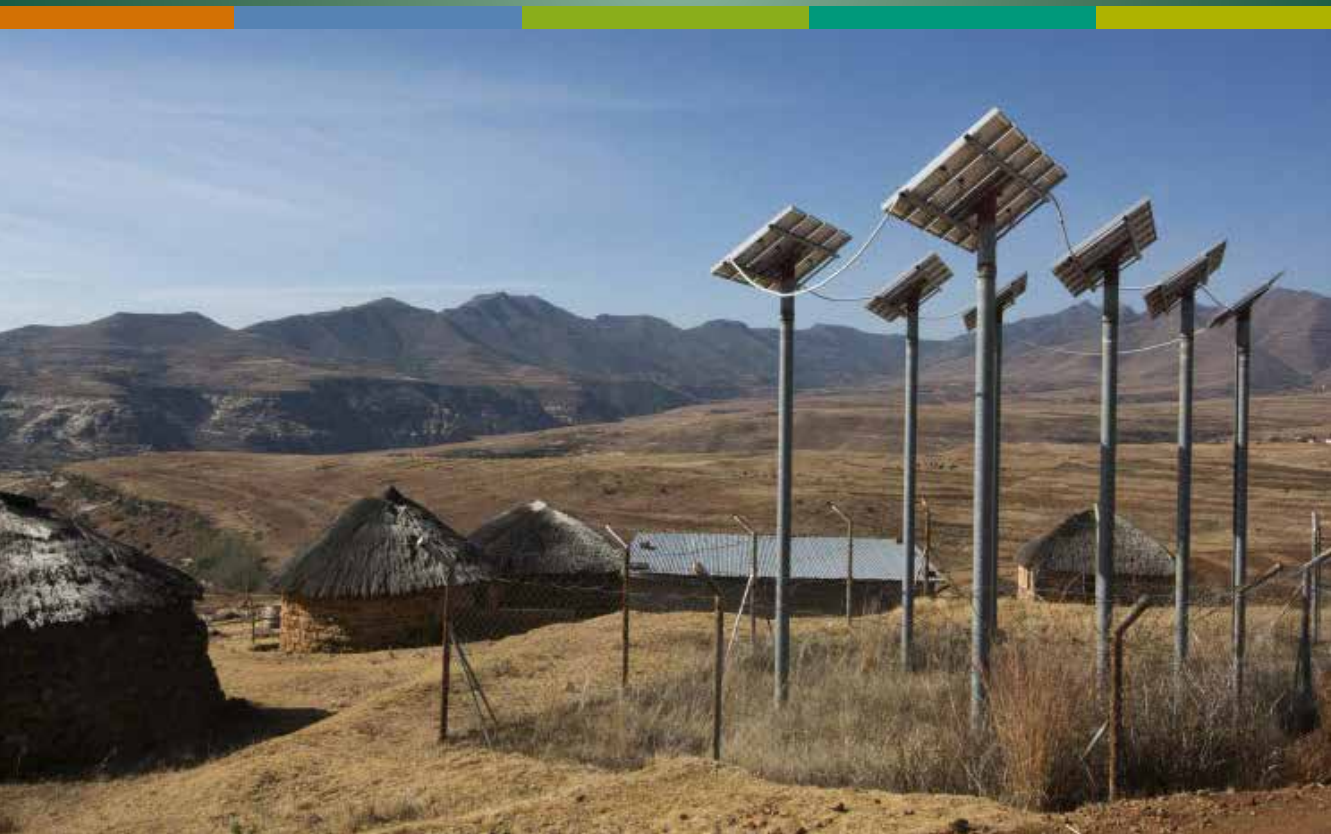




Food and Agriculture
Organization of the
United Nations

Energy in and from agriculture in the African Nationally Determined Contributions (NDC)

A review



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Food and Agriculture Organization of the United Nations (FAO)
Rome, 2019

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Acronyms and abbreviations

ABBREVIATIONS

B20	20 percent of biodiesel in diesel
CAR	Central African Republic
CHP	Combined Heat and Power
COP21	21 st Conference of the Parties
DRC	Democratic Republic of the Congo
E10	10 percent ethanol in gasoline
ECOWAS	Economic Community of West African States
FAO	Food and Agriculture Organization of the United Nations
GCF	Green Climate Fund
GEF	Global Environment Facility
GHG	Greenhouse Gas
HH	Households
IEA	International Energy Agency
INDCs	Intended Nationally Determined Contributions
IRENA	International Renewable Energy Agency
LPG	Liquefied Petroleum Gas
MRV	Measurement, Reporting and Verification
MSW	Municipal Solid Waste
N/A	Not Applicable
NDCs	Nationally Determined Contributions
P&Ms	Policies & Measures
SE4All	Sustainable Energy for All
UNFCCC	United Nations Framework Convention on Climate Change

UNITS

GgCO ₂ e	Gigagram CO ₂ equivalent
MtCO ₂ e	Million tonnes CO ₂ equivalent
kW	kilo Watt
MW	Mega Watt
ktoe	kilo tonnes of oil equivalent
MI	Million liters
Ha	Hectare
t	tonnes
USD	United States Dollars

FORMULAE

CH ₄	Methane
CO ₂	Carbon dioxide
N ₂ O	Nitrous oxide

Introduction

Intended Nationally Determined Contributions (INDCs) are national policy programs that were published by countries prior to the United Nations Framework Convention on Climate Change (UNFCCC) 21st Conference of the Parties (COP21) in Paris in December 2015. They represent the views of parties to the UNFCCC and describe how they can mitigate their greenhouse gas (GHG) emissions and adapt their economy, infrastructures, and social systems to the effects of climate change.

165 submissions were received by the UNFCCC secretariat. After the signature of the Paris Agreement, parties started the ratification process. During this period, they had the opportunity to modify their INDCs; which after the formal country ratification, became their Nationally Determined Contributions (NDCs). As of February 2018, parties have submitted 168 NDCs (UNFCCC, 2017). After submission, parties review NDCs every 5 years (UNFCCC, 2015).

Key findings:

- As of February 2018, out of the 54 African countries, 44 have published their NDC and 9 have published their INDC.
- 41 countries mention at least one modern bioenergy measure to mitigate their GHG emissions.
- 41 countries mention at least one traditional bioenergy measure.
- 30 countries mention at least one measure to reduce fossil energy in agrifood systems.
- The top five policies and measures mentioned by African countries are fuel-efficient stoves (39 countries), efficient woodfuel systems (26 countries), energy use in agriculture (24 countries), liquid biofuels (20 countries) and biogas (19 countries).
- 24 percent of African countries mention unconditional or partly unconditional policies and measures related to energy in and from agriculture.

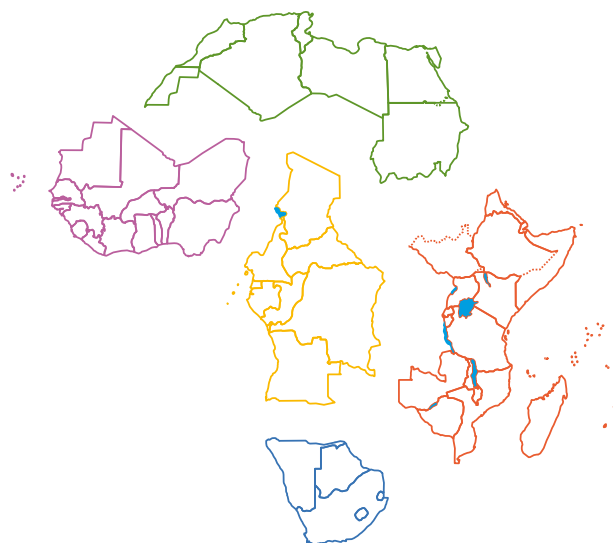
(I)NDCs contain measures of unconditional and conditional nature. Unconditional measures are actions that will be implemented by the party without external financial or technical support. When a measure is described as conditional, it means “conditional to external technology transfers and/or financing” from the Green Climate Fund (GCF) and other sources such as the Global Environment Facility (GEF), bilateral and multilateral funds, development banks or private funds associated with a Measurement, Reporting and Verification (MRV) system to verify that the funds are efficiently used to reduce GHG emissions.

FAO has started to perform a series of regional analyses of the (I)NDCs, starting with Africa. The definitions of regions is based on the FAO statistics nomenclature (Figure 1). It aims to present brief information on each country's policies and measures (P&Ms) in relation to energy in and from agriculture.

The paper aims to guide parties in the implementation of their NDCs and ensure future commitments are more comparable, quantifiable and ambitious in the field of energy in and from agriculture. The first part provides information on the different policies proposed by countries in their (I)NDCs, while the second part analyses the proposed actions regarding the regional context and defines possible synergies between sectors.



Figure 1 FAO sub-regions in Africa



All 53 African (I)NDCs², together with the 243 policies and measures related to “energy in and from agriculture”, were examined. These policies and measures were divided into three main categories:

- Modern bioenergy
- Traditional bioenergy
- Energy in agrifood systems

² All 54 African countries published (I)NDCs except Libya.

According to the International Renewable Energy Agency (IRENA, 2015): “Modern biomass technologies include liquid biofuels produced from straw and wood, industrial cogeneration and biorefineries, biogas produced through anaerobic digestion of residues, pellet heating systems and other technologies”. Modern bioenergy policies and measures were subdivided in four categories:

- Liquid biofuel for transport, electricity generation, residential use and mandated biofuel blending.
- Biogas including anaerobic digestion and gasification of agricultural and livestock residues.
- Solid biofuel including combustion, Combined Heat and Power (CHP) and pre-treatment processes such as briquettes, pellets, carbonization and industrial plantations. Non-specified biomass feedstock.

According to the International Energy Agency (IEA, 2017), traditional bioenergy “refers to the use of wood, charcoal, agricultural residues and animal dung for cooking and heating in the residential sector. It tends to have very low conversion efficiency (10 to 20 percent) and often unsustainable supply”. Traditional bioenergy policies and measures were divided in two subcategories:

- Woodfuel or charcoal refers to P&Ms related to an improved supply and efficiency of woodfuel and charcoal production.
- Cookstoves refer to P&Ms portraying an improved use of woodfuel and charcoal through more efficient cookstoves (reducing woodfuel or charcoal consumption) or using cleaner fuels (LPG, ethanol, solar or other)

Energy in agrifood systems concerns policies and measures aimed at reducing fossil fuel energy consumption in food production. This category is divided into three subcategories:

- Energy in agriculture refers to P&Ms improving energy efficiency, for instance through the use of inputs with a lower energy intensity such as organic fertilizers (Kool, 2012), or through the use of renewable energy in food production (e.g. solar irrigation, biofuel for machinery).
- Post-harvest handling includes operations such as packaging, storage and transport. Improving post-harvest handling could significantly reduce the energy consumed by food systems since more than 70 percent of the energy from food systems is consumed post-harvest, and 38 percent of the total energy consumed by food systems is utilized to produce food that is ultimately never consumed (FAO, 2011).
- Food processing comprises all food processing operations to diminish food losses along the value chain. It includes operations like drying, milling and food preparation. This category concerns policies and measures related to improved energy efficiency and the use of renewable energy in these operations (solar drying for instance).

In the African (I)NDCs, 243 policies and measures are related to energy in and from agriculture. 49 out of the 54 African countries cite at least one P&M related to energy in and from agriculture. The largest P&M category concerns traditional bioenergy with 95 entries representing 41 countries, the second category is modern bioenergy with 87 entries representing the same number of countries (41). Finally, the category related to energy in agrifood systems concerns 61 P&Ms presented by 30 countries.

Figure 2 Modern bioenergy mentioned in NDCs



This map presents countries that include at least one measure in their NDC related to modern bioenergy (87 measures in 41 countries). These measures can be divided as follows: 28 measures concern liquid biofuel, 26 biogas, 15 solid biofuel & 18 unspecified feedstock.

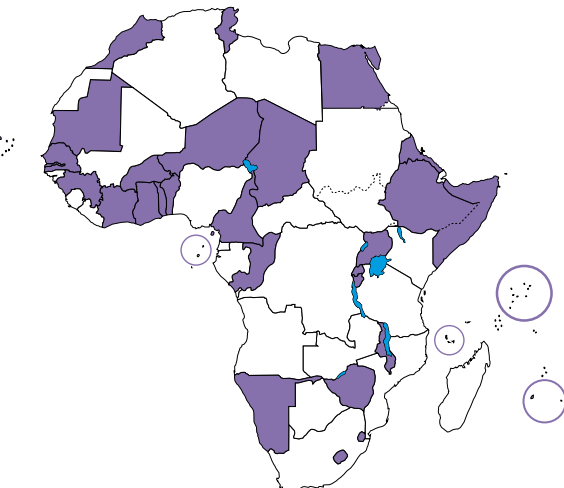
Figure 3 Traditionnal bioenergy mentioned in NDCs



This map presents countries that include at least one measure in their NDC related to traditional bioenergy (95 measures in 41 countries).

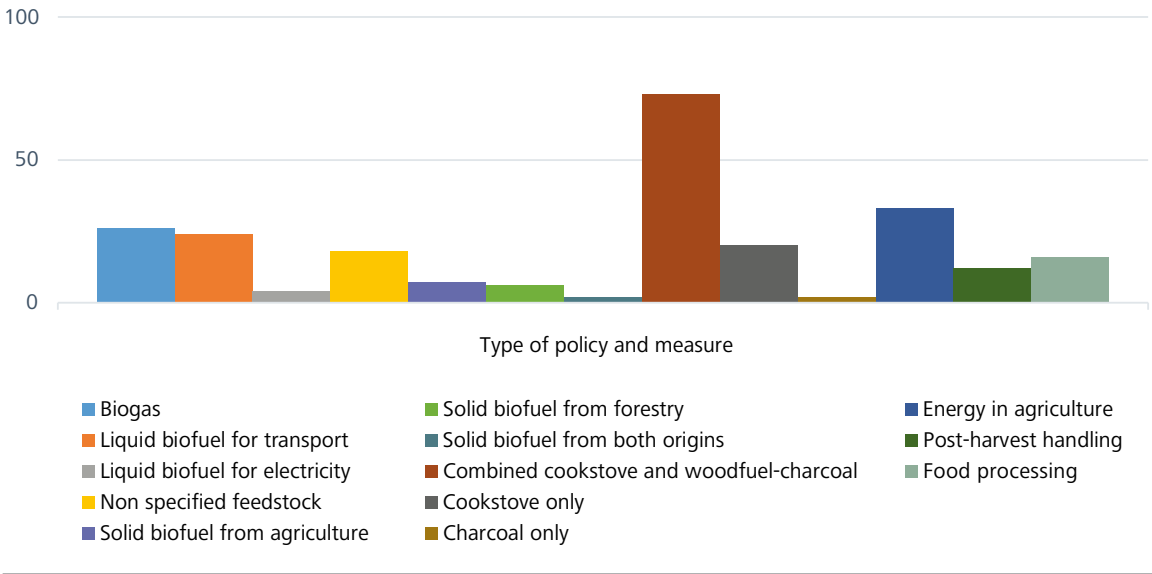
The measures are divided as follows: 24 countries combining sustainable wood to energy systems with efficient cookstoves, 15 only supporting efficient cookstoves & 2 countries only supporting more sustainable wood to energy systems.

Figure 4 Energy in agrifood systems in NDCs



This map presents countries that include at least one measure in their NDC related energy use in agriculture (61 measures in 30 countries). The measures are divided as follows: 33 for energy use at the production stage, 16 for value added in food processing & 12 for post-harvest handling. Six countries combine the three categories.

Figure 5 Policies and measures related to energy in and from agriculture in the African NDCs according to their type



Northern Africa

Algeria, Egypt, Libya, Morocco, Sudan and Tunisia

In this region, Libya did not publish an INDC nor a NDC despite being a party of the UNFCCC. Algeria, Egypt, Morocco, Sudan and Tunisia have published an NDC. These NDCs refer to bioenergy as a conditional way to mitigate their GHG emissions. However, Algeria, Egypt, Morocco and Tunisia did not specify the type of feedstock they want to use. Algeria has an ambitious target of 27 percent of renewable energy in the electricity mix by 2030 compared to 0.5 percent in 2014, with a clear emphasis on solar and wind complemented by cogeneration, biomass and geothermal sources. Egypt refers to the co-utilization of fossil fuel and biomass in the same plants to produce electricity, and the need to tackle enteric fermentation. Morocco intends to take stock, organize and valorize biomass to substitute crude oil in the industrial sector. This action has the potential to reduce emissions by 1.0705 MtCO₂e per year by 2030. Tunisia would like to valorize livestock waste, converting it into energy but has not specified the type of waste nor the type of technology to be used. Finally, Sudan would like to tap the potential of its sugar industry to produce electricity by installing 80MW of grid-connected plants.

Two countries propose measures to reduce emissions from the traditional bioenergy sector. Morocco planned to distribute 99 600 improved cookstoves from 2010 to 2030 with the potential to reduce emissions by 3 ktCO₂e per year by 2030. Sudan wants to create incentives to substitute wood stoves for Liquefied Petroleum Gas (LPG) stoves, increase firewood efficiency, and the sustainability and the efficiency of charcoal production.

Finally, two countries intend to reduce energy use in agriculture. Egypt wants to optimize the production of ammonia and related fertilizers to reduce CO₂ emissions from energy-intensive fertilizer production, reduce the burning of agricultural residues in fields and improve manure management (FAO, 2017b). Tunisia intends to optimize the use of synthetic mineral fertilizers.

Compost production from rice straw and manure in Egypt reduces burning of crop residues in the field



Western Africa

Benin, Burkina Faso, Cabo Verde, Côte d'Ivoire, the Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone and Togo.

Palm oil seedlings for planting (Sierra Leone)



@FAO/Caroline Thomas

This part of the analysis refers to the (I)NDCs for Guinea-Bissau, Liberia and Senegal because, at the time of this review, they had not yet published their NDCs. Among the sixteen countries in the region, fifteen mention energy in and from agriculture. Only Guinea-Bissau does not specifically mention this issue but states that studies should be conducted “on the energy potential of the country [...] incorporating the largest possible potential of renewable energies in the energy mix”.

Fourteen countries indicate the need to develop modern bioenergy to mitigate their GHG emissions. Liquid biofuels are the main bioenergy mentioned (ten countries) followed by biogas (seven countries). Except for Mauritania, all countries in Western Africa are members of the Economic Community of West African States (ECOWAS), which adopted biofuel-blending targets of 5 percent for ethanol and biodiesel in 2013 (ECOWAS, 2013) and a Bioenergy Strategy in 2016. In general, liquid biofuel production would be used for transport except for three cases: Cabo Verde wants to generate electricity from biodiesel in remote islands, Mali intends to develop 4 MW through hybrid systems (solar and jatropha) for rural electrification and Niger focuses on the production of biofuel and biogas for cooking purposes.

Three countries promote a blending mandate in their NDC: 10 percent of ethanol with gasoline (E10) and 20 percent of biodiesel with diesel (B20) in Nigeria; 5 percent of biodiesel from palm oil in Liberia with the potential to reduce emissions by 58 ktCO₂e per year. Burkina Faso promotes the creation of biofuel plants with a blending mandate of 10 percent of ethanol and 5 percent of biodiesel. Togo and Guinea advocate for the production of biofuel without specifying the feedstock, whereas Sierra Leone supports the production of liquid biofuels from sugarcane, corn and rice husk. Finally, the Gambia is interested in benefiting from transfers of bioenergy technologies for transport.

Regarding the biogas sector, two countries in the region do not mention any clear action: Benin and Côte d'Ivoire. Aside from Niger, two countries have demonstrated an interest in the development of biogas for cooking: Guinea wants to produce 40 ktOE of butane and biogas per year whereas Burkina Faso wants 75 000 households (HH) to be equipped with digesters by 2030. The country also wants to install twenty 250 kW cotton straw gasifiers for the production of electricity. Ghana envisages building 200 institutional biogas units in senior high schools and prisons. Finally, Senegal has set up ambitious unconditional and conditional targets (115 MW of cogeneration systems) regarding the recovery of waste from agro-industry and the adoption of household digesters: 27 500 unconditionally and 49 000 conditionally.

Côte d'Ivoire and Ghana wish to establish a national bioenergy strategy with a certain emphasis on forestry feedstock. Three countries highlight electricity production from biomass without specifying the type of feedstock: Burkina Faso through a 12.5 million conditional budget, Liberia by constructing 30 MW biomass units, and Senegal wants to build biomass plants for a total capacity of 50 MW. Finally, Benin, Côte d'Ivoire and Mali are interested in the production of briquettes from agricultural residues.

Fourteen out of sixteen countries intend to promote improved cookstoves. Côte d'Ivoire, the Gambia (with a GHG reduction potential of 278.4 GgCO₂e by 2030), Mali, Nigeria, Sierra Leone and Togo want to increase the use of clean energy for cooking through improved biomass stoves and/or LPG stoves without specifying the number of stoves distributed or the penetration rate of the improved stoves. Quantified cookstove objectives are summarized in Table 1.

Table 1 Summary of cookstove objectives in the (I)NDCs of Western African countries		
Country	Objective	GHG abatement potential
Benin	- 140 000 new HH have access to improved cook stoves (28.75% unconditional).	- N/A
	- 275 000 HH have access to butane stoves with a 35% subsidy on the tank cost (conditional).	- N/A
Burkina Faso	540 000 improved cookstoves are produced and used. At least 50% are used in urban and semi-urban areas (conditional).	610.2 ktCO ₂ e in 2030 for a cost of USD 12 096 000
Cabo Verde	Eliminate three-stone cooking stove (35% of HH still used it) through improved low-emission cookstoves by 2025 at the latest (unconditional).	100t of wood a year are currently taken from forests
Ghana	- 2 000 000 efficient cookstoves are adopted by 2030 (conditional – USD 50 million).	- N/A
	- 50% of HH adopt LPG in semi-urban and rural households by 2030 (unconditional – USD 6 million).	- N/A
Guinea	1 000 000 efficient cookstoves are adopted by 2030 (20% unconditional).	All the targets to reduce wood consumption and improve cookstove efficiency have the potential to mitigate a cumulative 23 MtCO ₂ e over the period 2015 - 2030.
Liberia	Distribute 280 543 efficient cookstoves (conditional)	282 ktCO ₂ e per year by 2030
Niger	- 100% of urban HH have access to improved cook stoves (12% unconditional).	- N/A
	- 30% of rural HH have access to improved cookstoves (12% unconditional).	- N/A
Senegal	- Production and access to 4.6 million improved wood cookstoves and 3.8 million improved charcoal cookstoves (unconditional).	- N/A
	- Production and access to 7.6 million improved wood cookstoves and 6.8 million improved charcoal cookstoves (conditional).	- N/A

Furthermore, two countries also wish to tackle emissions from stoves of small enterprises: Burkina Faso by improving the energy efficiency of stoves used by *dolo* (a traditional beer) producers and Guinea through additional pilot initiatives aimed at increasing the efficiency of smokehouses and brick making. Benin, Guinea, Senegal and Togo are interested in improving the efficiency of charcoal production with two of them citing the Casamance kiln charcoal-making process and with Guinea stating an objective of 3 000 units. Guinea, Mali and Senegal would also like to encourage the use of sustainable woodfuel in forests, through participatory forest management in Senegal and by a 50 percent reduction in the biomass demand from all inhabitants in Guinea. Benin and Côte d'Ivoire are interested in the creation of wood energy plantations (5 000 ha in Benin for a conditional cost of USD 1 billion).

Six countries would like to reduce indirect GHG emissions from agriculture by replacing chemical with organic fertilizers: Benin, Côte d'Ivoire, Senegal and Togo - but without a quantified objective. Through the supply of an extra 180 000 t of compost per year by 2030 for a conditional cost of USD 60 million, Ghana could improve agricultural yield and reduce spending on inorganic fertilizer. Burkina Faso explains that the compost produced by 75 000 household biogas digesters could fertilize 750 000 ha of cultivated land for a cost of USD 52.5 million and potentially abate 1.5 MtCO₂e by 2030. Mauritania and Niger are both interested in solar irrigation.

Three countries promote post-harvest handling techniques such as the improvement of infrastructures in Côte d'Ivoire, post-harvest storage in Ghana and Senegal (the latter having the conditional objective of replacing 95 percent of cold storage equipment within the food sector). Burkina Faso, Côte d'Ivoire, the Gambia, Ghana and Guinea would like to improve food processing and storage by developing efficient machinery (Côte d'Ivoire) or establishing food processing and preservation plants close to communities and markets (Gambia).

Central Africa

Angola, Cameroon, Central African Republic (CAR), Chad, Congo, Equatorial Guinea, Gabon, the Democratic Republic of the Congo (DRC) and São Tomé and Príncipe

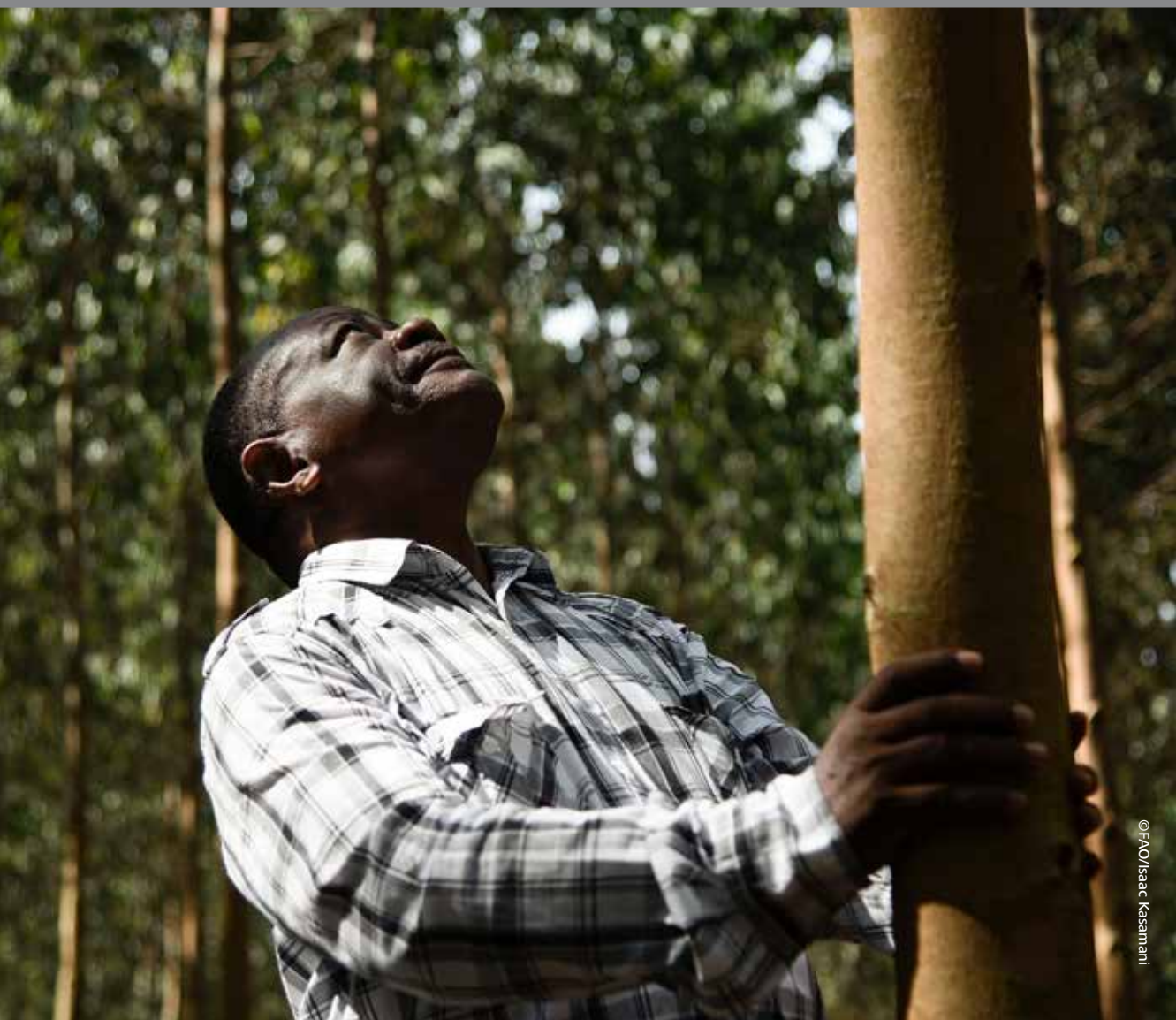
Only two countries - Angola and Equatorial Guinea - in this region had not published their NDCs in February 2018, and therefore the analysis refers to their INDCs. Except for Equatorial Guinea and Gabon, all countries in the region integrated energy in and from agriculture in their (I)NDCs. Four countries are interested in modern bioenergy for the development of renewable energy sources: Cameroon, the Central African Republic (CAR), Congo and the Democratic Republic of the Congo (DRC).

CAR indicates its willingness to develop a national liquid biofuel program for USD 27 million (conditional), with the potential to mitigate 250 ktCO₂e per year by 2030. CAR is also interested in developing the biogas sector. Cameroon and Congo both have ambitious bioenergy programs. Cameroon wants to develop the production of energy from molasses and cassava, to develop the biogas sector in rural areas, to create 80 MW of biomass plants (25 sites are already identified with 9 pilot projects underway) and to valorize agricultural waste such as cocoa pods, cashew apples, bagasse and rice husk for the production of briquettes.

Congo states that all forest plantations of more than 100 000 ha should install a biomass cogeneration unit to valorize wood by-products by 2025. The country would also like to develop liquid biofuels from sugar cane and palm oil to be used in agricultural machineries. This program would cost USD 3.7 million of which USD 0.7 million is unconditional. Congo wishes to increase the share of renewable energy to 90 percent by 2025 for extracting mining products using biomass complemented by hydropower. Finally, DRC intends to develop industrial wood to energy plantations at a conditional cost of USD 240 million with the potential to mitigate GHG emissions by 0.2 MtCO₂e.

Cameroon, CAR, Congo and DRC promote integrated approaches regarding improved efficiency of the charcoal production process and fuel-efficient stoves. In DRC, this program has the potential to reduce emissions by 0.15 MtCO₂e for a conditional cost of USD 70 million, whereas in CAR, GHG emissions could be reduced by 5.2 MtCO₂e per year by 2030 for a cost of USD 5.5 million. Congo wants to improve the efficiency of all charcoal units from 15 to 25 percent by 2025, and increase the use of improved cookstoves to 20 percent of households by 2025 and 50 percent by 2035. The cost of this program is USD 38 million of which USD 8 million are unconditional.

Cameroon and Chad are interested in the promotion of butane and biogas for cooking with Chad having an unconditional program of almost USD 58 million and a conditional one of USD 180 million. Finally, Angola would like to “reduce the demand for woodfuel by improving the charcoal process”. This could reduce GHG emissions by 750 ktCO₂e per year by 2030 at a conditional cost of USD 300 million.



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Four countries are interested in reducing the energy footprint of their agriculture: São Tomé and Príncipe by reducing the use of nitrogen fertilizers in agriculture by 2030; Cameroon by developing composting of agricultural and forestry waste, creating infrastructures for food storage, processing and transport in rural areas in order to expand the value of agricultural products; and Congo by developing liquid biofuels for agro-machinery and improving transport infrastructures. In this respect, Chad has a program based on four interlinked pillars with an unconditional cost of USD 2.9 million and a conditional cost of USD 19.3 million:

- Improve production of and access to organic fertilizers such as manure and compost.
- Develop renewable energy for farmers and herders.
- Improve production technologies with the development of storage and conservation units to reduce post-harvest losses.
- Improve food processing and storage (dewatering, drying, cold storage) through the use of renewable energy.

Eastern Africa

Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Seychelles, Somalia, South Sudan, Tanzania, Uganda, Zambia and Zimbabwe

Only four countries in this region had not published their NDCs as of February 2018: Eritrea, Mozambique², South Sudan and Tanzania. In their (I)NDCs, all countries refer to P&Ms related to energy in and from agriculture. Thirteen countries mention modern bioenergy policies. Seven countries mention the production of biogas. In Comoros, a conditional biogas and composting program could reduce emissions by 5.5 ktCO₂e in 2030. Somalia also wants to: “Introduce biogas as an alternative source of energy in areas with heavy loads of biodegradable feed” and Burundi to disseminate renewable energy such as biogas, gasification and wind. Burundi wants to produce briquettes and pellets from coffee husk, rice hulls and sawdust. Rwanda has ambitious objectives to install up to 35 000 household biogas digesters and 15 institutional biogas digesters annually by 2030.

Three other countries mention the production of biogas and the production of biofuel or a blending mandate. Zambia wants to develop rural biogas plants, rural biomass electricity generating facilities, trigger a switch from coal to biomass and introduce a blending mandate of biofuels without specifying the mandate percentage. Zimbabwe would like to build 1 250 institutional biogas digesters (50 to 80 m³ in size) in all provinces by 2030. The country would also like to introduce a blending mandate which could reduce GHG emissions by 202 GgCO₂e in 2030 at a cost of USD 100 million. Eritrea wishes to introduce biogas production on larger farms (with potential GHG abatement of 28.1 ktCO₂e by 2030) and smaller farms (with potential GHG abatement of 45.1 ktCO₂e by 2030). In addition, Eritrea plans to produce biodiesel from Municipal Solid Waste (MSW) which could reduce GHG emissions by 107.11 ktCO₂e by 2030). The Seychelles would like to increase the use of biofuels by targeting this category through import regulations.

Finally, Mozambique has the ambition to produce biofuels from cassava, jatropha, sugar cane, coconut and beetroot. Malawi has a clear program to promote the use of biofuels for lighting, cooking and transport with the unconditional objectives of 2 million liters (ML) of biodiesel per year and 18 ML/year of ethanol. Conditional objectives are 20 ML/year of biodiesel and 40 ML/year of ethanol. Furthermore, the country wants to promote the use of biomass briquettes as a substitute for firewood and charcoal unconditionally, and subject to support it would expand its program of briquette production and use. Three countries intend to develop the bioenergy sector but without specifying any process: Uganda encourages efficient biomass energy production, Tanzania promotes renewable energy sources including renewable biomass and Mauritius would like to expand its energy production to solar, wind and biomass in order to reduce emissions from the sector from 7 MtCO₂e to 2.1 MtCO₂e.

Eleven countries combine measures for increasing the efficiency of traditional biomass use and supply. Combined cookstoves and woodfuel/charcoal targets are included in Table 2.

² The INDC of Mozambique refers to the implementation of policies and programmes already adopted as their contribution to the national mitigation objectives. Two policies were used for this analysis: the Biofuel Policy and Strategy and the New and Renewable Energy Development Strategy (2011 to 2025).

Table 2 Summary of cookstove and charcoal or woodfuel objectives in the (I)NDCs of Eastern African countries				
Country	Cookstove objective	GHG reduction potential	Woodfuel / charcoal objective	GHG reduction potential
Burundi	Replace all traditional stoves with efficient stoves (HH, handicraft, brick making, catering) by 2030 - USD 3 million conditional	N/A	Replace all traditional charcoal units with efficient units by 2030 - USD 1.5 million conditional	N/A
Comoros	- Reduce the consumption of woodfuel, timber and industrial wood - Promote LPG use instead of petroleum and wood	- 104 ktCO ₂ e by 2030 - 12 tCO ₂ e by 2030	- Reforestation for fuel and other needs - Agroforestry activities for fuel and other needs	- 70.2 ktCO ₂ e by 2030 - 56 ktCO ₂ e by 2030
Eritrea	- Efficient wood stoves - Efficient electric stoves - LPG stoves to replace wood stoves	- 488.15 ktCO ₂ e / year by 2030 - 17.25 ktCO ₂ e / year by 2030 - 232.31 ktCO ₂ e / year by 2030	- Improve charcoal production process	14.1 ktCO ₂ e / year by 2030
Ethiopia	Use more efficient stoves	50 MtCO ₂ e / year by 2030	Protect and re-establish forests for their economic and ecosystem services	N/A
Madagascar	50% of HH to adopt improved stoves by 2030	23.9 MtCO ₂ e / year by 2030 for both targets	Improve charcoal production process	23.9 MtCO ₂ e / year by 2030 for both targets
Malawi	Distribute 400 000 energy saving cookstoves unconditionally and 2 million conditionally	N/A	Community-plantation of drought tolerant and fast-growing trees for communities to harvest fuelwood	1 MtCO ₂ e / year unconditionally 2 MtCO ₂ e / year conditionally
Mozambique	Electricity, LPG, wood pellets, charcoal briquettes and bioethanol are used as a primary cooking fuel by 10% of HH for a cost of USD 328 million	N/A	- Lower consumption of charcoal - Increase wood energy plantations to 140 000 ha - Increase energy crop plantations to 200 000 ha	- 14 MtCO ₂ e / year - N/A - N/A
Rwanda	- 100% of HH have improved cookstoves by 2030 - Enhance the use of LPG through reducing import taxes	- 4.2 MtCO ₂ e / year - N/A	Increase average charcoal yields up to 50% by 2030 and mandate licensing of sustainable charcoal production techniques	3.23 MtCO ₂ e / year by 2030
Somalia	- Diffuse energy efficient cookstoves - Establish an LPG market	- N/A - N/A	- Produce charcoal efficiently and sustainably - Produce charcoal with the invasive <i>prosopis juliflora</i> - Manage energy plantations sustainably	- N/A - N/A - N/A
Zambia	Introduce improved biomass stoves, encourage use of ethanol, LPG and electric stoves	N/A	Increase use of improved kilns for sustainable charcoal production	N/A

Only four countries promote the use of more efficient cookstoves: Kenya promotes clean energy technologies to reduce overreliance on woodfuel; Tanzania and Mauritius want to shift towards the use of cleaner energy technologies, such as natural gas with a potential GHG abatement of 4.9 MtCO₂e for Mauritius. Uganda promotes a wider uptake of energy efficient cookstoves or induction cookers which could reduce GHG emissions by 18 MtCO₂e per year by 2030. South Sudan wants to increase “the efficiency of biomass use (particularly fuelwood and charcoal) in the traditional energy sector”. Zimbabwe would like to promote sustainable energy alternatives for curing tobacco.

Eleven countries of the region mentioned at least one policy or measure related to energy in agrifood systems. Eritrea and Uganda are interested in expanding the use of off-grid solar systems to support food value addition and irrigation. Uganda also wants to foster value added food processing, post-harvest handling, storage and access to markets for agricultural products, including through micro-finance. With the Fanoole Dam restoration project, Somalia intends to provide electricity to towns downstream and establish a rice de-hulling machine with a daily capacity to hull 250 tonnes. This USD 28.2 million project has the potential to reduce GHG emissions by 23 MtCO₂e per year.

Three countries would like to reduce the energy footprint of their agriculture. Mauritius wishes to regulate the use and disposal of pesticides. Malawi intends to encourage the application of organic amendments, support the planting of nitrogen fixing plants and optimize chemical fertilizer application. The country would also like to replace 10 percent of the current cement production with soil- cement stabilized soil blocks and rice husk ash blended cement.

Burundi want to gradually replace 100 percent of mineral fertilizers with organic fertilizers by 2030. Burundi also intends to reduce post-harvest losses by improving marketing services for farmers and adding value to livestock and agriculture products by using renewable energy (hydro, solar and wind) for food dewatering, drying, storing, and cold storage. Comoros wants to improve the transformation of agricultural products. The Seychelles wants to develop sustainable modern agriculture supported by new and innovative technologies across all food production supply and value chains. Ethiopia and Zimbabwe want to increase food storage capacity in case of extreme weather events, with Zimbabwe focusing on grain storage and Ethiopia on food and feed storage.

Finally, Rwanda has developed a very comprehensive conditional program to reduce the energy intensity of different food value chains. It aims to ensure the production of fertilizer enriched with compost and shift away from using pure inorganic fertilizers by 2030. By the same year, 100 percent of farmers should have access to services for post-harvest treatment and storage of food crops. Post-harvest losses will be reduced from 10.4 percent, 27.4 percent, and 8.3 percent for maize, beans and rice respectively to at least 1 percent by 2030 compared to 2014. Local markets would be expanded by constructing infrastructure, including covered markets and serviceable transport networks, developing decentralized village-based agricultural processing centers that incorporate low-carbon sources of energy, such as biogas digesters and solar driers, and decentralized compost plants. The NDC also emphasizes the use of solar energy in warehouses. The operating capacity of group based organizations involved in agriculture production and running agro-processing facilities will be increased from 10 percent in 2014 to 90 percent by 2030. The installed capacity of agroprocessing installations will reach 1 200 000 Mt by 2030 from 400 000 Mt in 2014. GHG emissions in tea and coffee industries will be reduced with a GHG potential of 146 ktCO₂e.



Southern Africa

Botswana, Lesotho, Namibia, South Africa and Swaziland

The five countries of this region published their NDCs. Only Botswana does not refer to energy in and from agriculture in its NDC. Two countries intend to develop biogas production. Lesotho wants to build 60 000 household biogas digesters (with a 6m³ capacity). This could mitigate national emissions by 29.2 ktCO₂e per year at a cost of USD 108 million.

Namibia would like to develop large-scale feedlots which could reduce N₂O emissions by about 10 percent through the production of biogas from manure. The potential for GHG abatement is 201 GgCO₂e. The country also wants to increase the share of renewable energy (hydro, solar, wind and biomass) in electricity production from 33 percent in 2010 to 70 percent in 2030.

Swaziland wants to introduce a blending mandate of 10 percent ethanol. It also plans to increase the use of grid connected renewable technologies using fuel sources such as waste, solar, bagasse (from the sugar industry) and wood chips, from 16 percent to 32 percent of the national energy mix in 2030. Finally, South Africa is interested in technology transfer using advanced bioenergy to further reduce GHG emissions.

Solar irrigation (Swaziland) reduces the reliance of agriculture on fossil fuels



Swaziland would like to tackle the issue of unsustainable wood harvesting by implementing small-scale, decentralized renewable energy technologies to improve energy access in rural areas, but without specifying a reachable target.

Namibia would like to reduce wood removal in forests by 50 percent, a measure which could have the potential to reduce GHG emissions by 701 GgCO₂e. Lesotho has developed a combined approach to tackle clean cooking issues. The country wants to replace fuelwood with LPG at a rate of 10 percent per year from 2020 to 2030 and to plant 120 000 ha of forest to meet the public demand for fuelwood used for heating and cooking (at a cost of USD 10 million). Lesotho also plans to progressively reduce the use of wood for heating to 10 percent by 2030 and to disseminate efficient stoves to reach a 30 percent penetration rate by 2030, at a cost of USD 2 million.

Three countries would like to reduce the carbon footprint of their agricultural systems. In its NDC, Swaziland identified possible actions to achieve food and nutrition security such as hydroponics and solar dryers. Namibia would like to reduce the use of chemical fertilizers by 20 percent through conservation and climate-smart agricultural practices, including the use organic manure and compost. Lesotho wants to improve community food security through the promotion of food processing and preservation technologies. This program has an estimated cost of USD 1.62 million.

Conclusion

In the absence of guidelines on determining (I)NDCs, the contributions received by the UNFCCC secretariat are very diverse in nature. The analysis of these diverse commitments from African countries show regional trends on energy in and from agriculture contributing to climate change adaptation and mitigation.

In Northern Africa, traditional and modern bioenergy is not the key priority for Parties. Sustainable bioenergy is recognized as one of the renewable energy sources but countries do not mention specific bioenergy sources and use. However, three countries recognize the potential to reduce energy use in agriculture, to act against climate change by optimizing the use of fertilizers, curbing field burning of agricultural residues or using bioenergy in agrifood systems.

Parties from Western Africa demonstrate a clear emphasis on providing fuel-efficient stoves to mitigate GHG emissions. In fact, more than 90 percent of the population do not have access to clean cooking solutions (SE4All, 2014). The second most cited category of measures is liquid biofuel: 62.5 percent of Western African countries use liquid biofuel. This trend is due to the adoption of the 5 percent biofuel-blending target for ethanol and biodiesel in 2013 (ECOWAS, 2013) and a Bioenergy Strategy in 2016. Finally, nine countries provide examples of measures related to energy use in agriculture focusing on the use of organic fertilizers and improved food processing (drying, cold storage, post-harvest management and food transport infrastructures).

In Central Africa, six countries indicated their willingness to implement measures related to traditional bioenergy with a greater emphasis on woodfuel efficient system compared to Western Africa. Five countries support the development of their modern bioenergy sector, with an equal priority for liquid biofuel (4 countries) and solid biofuel production (4 countries).

Compared to Western Africa, a slightly higher proportion of the population in Eastern Africa (94 percent) does not have access to clean cooking solutions (SE4All, 2014). The number of countries mentioning fuel efficient stoves as a measure to mitigate GHG emissions is also slightly higher. However, countries in Eastern Africa often mentioned the need to support more efficient woodfuel systems. Ten countries also mention measures for reducing energy use in agrifood systems focusing on organic fertilizers, value addition and solar-powered irrigation systems. In addition, an important proportion of countries (six) in this region are interested in fostering biogas development. The trend could be explained by the existence of limited biogas capacities, notably in Kenya, Tanzania and Mauritius.

Measures concerning energy in and from agriculture are mainly linked to Lesotho, Namibia and Swaziland in Southern Africa. The three countries mention measures related to energy use in agriculture such as reducing chemical fertilizer use and promoting community food processing or hydroponics and solar drying. Lesotho and Namibia mention the development of biogas as well as afforestation/reforestation measures.

Table 2 Summary of policy and measures related to energy in and from agriculture in African (I)NDCs

Countries	INDC	NDC	Liquid biofuel	Biogas	Solid biofuel	Non specified biomass feedstock	Woodfuel efficient system	Fuel-efficient stoves	Energy use in agriculture	Food post-harvest handling	Food value-added processing and marketing	Conditionnal	Unconditional
Algeria													
Egypt													
Lybia													
Morocco													
Sudan													
Tunisia													
Benin													
Burkina Faso													
Cabo Verde													
Cote d'Ivoire													
Gambia													
Ghana													
Guinea													
Guinea-Bissau													
Liberia													
Mali													
Mauritania													
Niger													
Nigeria													
Senegal													
Sierra Leone													
Togo													
Angola													
Cameroon													
Central African Republic													
Chad													
Congo													
Equatorial Guinea													
Gabon													
Democratic Republic of the Congo													
Sao Tome and Principe													

Countries	INDC	NDC	Liquid biofuel	Biogas	Solid biofuel	Non specified biomass feedstock	Woodfuel efficient system	Fuel-efficient stoves	Energy use in agriculture	Food post-harvest handling	Food value-added processing and marketing	Conditional	Unconditional
Burundi													
Comoros													
Djibouti													
Eritrea													
Ethiopia													
Kenya													
Madagascar													
Malawi													
Mauritius													
Mozambique													
Rwanda													
Seychelles													
Somalia													
South Sudan													
United Republic of Tanzania													
Uganda													
Zambia													
Zimbabwe													
Botswana													
Lesotho													
Namibia													
South Africa													
Swaziland													
Total	53	44	20	19	12	17	26	39	24	10	13	44	13

Eight countries propose unconditional measures related to energy in and from agriculture. The majority of them are situated in Western Africa: Cabo Verde, Ghana and Senegal. This proportion is even greater when considering partially unconditional measures: Benin (28.75 percent), Mali (27 percent), Guinea (20 percent) and Niger (12 percent). The majority of the unconditional measures concern fuel efficient stoves (77 percent of countries) followed by more efficient woodfuel systems and energy use in agriculture (38 percent each). Finally, the provision of household digesters or the support to the sector represents 31 percent of countries proposing unconditional or partially unconditional measures related to energy in and from agriculture.

The analysis of African (I)NDC through the lens of energy in and from agriculture demonstrate that bioenergy is an area of interest for African countries. Access to clean cooking technologies remains a challenge whereas modern bioenergy systems are seen as sustainable sources of renewable energy to reduce the heavy dependence on fossil fuels for electricity generation, transport and residential use. Finally, the issue of energy use in agriculture and the need to foster the deployment of renewable energy in agrifood systems is a concern shared by most African parties to the convention. In this regard, energy in and from agriculture is perceived as a realistic solution to mitigate emissions from the agriculture sectors as well to adapt them to climate-induced disasters.

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