result of the growing population and limit the amount of "green house" gasses being pumped in the air. If used on the scale of the Urban Unit the effect will be even greater. It is well known that the cities as we know today are one of the major contributors to CO2 gas and other greenhouse gasses. At the same time it's the same cities that offer the biggest opportunities in reducing emissions. By stimulating the use and realization of concepts like the Urban Unit of the future Africa will be able to accommodate the urbanization without the strain on the environment and limit the amount of "greenhouse" gasses.

The African cities of the future should located around transportation axes and be as flexible as possible and should be designed with mixed-use in mind, next to sustainability and durability. For instance apartments can be designed in such a way the can be transferred into offices and back again. Also workspaces can be designed with flexibility in mind, if needed they it should be able to expand the workspaces (and of course also the other way around). There will be three main types of houses: apartments, row-houses and single houses. The houses will accommodate dedicated workspaces as much as possible. Combined with the availability of internet people don't need to travel as much as before. This will guarantee the cities will be ready for the future. Cities have to offer room for four main functions: housing, work-area's, services and recreation and one extra function, namely energy-production. By using the urban fabric (buildings and roads, etc) for the production of "green" energy the city can reduce the emissions of "green house" gasses associated with a "normal" city. Lastly there will be three types of open space, public space (parks etc.), private space (balcony gardens and normal gardens) and public-private space (privately maintained and used public space and community gardens).

As mentioned before the new cities should be located around axes of transport, the higher the density the closer it should be located near transport. Africans rely heavily on the car for transportation. Of course it is not always possible to accommodate all transport below ground but the centre of the city should be dedicated to transport and connections with the outside world. By locating the city in such a way and at the same time realizing a public transport network the urban design will strongly promote the use of public transport. Public space should be designed in such a way it connects the city with the surrounding landscape and at the same time promotes biking and walking. Existing roads will also be used o connect the city with the surrounding landscape. It's even possible to produce energy with the roads by constructing them with solar energy producing materials.

In the design the landscape will be leading by using height differences, existing waterways, existing roads and other landscape features. By using these features the landscape can be both physically and mentally in contact with the urban space, for instance houses can be connected to the landscape by locating them next or near those features. The local climate will furthermore dictate the focus on which reusable and "green" energy will be used. The focus in most cases will be on solar and wind energy.

Lastly but not the least important the new towns should offer its inhabitants the possibilities they were searching when leaving for the city: a better life. Enough room for services, right from the start of development, will promote urban cohesion. On every level of the town there should be room for meeting people and awareness should be promoted by designing public spaces with environmental principles and the realization of public gardens. Community gardens, decentralized management and shared ownership of public space will increase the commitment of the inhabitants and promote participation.

Dealing with the imminent climate change and the urbanization, fuelled by massive population growth, will be the challenge for Africa in the coming decades. But because the process of urbanization is only relatively young it also offers Africa a great opportunity. The implementation of eco-efficiency and sustainability can offer the building stones for a better future for a lot of people. A prime example is William Kamkwamba: this teenager had a dream of bringing electricity and running water to his village. And he was not prepared to wait for politicians or aid groups to do it for him. The need for action was even greater in 2002 following one of Malawi's worst droughts, which killed thousands of people and left his family on the brink of starvation. Unable to attend school, he kept up his education by using a local library. Fascinated by science, his life changed one day when he picked up a tattered textbook and saw a picture of a windmill. "I was very interested when I saw the windmill could make electricity and pump water. I thought: that could be a defence against hunger. Maybe I should build one for myself." When not helping his family farm maize, he plugged away at his prototype, working by the light of a paraffin lamp in the evenings. The finished product - a 5-m (16-ft) tall blue-gum-tree wood tower, swaying in the breeze over Masitala, seemed little more than a quixotic tinkerer's folly. But his neighbour's mirth turned to amazement when Mr Kamkwamba scrambled up the windmill and hooked a car light bulb to the turbine. As the blades began to spin in the breeze, the bulb flickered to life and a crowd of astonished onlookers went wild. Soon the whiz kid's 12-watt wonder was pumping power into his family's mud brick compound. Next he installed a solar-powered mechanical pump, donated by well-wishers, above a borehole, adding water storage tanks and bringing the first potable water source to the entire region around his village. *("The boy who harnessed the wind", William Kamkwamba and Brian Maeler, 2009)*