

WEAVING THROUGH PARADOXES OF GREEN TRANSFORMATION AND SUSTAINABILITY OF NATURAL CAPITAL IN BIOMASS ECONOMY: THE PATH FORWARD FOR AFRICA

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Abstract

Biomass economy is the dominant sector with 81.2% of the population reliant on traditional biomass for domestic purposes. Solid biofuel accounts for 81.2% of the total bioenergy consumed annually while 70 - 90% of primary energy supply in some poor countries are provided through biomass and waste. Hence biomass holds great potential for improving the economic wellbeing of many countries. Despite these benefits, biomass extraction also forebodes grave danger for the biogeophysical properties of the planet reordering biotic and abiotic components of the ecosystem. With business as usual scenario, unsustainable biomass extraction and consumption will continue into the future thereby reinforcing climate-related extreme events. This will require dramatic green transformation aimed at reducing depletion of natural capital and eco-efficient utilization of green infrastructure. In the paper, it is noted green transformation is fast catching up in sub-Saharan Africa. However, these exploitations externalize cost to others. Therefore, it is a paradox of sustaining man but with consequential impact on man. The issue of the externality are critically examined together with the interrelatedness of biomass depletion with climate change. Our critical engagement with this issue is via qualitative analysis of relevant literature which points us toward challenges of biomass economy before arriving at a synthesis for constructing a pathway to Africa's green future.

Keywords: Biomass Economy, Natural capital, Food security, Climate change, green transformation, Africa

1.0 Introduction

Natural capital plays a vital role in biomass economy globally. Biomass economy relies extensively on the existence of stable environment provided by the ecosystem services to grow. Natural capital is essential for human existence providing man with vital biogeophysical necessities for our planetary existence. Our industrial growth is reliant on depletion of green infrastructure which ensures man is protected from the climate-related extreme events. Natural capital is, therefore, vital for providing local communities and industries with much needed energy to provide their material wellbeing. However, the process which provides man with our basic needs also engenders depreciation of natural capital. Carbon production and consumption play crucial role in food, energy and water production, globally. With our growing consumptive pathology, world energy production and consumption is gradually rising. In 2010, the world's energy consumption grew by 5.6% faster than any year since 1973 (ETC, November, 2011). According to UNDESA (2010), the single largest demand humanity puts on the biosphere is its carbon footprint that has increased tenfold since 1961. Resultantly, our ecological footprint exceeds the earth's capacity to regenerate by 30% and as such we will need 13 planets to stay within the planets carrying capacity (WWF, 2008).

According to IEA (2010) about 1.3 billion people do not have access to energy globally. Global demands for energy are on the rise with its attendant consequences. If the trend is not reversed, countries in the Southern hemisphere will face the dilemma of how to reconcile their energy consumption and carbon footprints within the acceptable limits of 2°C that will not adversely affect the ecosystem. For sure, economic development in Africa has not

matched with physical growth of capacity of nation-states and other actors to manage the consequences of growth. Growth in biomass sector has led to depletion of social ecologies and the increase in food insecurity in Africa. Africa has made remarkable progress towards consolidating biomass and waste by advancing integration of renewable energy into the energy supply mix. Yet, most of such measures are at the expense of natural capital. With business as usual scenario, unsustainable biomass extraction and consumption will grow to about 51% - 57% in the 2035 (IEA, 2010) which will reinforce climate-related events.

Most recently, there is a growing emphasis on modern biomass economy which aims at ushering in a global economy where biomass consumption and production are not just heightened but are ecologically sustainable (Okoh, 2014). Yet, such claim is not really tenable in Africa where the petroleum-based future is already taking shape. What has emerged is biomass and waste will rather reconfigure global socio-economic and political space on the heels of bioengineering and biotechnology globally. But for Africa with low adaptive capacity, a new power configuration of bio-corporations intent on defending the interests of economically powerful lobby groups has emerged. Balancing the interests of the diverse groups with different intentions for Africa's natural capital is critical to Africa's green future.

This challenge to Africa's biomass economy is the focus of this paper. This is critically examined in light of the threats to green infrastructure in the unbundling of ecosystem services through the current financialization of natural capital drive. We determine how Africa can sustain its natural capital through green transformations. Nevertheless, must ensure economic growth initiative is not derailed by pollutions leading to further destruction of the ecosystem.

This paper is structured into five chapters: The first chapter starts with introduction. Conceptual issues form the second chapter. Africa in the era of biomass economy is the third section. Implication of biomass economy for Africa's green transformation is the basis of our analysis in the fourth chapter. In the final chapter, we construct pathway to low carbon civilization.

2.0 Conceptual Issues

The environment encompasses natural resources viewed largely as natural capital. Daly, (1994) describes natural capital as the stock which yields flow of natural resources; the population of fish in the ocean regenerating flow of caught fish meant for the market, the standing forest which regenerates the flow of cut timber, the petroleum deposits on the ground whose liquidation yields the flow of pumped crude oil. Hence, the environment plays crucial role of 'stock'. As stock concept, the environment can be measured by indices of air and water quality, ore deposits, genetic diversity and so forth (Pearson, 2000; Field and Field, 2009). It represents raw materials flowing into production and consumption process directly. These resources can be further differentiated into renewable and non-renewable resources. On the other hand, the environment can be viewed as sink. And as sink concept, the environment performs the vital function of absorbing carbon dioxide emitted by pollution while through decomposition it can also reproduce environmental capital (Okoh, 2013).

There are different types of capital depending on the stock which produces the range of ecological and economic goods and services used in the economy. These are: natural capital, human capital and manufactured capital with the latter two as human made capital. Natural capital and human-made capital are inter-dependent hence to some extent complementary. Given this, natural capital and human-made capital are essentially complements and not substitute. Natural capital to a large extent is the determinant of future development as it is a

limiting factor. Therefore, to sustain income the natural capital must be maintained. For this reason, the stock of natural capital should not be extracted such that it limits its regenerative capacity to sustain the well-being of not only present but future generations. In this sense, we are bound to be trade-offs. That is, we must pick an option either to eschew economic growth in preference for eco-transformation.

2.2 Sustainability of Natural Capital

Economists believe there is sustainability of natural capital (Pezzey, 1992). The assumption is that at the earliest stage of development, societies will depend heavily on natural resources for economic growth. Development consists of high levels of throughput from the natural environment and this could be in the form of natural goods and services. Humanity receives extensive benefits from natural environment in the goods and services provided by natural environment for economic growth, energy, protection from floods and soil erosion. With the increase of economic activities leading to growth and development, natural capital is increasingly transformed into physical, human and social forms of capital. This transformative process of environmental capital is an attribute of economic growth as it rebalances capital. However, for an economy to develop sustainably, its production structure must be flexible enough to allow substitution between scarce and abundant forms of capital. Therefore, there must be change in technology before productivity is increased in the face of declining resources throughout.

The above assertion as Hartwick (1977) suggests is not justifiable because for sustainability to take place society should first invest all profits or rents from exhaustible resources in reproduction capital. This process may not endure indefinitely but this depends on the extent to which physical capital is substitutable for natural capital. However, this may not subsist as it is also necessary in some cases to combine the conversion of capital stocks with directed technological progress. The possibility for this process to endure indefinitely depends on the extent to which physical capital is substitutable for natural capital.

Conversely, Smulders (2000) argues on how decreasing returns to capital, growth will cease in the absence of technological progress that is able to secure increasing productivity from reduced resource inputs. Given this argument, what then is sustainability?

Generally, sustainability is defined as “non-declining consumption” over time (Pezzey, 1992). According to this view, the goal of economic growth is to provide avenues for consumption to continue infinitely. Yet, consumption itself is an act of depletion and once most items are exhausted regeneration takes very long time. The simple argument is of sustainability being a matter of taking decisions in the short run that does not have serious negative impacts in the long run.

In the face of this argument, Field and Field (2009) argue for sustainability noting how natural biological and ecological processes create connections between the rates of resource use in the present and quality of resources available to future generations as the focus of sustainability. Therefore, the resource use rate which is sustainable is one maintained over the long run without impairing the fundamental ability of the natural resource base to support future generations. In this sense, sustainability should not be taken to mean natural resources are untouched rather it takes cognizance of the intergenerational equity between present and future generations in resource use and distribution. This then means present consumption should be at rate the stock of non-renewable resources can be such that it contributes to the long run economic and social health of the population. In the case of renewable resources, this

implies establishing rates of use coordinated with the natural productivity rates affecting the way the resources grow and decline.

However, there might be negative or positive relations between some environmental services and environmental quality between present and future generations. This inter-temporal dimension will require trade-off between pollution activities of today and growth which should be such that do not impair the fundamental ability of resource base to support and satisfy future generations. This is because some pollutants tend to accumulate in the environment rather than dissipate and disappear. Example of this is metal, similarly carbon dioxide emission over many decades also accumulate in Earth's atmosphere.

2.3 Biomass economy

Biomass economy has been considered one of the fastest growing sectors in Africa (Rosillo-Calle, 2007; IEA, 2009; Stecher, 2013). Biomass economy proponents see agriculture as potentially effective in transforming economies from fossil dependence to low carbon economy where carbon consumption causing climate change is limited. Its remit is to promote non-fossilized biological materials as feedstock for production. Biomass economy comprises of the traditional and modern biomass economy (Rosillo-Calle, 2007; Stecher, 2013). Traditional biomass economy is basically based on wood fuel and waste consumption for energy while modern biomass economy makes use of agricultural feedstock for energy. Here, large amounts of biomass are applied as feedstock in the industrial production of synthetic materials, such as bio-plastics to replace cokes in iron and steel manufacturing (PBL, 2012).

Conversely, Kulshreshtha et al. (2011) sketch the sustainability of biomass economy landscape by defining and identifying sustainable choices as those maximizing per capital utility subject to ethical constraints in that per capita utility will not decline over time. This utilitarian formwork can be applied to derive sustainable outcomes in the context of biofuel, and in particular to identify which biofields to produce.

Hence in biomass economy, agriculture is the driving force but relies on bio-technology to harness this energy. However, biomass economy is not entirely new per se but is part of the current reinvention of the age known process of appropriating nature. As Monbiot (2014) suggests, the current financialization of natural capital serves to unbundle ecosystem services such that they can be individually traded. Yet, we cannot safely disaggregate green infrastructure without destroying its functions as a coherent holistic system.

Ultimately, however, neo-Malthusian concern for degradations as drivers of negative growth is the kernel of modern biomass economy since it is certainly exhaustible and can also be pollution augmenting. Thus, it is a double-edged sword. Crucially, its effectiveness is dependent on those applying biomass technologies and the goal for attaining the bio-based economy. If the bio-economy places higher value on shareholders returns, then profit maximizing technologies will further ensure ecological deteriorations and is a disservice to green infrastructure. But when the goal of biomass economy out rightly considers planetary heritage then its emphasis will be on efficiency in resource utilization leading to eco-equilibrium between our consumption and production.

Clearly, then, biomass economy is only sustainable to the level of how we allow green technologies to relate with us and nature. If the economic pillar of sustainability is superimposed over ecological or social pillar, the goal of bringing about equitable transition to low carbon society in biomass economy will be defeated. But if not, then we shall arrive at

an eco-disequilibrium wherein our economic needs and ecological resources are discordantly interrelated.

In the current green valuation regime, land grab is crucially the future of biomass economy. Land grabs is an international phenomenon associated with biomass economy. It is a global phenomenon dealing with the “purchase of vast tracts of land by wealthier food insecure nations and private investors from mostly poor developing countries in order to produce crops for export (Daniel and Mittal, 2009; Baxter, 2010). For this reason, it can be assumed on the surface land grabs are beneficial to both the foreign investor and the host community.

Interestingly, some of the current participants in the 'new scramble for Africa' also experienced colonial rule (Cotula et al. 2009). In fact, drivers of Large Scale Land Acquisitions (LSLA) rest more on economic hegemonic pretensions than in the claim of feeding the teeming global hungry population. Certainly, the search for an alternative source of food and energy is theoretically the main basis for land grabs. However, geostrategic machination of the investors is the most important motive for land acquisitions (Baxter, 2010). And the medium through which such land deals are implemented is through the use of force. Force here ensures compliance. Still, such forceful eviction of the real owners of the land is ecologically entropic as further constraints are placed on green infrastructures not just by the bio-corporations but most importantly by the displaced farm families. Resolving this ecological disequilibrium therefore will require convergence of all forces in the decimation of natural capital.

3.0 Drivers of Biomass Economy in Africa

There are different factors as drivers of biomass economy in Africa. These drivers are not only interrelated but are agriculture based issues therefore has food security imperative. The drivers are intricately linked with food, fuel and financial crises. The specific drivers of biomass economy are as follows:

i. Alternative source of fuel

Traditional biomass in Africa is driven by the growing need of the people to use bioenergy for domestic purposes. In Africa, over 80% of the population dependent on wood for as source of energy. Traditional biomass consumption is widespread in Africa with most of the rural dwellers burning wood as fuel. Poverty is a major driving force for this untenable extractive business. With most of the poor in rural areas, finding ready alternative to wood fuel is a difficult endeavour.

IPCC Fourth Assessment Report (2007) links the rising trend towards biomass economy to increases in GHGs. Cognizant of the perilous state of global carbon emissions, different nations seek to reduce fossil dependency by finding alternative sources of energy. With the incidence of climate change, finding alternative sources of energy to cap emissions of greenhouse gases informed the recent traction of bioenergy.

Given this scenario, production of liquid biofuel is viewed as a solution to the carbonization of the biosphere and is also a major trigger of transformation of natural capital in Africa. The biofuel boom, therefore, is driven by climate change doom and the need to provide alternative sources of energy through food crops such as maize, sugarcane, palm oil and non-food crops like *Jatropha*.

ii Food security

Threats to food production underpin biomass economy globally. In modern biomass economy, large scale land acquisition is considered a strong incentive to invest abroad guaranteeing the investors food in periods of crises. In Praskova (2012) opinion, this land acquisition is linked with rich countries that face food supply problems and/or constraints, such as low agricultural productivity. This is due to limited water supply or productive land (land degradation, soil erosion) or population growth and trends in diet changes (shift to greater consumption of dairy products and meat is increasing the need for animal feed stuff). The constraint experienced by region where water shortages are high is very significant and are vital impetus for land grabs. Countries in the Middle East like Saudi Arabia that are faced with water shortages need new fertile lands to augment their depleted food supply.

The race towards biomass economy is exacerbated by the 2007/2008 global food and energy crisis. Food hikes of 2007/2008 propelled major food exporting countries to restrict food exports thereby posing further constraints to those who rely on them. Though food prices of maize, wheat and other food crops have dropped since 2008, some of the structural factors underpinning rising prices are likely to stay (Cotula, et al., 2009). To avoid committing the costly mistakes which lead to the food shortages, most nations now establish farms in foreign land to guarantee access to food in periods when there are shortages. This is to avoid dependency on exporting nations and will also reduce their import bills. By so doing, net food importing countries sort to improve their food security by maintaining direct control over the production and supply of their food chain. This explains why outsourcing food production abroad is a ready solution to their food crisis.

iii. Demographic Explosion

Demands for biomass is also heightened by demographic pressures placing serve strains on the agricultural system. Population growth and urbanization limit food supply as changing diets and consumption patterns by middle class in emerging economies pushed up food demands. Against this background, acquisition of new sources of producing food is vital for the survival of these states. Thus, it is a strategic choice to engage in biomass economy in Africa where land is inexpensive and where institutional debilities have put in place governments who are more amenable to investors' overtures.

iv. European Union Renewable requirements

Another related reason is the European Union renewable energy requirement directing members to set mandatory target of a minimum 10% share of their renewable energies in transport by 2020. The minimum target of 10% will be supplied mainly by biofuels and 'as much as two-thirds are likely to be imported, the majority from developing countries. Pressures for carbon cuts warranted involvement of energy firms in the race to find alternatives to fossil fuel. Energy firms such Mobil, shell BP, Total and a host of others are engaged in the biofuel boom mindful of future gains both in financial returns and as part of the Community Social Responsibility (CSR) of their firms. In investing in biofuel, the organizations will be favourably positioned to cash in on any future gains. To some extent, investing in biomass economy and biotechnology is a symbolic gesture by some of these firms to showcase their compliance with global mandate to limit dependency on fossil fuel.

iii. Financial Returns

Traditionally, agricultural value chains have tended to concentrate returns in processing and distribution, while the risks fall mainly on primary production, acting as a disincentive for

investment in agriculture (Cotula et al., 2009). But all this is changing with the mad rush for land. In the aftermath of the 2007 financial crises, many investments portfolios collapsed. The drive to invest in new enterprise lies with the fact that present investments were considered too risky. Investing in biomass and agriculture, therefore, was seen as a new safe and profitable investment in an unsteady financial context. Big time investors considered farmland investment as the future of investment funding. This explains why land grabs in Kenya like in Ethiopia is very high, with more than “90 funds from all over the world investing in farmland (Makutsa, 2010).

iv. **Carbon Market**

Carbon trade is a market-based mechanism for trading in carbon with the view to reducing the production and consumption of carbon. Fossil fuel dependent global economy has been the principal source of emission of GHGs. It is, therefore, perceived through REDD+ mechanism carbon stored in forests can be valued and quantified. Once forests are commodified by placing value on it, it will then improve the sink function of the forest. In this sense, forest is seen as more valuable standing than when they are cut down. Private companies will have to earn the right to cut down trees or emit carbon either by planting new trees somewhere else or by initiating better forest management (Okoh, 2013) in anticipation of increased return. Today by using land for forestation projects, many firms are now targeting long-term gains by investing in land.

v. **Carbon Credit**

Carbon credit is part of the Clean Development Mechanism (CDM) negotiated at Kyoto as the climate change regime. To La via Campesina (2009), a carbon credit is equivalent to the emission of a ton of carbon dioxide. Compared to the current rate fixed by Kyoto Protocol, it allows its holder to emit more gases which is responsible for global warming. Carbon credits are allowed to state or companies participating in reducing GHG emissions. Such carbon appropriation is supposed to help participating countries respect their engagements to the Kyoto Protocol. A good example of where this scheme featured prominently in the initiation of project in Africa is Mali Biocarburant biodiesel project in the Cede of koulikoro. According to La via Campesina (2009) report carbon credit of \$65,000 from the Netherlands and Switzerland governments has been the source of biofuel projects in Mali.

Generally, funds used as carbon credit are mostly derived from \$130 billion dollar set aside by rich countries as part of their commitment to Kyoto. It is based on the idea that the best way to control climate change is to transform carbon emissions into exchangeable good on the international market.

vi. **Growth in Transition Countries**

Unprecedented economic growth in transition countries immensely facilitated land grabs. In the last decade, BRICS nations recorded impressive growth both in economic and demographic spheres. This growth necessitates finding alternative avenues to invest fund and source for food production to feed their rising population. This fuelled interests to acquire farmlands in foreign land to reduce food and energy constraints. Consumers in these countries with increased growth are demanding higher standard of living and are hastening to catch up with Western welfare standard. However, Western consumptive pathology comes with the high price of degrading the environment. This has become necessary in that developed countries in their rapid industrialization also degraded the environment and are set to continue into the future. Finding new sources of energy is a precondition for a food secured future.

Premised on this, BRICS nations are now actively involved in large-scale land grabs using South Africa as their regional hub. Matondi et al. (2011) are of the view large-scale acquisition of land renewed interests in plantation-based agriculture globally. The renewed interest in plantation-based agriculture is itself fuelled by scepticism regarding the effectiveness of market and trade mechanisms guaranteeing access to basic food supplies. This is in fulfilment of the promise of using large-scale agricultural production to modernize the agricultural sector in low income countries. But in places where diffusion of technology is taking place, the pace has been slow if it even occurs (Daniel and Mittal, 2009).

viii. African Countries' Incentive

Incidences of hunger and starvation are on the rise despite growth in GDP in many low income countries. Industrial agricultural food production is perceived as strong mechanism to grow the continent using mechanized agriculture as a source of employment and revenue. With this Foreign Direct Investment is seen as capable of bringing new technologies, developing productive potentials, facilitating infrastructure development, and creating employment and supply of food to local markets (Cotula et. al., 2009). Some African countries also needed to diversify from depending on a single resource based growth. Examples of such monoculture entities are: oil in Sudan, copper in Zambia (using agriculture as the alternative (Cotula et al., 2008). Attracting foreign investor to grow food and biofuel crops locally is therefore seen as a means of not only improving their rural dwellers economic well-being but will most essentially transfer new farm techniques to the host countries.

4.0 NATURAL CAPITAL VERSUS BIOMASS ECONOMY IN AFRICA

Africa is a continent where large proportions of the people still live in rural areas. Of this, about 80% are engaged in agriculture related activities. The livelihoods of many people who directly depend on natural resources are intricately linked with exploiting fragile environment and ecosystem. Nonetheless, the wellbeing of man to a large extent depends on an efficient functioning ecosystem. Ecosystems provide man with countless benefits in the form of goods and services which are collectively referred to as the ecosystem services. However, the level of goods and services provided by the ecosystem depends on the ability of the ecosystem to regenerate.

In Africa, as of late the level goods and services have witnessed diminishing returns. For this reason, natural capital has failed to meet all man's requirements. Africa in the haste to build cites and develop approximate infrastructure for human welfare have been depleting the ecosystems at an unsustainable rate. Prediction for the coming years indicates declines are inevitable if the world is to continue with its consumption culture (IEA, 2009). Population growth, changing land use, economic expansion and global climate change are accelerating Africa's degradation. Given this, most countries in Africa witnessed large scale soil erosions and water-quality deteriorations, deforestations and declining soil productivity in rural areas. Similarly, urban areas like Lagos in Nigeria, Johannesburg in South Africa, Cairo in Egypt and a host of others are now increasingly confronted with the challenges of diminished air, and water quality.

The main reason for this is the strong priority on economic growth seen as capable ensuring sustained improvement in living standards of the people. Giving the high priority on economic growth in some countries in sub-Saharan Africa, extensive demands are placed on ecosystem services. Therefore, demands for goods and services have outstripped supply for several commodities putting more pressures on natural systems. And as a healthy ecosystem underpin all economic activities, the quality of life and social cohesion is affected by the

defective interaction with the source of man's well-being. Consequently, Congo basin the second largest rainforest in the world known to provide man with shade from excruciating rays of the sun is depleted daily for timber and bio-prospecting. Given this, its natural function as animal sanctuary for many species is threatened.

With the current accelerating pace of resource depletion, Africa is challenged into rebalancing economic growth and environmental quality. The dilemma most nations face today is whether they should pursue economic growth through intensive dependence on natural capital or they should deliberately maintain a desirable extraction within earth's carrying capacity. This then will amount to positive management of the environment for present and future generations' wellbeing.

But Africa is a continent in a hurry to catch up with the West. Yet, Africa is neglectful of the fact rapid industrialization and urbanization comes at a price: the ill-health of the environment. Since no nation can achieve substantial economic growth without large scale urbanization and industrialization; the problem then is how to ensure eco-efficient and eco-equilibrium in resource utilization without the huge environmental costs.

No doubt concerns for the environment are a more recent phenomenon in Africa. Nonetheless, such concerns are not misplaced. Hitherto, emphasis was on economic growth which historically has been the defining focus of most economies. In this landscape, emphasis on economic growth was conceived as the appropriate framework to close the economic gap with the developed economies. But with the prevalence of threats of different calibre, Africa's major challenge is how to reconcile competing needs for economic growth with eco-development.

However, an eco-efficient future, will require a pathway capable of reducing carbon dependency, promote resource and energy efficiency while lessening environmental depreciations. That is to say Africa's growth should transcend 'brown economy'. (A brown economy is one heavily invested in environmental dependent assets but sacrifices environmental quality to attain economic growth). On the basis of this, embracing brown economy is with serious consequences for Africa. Hence finding ways to protect global ecosystem, reduce the risks of global climate change, improve energy security and simultaneously improve livelihoods assets of the poor is important for Africa's quest to achieve equitable green transformation for its people.

5.0 Path Forward

Environmental quality and resources depletion are issues very fundamental to green transformation of African societies. These societies face the major challenge of how to resolve environmental pressures while designing appropriate policies targeted at different groups within society. In theory, green development holds the potential of transforming Africa towards biomass economy. Given that the goal of modern biomass economy is to ensure equitable and efficient allocation of scarce and infinite environmental resources, it can actually revitalize the continent if the resources are effectively and efficiently deployed.

Yet, it is obvious the real world we live in today has not really changed in terms of the goals of man for the environment. Large scale fuel wood consumption will continue to give Africa an adverse carbon footprint. In a finite world, destruction of natural capital to revitalize growth will in the short run bring about exogenous growth but endogenous growth in the long run is threatened. Additionally, it is also recognized resource exhaustion through unsustainable exploitation of the world finite resources fosters not only exhaustion of

resources but can change our world in many fundamental ways. This is because the current premium placed on economic growth strategies in biomass economy has a bias towards market fundamentalism encouraging rapid accumulation of physical, financial and human capital.

The basic issue therefore is how to manage consumption and production with increasing demands placed on ecosystem services, consumption and production of human needs. Hence, change in the production or consumption are critical in biomass economy as different phases of the economic process may cancel each other out when it comes to overall energy consumption. To achieve efficient use of energy will require (de)materialization. Materialization of critical natural capital for efficiency gains will lock present generation into a fossil fuel dependent future. Correspondently, there will be the general degradation of quality of life.

Said, human beings impact on the environment in many ways that are not related to pollution in a way we view technology. Given this, our natural capital are not entirely free from constraints in transforming economies and as such for biomass economy to be fully integrated into mainstream policy in Africa there must be a move towards partial dematerialization of nature. Dematerializing nature will, therefore, mean finding alternative sources of energy which are not carbon intensive and does not compete with food crop for land. At best, dematerialization will minimize resource extraction, while maximizing reuse and recycling.

But given the present state of consumption, dematerialization is not the cure-all for resource depletion as we are not recycling to the extent required. Dematerialization can only be achieved through innovations in technology promoting resource efficiency as the main driver of growth. But can Africa sustain the present growth through dematerializing of economic process itself without sacrificing prosperity? Can the continent evolve a new service-oriented economy wherein goods are not accumulated but converted into services? These are questions for further research.

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