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Assessing the Critical Role of Advanced Biofuels in the African Transport Sector Transformation for a Sustainable Future

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Abstract

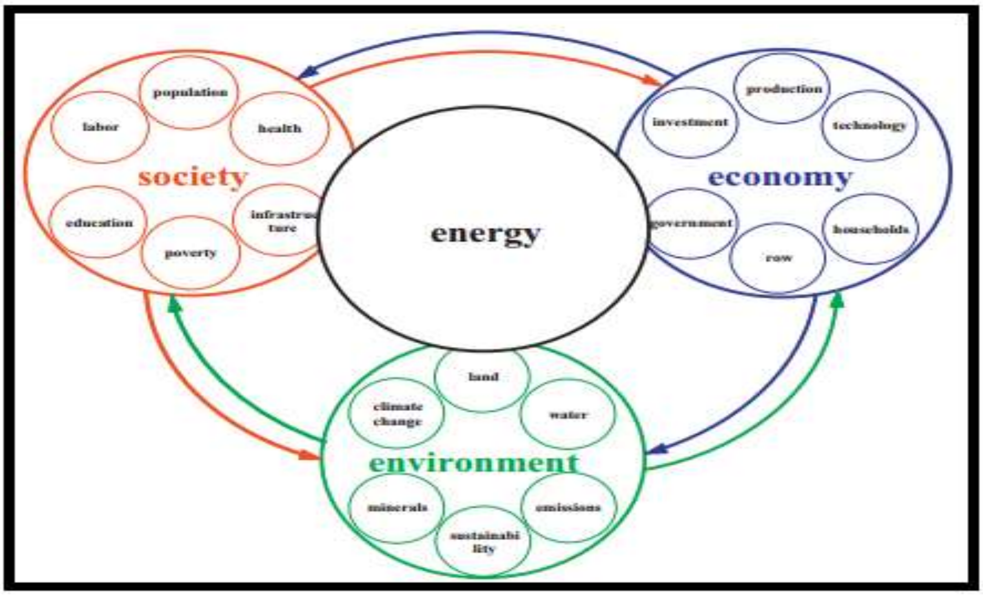
Energy demand continues to rise due to rising population and hence, strong need arises for efficient and judicious utilization of clean and alternative energy sources in ensuring a sustainable future. Focussing on the transport sector, there has been a gradual transition from conventional fossil fuels which dominates the sector to not only first-generation biofuels but also advanced / higher-generation biofuels however, the uptake is very slow and minimal especially in the African continent. This paper targeted the assessment of crucial role or the potentialities and benefits of Advanced or higher generation Biofuels in the African transport sector in view of sustainability. The existing affairs of the continent's energy utilization was looked in to with the vivid evaluation of the possible extent to which biomass could go in up-scaling the transport sector energy supply through the advanced biofuels in avoiding classes with food, coupled with the associated benefits covering the sustainability pillars. In the process, rigorous manual works were done added with aid from M.S EXCEL forecasting in projecting supplies as well as incorporating insightful thoughts from RETSCREEN Baseline. The analyses outputs reveal that for a 2013 baseline year, reduction of fossil-based oils by 50% and augmenting with 90% of the total un-edible biomass resource for higher generations biofuels leads to transport fuel energy increase by 64.16% with massive CO_2 emission savings of 155MT; whereas on a 2030 projection scenario ensures transport fuel energy increase by 73.65% with a huge emission savings of 139MT. As a final point, it is evident that Africa could really transform its transport sector sustainably by efficiently and effectively harnessing its un-tapped biomass for advanced biofuels development without any impacts on food nor other possible challenges on process. However, a strong task is needed regarding setting up of appropriate course of actions by the decision makers in favor of such continental bloom at the transport sector level and its benefits.

Key Words:
[Energy Demand, Advanced Biofuels, Sustainable Development, Transport Sector, Africa]

Contents

1.0: Introduction

Energy access in general having a strong correlation with sustainable development (see Fig. 1) has been the most challenging aspect in the African continent especially the Sub-Saharan Africa i.e. Western, Easter, Central, and Southern Africa. Northern Africa is considered highly performing in the energy access however, has been blinded with the huge fossil fuel availability hence having negligible or zero tolerance to renewable energy adoption in final energy generation. Major concern about climate change challenge arising from greenhouse gases emission due to fossil fuel combustions and the continuous depletion or decline in fossil fuel reserve has made energy need the most important but highly challenging as population growth continues to rise exponentially [1]. This is in strong cognizance of the renewable energy resources dowered by the African continent but with severely low-level access based on records of majority of the population having no enough final energy services especially in Sub-Saharan region hence, a paradox [2]. Furthermore, on relating to global perspective, only 3.5% of total energy consumption goes to Africa [3], in comparison to the Africa's population which is recently about 16% of the world's total reading [4]. It must further be mentioned that energy utilization level in the continents for final energy generation is highly in-efficient with huge energy loss [3], therefore, an area of strong attention as it were.



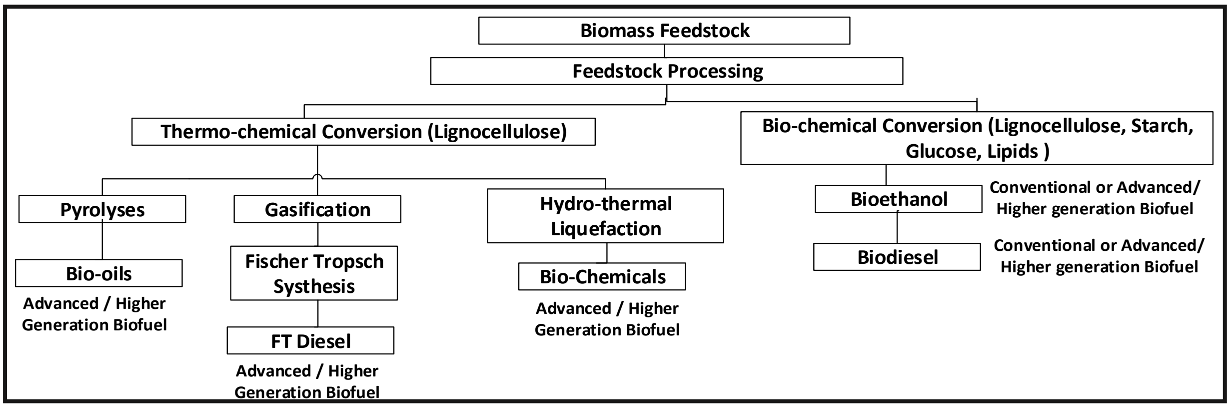
Source: [5]

Fig. 1: Correlation Between Energy Access and Sustainable Development

Narrowing down the discussion to transport sector, owing to the continuous decline in fossil fuels which is ultimately a decline also in the refined petroleum products applicable in the transport sector, the prices of the petroleum products have been on an increase over years in the African continent which could be seen or supposed to be a driving force for the expansion of biofuels uptake. It must be stated that according to the Energy Independence and Security Act of 2007 (EISA, P.L. 110-140), there has been expansion of the Renewable Fuel

Standard (RFS) through mandating that increasing volumes of biofuels (be it conventional or higher generations or advanced-based) be used in the United States transportation fuel supply [6]. This is something worth emulating in the African context with diversification and rapid expansions. However, it is good news that some countries in the continent have got national biofuels policies although only a few have started implementing with negligibly expanding their transport sectors with the biofuels applications including the blending actions with fossil-based oil products.

Furthermore, the idea behind advanced biofuels as more preferable to conventional biofuels is the fact that, energy solutions could be developed successfully with them without any clash with food since they are synthesized from non-edible biomass feedstock in contrast to the conventional ones. On a general perspective, Biofuels production is basically based on two alternative pathways namely the Thermo-chemical Conversion and the Bio-chemical Conversion path. The Thermo-chemical conversion give rise to Bio-oils, Fischer Tropsch Diesel, and other Bio-chemicals whereas; Bio-chemical Conversions give rise to Bioethanol and Biodiesel. This is developed in Fig. 2 below as put forward by [1].



Source: [1]

Fig. 2: Conventional Biomass Conversion Pathways to Biofuels

The purpose of this paper is on evaluating and exploring the potentials and benefits coupled with value chains extension for higher generations or advanced biofuels in view of Africa's transport sector transformation for a sustainable future.

2.0 Methodology

The methodology of this research paper is a strong motivation from the Intended Nationally Determined Contributions (INDC) for global countries ambitions on energy access improvement and climate change combat through mitigations and adaptations. The transport sector of the continent is an area that needs absolute transformation due to so many challenges arising mainly from the massive fossil-based energy usage. The step by step procedure put forward in this paper are as shown in the succeeding paragraphs:

Transport fuel energy mix scale-up evaluations with advanced biofuels has been done for a given baseline year where data was easily obtained from literature i.e. 2013 with extension to 2030 Business as Usual (BAU) Scenario. It involved lowering the fossil-based oil by a certain portion and incorporating the huge amounts of the explored biomass (agro residues and forestry production) in seeing the extent to which the mix could be possibly augmented and intensified.

Furthermore, environmental impacts evaluations based on GhG emissions quantifications in all cases were done using the standards emissions factors for the associated fuels in the mix of both cases. It was wrapped up with the evaluations of the overall huge emissions reductions possibilities on implementing the proposed scenarios for both years considered i.e. the 2013 baseline year and the 2030 projection as opposed to the already established cases.

In addition to the preceded steps, comprehensive qualitative assessments were done on further benefits namely the social or societal and economic benefits briefly from gathered experiences. This was followed by the challenges of implementation highlights as well as views on effectively overcoming them in the transition process.

The final aspect in the methodology was dipping in to some possible opportunity measures in favor of the transitions to the clean energy service in the transport sector. This was basically on the value chain extension breakdown as necessary measures in the implementation process for more efficient operations.

3.0: Results and Discussion

3.1: Analyses of Transport Energy Mix Extension with Advanced Biofuels

The energy conversion efficiencies specifically for converting lignocellulosic biomass feedstock to biofuels are as shown below, and applicable for the chemical energy consumptions evaluations for the scale-up

Table 1: Energy Conversion Efficiencies from Biomass to Biofuels

Feedstock	Biofuels	Technique of Transformation	Conversion Efficiency
Lignocellulose	Bioethanol	Hydrolysis and Fermentation	35%
Lignocellulose	Biodiesel (FT Diesel)	Gasification and F.T Synthesis	36%

Source: [7]

1) 2013 Baseline Transport Fuel Analyses

- Base Case Overview

The 2013 data for the Total Final Energy Consumption (TFEC) by fuel in the Transport Sector according to [8] is as shown below:

Table 2: Aggregate Transport Sector Energy Consumption by Fuel during 2013

Fuel Type	Specifications	Energy Consumption (PJ)	Share
Fossil Fuels	Oil (i.e. Diesel, Gasoline, LPG, Kerosene etc.)	3960	99%
Biofuels	Bioethanol	0	0%
	Biodiesel	0	
Others	Such as Electricity used in Electric Vehicles	40	1%
Total		4000	100%

Source: [8]

- Evaluations for the Proposed Case

The quantified lignocellulose biomass based on different varieties secured from FAOSTAT database with the further developed aggregate energy contents based on standard energy density and specific energy value has been put forward in the below:

Table 3: Biomass Resource Data for Africa during the 2013

Domain	Item	Quantity	Calculated Energy Content (PJ)
Agro Processing	Crop Residue	2373924884kg	31.082
Forestry Production	Wood Fuel	650136757m^3	14199
Total		N/A	14230

Source: [9]

Lowering the fossil-based oils consumption by 50% for the oils, with adding up 90% of the total obtained Biomass resource (see Table 3) for Advanced biofuels is worth doing and beneficial. The suggested 90% portion is assumed to be divided equally for the production of the two (2) Biofuels, i.e. 45% for Biodiesel production based on its conversion efficiency and 45% for Bioethanol production also based on its conversion efficiency. The results of the analysis are put forth in table 4:

Table 4: Newly Proposed Total Final Energy Consumption by Fuel in Transport during 2013

Fuel	Specifications	Energy Consumption (PJ)	Share
Fossils	Oil (i.e. Diesel, Gasoline, LPG, Kerosene etc.)	50% of 3960 = 1980	30.2%
Biofuel	Bioethanol (Based on 45% of total biomass use)	(45%×14230)×0.35=2241.23	69.2%
	Biodiesel (Based on 45% of total biomass use)	(45%×14230)×0.36=2305.26	
	Total Biofuels	4546.485	
Others	Such as Electricity used in Electric Vehicles	40	0.6%
Grand Total		6566.485	100%

Concluding Assessment:

Proposed Total Final Energy Consumption in the Transport Sector = 6566.485PJ

Conventional Total Final Energy Consumption in the Transport Sector (IRENA) = 4000PJ

% Fuel Energy Increase = $\frac{6566.485-4000}{4000} \times 100\% = \mathbf{64.16\%}$

- The 90% of the total Biomass Consumption resulting to the 4546.485PJ Biofuel Production is estimated to be 12807PJ, i.e. 6403.5PJ for Biodiesel and 6403.5PJ for Bioethanol.
- The total Biomass resource energy value was estimated at 14230PJ for the 2013 base year.

Therefore, Biomass Left Over = 14230PJ - 12807PJ = 1423PJ

2) Evaluations for the 2030 Projection

➢ Base Case Overview

Below table shows the Business as Usual (BAU) Total Final Energy Consumption by fuel in the Transport Sector as secured from [10]

Table 5: BAU 2030 Projection Data for Final Energy Consumption by Fuel in Transport Sector

Fuel Type	Specifications	Energy Consumption (PJ)	Share
Fossil Fuels	Oil (i.e. Diesel, Gasoline, LPG, Kerosene etc.)	4438.22	96.4%
Biofuels	Bioethanol	41.87	0.9%
	Biodiesel		
Others	Such as Electricity used in Electric Vehicles	125.61	2.7%
Total		4605.7	100%

Source: [10]

➢ Assessments for the suggested or Proposed Case

The 2013 obtained quantified biomass feedstock mass and volumetric values as well as the developed energy equivalence has been used for the forecasting using MS Excel in obtaining the 2030 Projection data as shown in the table below i.e. Table 6:

Table 6: 2013 Data for Agro Residues and Forestry Production with the 2030 Forecasted Data

Year	Crop Residue (kg)	Wood Fuel (m^3)	Crop Residue Calculated Energy C. (PJ)	Wood Fuel Calculated Energy C. (PJ)	Total Energy C. (PJ)
2013	2373924884	650136757	31.082	14199	14230
2030	3752248609	801919796.1	48.497	17514	17562

Lowering the fossil fuel consumption by 50% for the oils, and then replacing with 90% portion of the total Biomass resource available for biofuels is a proposal that is feasible. The suggested 90% portion is assumed to be divided equally for the production of the two (2) Biofuels, i.e. 45% for Biodiesel production based on its conversion efficiency and 45% for Bioethanol production also based on its conversion efficiency.

Moreover, for the BAU Biofuels consumption already in the mix, which is 41.87PJ, suggesting these productions be 50% Bioethanol i.e. 20.935PJ and 50% Biodiesel i.e. 20.935PJ, and all to be produced as advanced biofuels from the forecasted quantified lignocellulose Biomass potential of the 2030 projection from FAOSTAT baseline is worth doing:

Therefore, the newly proposed Total Final Energy Consumption (TFEC) for the 2030 projection based on the above arguments is as follows:

Table 7: Newly Proposed Total Final Energy Consumption by Fuel in Transport for 2030

Fuel	Specifications	Energy Consumption (PJ)	Share
Fossils	Oil (i.e. Diesel, Gasoline, LPG, Kerosene etc.)	50% of 4438.22 = 2219.1	27.7%
Biofuel	Bioethanol (to be 50% of total biofuel already in Mix)	20.935	70.7%
	Biodiesel (to be 50% of total biofuel already in Mix)	20.935	
	Total Biofuels in Mix i.e. existing biofuels	41.87	
	Bioethanol Proposed (for the 45% of total biomass use)	(45%×17562)×0.35=2766.02	
	Biodiesel Proposed (for the 45% of total biomass use)	(45%×17562)×0.36=2845.04	
	Total Proposed Biofuels	5611.059	
	Total Biofuels (Proposed + Existing)	5652.929	
Others	Such as Electricity used in Electric Vehicles	125.61	1.6%
Grand Total		7997.639	100%

Concluding Assessment:

Proposed Total Final Energy Consumption in the Transport Sector = 7997.639PJ

Conventional Total Final Energy Consumption in the Transport Sector (IEA) = 4605.7PJ

% Fuel Energy Increase = $\frac{7997.639-4605.7}{4605.7} \times 100\% = \mathbf{73.65}\%$

- The 90% of the total biomass used in replacement of the reduced 50% Oils = 15806PJ
- Biomass required for the 41.87PJ Biofuels already in mix on equal share for Biodiesel and Bioethanol = $\frac{20.935}{0.35} + \frac{20.935}{0.36}$ = 117.97PJ
- Total Biomass required for both proposed Biofuels and the existing Biofuels = 15923.97PJ

Therefore, Biomass Left Over = 17562PJ - 15923.97PJ = 1638.03PJ

3.2: Environmental Benefits Assessment (GhG Emissions Evaluations)

The emissions calculations here show the massive reductions on shifting to the proposed patterns in all cases. The benefits will not only be from environmental perspective but also from economic point of view due to massive reduction in the cost of incur from fossil fuels utilization for energy. The table below gives the Emissions factors derived from RETSCREEN decision tool standards for the concerned fuels as applicable in the exercise:

Table 8: GHG Emission Factors for Oil and Biofuels

Fuel type	GHG Emission Factors		
	CO_2 Emission Factor	CH_4 Emission Factor	N_2O Emission Factor
Oil	0.269ton/MWh	0.0029kg/GJ	0.0019kg/GJ
Biodiesel (FT Diesel)	0.007ton/MWh	0.0299kg/GJ	0.0037kg/GJ
Bioethanol	0.007ton/MWh	0.0299kg/GJ	0.0037kg/GJ

[RETSCREEN Standards]

1) Emissions Evaluations for the 2013 Baseline Year

➢ Base Case Emission Analysis

In respect of the Total Final Energy Consumption from Transport Sector which was obtained from [8] and used for the energy scale up analysis (i.e. Table 2), the table is brought here as follows which included the estimated GhG Emissions for the energy mix in the year:

Table 9: Transport Fuel Energy Consumption during 2013 with the Calculated GhG Emission

Fuel Type	Specifications	Energy Consumption (PJ)	Share	CO_2 Emission (MT)
Fossil Fuels	Oil (i.e. Diesel, Gasoline, LPG, Kerosene etc.)	3960	99%	295.90
Biofuels	Bioethanol	0	0%	---
	Biodiesel	0		---
Others	Such as Electricity used in Electric Vehicles	40	1%	---
Total		4000	100%	295.90

- Proposed Case Emission Analysis

From the proposed case total final energy consumption for the transport sector i.e. based on 50% reduction in Oils consumption and 90% use of biomass for biofuels that was previously analyzed in transport fuel energy scale up, the table for the proposed case transport fuel energy scale up which was Table 4 is brought down here for with the incorporated calculated GhG Emissions for the fuels consumed in the sector:

Table 10: Newly Proposed Total Final Energy Consumption during 2013 with the calculated CO_2 Emission

Fuel Type	Specifications	Energy Consumption (PJ)	Share	CO_2 Emission (MT)
Fossil Fuel	Oil (i.e. Diesel, Gasoline, LPG, Kerosene etc.)	50% of 3960 = 1980	30.2%	147.95
Biofuel	Bioethanol (Based on 45% of the Feedstock Use)	$(45\% \times 14230) \times 0.35 = 2241.23$	69.2%	4.48
	Biodiesel (Based on 45% of the Feedstock Use)	$(45\% \times 14230) \times 0.36 = 2305.26$		4.36
Others	Such as Electricity used in Electric Vehicles	40	0.6%	--
Total		6566.485	100%	156.79

Therefore, the CO_2 Emission Savings on replacing the Conventional / Base Case with the Proposed Case for the 2013 base year is as follows:

CO_2 Emissions Savings = Conventional Case Emission – Proposed Case Emission

= 295.90MT – 156.79MT = 139.11MT

2) GhG Emissions Evaluations for the 2030 Projected Year

- Base Case Emission Analysis

In line with the BAU Total Final Energy Consumption from Transport Sector which was obtained from [10] and used for the energy scale up analysis (i.e. Table 5), the table is brought down with the incorporated calculated GhG Emissions for the fuels as follows:

Table 11: BAU Total Final Energy Consumption for 2030 Projection with the GhG Emissions Estimates

Fuel	Specifications	Energy Consumption (PJ)	Share	CO_2 Emission (MT)
Fossil Fuels	Oil (i.e. Diesel, Gasoline, LPG, Kerosene etc.)	4438.22	96.4%	331.63
Biofuels	Bioethanol	41.87	0.9%	0.081
	Biodiesel			
Others	Such as Electricity used in Electric Vehicles	125.61	2.7%	--
Total		4605.7	100%	331.71

- Proposed Case Emission Analysis

From the proposed Total Final Energy Consumption for the Transport Sector in scaling up the transport fuel as seen previously in Table 7, the summarized table for the proposed case scale up is brought down as follows with the incorporated calculated GhG emission for the fuels in the sector.

Table 12: Newly Proposed Total Final Energy Consumption in Transport for 2030 Projection

Fuel	Specifications	Energy Consumption (PJ)	Share	CO_2 Emission (MT)
Fossils	Oil (i.e. Diesel, Gasoline, LPG, Kerosene etc.)	50% of 4438.22 = 2219.1	27.7%	165.82
Biofuel	Bioethanol (to be 50% of total biofuel already in Mix)	20.935	70.7%	0.041
	Biodiesel (to be 50% of total biofuel already in Mix)	20.935		0.041
	Total Biofuels in Mix i.e. existing biofuels	41.87		0.082
	Bioethanol Proposed (for the 45% of Feedstock Use)	(45%×17562)×0.35=2766.02		5.378
	Biodiesel Proposed (for the 45% of Feedstock Use)	(45%×17562)×0.36=2845.04		5.532
	Total Proposed Biofuels	5611.059		10.91
	Total Biofuels (Proposed + Existing)	5652.929		10.992
Others	Such as Electricity used in Electric Vehicles	125.61	1.6%	--
Grand Total		7997.639	100%	176.812

Therefore, the CO_2 Emission Savings on replacing the Conventional / Base Case with the Proposed Case for the 2030 Projection is as follows:

CO2 Emissions Savings = Conventional Case Emission - Proposed Case Emission

= 331.71MT – 176.81MT = 154.90MT

Table 13: Overall GhG Emissions Summary for the 2013 Baseline and 2030 Projection Analyses

2013 Baseline Emission Analysis Summary				*BAU 2030 Forecast Emission Analysis Summary*			
Base Case		*Proposed Case*		*Base Case*		*Proposed Case*	
Fuel	*Energy Usage (PJ)*	*Fuel*	*Energy Usage (PJ)*	*Fuel*	*Energy Usage (PJ)*	*Fuel*	*Energy Usage (PJ)*
Oil	*3960*	*Oil*	*1980*	*Oil*	*4438.22*	*Oil*	*2219.12*
Biofuels	*0*	*New Biofuel*	*4546.485*	*Biofuels*	*41.87*	*New Biofuel*	*5611.059*
		Ex. Biofuels	*0*			*Ex. Biofuels*	*41.87*
295.90MT CO_2 Emission.		*156.79MT CO_2 Emission*		*331.71MT CO_2 Emission*		*176.81MT CO_2 Emission*	
***139.11MT** CO_2 Emission Reductions on Implementing the Proposed Case as a shift from the Base Case, and is Equivalent to **25113084** Automobiles Off-Usage during the Base Year*				***154.90MT** CO_2 Emission Reductions on adopting the Proposed Case, as compared to the Base Case, and with an Equivalence of **27968056** Automobiles Off-Operations for the Projected Year*			

3.3: Socio-economic Benefits Insights

Expanding the transport fuel access through the biofuels i.e. Bioethanol and Biodiesel as clearly shown the possibilities from the cases analyzed with the benefits all in boosting the transport sector of the continent also tends to offer additional social and economic Benefits in the process. Some of which are:

- Drastic reduction of overdependence on petroleum-based fuels thus, lowering their utilization in favor of the green transformation target of the continent.
- Ensuring greater access to biofuels for automobiles to the masses.
- Continuous fall in the costs of transportation as more and more modern biomass is exploited for biofuels at low costs as compared to the conventional fuels.
- Chances exist also in improving job opportunities from biomass feedstock extraction to processing level and finally to distribution level for end use.

3.4: Challenges of the Advance Biofuels High Implementation with Viable Solutions

Having seen the discussed benefits associated with this transformation, however, there could be some challenges which are surmountable, and are outlined in brief below:

i. Food Impact: Since what is advocated for is solely advanced biofuels i.e. biofuels from non-edible feedstock, which has no direct negative impact on food however, it could have indirect impact due to excessive use of lands for growing the biomass feedstock for advanced biofuels production rather than for food crops. This will lead to food production shortage thereby resulting to increase in food prices.

ii. Water Impact: It must be stated that biomass plantation requires huge amount of water to realize the full benefits, which is same to the processing activities to biofuels. This severely affects areas of water scarcity in trying to implement, thereby making the plantations and other processing activities to biofuels unsustainable. Moreover, excessive processing of the biomass to biofuels results in increased ethanol and biodiesel spillage to water bodies thereby contaminating or polluting the water bodies and serving as threat to aquatic animals and to some water requiring activities.

iii. Deforestation Impact: Continuous deforestation as an anti-forestry operation for abundantly obtaining the lignocellulose-based biomass for the advanced biofuels production is somewhat critical, as could affects the ecosystem in quite a number of ways such as giving room for augmented CO_2 Emission, higher tendencies for soil erosion, land degradation and so on.

- Solutions Offering to the Preceded Outlined challenges:

Having stated that the nature of the challenges which is ''Surmountable challenges'' in the previous discussion, below points serve as a proof in dealing with the biofuels adoption:

i. Addressing the Food Impact: Regarding the indirect impact on food resulting from excessive use of land for biofuels, land availability is not and has never been a problem to execution of activities due to huge unutilized lands available in Africa and Beyond. Buttressing the above point will be based on a study conducted by [11], showing explicitly the arable lands availability on a 2050 scenario on a global perspective. The findings revealed 390million hectares on a low band (0-100EJ), 1300million hectares on a mid-band (300-600EJ), with finally 4000million hectares on a high band (>600EJ).

ii. Addressing the Water Impact: Water scarcity issue to areas with such experiences could be addressed in a similar way to the proposal given on Bio-power analysis. These are the practice of rainfall harvesting technique, water recycling and reusing, and finally the adoption of improved irrigation systems all in favour of sustainability of biofuels projects at all levels.

iii. Addressing the Deforestation Impact: Addressing the negative impacts of deforestation could be done also similar to what has been proposed in Bio-power analysis, which is the practice of Sustainable Forest Management in terms of Afforestation and Reforestation. This will to a greater extent ensures sustainability of biomass feedstock supply for biofuels production and energy scale up at large.

3.5: Opportunity Areas on Implementation

- Biofuel Value Chain Extension: The Opportunity area of interest in this regard is solely the value chain extension which aims at valorization or adding value to biofuels in the processing chain for end use. This offers a lot of benefits. The major biofuels value chain extension are biodiesel and bioethanol as follows:

Feedstock: Having proposed the use of lignocellulose materials in the analysis, opportunities exist in applying other feed stocks like the Non-edible Oil Seed Crops (such as Jatropha Curcas, Castor Seed, Pongame Seed, Neem Seed etc.), and the use of Algae coupled with the value addition. All these applications have no direct impact on food. Below show the value addition chains:

i. **Biodiesel Value Addition:**
   a. **Use of Tert-Butyl Hydro Quinone (TBHQ) or Beta-Hydroxytoluene (BHT):** Anti-Oxidants Additives for Oxidative Stability of the Biodiesel or its Blends. This is to inhibit the Fuel reaction with Atm. Oxygen to form Peroxide, leading to Fuel Filter Plugging, Sludge and Laquer formation in Diesel Fuel Injector System
   b. **Use of Bio-Winter Flow Cold Flow Improver (CFI):** Cold-Weather Performance Additives which improves Low Temperature Operability in both Full Grade Biodiesel and its Blends
   c. **Use of Multi-Functional Additives with Anti-Foam:** For Excellent Emulsion Control and Inhibition of Foam formation. This is to inhibit poor Water Separation of Biodiesel Blends which may result in problems like Fuel Filter Blocking, Increased Corrosion and Microbial Contamination

ii. **Bioethanol Value Addition:**
   a. **De-naturing:** Poisoning of the Bioethanol Product by use of Additives like Denatonium, Acetone, Isopropyl Alcohol etc.
   b. **Blending and Use of DCI-11 Plus Additive:** Blending with Gasoline improves ignition in cold weather, and use of the additive specified prevents acid attack in Engine

4.0: Conclusions

Comprehensive and elaborate lignocellulose-based biomass assessment for Advanced Biofuels as an opportunity for shifting away from conventional biofuels has been made successful for a transport sector transformation in the African context. The elaborate assessments covered fuel energy mix up-scaling with the associated GhG Emissions benefits assessment as well as the societal and economic great impacts with further possible opportunity domains in improved revolutionization of the sector. This has been driven by the sustainable development targets placing energy access a serios concern and also the Nationally Determined Contributions (NDC) for countries clear developmental ambitions following the 2015 Paris Agreement all combined together. It is obvious on the quantitative analyses performed that for a given baseline year selected to be 2013 due to ease of data availability, descending the fossil-based transport oils by 50% with huge additions of the 90% of the explored total biomass resources for the advanced or higher generations biofuels turned out with 64.16% increment in transport energy mix, and with massive emissions savings of 155MT that is equivalent to 27968056 automobiles disregarded for operations in the baseline year. Extending the analyses to 2030 projections gives the transport fuel energy increase by 73.65% with its associated GhG Emissions reduction of 139MT based on fossil-based Oils decrement by 50% and augmenting with 90% of the total extended / forecasted Biomass resource (i.e. Agro Residues and Wood Fuel) for Biofuels (i.e. Advanced Biodiesel and Bioethanol) generation. The specified emissions reduction benefits could be seen on estimates as equivalent to 25117084 automobiles neglected from operation in the projected year. On a final note, the specified approaches in the research paper is mainly to justify to the decision makers the extent to which the energy transition is possible with Biomass as a basis for their own outstanding decisions in view of the subject matter for the African future.

5.0: Recommendations

Having successfully conducted the analyses and having t=seen the benefits associated with the research targets, the following points are strongly recommended in improving the transport sector of the African Continent:

- Appropriate policies and regulatory framework in favor of biofuels production from non-edible biomass feedstocks is strongly needed in all the 54-member states of the continent, stating clearly its relevance and the copious opportunities associated coupled with proper monitoring of the success stories. It must be stated that some countries have got the general biofuels policies but the level of implementation is chronically poor either as a result of inappropriateness of the policies or technical reasons and so on and have not yet gotten in to full commercialization in favor of the transport sector.
- Bioenergy Research and Development practitioners especially those dedicating their research to biofuels need adequate supports by finances and the enabling environments for conducting the researches in improving their technical knowhow and innovations.
- Energy Efficiency act is crucial on Biofuels projects adoptions both at the production and utilization levels.

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