Bioethanol for Clean Cooking

Regional Capacity Building Workshop - Introduction to Bioethanol for Clean Cooking

December 09, 2020

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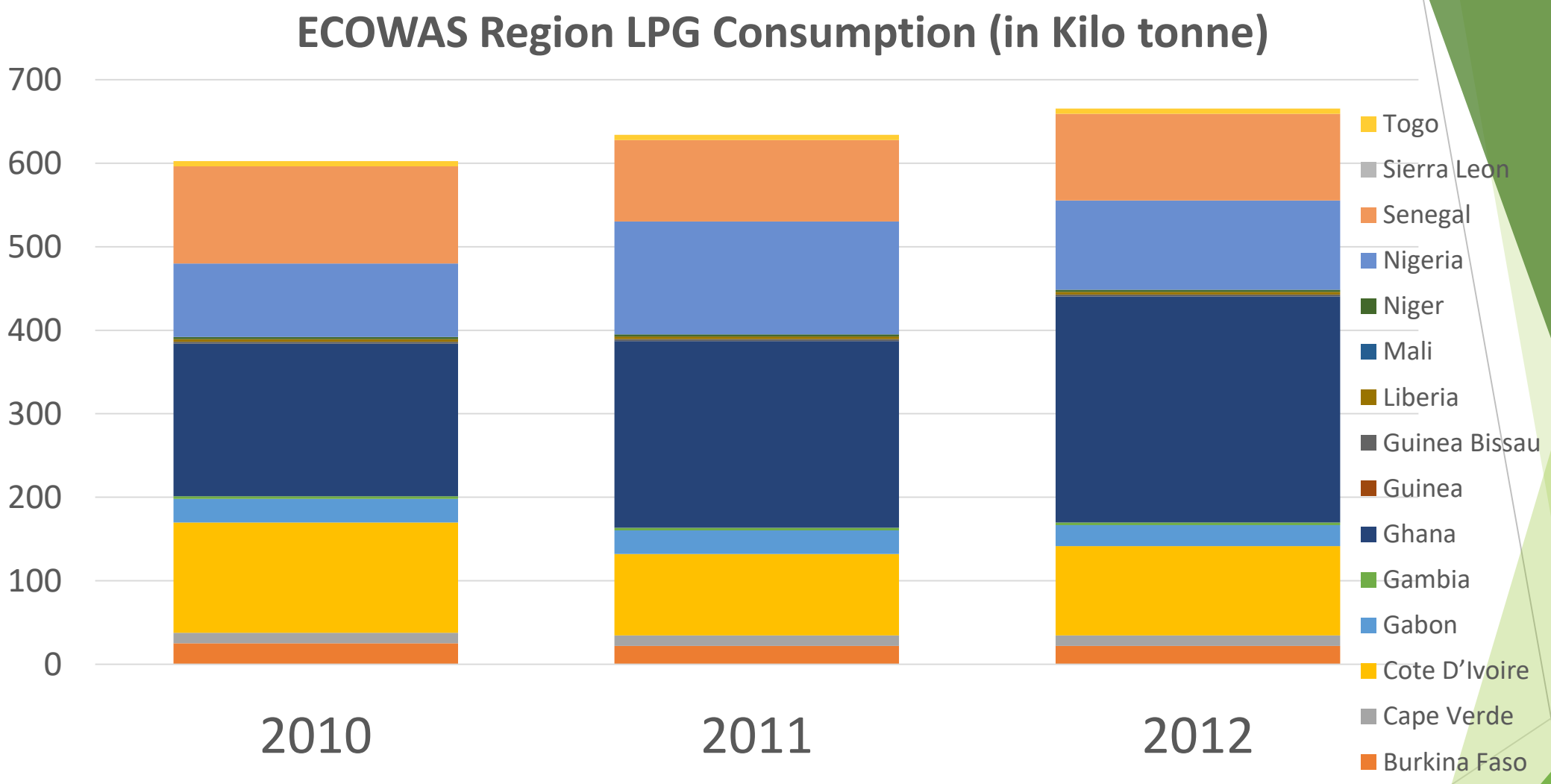
Cooking energy (“modern”) in ECOWAS countries

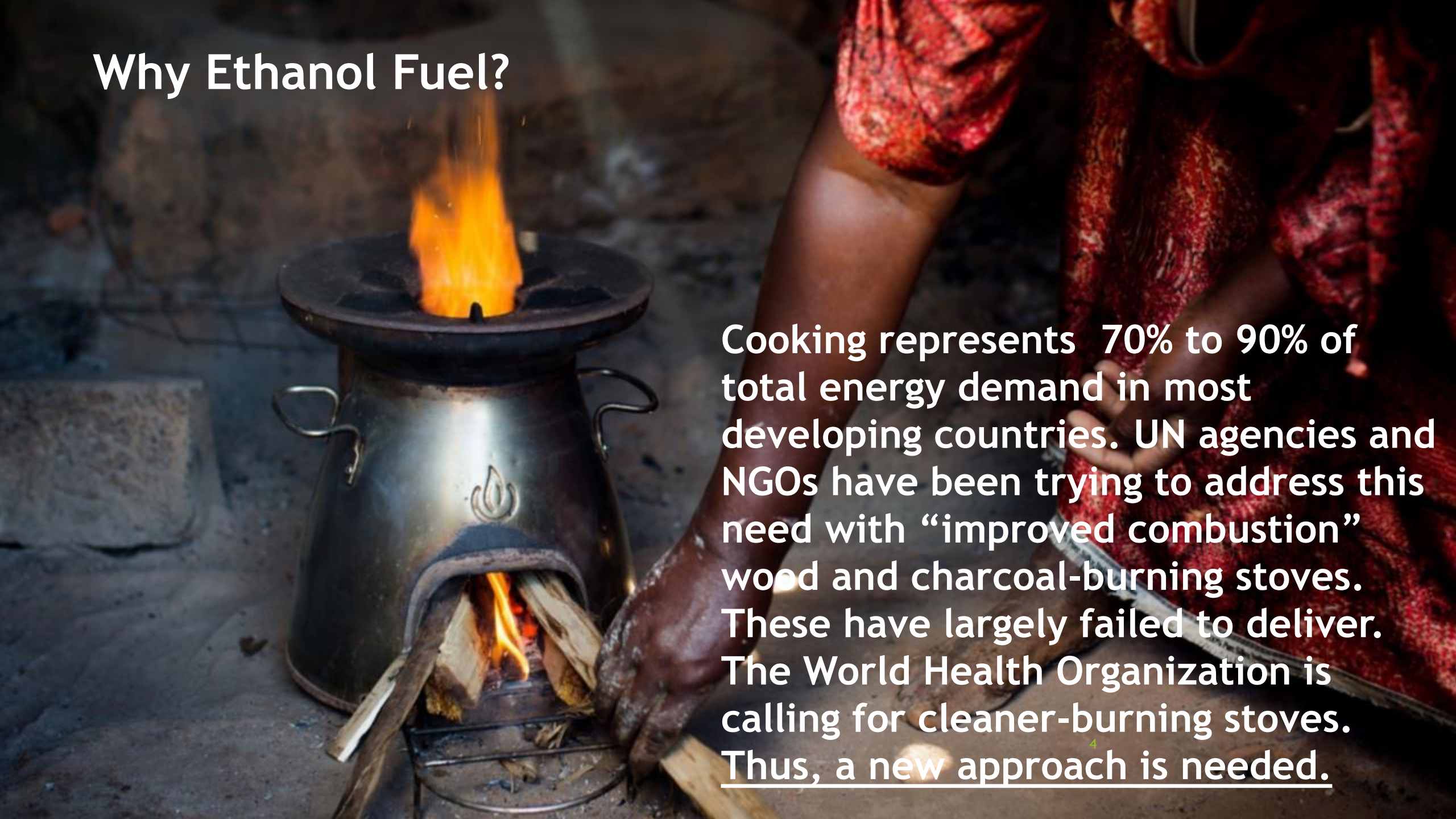
Country	LPG	Electricity	Kerosene	Census year
Benin	5.0%	0.3%	2.8%	2013
Burkina Faso	1.3%	0.7%	0.1%	2014
Cape Verde	76.5%	0.3%		2017
Côte d’Ivoire	22%			2014
Gambia	3.4%		0.6%	2013
Ghana	22.8%	0.5%	0.5%	2013
Guinea	0.8%	0.6%	0.5%	2014
Guinea-Bissau		5%		2011
Liberia	0.95%	0.9%	0.4%	2008
Mali	28.9%			2017
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

Source: ECREEE, Regional Progress Report, 2017



source: theGlobalEconomy.com

Why Ethanol Fuel?



Cooking represents 70% to 90% of total energy demand in most developing countries. UN agencies and NGOs have been trying to address this need with “improved combustion” wood and charcoal-burning stoves. These have largely failed to deliver. The World Health Organization is calling for cleaner-burning stoves. <u>Thus, a new approach is needed.</u>

Why Ethanol for cooking? *The consumer:*

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

- Many developing countries have an urgent need for more energy in the cooking sector.
- The ever increasing use of fuelwood and charcoal for cooking 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—causing many burns and fires. LPG, an excellent cooking fuel, can be difficult and expensive to deliver.
- Kerosene and LPG are imported fuels, demanding scarce FOREX from the nation. This is especially costly for countries with soft currencies. Where kerosene and LPG were once widely subsidized, these subsidies are now being phased out.
- Ethanol fuel today is competitive with the cost of charcoal and kerosene.
- Ethanol can enter the market without subsidies. If VAT is charged selectively on some fuels but not others, it is good for ethanol to enjoy equal treatment.

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.

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.

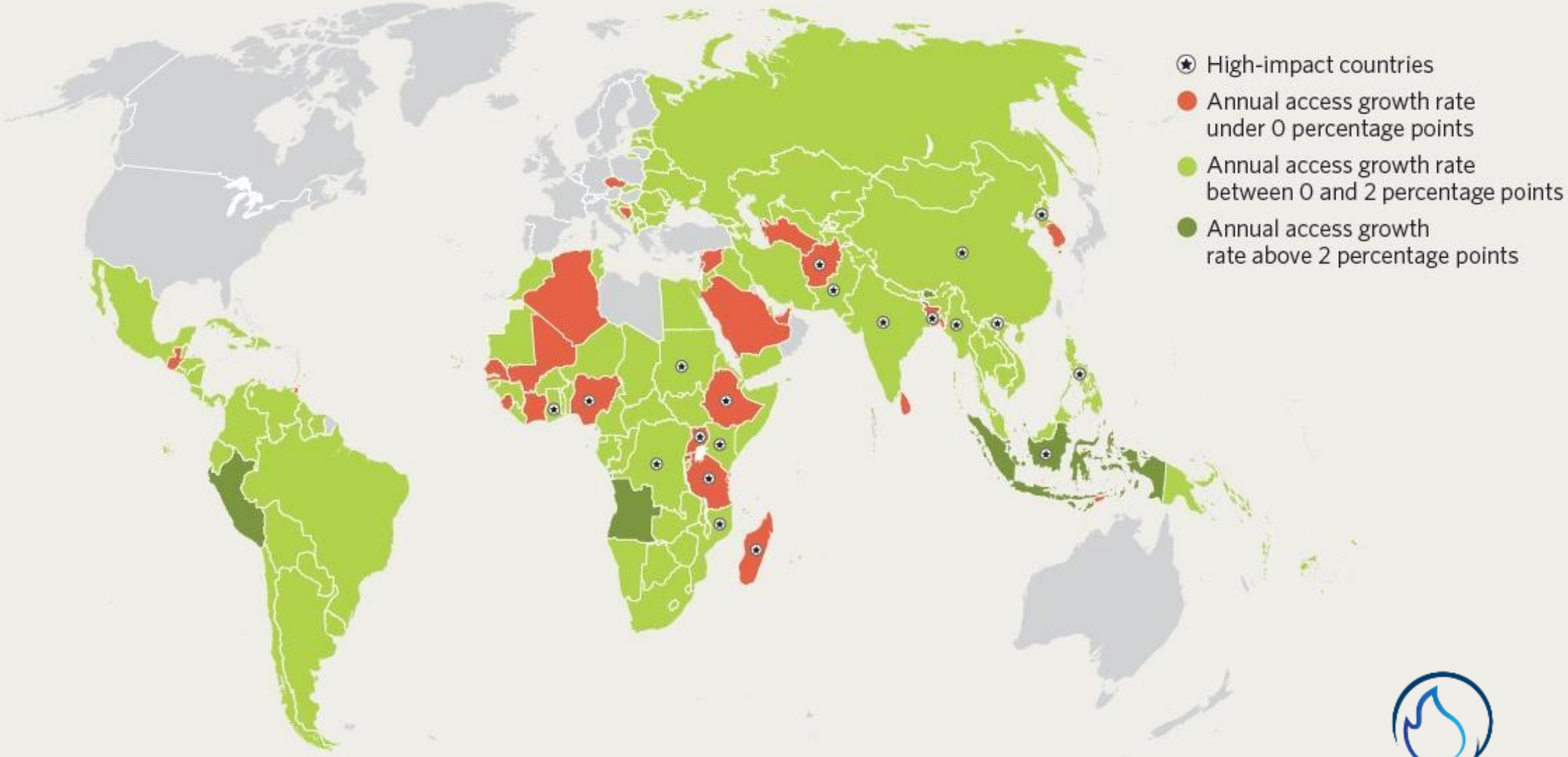
Of 3.04 billion people without access to clean energy, 807 million are in Sub-Saharan Africa and 2.1 billion in Asia.

This illustrates why we must bring the alcohol fuels into the household energy sector.

We cannot not solve the problem of cooking and energy access only with LPG or more efficient use of wood and charcoal stoves. We need another clean fuel option *in addition to* LPG.

FIGURE 16 Speed of progress toward clean cooking goal, 2012–14

SE4ALL Global Tracking Framework 2017



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

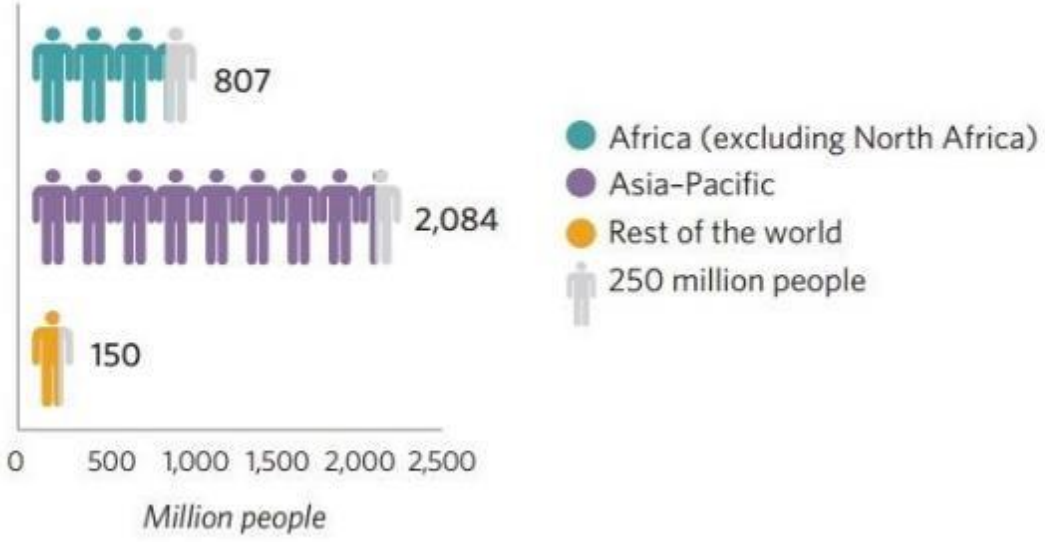
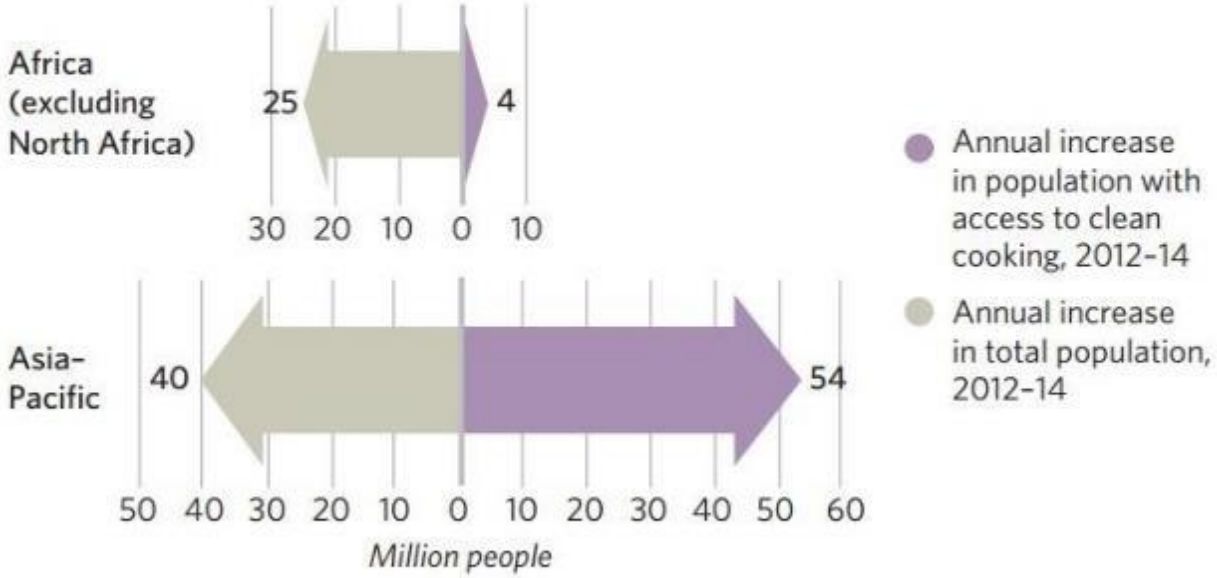


FIGURE 15 Demographic challenges for progress on access to clean cooking



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

Sub Saharan Africa stands out as a continent where access to clean energy is **actually declining**, even though the continent is rich in energy resources.

Air Quality & Health Burden Ghana

11,739 Annual Deaths from air pollution

Outdoor
AIR POLLUTION
Leading Killer

Acute lower respiratory infection

National Air Quality

55

annual average PM 2.5

Household
AIR POLLUTION
Leading Killer

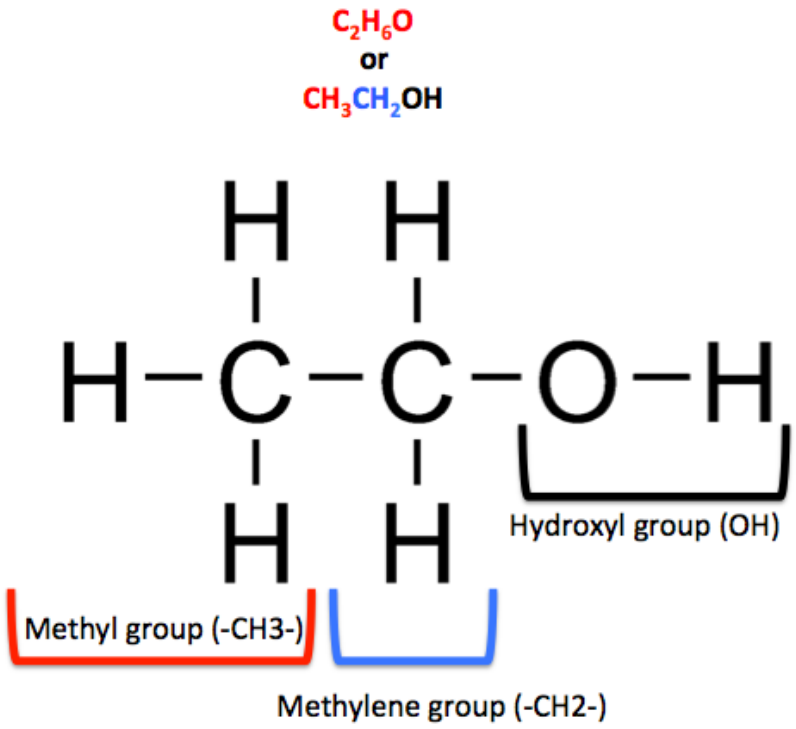
Acute lower respiratory infection

Child Deaths (0-5yrs)

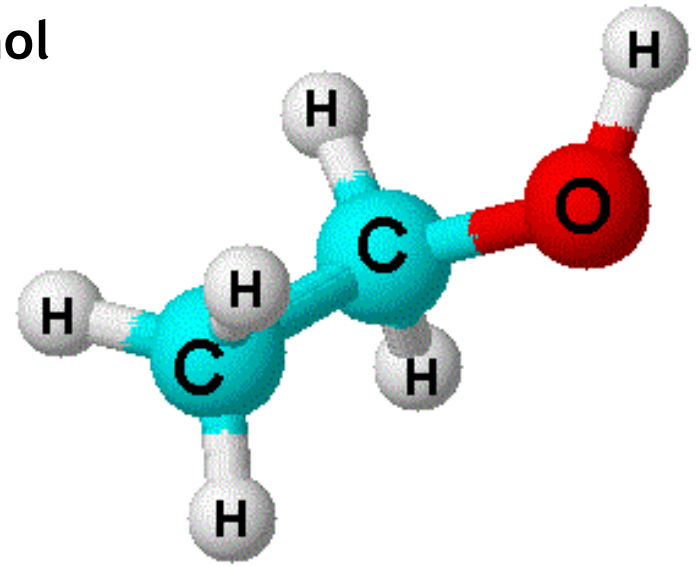
2992

per year

Why ethanol? A little chemistry



ethanol



Why ethanol, why alcohols? 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.

Fuel Quality and Conditioning

Cookstove fuel must be good quality ethanol (hydrous ethanol at ~95% ethanol, ~5% water) with low impurities. Amyl alcohols and fusel oils (C_3 to C_8 alcohols) should be below 600 ppm. These impurities have too much carbon and produce soot when burned. We want soot-free performance.

The fuel must be denatured with at least 10 ppm denatonium benzoate (Bitrex) with a colour dye of a non-light sensitive industrial type that won't fade. We suggest a light green, blue or purple colour at about 5 ppm. Other denaturants may be added, such as methanol, up to 20% by volume.

Rectified ethanol is the best stove fuel. Technical alcohol is possible to use, if the "tails" or heavier impurities, i.e., fusel oils, are not in the Technical Alcohol, only the light impurities (methanol, etc.).

Ethanol cooking fuel in Haiti

Industrial Ethanol Suitable for Cookstove Fuel

Best: REN ethanol min 95% vol. (Rectified Spirit)
An industrial or second-grade ethanol produced via fermentation. It is used in numerous industrial applications (vinegar production, industrial solvents, cleaning products, burning alcohol, etc.). Not as highly-rectified as PCC (pharmacy, perfumery and cosmetic) and beverage grade ENA (extra neutral alcohol).

Next Best: REN low-grade ethanol min 95% vol. A lower-grade fermentation REN ethanol. It is used in numerous industrial applications and as an ethanol feedstock for further rectification. It is often referred to in the industry as "Korean Grade B".

Do Not Use: Heads and tails (foreshots & feints) min 90% vol.
Heads and Tails, also known as *mauvais gout* or foreshots & feints, are a by-product of the distillation and rectification process of beverage spirits and neutral potable alcohol. Heads and tails are used in cleaning products and as a low-grade industrial alcohol. They are not suitable for stove fuel, because they contain too much carbon.

Use with specified limitations: Industrial alcohol for fuel blending
Ethanol for fuel blending contains denaturants that fully denature the product. Denatured fuel-grade ethanol is meant to avoid being subject to the excise duties applicable to undenatured alcohol. Two requirements should be met: (1) hydrocarbon denaturants should be kept to a minimum (≤1%) and (2) higher alcohols containing more carbon than ethanol (C3 – C8 alcohols) should be <600 ppm. Bitrex, color and methanol are better denaturants than hydrocarbons.

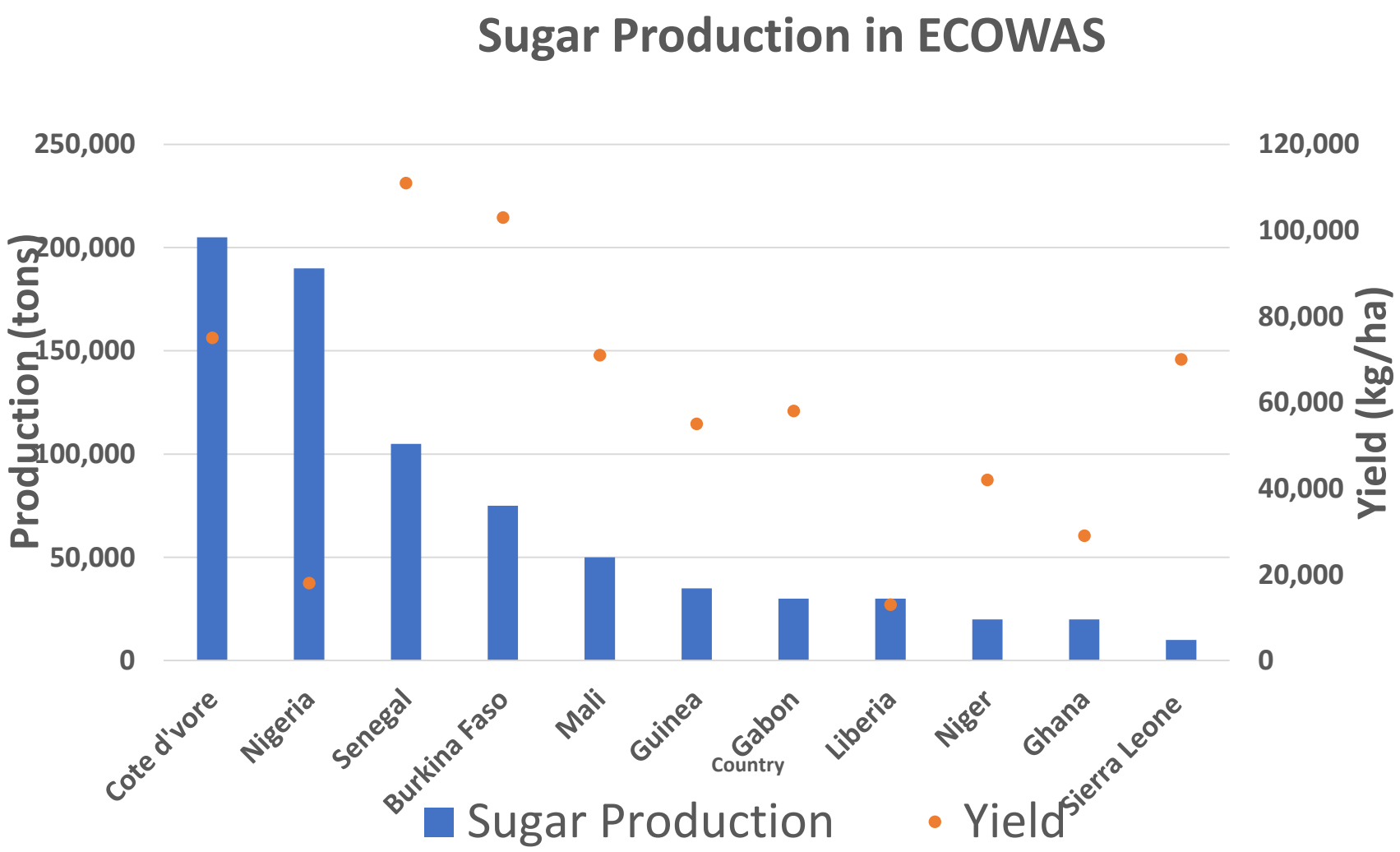
Why Ethanol for cooking? *The producer:*

Cooking fuel is the largest and easiest fuel market for producers

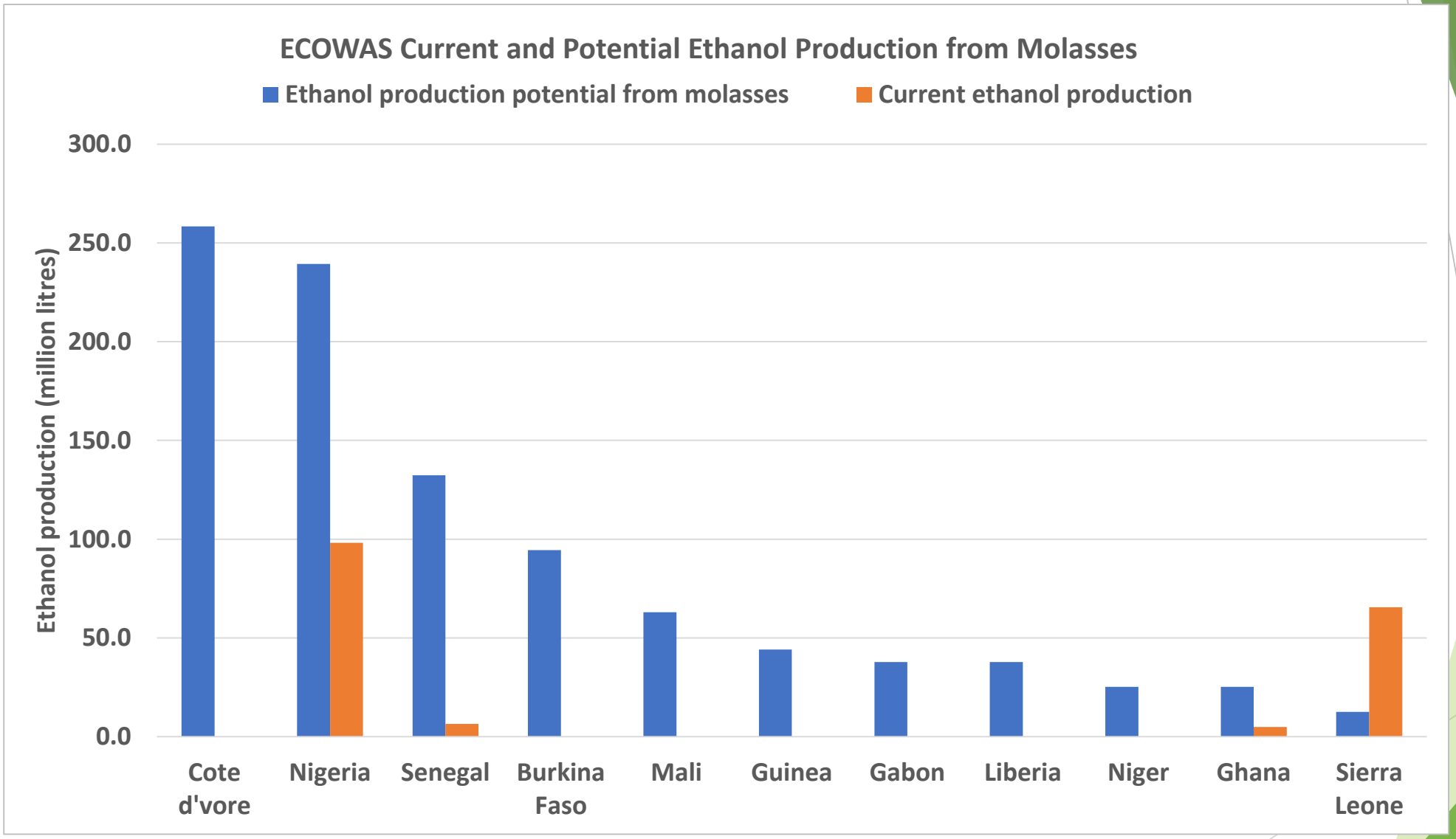
- Greater supply of energy, in the form of convenient, practical fuels, needs to be attracted into the household sector. There are limitations with all of the existing fuels. Electricity has significant constraints in efficiency, reliability and cost.
- The household energy market is huge—and less demanding technically than fuel blending for transportation. Producers can benefit from developing this market.
- The household energy sector is often overlooked by business leaders and policy makers, and it has long been overlooked by ethanol producers.
- The cooking market provides diversification for producers. It is a supplier's market; once demand is built, the market will not go away.
- Unlike fuel commodity markets, the cooking fuel market is stable and predictable.
- Alcohol fuels can use the kerosene infrastructure. As kerosene recedes from the market, bioethanol can take the place of kerosene with limited infrastructure investment .
- To compete in today's world, sugar producers must produce not just sugar but also ethanol and power. The nation needs this energy.
- Cooking is a good market for ethanol producers because it puts a human face on what they do.

Comparison of cost of cooking with various stoves & fuels

5,000 MJ useful energy/household - year	Fuel	Charcoal	Ethanol	LPG	Kerosene	Electricity
	Stove	Traditional Metal	CC	Single burner	Wick stove	Single burner
	Unit	kg	Liter	kg	Liter	kWh
Energy content of fuel	MJ/(kg,lt,kWh)	27	20.2	46	34.7	3.6
Estimated price of fuel	USD/(kg,lt,kWh)	0.22	0.70	1.5	0.70	0.10
Stove life	Year	1	7	7	5	5
Stove efficiency	%	25%	60%	60%	40%	40%
Stove price	USD	4	22	22	10	20
Useful energy cost	USD/MJ	0.0364	0.0542	0.0586	0.0508	0.0841
Energy cost	USD/MJ	0.0356	0.0536	0.0580	0.0504	0.0833
Stove Cost	USD/MJ	0.0008	0.0006	0.0006	0.0004	0.0008
Percentage cost of stove per useful energy		2%	1%	1%	1%	1%
Percentage cost of fuel per useful energy		98%	99%	99%	99%	99%



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



Source: Project Gaia

Ethanol in the ECOWAS

Countries in the ECOWAS are slow in energy access while they are sugar and ethanol producers, which includes **Nigeria, Sierra Leone, Senegal, and Ghana.**

Global ethanol capacity in 2019 was close to 120 billion liters. Excess capacity in the market would have supported 8.5 million cookstoves.

An ethanol and methanol stove and fuel program is in the commercial pilot stage in Nigeria with 2,500 stoves and 15,000 returnable fuel canisters to deliver fuel. A micro distillery has been built in Nigeria, but several large distilleries have also recently come on line. These plants use sugarcane and cassava feedstocks. Nigeria imports 200,000 tons of ethanol per year. An ethanol gelfuel stove business is running in Nigeria.

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	7.1	12.95	17.7
With growth factor@1% per year to 2030	7.81	14.245	19.47

Source: Project Gaia

Thank you!

www.projectgaia.com