ETHANOL

Clean Cooking Solutions

Social ■ Health ■ Economic ■ Environment ■ Climate Impacts

ECREEE

TOWARDS SUSTAINABLE ENERGY

EIC

ETHANOL IMPACT CONSORTIUM

Ethanol Clean Cooking Solutions in ECOWAS states:

Social, Health, Economic, Environmental and Climate Impacts

PGI PRESENTATION

Development of Regional Capacity for
Bioethanol for Cooking and Transportation in ECOWAS

Ethanol Clean Cooking Solutions in the ECOWAS States: Social, Health, Economic, Environmental and Climate Impacts

November 29, 2022

Project Gaia, Inc. for the Ethanol Impact Consortium (EIC)

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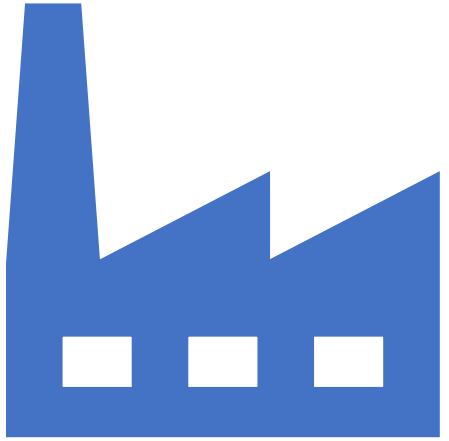
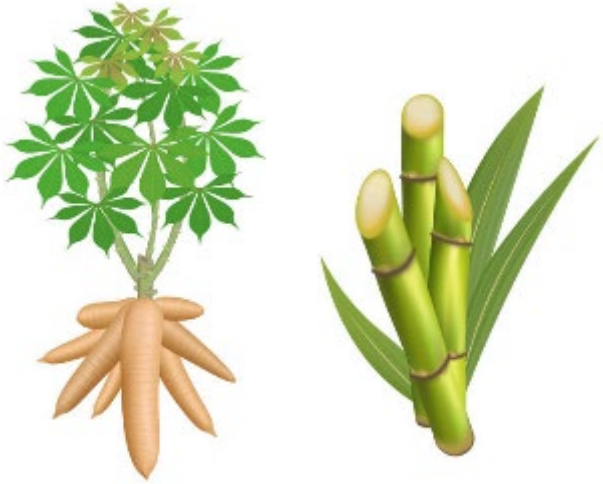
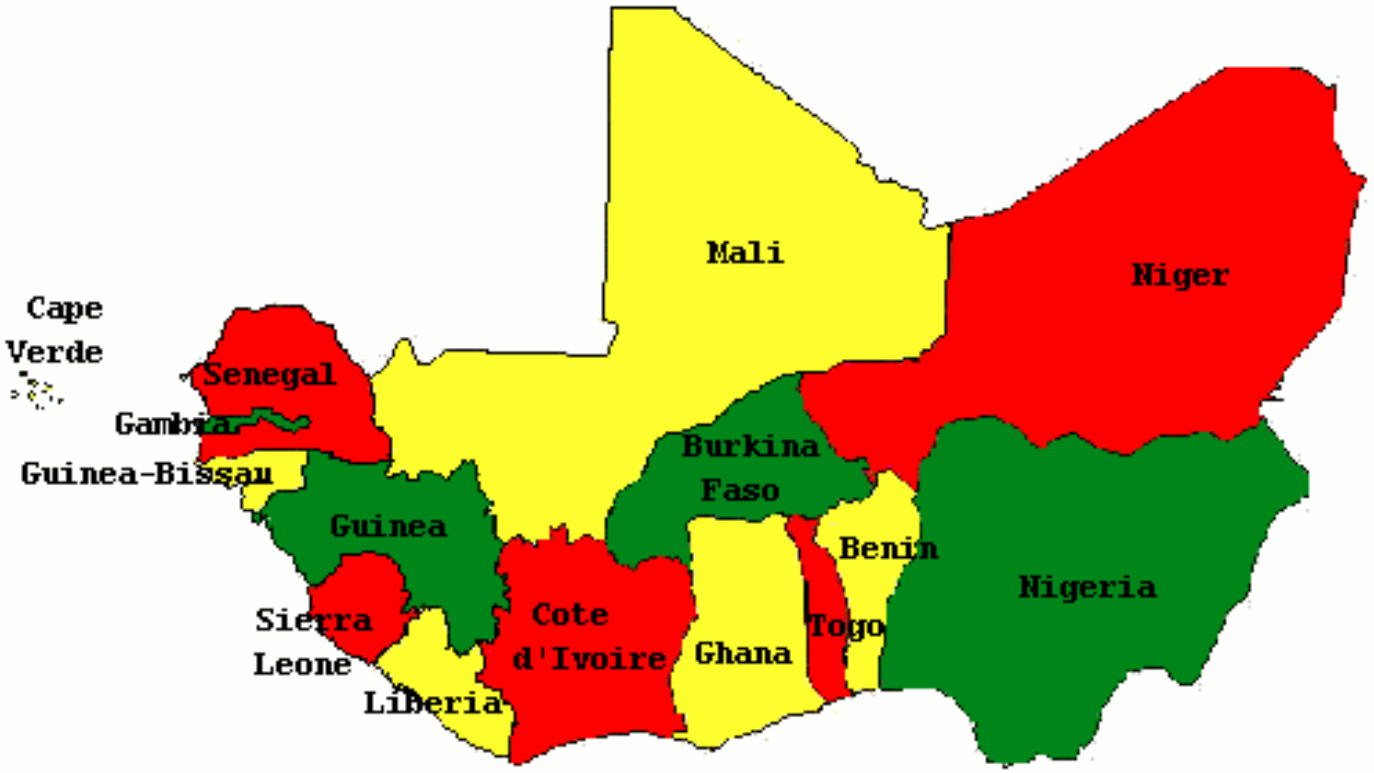




The Economic Community of West African States (ECOWAS)



The ECOWAS Region

The Economic Community of West African States (ECOWAS) is an organization of fifteen member countries in the western Africa region.

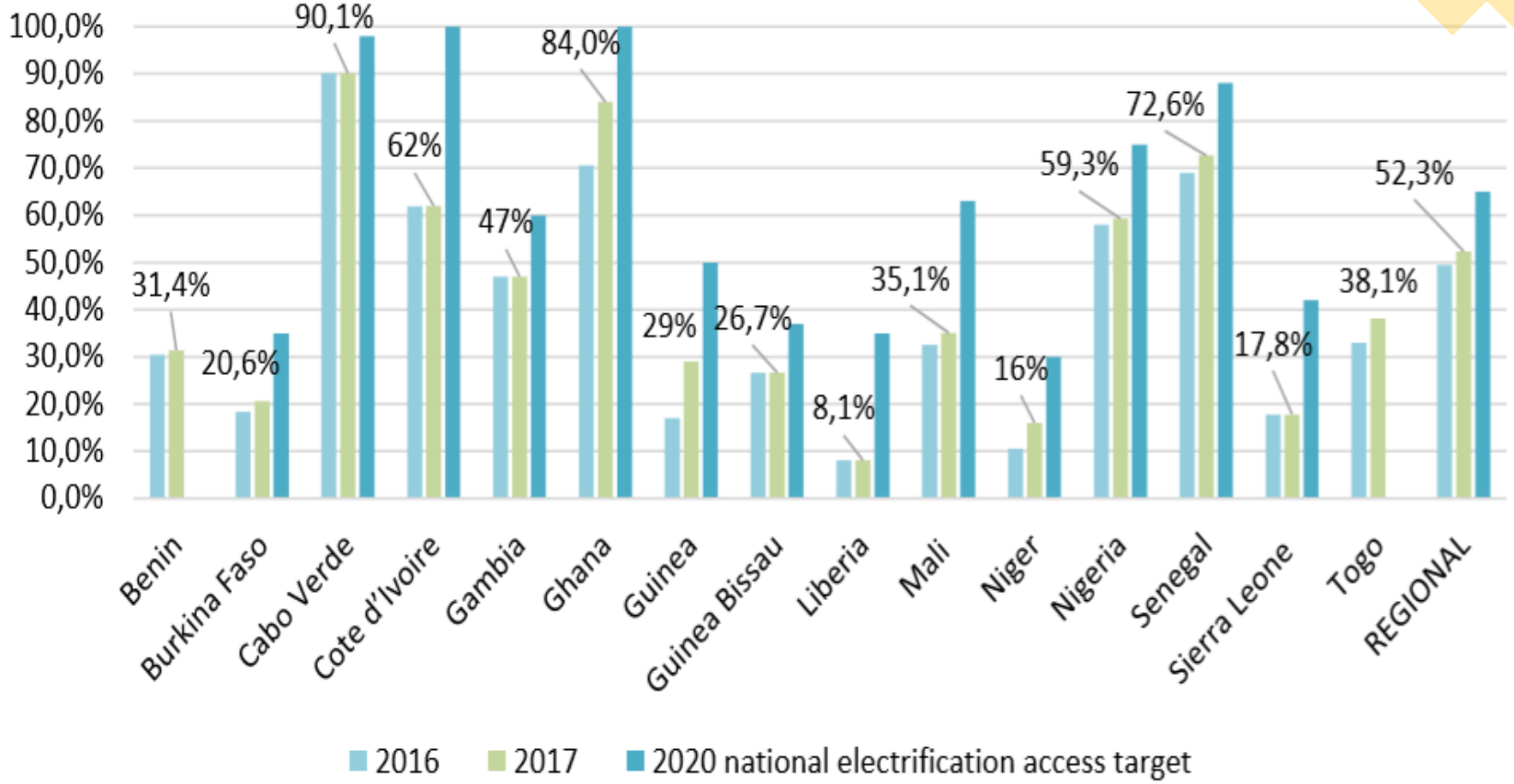
The ECOWAS region covers a land area of more than 5 million square kilometers and is home to about 400 million people, roughly one third of Africa's total population.

Eleven member states of the ECOWAS community are still considered Least Developed Countries (LDCs).

Energy context of the ECOWAS region

- Biomass is almost 80% in the final energy consumption, varying from 60% (Senegal) to over 90% (Niger, Guinea Bissau).

- In 2017, only 52.3% of the ECOWAS population had access to grid electricity. Rural electrification rates are less than 10% in countries such as Guinea, Niger, Liberia, Guinea-Bissau, and Sierra Leone.



Share (%) of Population Connected to an Electricity Grid in 2017 and 2016 (Source: Regional Progress Report, 2017)

Modern Cooking Solution Penetration in ECOWAS Countries

Country	LPG	Electricity	Kerosene	Census year
Benin	5.0%	0.3%	2.8%	2013
Burkina Faso	1.3%	0.7%	0.1%	2014
Cape Verde	76.5%	0.3%		2017
Côte d'Ivoire	22%			2014
Gambia	3.4%		0.6%	2013
Ghana	22.8%	0.5%	0.5%	2013
Guinea	0.8%	0.6%	0.5%	2014
Guinea-Bissau		5%		2011
Liberia	0.95%	0.9%	0.4%	2008
Mali		28.9%		2017
Niger	0.5%			2012
Nigeria	0.9%	0.2%	25%	2008
Senegal		43.5%		2014
Sierra Leone	0.8%	0.5%	0.7%	2015
Togo	2.76%	0.08%	0.37%	2010

Share (%) of Households Using Modern Cooking Solutions in ECOWAS Countries (Source: Regional Progress Report, 2017)

- Over 90% of the population uses traditional biomass for domestic cooking.
- The penetration of modern energy services (electricity, biogas, LPG, ethanol, biodiesel and improved stoves) in the ECOWAS region is still very low and energy poverty is increasing. (Energy access is not keeping up with population growth.)
- Heavy reliance on wood and charcoal is causing pervasive depletion of forest resources, exacerbated by increasing demand, with devastating economic, social, environmental and health consequences.
- The lack of access to modern, affordable and reliable energy services is linked to a variety of economic, social, environmental and political problems. The challenges are also related to energy access, energy security and climate change resiliency and mitigation.

Lessons from the Global Tracking Framework

Cooking fuel is the largest and easiest fuel market for producers

Losing ground: In Africa, of 29 million new people added in 2012-14, only 4 million had some access to clean energy, while 25 million did not.

SUSTAINABLE ENERGY FOR ALL

Hardly gaining: In Asia, of 94 million new people added during the same period, 54 million had access to clean energy while 40 million did not.

Of 3.04 billion people without access to clean energy, 807 million are in Sub-Saharan Africa and 2.1 billion in Asia.

This illustrates why we must bring the alcohol fuels into the household energy sector. All solutions are needed.

The problem of energy access for cooking may not be solved with LPG alone, or with more efficient use of wood and charcoal stoves. Other clean fuel options *in addition to* LPG are needed, especially solutions favoring domestic sourcing.

SE4ALL Global Tracking Framework 2017

http://www.worldbank.org/en/topic/energy/publication/global-tracking-framework-2017

FIGURE 14 Location of the 3.04 billion people living without access to clean cooking, 2014

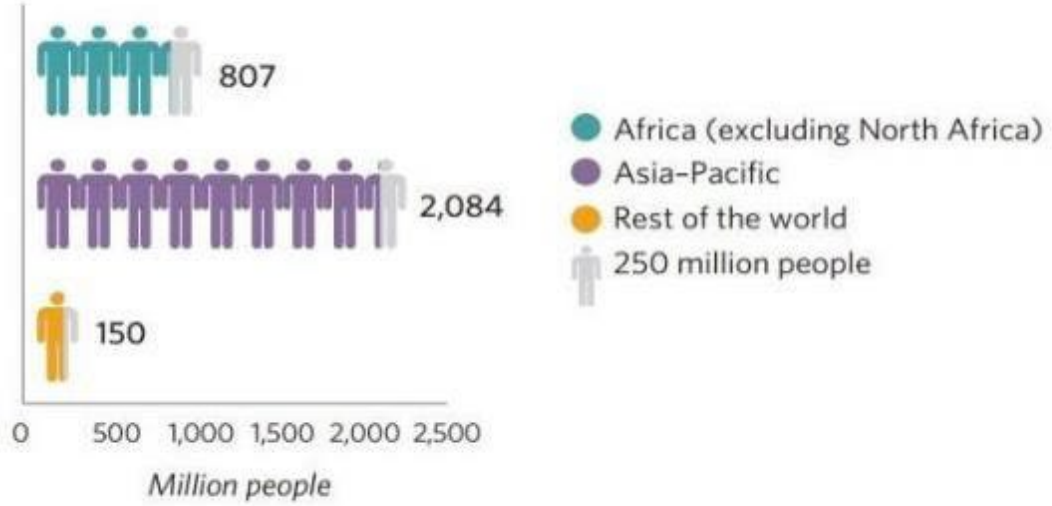
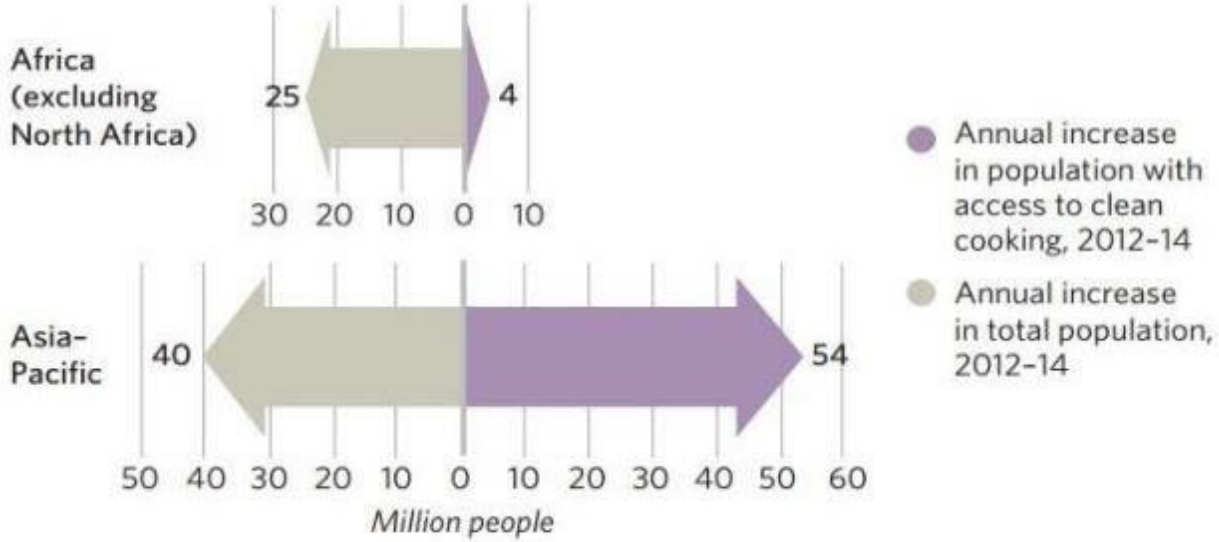


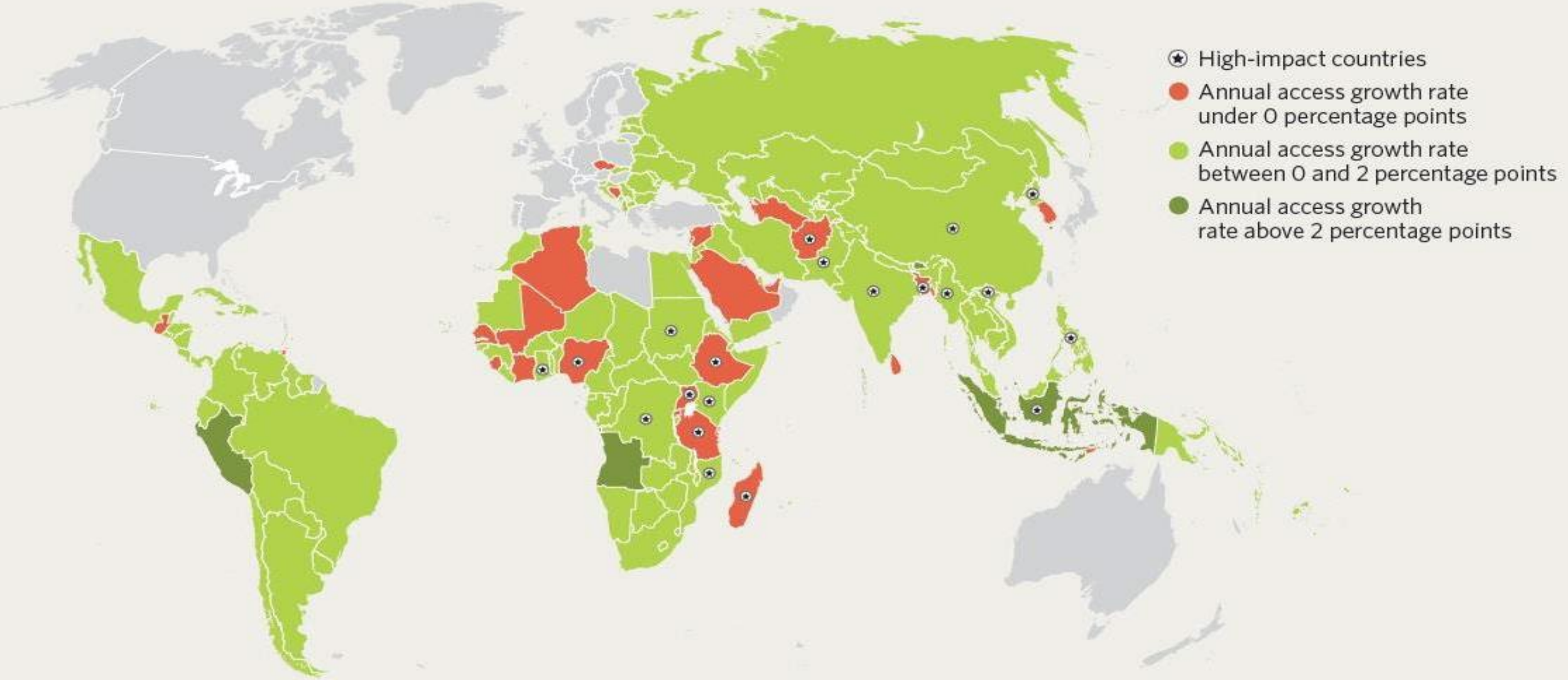
FIGURE 15 Demographic challenges for progress on access to clean cooking



SE4ALL Goals for energy access are not being met and are unlikely to be met by 2030.

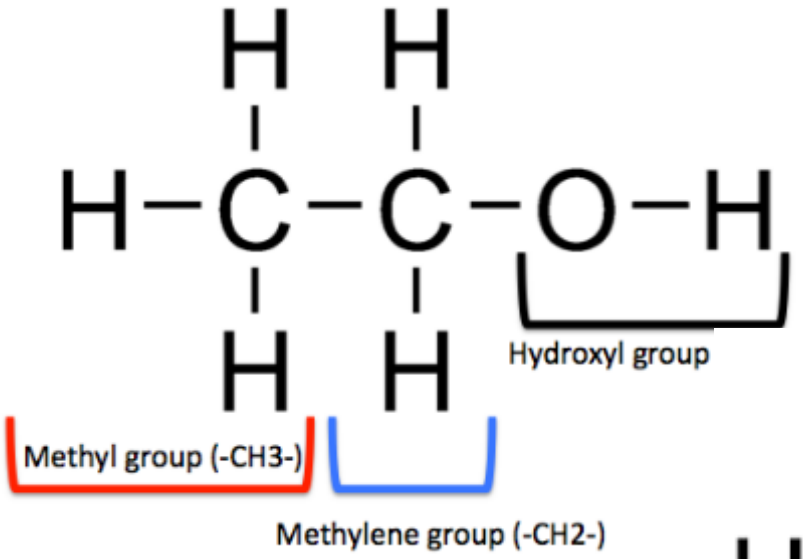
Sub Saharan Africa stands out as the continent where access to clean energy **is declining**, even though the continent is rich in energy resources and the potential for biomass production.

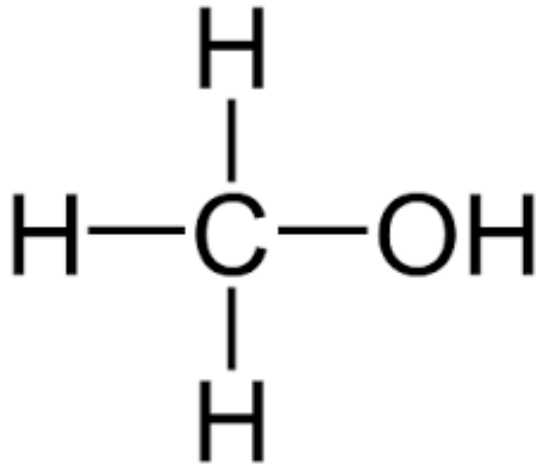
Speed of progress toward clean cooking goal, 2012–14



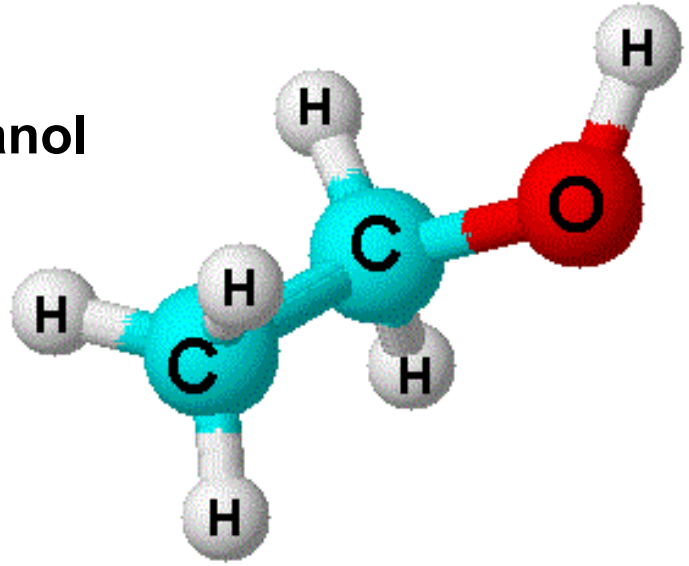
Why ethanol, why alcohols, as fuel? A little chemistry

C_2H_6O
or
CH_3CH_2OH

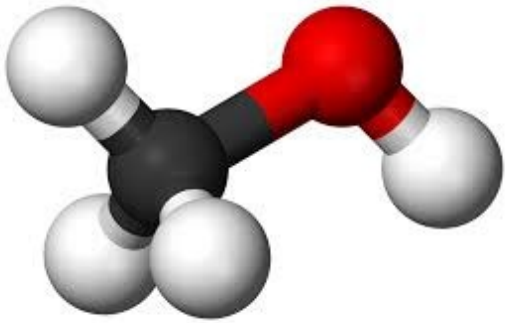




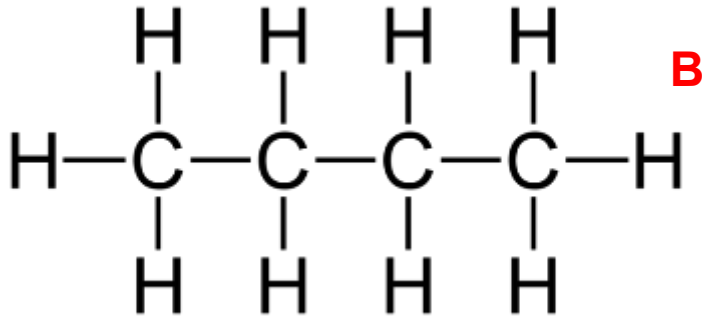
ethanol



methanol

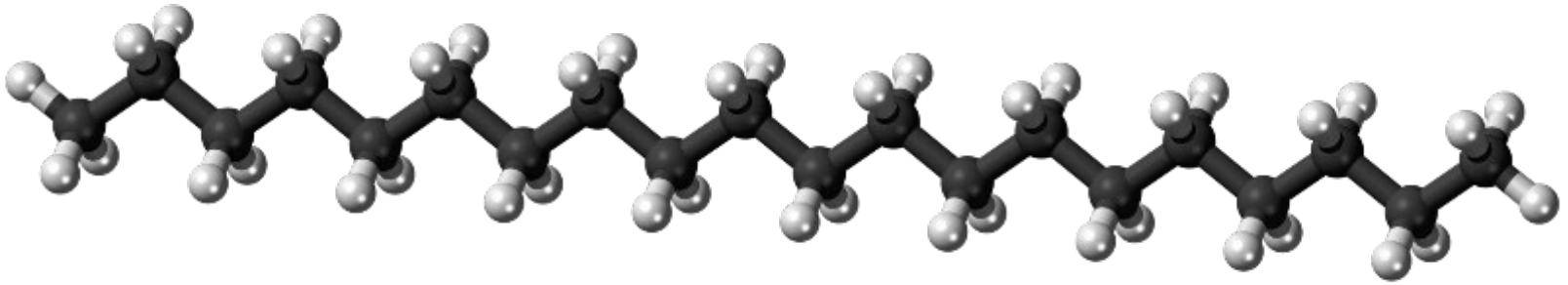


Kerosene has too much carbon. LPG has less. And ethanol, even less. Plus, an oxygen to help in combustion!



Butane

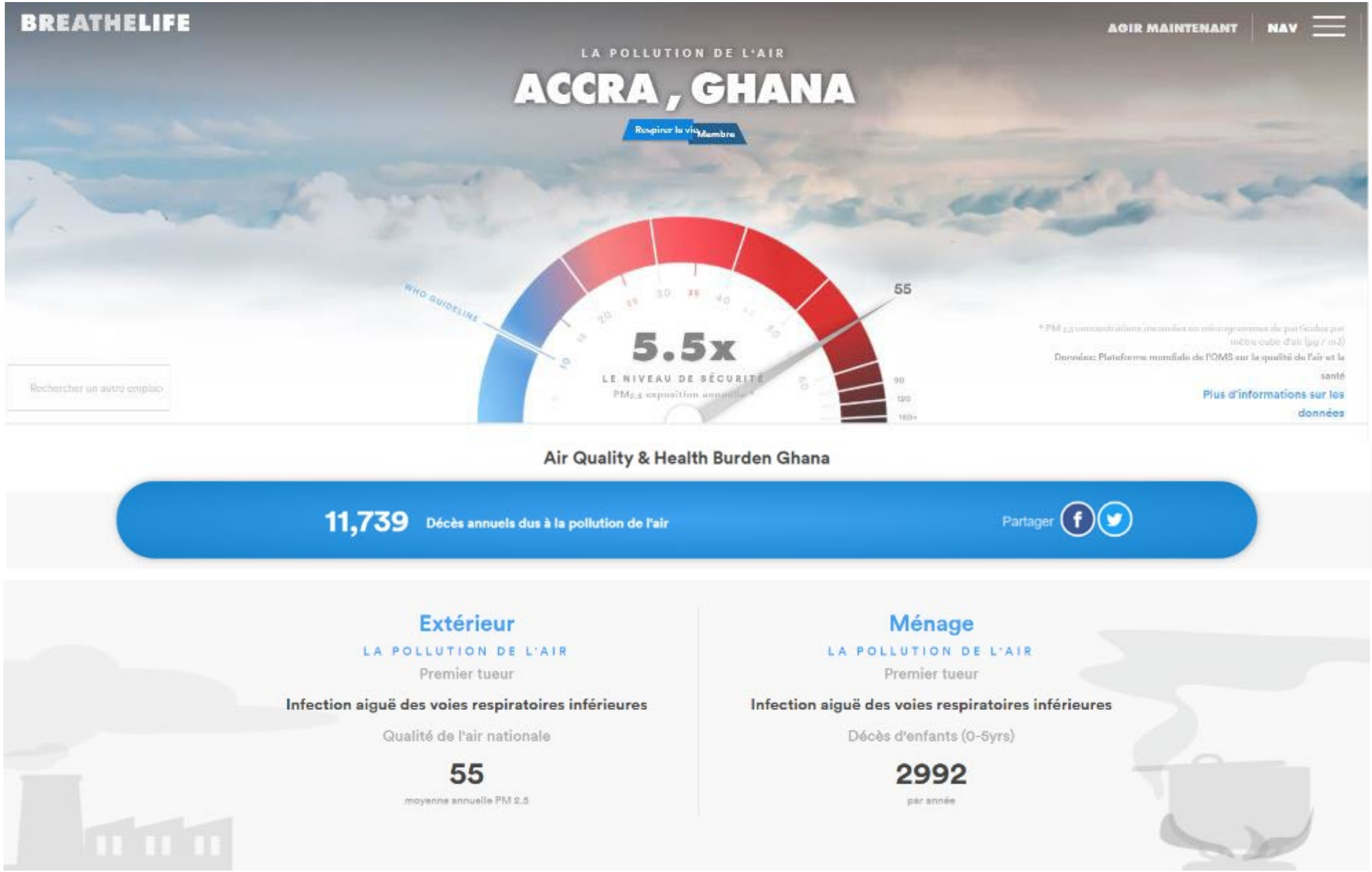
Kerosene is a mixture of hydrocarbons with number of carbon atoms ranging from 6 till 16. Its chemical formula might look like this: C16H32.



Kerosene

All of this carbon takes a lot of oxygen to burn up. It is the unburned carbon that causes smoke and soot.

LPG is a mixture of prominently two hydrocarbons, propane (C3H8) and butane (C4H10). So, although a fossil fuel, LPG burns much cleaner than kerosene, *but not as clean as ethanol*!



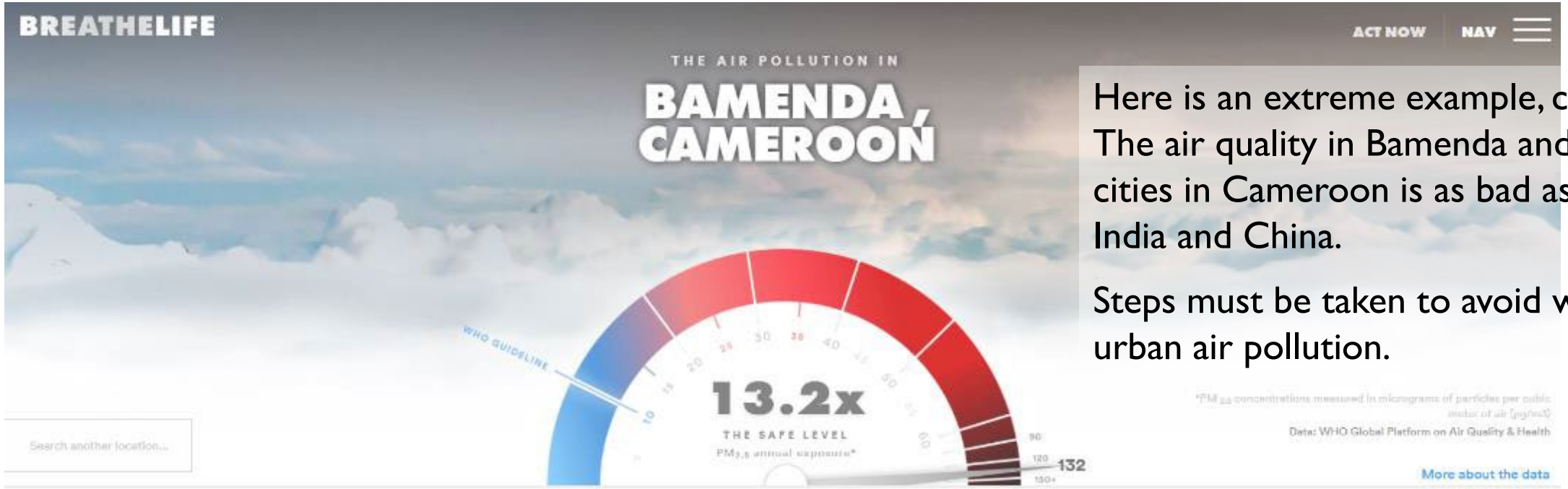
https://breathelife2030.org/city_data/accra/

Air quality in African cities is declining both as a result of dirty tailpipe exhaust and dirty cooking fires.

Biofuels have the ability to clean up both, by reducing emissions of PM2.5, CO, NOx and VOCs.

Air quality in Accra is 5.5 times more than the recommended level of pollutants by the WHO.

This may result in almost 12,000 premature deaths per year, including 3,000 children, 0 to 5 years in age.



Here is an extreme example, close by. The air quality in Bamenda and other cities in Cameroon is as bad as any in India and China.

Steps must be taken to avoid worsening urban air pollution.

Rural cooking smoke is making Delhi air pollution worse

(Oct. 26, 2017)

Ambient air pollution in Delhi has worsened. Multiple sources contribute to this increase, including industry, transport, dust, waste burning, seasonal crop burning (outside Delhi), power plants, and diesel generator sets.

One often overlooked source is coming from the homes of people living beyond Delhi's city limits. That source is cooking and space heating using solid fuels.

http://cleancookstoves.org/about/news/10-26-2017-rural-cooking-smoke-is-making-delhi-air-pollution-worse.html

The Problem of Black Carbon

- Black carbon (BC) from incomplete biomass and fossil fuel combustion is the most strongly light-absorbing component of particulate matter (PM) air pollution and the second most important climate-forcing human emission.

- Black carbon, a byproduct of poor or incomplete combustion, is estimated to contribute the equivalent of 25 to 50% of carbon dioxide warming globally.

- It also has local climatic effects. For example, black carbon disrupts annual weather patterns.

- Since the atmospheric lifetime of black carbon is only a few days, reducing black carbon emissions can bring about a rapid climate response in a short amount of time.

- Studies show that proximity to highways and smoke from cookstoves are major risk factors in human health.

Photo: Climate and Clean Air Coalition
https://www.ccacoalition.org/en/slcps/black-carbon

Why Bioethanol for fuel?

- All the ECOWAS countries have a need for more and cleaner energy.
- Bioethanol can be locally produced, on a large or small scale.
- The ever-increasing use of fuelwood and charcoal is impacting human health, local environments and contributing to climate change.
- There is no substitute to liquid fuels for efficiency, mobility and cost of delivery. Direct heating with liquid fuel is the cheapest, most efficient way to deliver energy for cooking, especially to hard-to-access areas.
- Kerosene is losing favor because it is a dirty, dangerous fuel. LPG, an excellent cooking fuel, can be difficult and expensive to deliver.
- Imported fuels demand scarce FOREX. This is especially costly for countries at a disadvantage on exchange markets.
- Imported fuels like LPG are subject to commodity price shocks
- Bioethanol fuel today is competitive with the cost of other fuels including charcoal and kerosene, and LPG when not subsidized.
- Bioethanol can enter the market without subsidies (but favorable VAT treatment is helpful).
- The market is huge — brings many new economic opportunities.
- Bioethanol uses existing distribution infrastructure.
- It helps the sugar industry in the region become more competitive.

Bioethanol – the most '*democratic*' of fuels

- ✓ Can be locally made
- ✓ Based on local agriculture and agricultural feedstocks
- ✓ Conversion of sugar and starch crops/feedstocks not difficult
- ✓ Can be produced on a large, small or micro scale with almost the same economics
- ✓ What farmers already grow can produce feedstock
- ✓ What farmers throw away may produce feedstock
- ✓ Micro production favorable to local ownership, integration with the farm and wide accessibility.

Cellulosic ethanol may be achievable in advanced economies. Sugar and starch crops in developing economies can have excellent environmental, sustainability and GHG values and should be the focus.

Africa's sugar industry is a big opportunity for ethanol fuel production.

Cookstove fuel and ethanol blendstock for gasoline are two compatible markets to develop in ECOWAS, and are named in several country NDCs, but as yet are largely unachieved.

The main obstacles to developing ethanol fuel are (a) policy, (b) finance, and (c) program support. Standards are an important part of policy.

Cookstove fuel is easier to develop (fewer technical requirements, easier processes, less infrastructure) and is potentially a larger market than fuel blending.

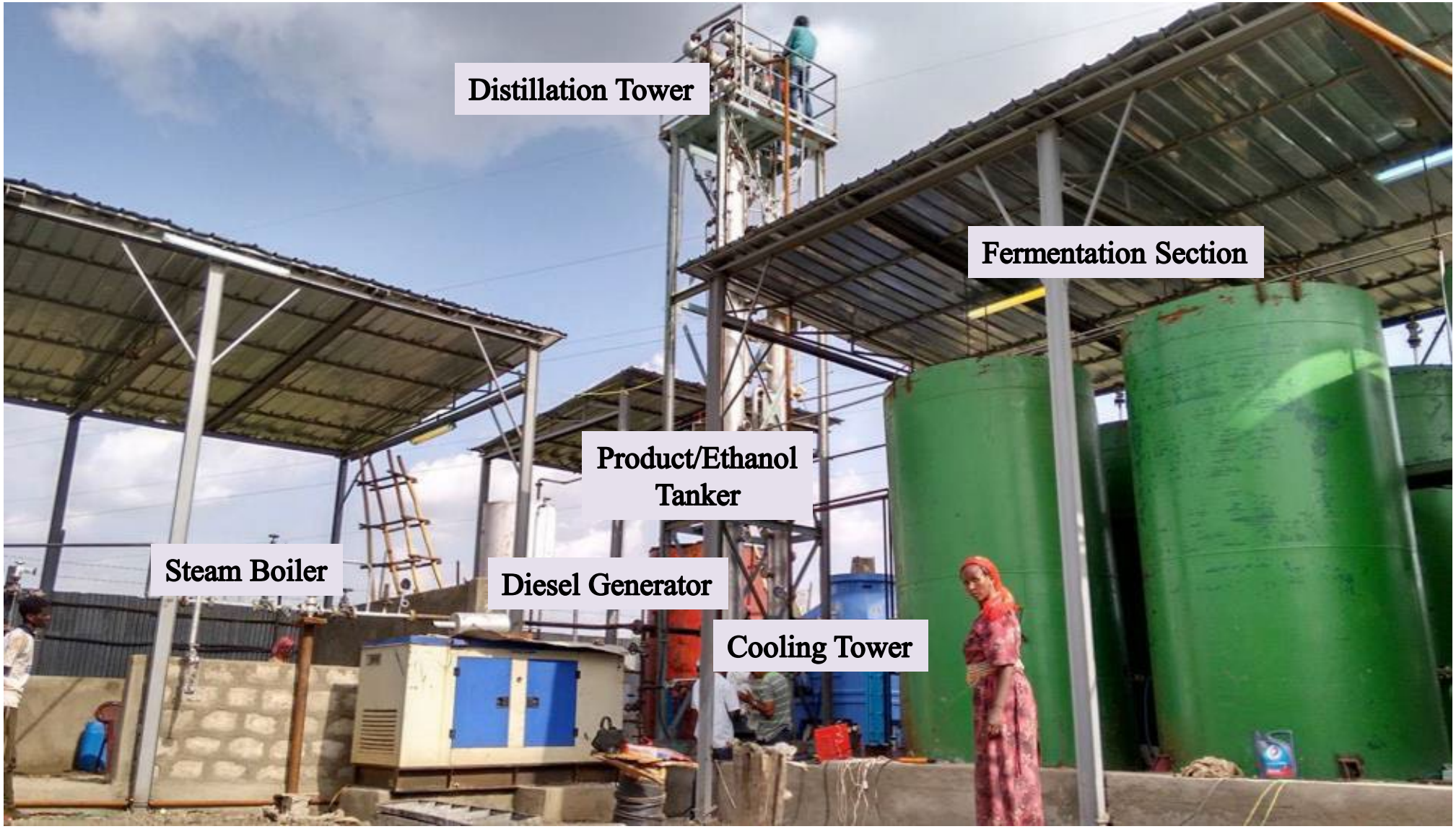
Ethanol Supply Chain

Ethanol moves efficiently by tanker truck from the distillery to a fuel depot on the city outskirts

Micro Distilleries: Producing from Dedicated Feedstock Supplies

2,500 liter/day micro distillery in Ilorin, Nigeria

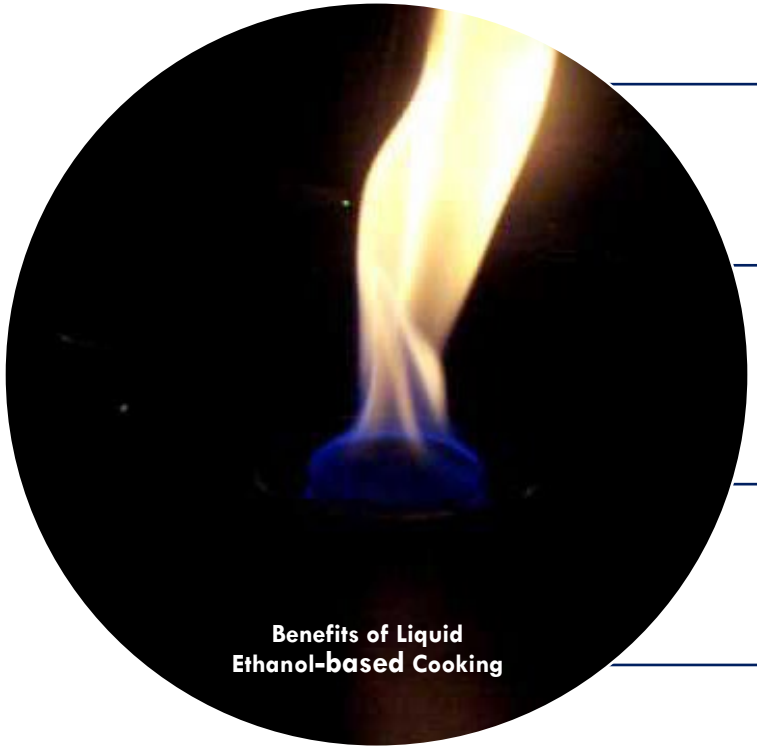
1,000 Liter/Day molasses microdistillery built by Gaia Clean Energy in Addis Ababa, in partnership with the Former Women Fuelwood Carriers' Association (FWFCA)



Bioethanol Potential as a Fuel for Cooking

- Charcoal & fuelwood are the primary sources of domestic energy in the region. Given the increase in urbanization, charcoal use has increased, which drives deforestation.
- Cleaner, more efficient cookstoves significantly **improve heat output, reduce household air pollution, reduce health risks and improve outdoor pollution**

An ethanol stove saves 4 to 6T of CO_2 per year replacing charcoal or firewood stove



Burns Cleanly — Does not produce air pollution in the kitchen or around the home

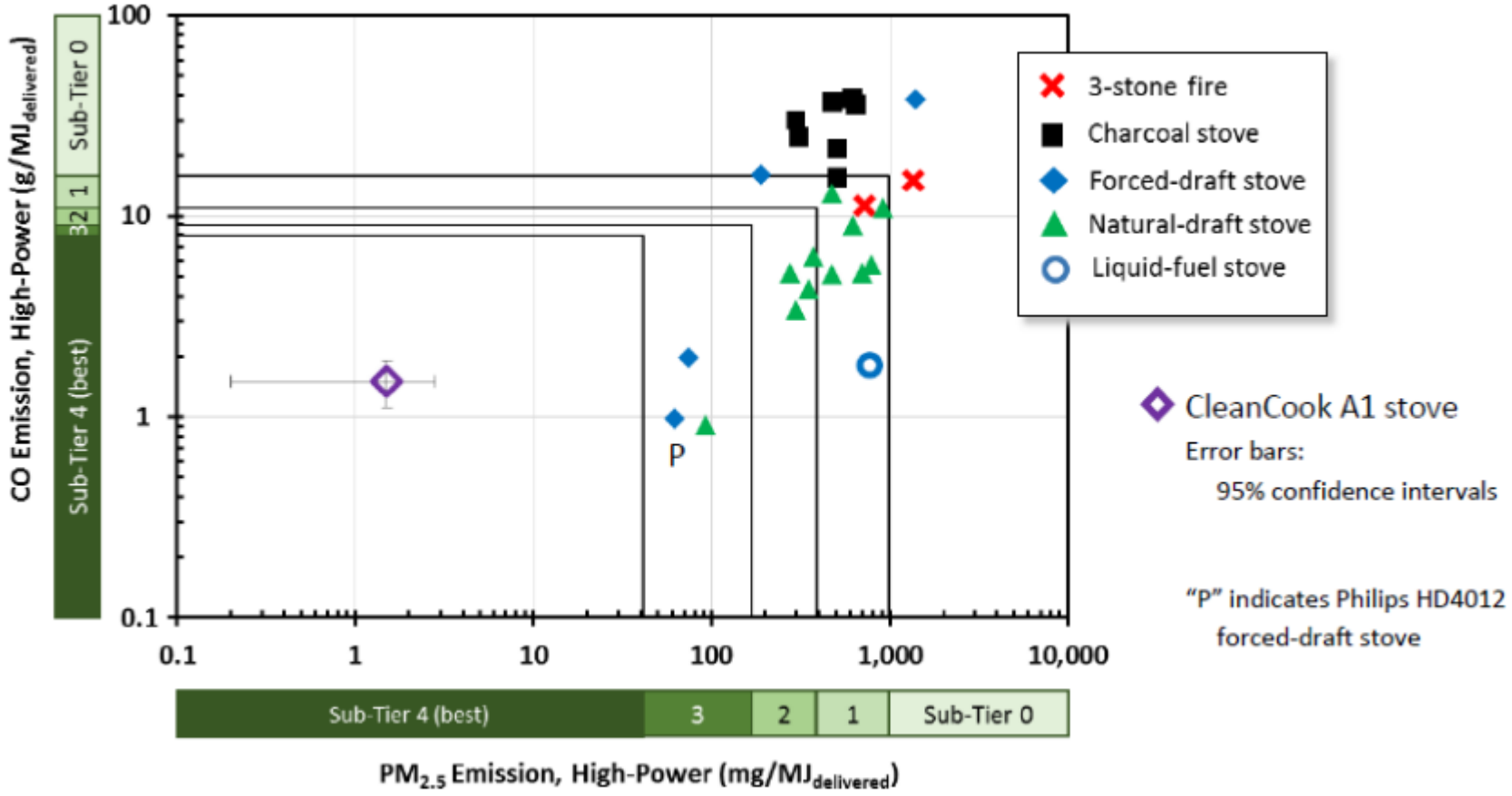
Safe — Easily extinguishable. Ethanol is relatively non-toxic

Affordable — Cheaper than kerosene & charcoal

Local Systems — Locally produced supporting agriculture and local economy

Bioethanol is already a cost-competitive and consumer-tested fuel

Stove performance



CO versus PM2.5 indoor emission rates *per useful energy delivered to water in the cooking pot* during high-power. (U.S. Environmental Protection Agency Cookstove Testing Laboratory, 2015.)

The Cleancook ethanol stove is an ISO/IWA Tier 4 (top tier) stove.

Interestingly, it is probably one of the most widely tested stoves of all of the stoves the CCA and its members work with.

Tier values for ISO voluntary performance targets (VPT) as established by the WHO

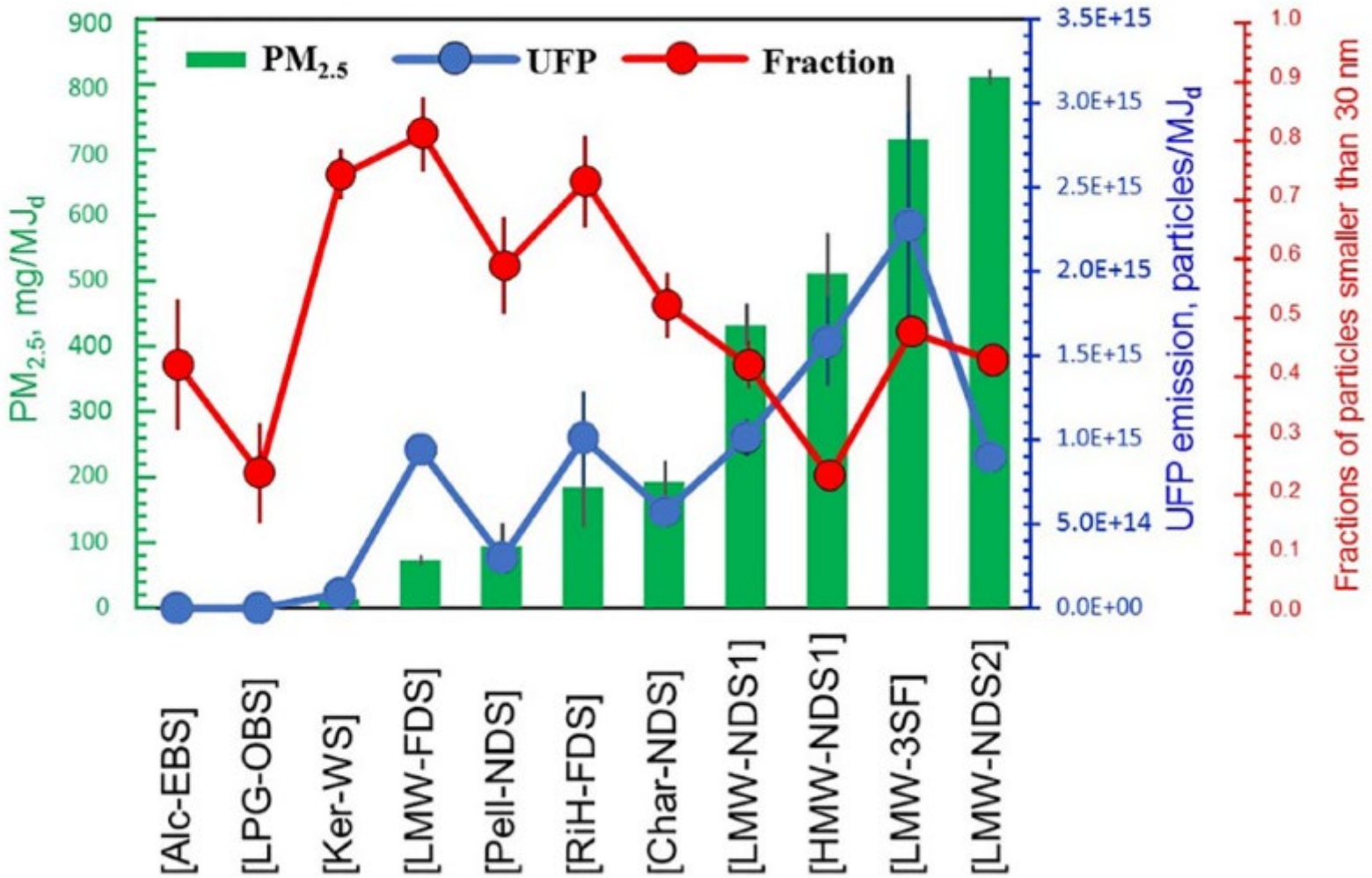
Performance	Tier	Thermal efficiency (%)	Emissions (default)		Safety (score)	Durability (score)
			CO (g/MJ_d)	$PM_{2.5}$ (mg/MJ_d)		
Better performance ↑	5	≥ 50	≤ 3.0	≤5	≥ 95	≤ 10
	4	≥ 40	≤ 4.4	≤ 62	≥ 86	≤ 15
	3	≥ 30	≤ 7.2	≤ 218	≥ 77	≤ 20
	2	≥ 20	≤ 11.5	≤ 481	≥ 68	≤ 25
	1	≥ 10	≤ 18.3	≤ 1030	≥ 60	≤ 35
	0	< 10	> 18.3	> 1030	< 60	> 35

Source: reference 1, Table 1

MJ_d, megajoules delivered

The Cleancook ethanol stove is an ISO/VPT Tier 5 stove.

From: Setting national voluntary performance targets for cookstoves, WHO, 2021



Emissions of PM2.5 by mass, UFP numbers, and fractions of particles smaller than 30 nm for fuel/stove types. Stoves are arranged in an increasing trend in PM2.5 mass emission, with alcohol the lowest. (Laboratory comparison of emission factors, USEPA technical paper, 2017.)

When using a good quality ethanol fuel, the ethanol stove burns more cleanly than an LPG stove.

(See Project Gaia's recommendation to ECREEE for a quality ethanol stove fuel standard.)

Cooking with ethanol in Sierra Leone (from the Sunbird Addax distillery).

Both liquid ethanol and ethanol gelfuel cooking businesses are developing in Nigeria and Ghana. Interest has been shown, and pilot studies conducted, in Sierra Leone, Senegal, Ivory Coast and Mali.

Courtesy Dana Armstrong, UC Davis, 2019

Bioethanol as cooking fuel

Use of a modern, well-proven alcohol stove with an *adsorptive fuel canister* has made cooking with ethanol much more attractive for the consumer. Use of liquid ethanol simplifies the supply chain. The adsorptive fuel canister technology provides a spill and explosion-proof cooking technology that is safer than kerosene LPG.

Ethanol combusts almost completely in the stove, leaving only CO_2 and H_2O as emissions.

- Consumers like the stove and fuel
- Convenient ethanol supply chain can be built to deliver the fuel
- Ethanol stove is competitive with other modern stoves in performance and cost
- Ethanol price points can be competitive to LPG, kerosene and charcoal.

Once in the canister, fuel does not spill out, but evaporates into a combustion chimney to support a hot flame. The canister is closed with a regulator when the stove is not in use.

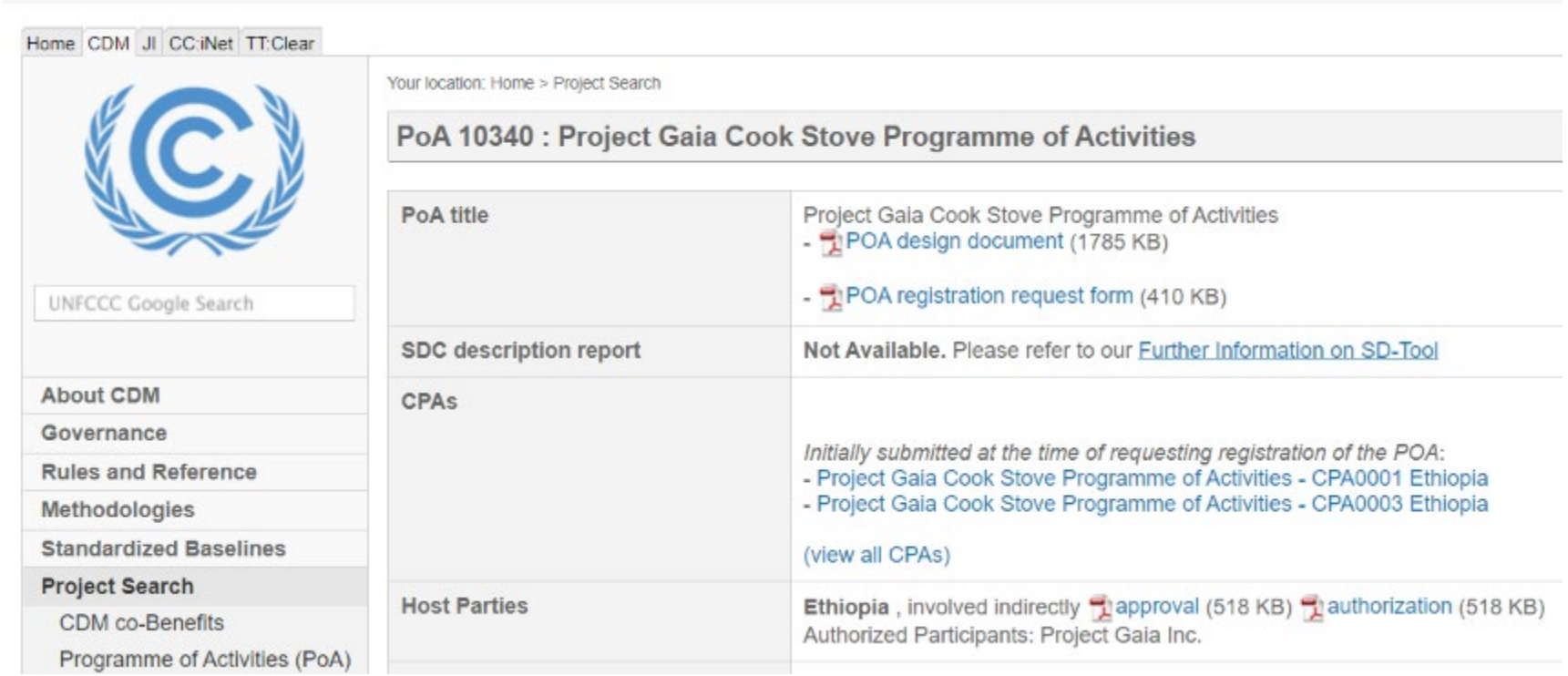
Bioethanol Stoves – rapidly evolving

Clockwise, left to right:

Cleancook 1 & 2 burner, Blue Flame 1 & 2 burner, Kiki Green gelfuel stove, 1 & 2 burner, and Koko Stove with Koko Point fuel dispensing.

Gold Standard®

Climate Security & Sustainable Development



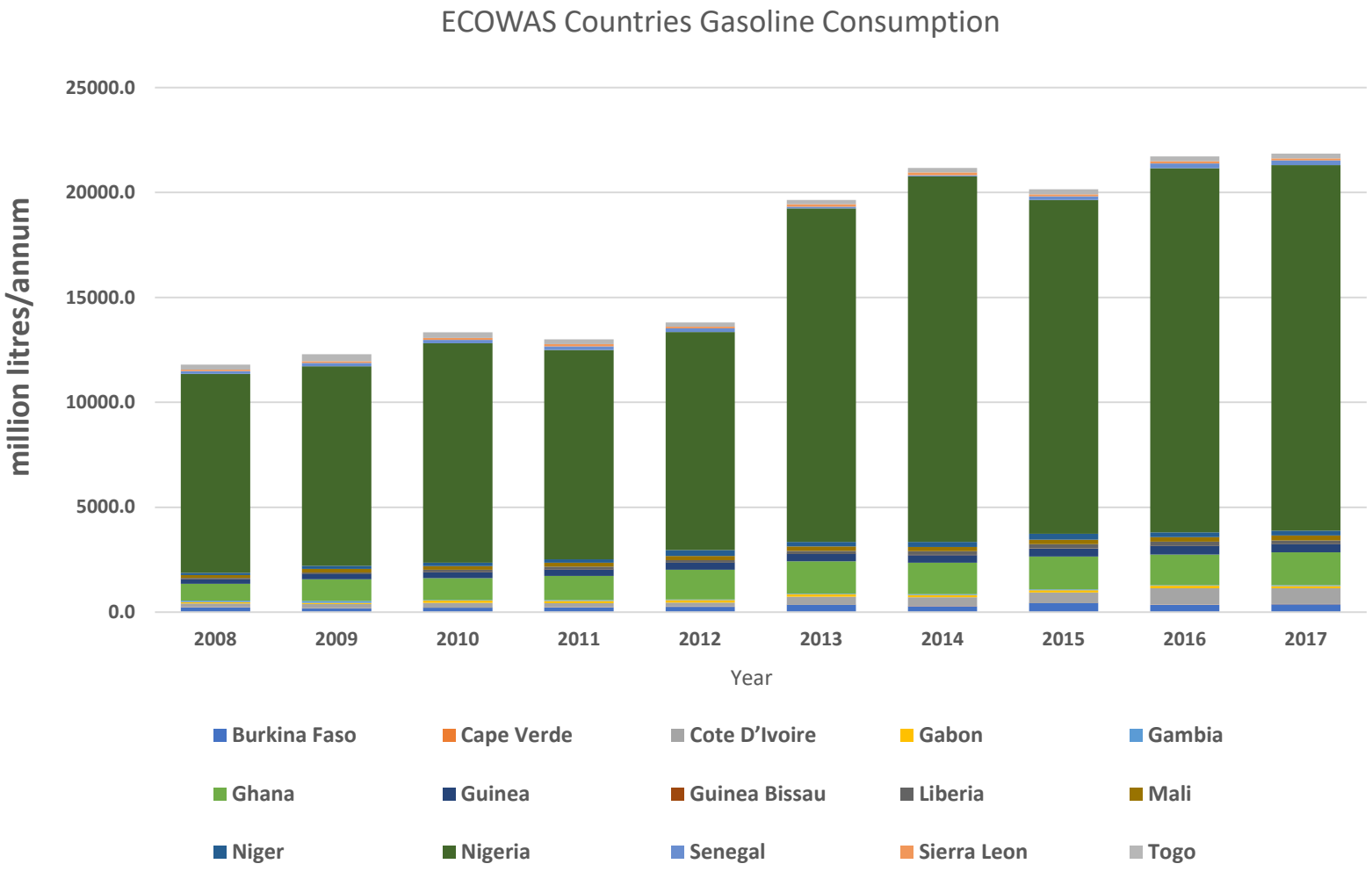
An ethanol stove using 1 liter of ethanol will displace 2½ to 4 kg of charcoal per day and 8 to 12 kg of fuelwood. It will displace 1.2 liters of kerosene and 0.5 kg (1 liter) of LPG.

Under the Project Gaia cookstove program of activities, a stove will earn 4 to 6 tons of CO2-e per year.

Bioethanol for Fuel Blending

Fuel pump choices in the U.S. Midwest. E10 choices, plus E15 and E85.

ECOWAS Region Gasoline Consumption



Source: theGlobalEconomy.com

Increasing fossil fuel import dependency, and shortages and fluctuating fossil fuel prices are major concerns of the ECOWAS.

Increasing and fluctuating oil prices have had a devastating effect on the economies of ECOWAS oil importing countries.

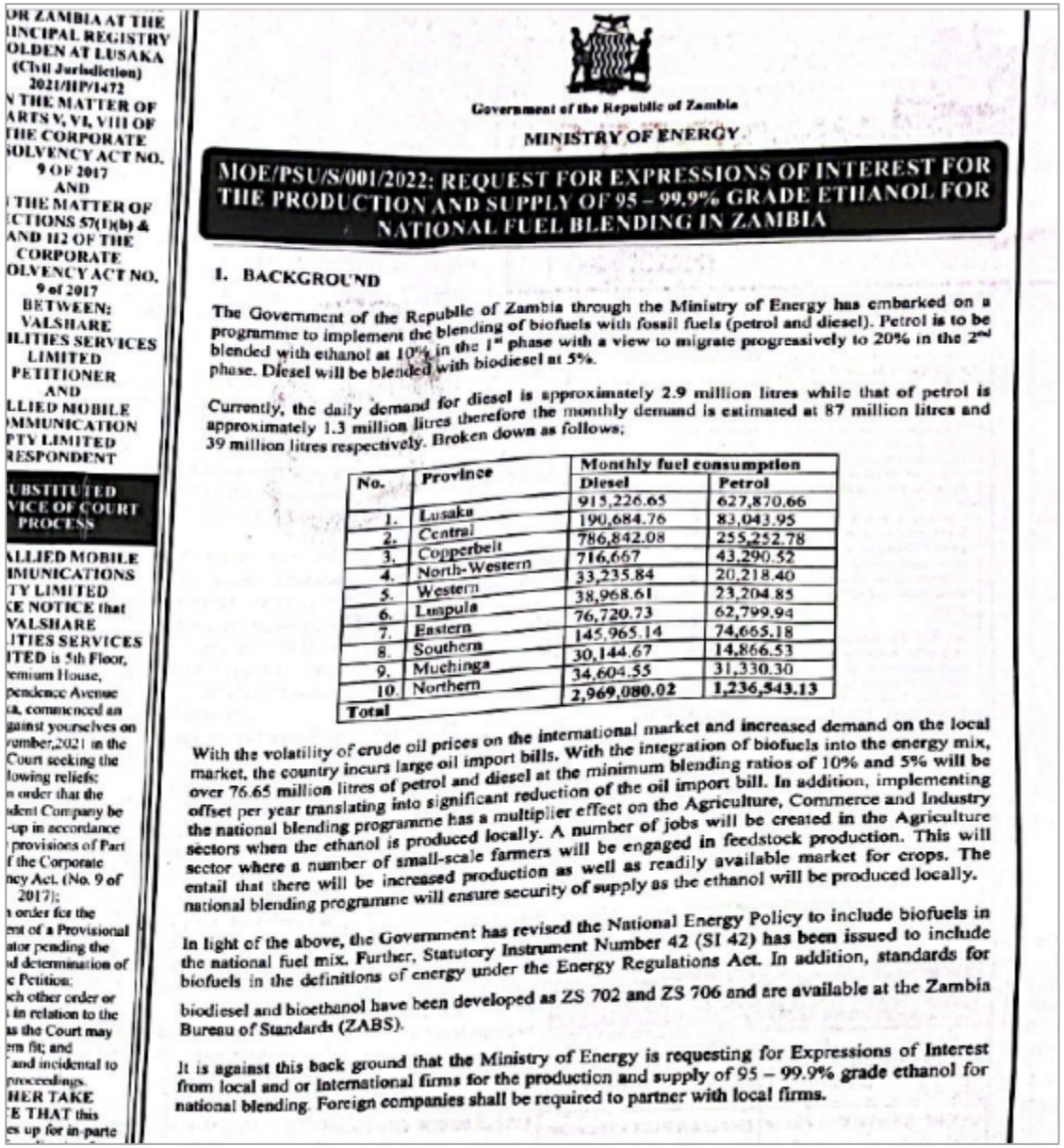
The ECOWAS countries can diversity their energy mix utilizing the bioenergy potential of the region.

Ethanol-Gasoline Blending Targets in ECOWAS

To develop the biofuel sector, the region had set a 5% target of ethanol blending into gasoline by 2020. However, this has not been implemented and only Burkina Faso, Mali, Nigeria, Ghana and Senegal have developed specific strategies for biofuel.

Developing a region-wide biofuel strategy would be well-advised.

Country	Target (2020)	Target (2030)	Remark
Benin	E5	E15	E10 (in 2025)
Burkina Faso	-	E10	
Cape Verde	-	-	
Côte d'Ivoire	E1	E5	
Gambia	-	-	
Ghana	E10	E20	
Guinea	-	-	
Guinea-Bissau	-	-	
Liberia	E2	E10	
Mali	-	E11	
Niger	-	E2	
Nigeria	E10	-	2030 goal not specified
Senegal	E5	E10	
Sierra Leone	-	-	There is a blending plan but not specified
Togo	E2	E7	



OR ZAMBIA AT THE
INCIPAL REGISTRY
OLDEN AT LUSAKA
(Civil Jurisdiction)
2021/HP/1472
N THE MATTER OF
ARTS V, VI, VIII OF
HE CORPORATE
OLVENCY ACT NO.
9 OF 2017
AND
THE MATTER OF
CTIONS 57(1)(b) &
AND 112 OF THE
CORPORATE
OLVENCY ACT NO.
9 of 2017
BETWEEN:
VALSHARE
ILITIES SERVICES
LIMITED
PETITIONER
AND
LLIED MOBILE
MMUNICATION
PTY LIMITED
RESPONDENT

UBSTITUTED
VICE OF COURT
PROCESS

ALLIED MOBILE
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VALSHARE
ITIES SERVICES
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Government of the Republic of Zambia

MINISTRY OF ENERGY

MOE/PSU/S/001/2022: REQUEST FOR EXPRESSIONS OF INTEREST FOR THE PRODUCTION AND SUPPLY OF 95 – 99.9% GRADE ETHANOL FOR NATIONAL FUEL BLENDING IN ZAMBIA

1. BACKGROUND

The Government of the Republic of Zambia through the Ministry of Energy has embarked on a programme to implement the blending of biofuels with fossil fuels (petrol and diesel). Petrol is to be blended with ethanol at 10% in the 1st phase with a view to migrate progressively to 20% in the 2nd phase. Diesel will be blended with biodiesel at 5%.

Currently, the daily demand for diesel is approximately 2.9 million litres while that of petrol is approximately 1.3 million litres therefore the monthly demand is estimated at 87 million litres and 39 million litres respectively. Broken down as follows;

No.	Province	Monthly fuel consumption	
		Diesel	Petrol
1.	Lusaka	915,226.65	627,870.66
2.	Central	190,684.76	83,043.95
3.	Copperbelt	786,842.08	255,252.78
4.	North-Western	716,667	43,290.52
5.	Western	33,235.84	20,218.40
6.	Lunpula	38,968.61	23,204.85
7.	Eastern	76,720.73	62,799.94
8.	Southern	145,965.14	74,665.18
9.	Muchinga	30,144.67	14,866.53
10.	Northern	34,604.55	31,330.30
Total		2,969,080.02	1,236,543.13

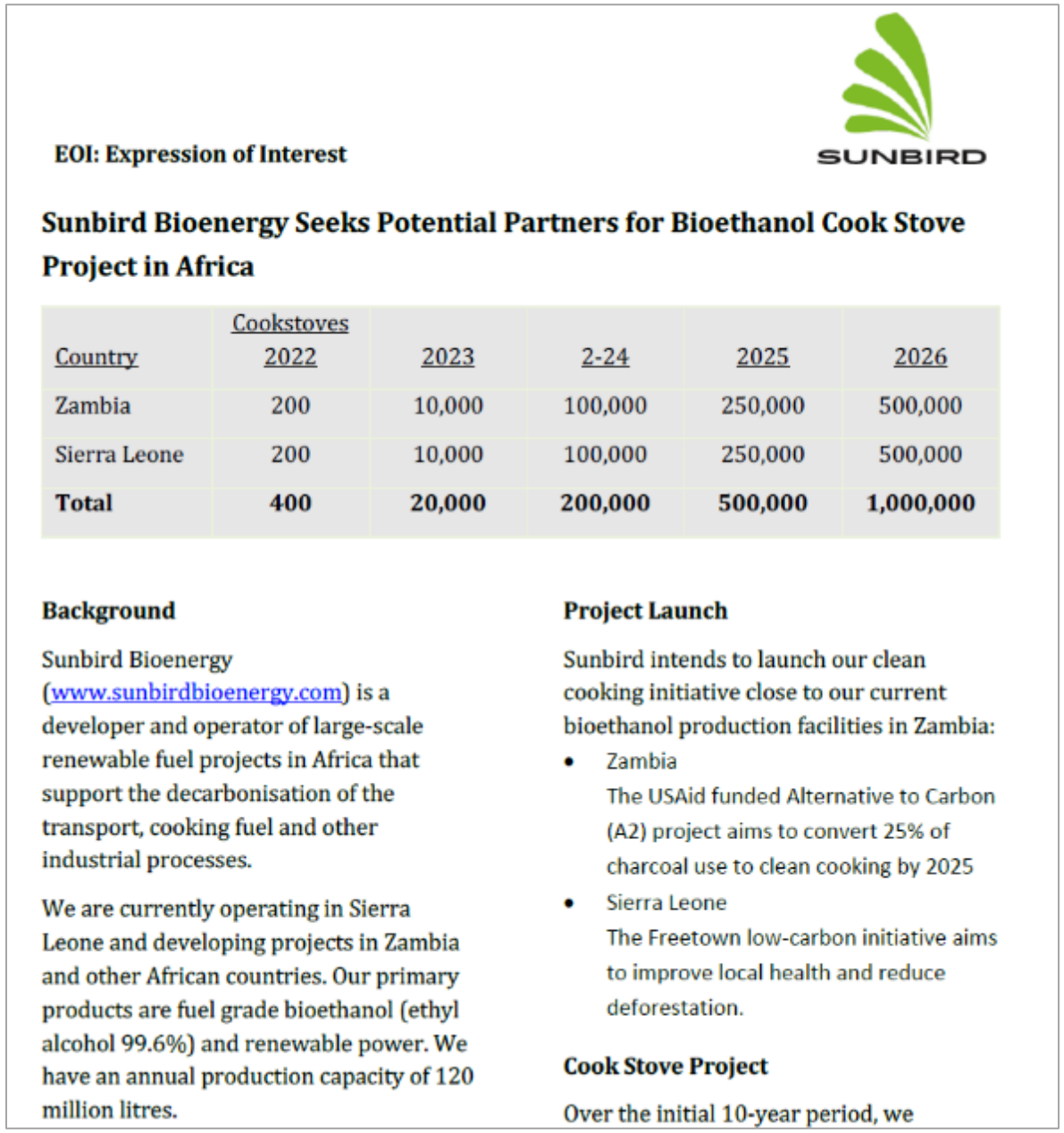
With the volatility of crude oil prices on the international market and increased demand on the local market, the country incurs large oil import bills. With the integration of biofuels into the energy mix, over 76.65 million litres of petrol and diesel at the minimum blending ratios of 10% and 5% will be offset per year translating into significant reduction of the oil import bill. In addition, implementing the national blending programme has a multiplier effect on the Agriculture, Commerce and Industry sectors when the ethanol is produced locally. A number of jobs will be created in the Agriculture sector where a number of small-scale farmers will be engaged in feedstock production. This will entail that there will be increased production as well as readily available market for crops. The national blending programme will ensure security of supply as the ethanol will be produced locally.

In light of the above, the Government has revised the National Energy Policy to include biofuels in the national fuel mix. Further, Statutory Instrument Number 42 (SI 42) has been issued to include biofuels in the definitions of energy under the Energy Regulations Act. In addition, standards for biodiesel and bioethanol have been developed as ZS 702 and ZS 706 and are available at the Zambia Bureau of Standards (ZABS).

It is against this back ground that the Ministry of Energy is requesting for Expressions of Interest from local and or International firms for the production and supply of 95 – 99.9% grade ethanol for national blending. Foreign companies shall be required to partner with local firms.

In February 2022, the Government of Zambia's Ministry of Energy issued a request for Expressions of Interest (EOI) for the production and supply of 95 – 99% grade ethanol for its national fuel blending program, to achieve a target of 20% blending.

Zambia will join Zimbabwe and Malawi as fuel blending nations. South Africa is seeking its own program.



EOI: Expression of Interest

SUNBIRD

Sunbird Bioenergy Seeks Potential Partners for Bioethanol Cook Stove Project in Africa

Country	Cookstoves 2022	2023	2-24	2025	2026
Zambia	200	10,000	100,000	250,000	500,000
Sierra Leone	200	10,000	100,000	250,000	500,000
Total	**400**	**20,000**	**200,000**	**500,000**	**1,000,000**

Background

Sunbird Bioenergy (www.sunbirdbioenergy.com) is a developer and operator of large-scale renewable fuel projects in Africa that support the decarbonisation of the transport, cooking fuel and other industrial processes.

We are currently operating in Sierra Leone and developing projects in Zambia and other African countries. Our primary products are fuel grade bioethanol (ethyl alcohol 99.6%) and renewable power. We have an annual production capacity of 120 million litres.

Project Launch

Sunbird intends to launch our clean cooking initiative close to our current bioethanol production facilities in Zambia:

- Zambia
  The USAid funded Alternative to Carbon (A2) project aims to convert 25% of charcoal use to clean cooking by 2025
- Sierra Leone
  The Freetown low-carbon initiative aims to improve local health and reduce deforestation.

Cook Stove Project

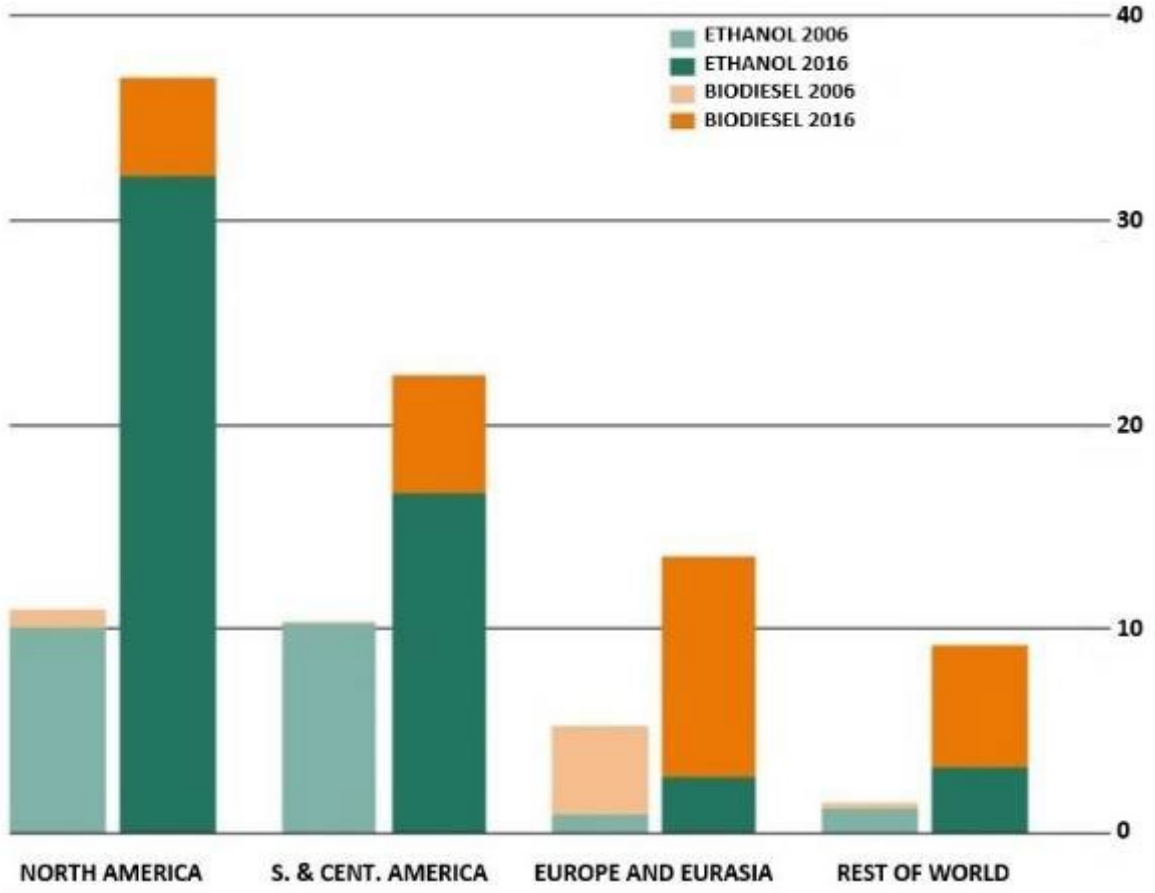
Over the initial 10-year period, we

In late April, Sunbird Bioenergy made the announcement that it would seek partners for bioethanol cookstove projects in Sierra Leone and Zambia.

It is proposing to deploy and supply half-a-million stoves in each country.

Its plants are based on cassava.

Global Biodiesel and Ethanol Production (in billion gallons)



Source: Hassan & Ayodeji, 2019

The potential for ethanol production in the ECOWAS region remains unrealized, as the region produces only about 175 million liters of ethanol annually.

Active Bioethanol Producers in the ECOWAS Region

Recent news:

NOSAK in Nigeria is said to be reopening their redistillation plant in Lagos and building a new plant to produce from local feedstock.

In Ghana, a Chinese investor is said to be looking in the south. A new redistillation plant is planned for Tema port.

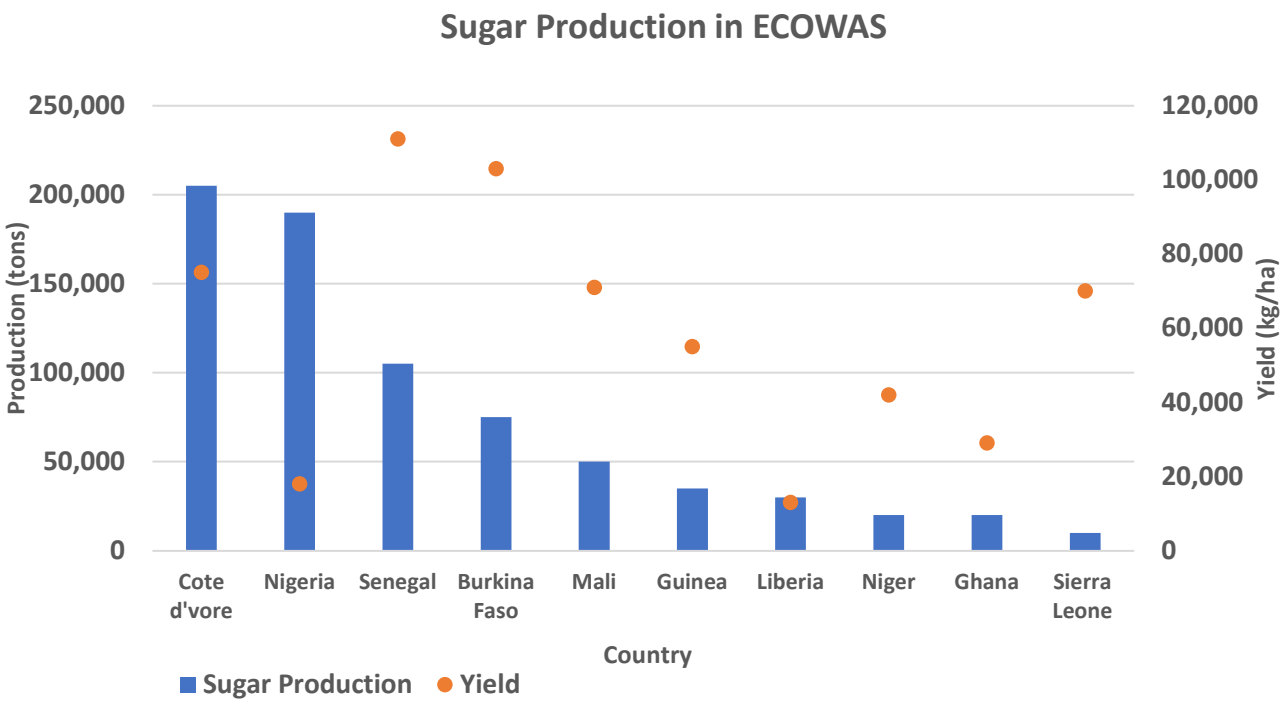
The China Sinolight sugar factory distillery in Mali is producing at reduced capacity.

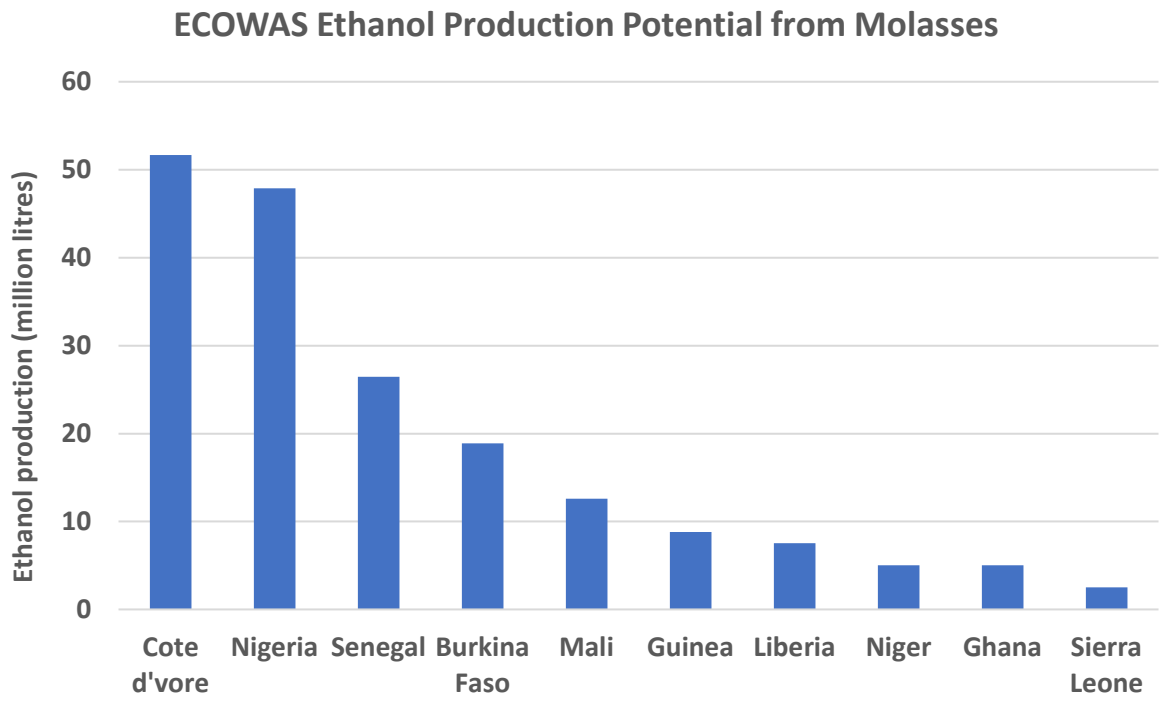
Country	Ethanol Producer	Production Capacity, annual (million liters)	Remark
Benin	Benin Sugar Plant	4.2	Molasses feedstock
	Benin International Plant (YUEKEN)	3.0	Cassava molasses
Burkina Faso	SN SOSUCO (not currently producing but has feedstock supply for production)	20	Molasses feedstock
Ghana	Caltech Ventures, Ltd.	1.5	Cassava feedstock
	Southline Group (in planning)	12	Cassava feedstock
Nigeria	UNIKEM Industries Ltd.	200	Importer ethanol (re-distillation)
	UNICANE Industries Ltd.	36 with expansion to 120	Cassava, sugarcane, cashew apple
	Allied Atlantic Distilleries Limited (AADL)	9	Cassava feedstock
Senegal	Senegalese Sugar Company	10	Molasses feedstock
Sierra Leone	Sunbird Bioenergy Sierra Leone Ltd.	60+	Sugarcane and cassava

Source: Compiled by Project Gaia

Feedstocks for Bioethanol Production in the ECOWAS Region

The Potential for Sugarcane and Molasses

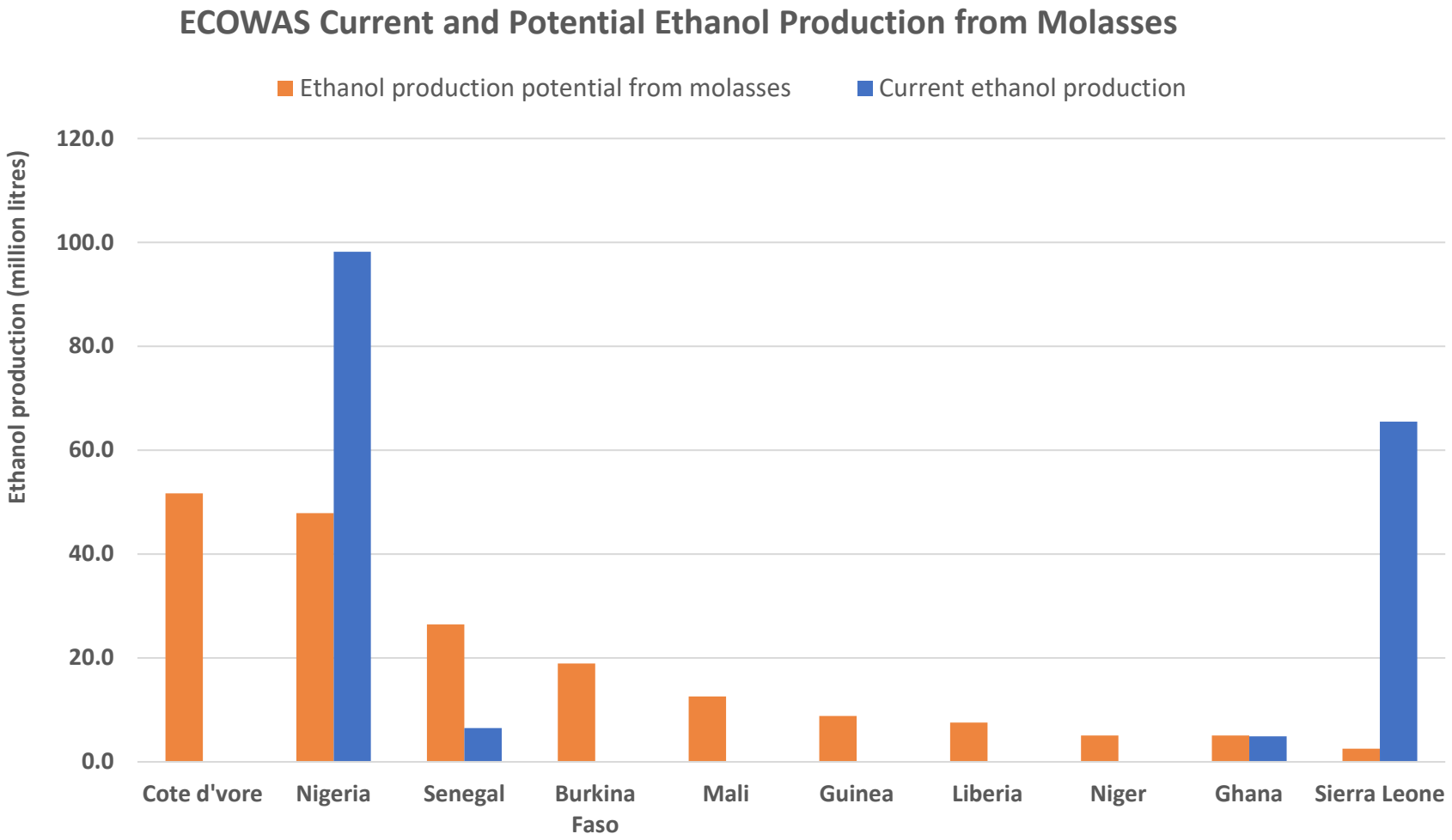




Source: http://www.vib.be/en/about-vib/Documents/vib_fact_Sugercane_EN_2017_1006_LR_single.pdf

Source: Project Gaia

ECOWAS Current and Potential Bioethanol Production from molasses



Source: Project Gaia

The current bioethanol production in the ECOWAS region is very small compared to the region's potential to produce bioethanol. Currently, only five of the ECOWAS member states produce ethanol on an industrial scale, while nine of the 15 countries show significant potential to produce ethanol from currently available sugar byproduct molasses

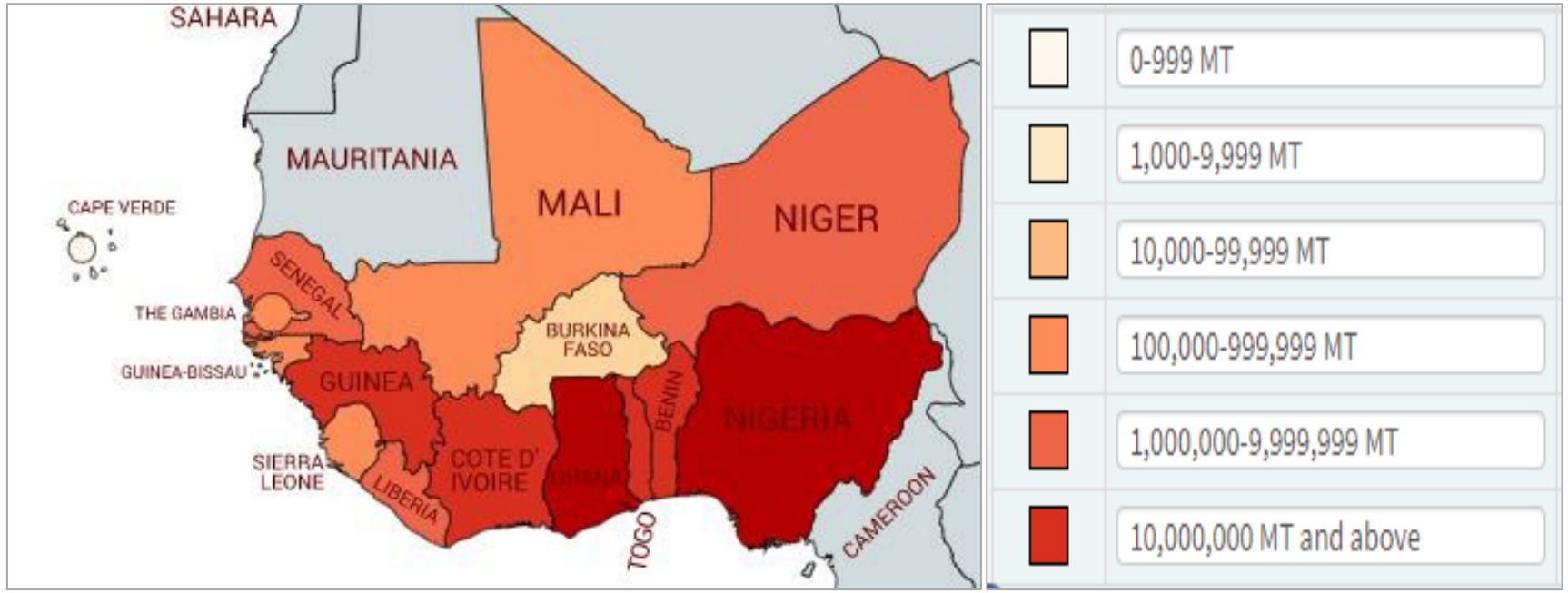
Bioethanol Production Potential from Molasses if Regional Sugar Production is Increased to Meet Demand from Domestic Consumption

Country	Sugar imported (2018/19) (tons)	Ethanol potential in million liters if sugar production were to be increased in the region to meet demand
Benin	168,100	42.4
Burkina Faso	105,838	26.6
Cape Verde	18,372	4.6
Côte d'Ivoire	332,272	83.8
Gambia	178,669	45
Ghana	334,593	84.4
Guinea	242,869	61.2
Guinea-Bissau	9,624	2.4
Liberia	20,534	5.2
Mali	2,738	0.6
Niger	32,076	8
Nigeria	1,597,866	402.6
Senegal	157,328	39.6
Sierra Leone	44,334	11.2
Togo	295,262	74.4
Total	3,540,497	892.2

Source: Project Gaia

Bioethanol Production Potential from Cassava

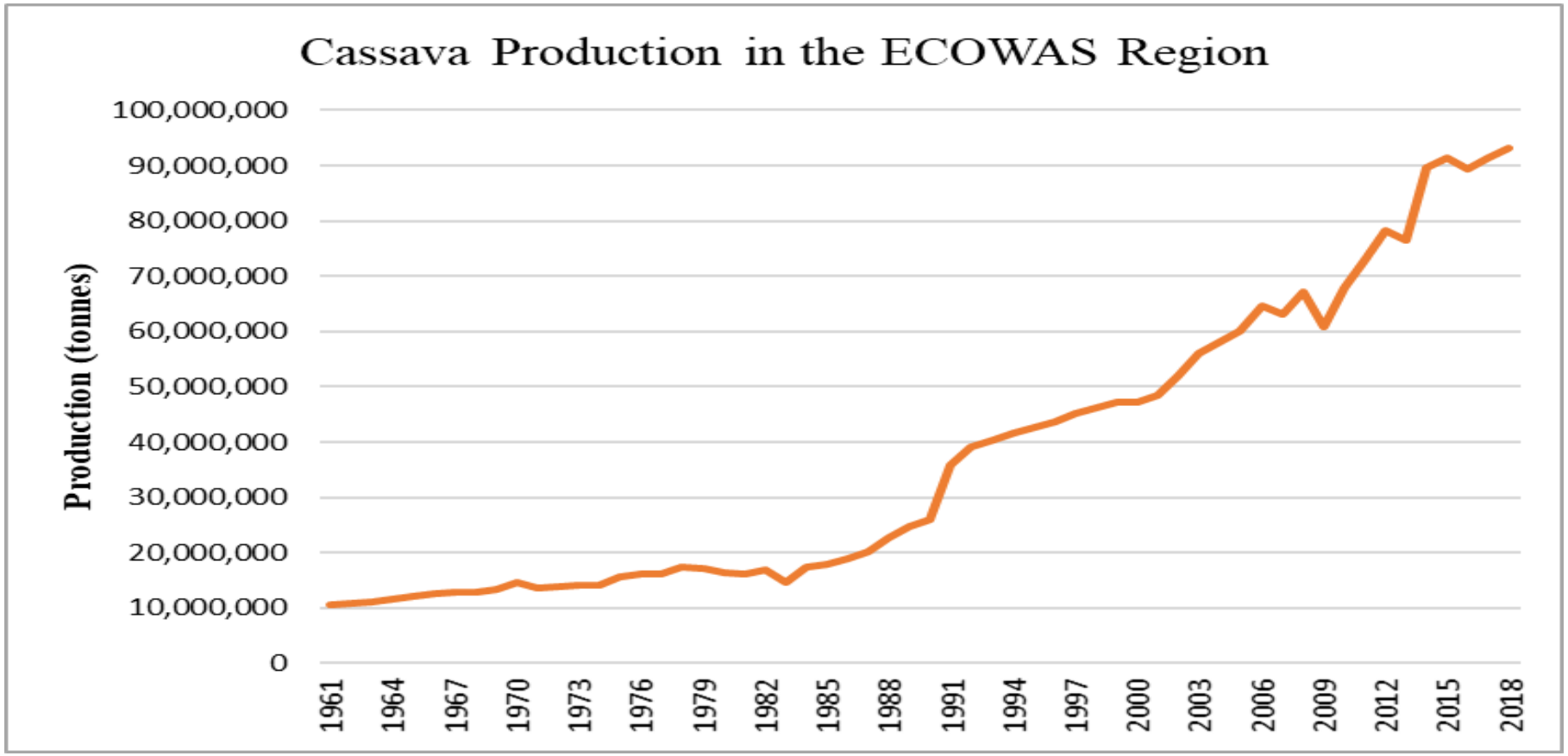
Cassava Production in Metric Tons Across the ECOWAS Region



Source: FAOSTAT

Cassava grown in the ECOWAS region is still mostly limited to domestic consumption with little opportunity for value addition and exportation. The future of cassava in West Africa will be shaped by its expansion into industrial uses, including cassava flour, starch, animal feed and bioethanol, leading to a potentially large expansion of cassava production in the region.

Cassava Production Increase in the ECOWAS Region



Cassava is an important feedstock for ethanol production. Modern farming techniques can increase cassava yield from 10 to 60-80 tons of cassava per hectare. A kilogram of cassava can be processed to make 1.1 liters of ethanol.

Source: FAOSTAT

Cassava production in the ECOWAS region has increased nearly nine-fold since 1961 from 10.6 million MT to 93.0 million MT in 2018 due to an increase in area cultivated (from 1.35 million ha to 9.5 million ha) and a small increase in average yield.

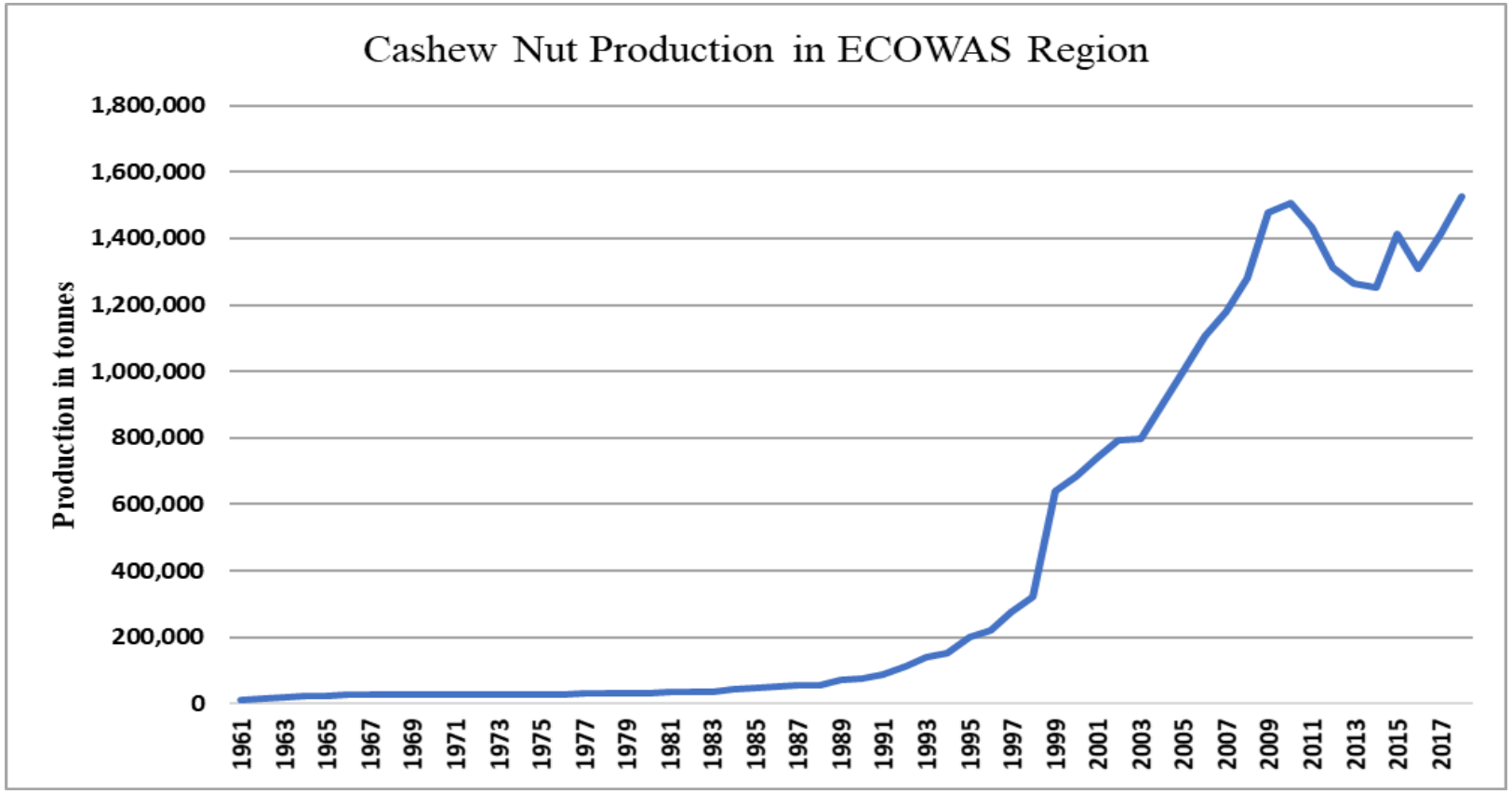
Ethanol in Nigeria

UNICANE cassava ethanol plant on Niger River north of Lokoja, Kogi State.

Ethanol fuel sales point in Kaduna.

Cooking with ethanol in Benin City.

Bioethanol Production Potential from Cashew Apple and other Feedstocks Produced in the Region



Source: FAOSTAT

Sorghum, Maize, Sweet Potato, Millet, Cocoa Beans and other feedstocks also provide a potential for ethanol production in the region. The UNICANE distillery in Kogi State, Nigeria, accepts cashew apple feedstock.

Current Bioethanol Demand in the ECOWAS Region

Country	Estimated Annual Demand (million lit)	Price ($/lit)
Benin	**89**	**0.75 (2017)**
Burkina Faso	**21**	**0.75 (2018)**
Cabo-Verde	**2**	**0.70 (2018)**
Côte d'Ivoire	**30**	**0.69 (2019)**
The Gambia	**10**	**0.70 (2017)**
Ghana	**98**	**0.75 (2018)**
Guinea	**22**	**0.92 (2015)**
Guinea Bissau	**5**	**0.55 (2011)**
Liberia	**-**	**-**
Mali	**18**	**0.70 (2017)**
Niger	**14**	**0.70 (2016)**
Nigeria	**400**	**0.70 (2017)**
Senegal	**29**	**0.75 (2016)**
Sierra Leone	**6**	**0.69 (2017)**
Togo	**56**	**0.75 (2017)**
Total	**800**	

Source: UN Comtrade

The ECOWAS region demand for ethanol is mainly for production of alcoholic beverages, i.e., production of gin, brandy, whisky, and other beverages. There is also a small demand from the cosmetics, paint and pharmaceutical industries, particularly in Nigeria and Ghana, but quantifying this demand is difficult since there is no data available. Currently there is no ethanol demand for gasoline blending and the demand for cooking is quite small. Nigeria and Ghana have active liquid ethanol and ethanol gel ethanol cookstove projects. We have seen interest coming from Ivory Coast, Mali, Senegal, Sierra Leone and Liberia.

Scenarios for Bioethanol Demand in ECOWAS Countries by 2030

Three Scenarios for Ethanol Demand in ECOWAS Countries by 2030			
Scenarios	**Prudent**	**Ambitious**	**Aspirational**
Existing Demand (billion liters)	1	1	1
E5 blend	1.1		
E10 blend		2.2	2.2
Displace cooking kerosene at 40%/70%/100%	5	8.75	12.5
Displace 5% of solid fuel use		1	
Displace 10% of solid fuel use			2
Total demand (billion liters)	7.1	12.95	17.7
With growth factor@1% per year to 2030	7.81	14.245	19.47

Source: Project Gaia

Regional biofuels policy

- ECOWAS can achieve harmonization of biofuels production and use when a uniform policy and regulations for the region are developed and applied uniformly. Such integration can promote bioenergy production and use in the region to help achieve universal clean energy access, promoting economic development.
- In 2006, ECOWAS adopted a White Paper on access to modern energy services for populations in rural and peri-urban areas and in 2008 ECREEE was established to promote renewable energy.
- A Bioenergy Strategy Framework was adopted in 2012 by the energy ministers of the ECOWAS region. Renewable energy is included in the national policies of member states. Several member states have adopted comprehensive biofuels policies.
- Now ECREEE has taken the step to develop biofuels standardization, which is the basis for all good policy making.
- Bioenergy production, trade, use and policy transcend national borders. Policy coherence and long-term benefits are best realized in a regional context. This can be achieved only when there are region wide standards developed and accepted for the use of biofuels.

Bioethanol Standards

- Standardization is the process of establishing a technical standard among competing products in a market. The method of standardization is generally a consensual one, designed to bring benefits without hurting competition.

- Standardization reduces trade barriers, promotes quality, performance and safety, increases the compatibility of products, systems and services, and promotes common technical understanding. Standards provide certainty, references, and benchmarks for designers, engineers, chemists and service providers, including inspection services and laboratories.

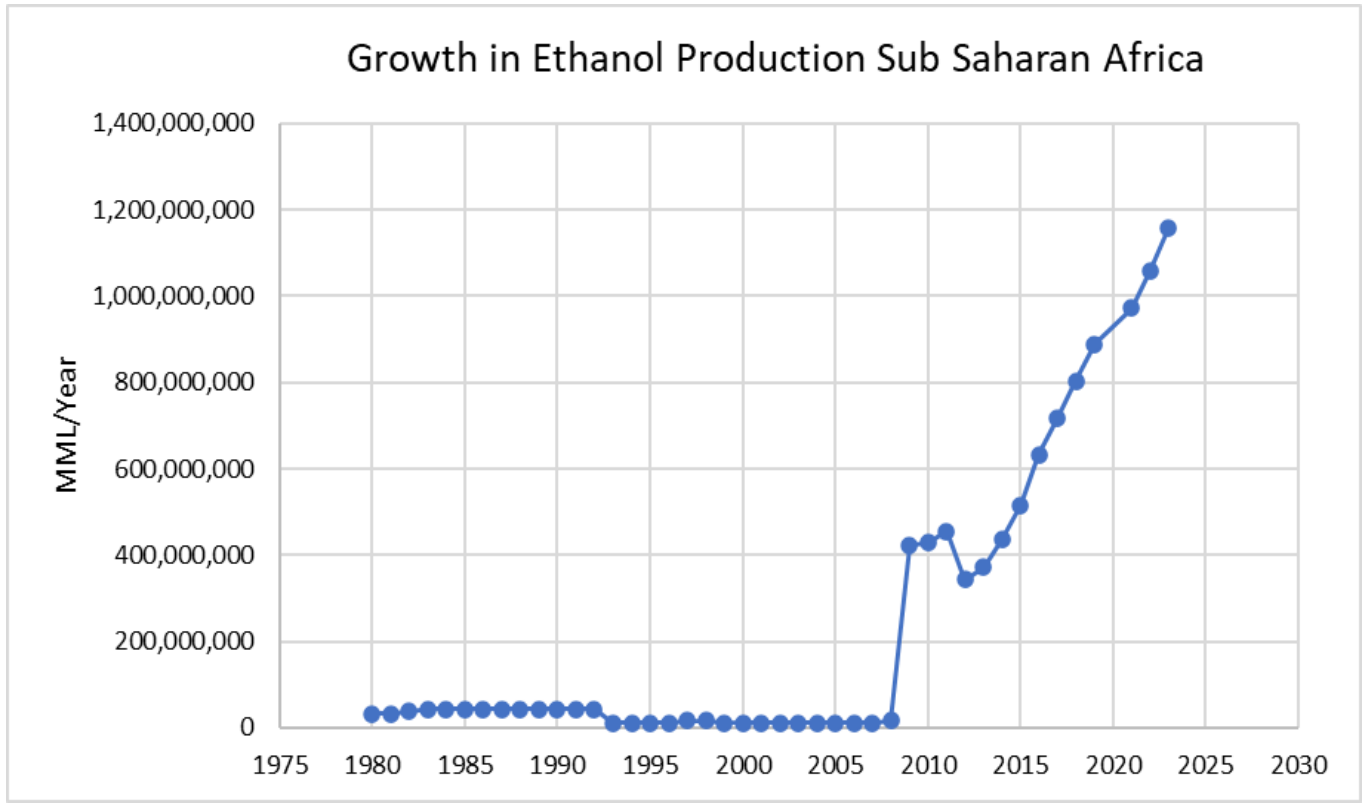
- Standards are important for producers, suppliers and consumers. Standards and verifications help to ensure predictable performance and transparent results.

- A standard describes a product or a process, i.e., a test method, to determine the salient characteristics of a product.

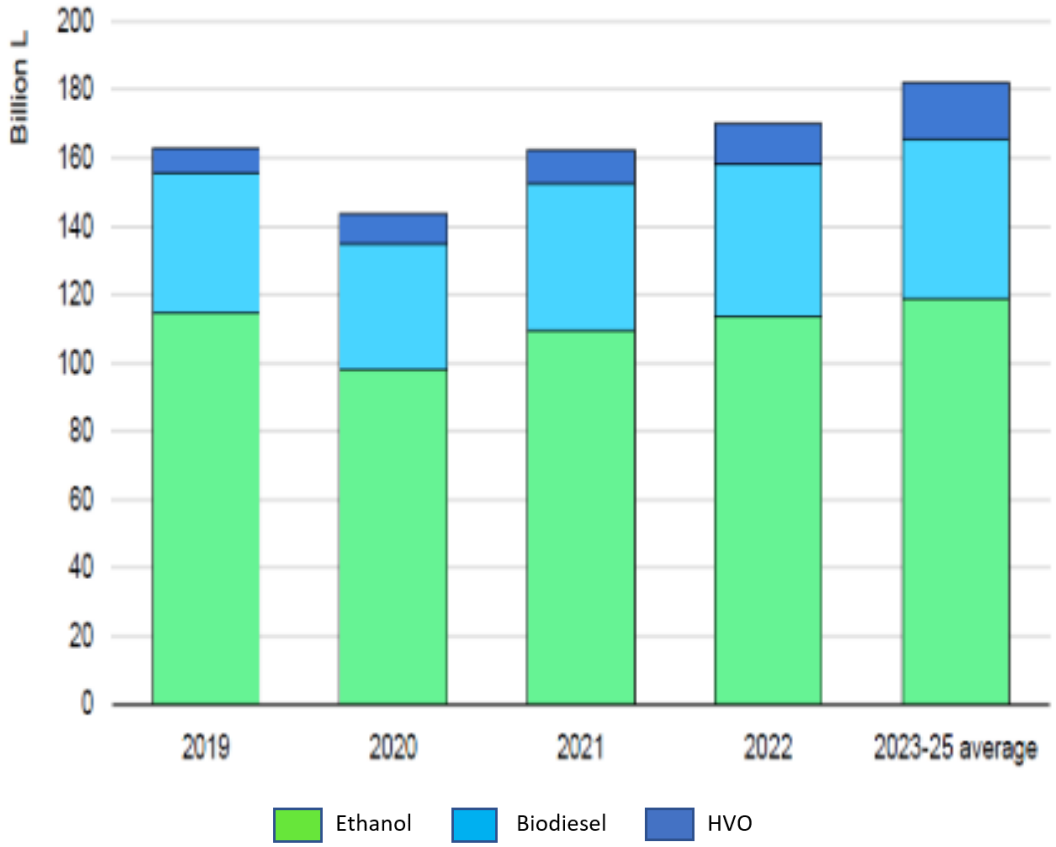
- Experience has shown that standards have been critical for the development of biofuels. Ethanol or biodiesel can substitute for petroleum fuels or mix with them to improve their performance and reduce emissions. This means that biofuels must be formulated to perform as standalone fuels or be compatible to mix with petroleum fuels. Each use requires distinct formulations and thus different standards. In addition, ethanol is produced for an extremely wide range of uses, from food and beverage constituents to chemical and fuel uses. Ethanol is not produced as a pure product but is refined for its different applications. Therefore, these must be specified and testing for these specifications must be agreed upon.

Why Biofuels Standards Now

The use of biofuel has grown rapidly around the world and continued growth is projected. Prior to the SARS-CoV-2 pandemic, the International Energy Agency (IEA) was forecasting a global increase in production and use of transportation biofuels of 25% to 2024. Ethanol production has grown rapidly in SSA since 2008.



Global Biofuel Production 2019 and Forecast to 2025



Source: EIA, 2020

The Paris Agreement targets, fossil fuels, ethanol and the NDCs

To meet the Paris Agreement targets, according to a recent study published in *Nature*, "fossil fuel producers should avoid extracting at least 90% of coal reserves and 60% of oil and gas reserves by 2050."

Despite the remarkable uptake of renewable energy, the transition away from fossil fuels is not happening fast enough. This underscores the need to accelerate the deployment of low-carbon fuels and technologies at scale.

Regardless of the extent to which the world succeeds in scaling back on fossil fuels, the growing need to do so will drive up the cost of fossil fuels. Sooner or later, other forms of energy will be cheaper—with fewer external costs and greater domestic dividends.

Ethanol is a liquid fuel. It is a ready substitute for petrol, kerosene and diesel. It can even replace bunker fuel. Already there are gasoline, diesel, jet and marine engines running on ethanol fuel. When we speak of renewable energy, we cannot do it all with wind and solar generated electricity. We need liquid fuels as well.

Ethanol cookstoves can earn 4 to 6 tons of carbon per year. An E-20 petrol blend can save 2 to 3 tons of carbon per year per automobile. Thus, a million cookstoves would generate 4 to 6 million tons of carbon savings per year. If there are 13 million cars on the road in Nigeria, an E-20 blend would save 20 to 30 million tons of carbon per year. These are ideal strategies for meeting Nationally Determined Contributions (NDCs).

We recently completed a report for ECREEE on biofuels in ECOWAS with recommendations for regional standards for stove fuel and petrol blendstock.

Please ask for it!

Contents include:

- Biofuels laws, policies and standards in member states
- Bioethanol production in the region, supply and pricing
- Assessment of feedstocks in the region
- Demand mapping—current and potential demand, demand scenarios
- Why biofuels standards, some technical background
- Proposed biofuels standards for ECOWAS
  - Ethanol
  - Biodiesel
  - Global look—Brazil, U.S., India, China, EU, Worldwide
- Regional testing facilities

Thank you!

UNIDO, Dar es Salaam