

IRENA's Bioenergy Programme and resource assessment

6 July, 2015

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IRENA Bioenergy programme

1. Versatile source for energy application
Biomass accounts for nearly 90% of RE heat and 80% of RE transport fuel in 2030 (REmap 2030)
2. Diversity in feedstock and technology
Various feedstock : energy crop, ag. residue and waste, fuelwood, wood residue and waste
Different technology pathway : combustion, gasification, fermentation, etc.
3. Multi-dimensional role from economic, social, and environmental point of view
Under Food/Energy/Water Nexus, bioenergy interact with environment / society in positive / negative manner
4. Storable, transferable feedstock
5. Relatively low energy density
require collection, transportation, densification with extra cost

Potential benefits and trade-offs from bioenergy application

Benefits	Trade-offs
<ul style="list-style-type: none">• Energy security• Climate change mitigation• Rural development• Job opportunity, income generation• Avoid in house air pollution• Mitigate the burden for fuel collection labor	<ul style="list-style-type: none">• Food security• Biodiversity• Life cycle emission increase through land use change, long distance trade• Land grab, social equity

To enhance multi-dimensional role of biomass while mitigating the possible trade-offs associated with bio-energy deployment, an effective policy mix is needed rather than a single stand-alone policy or individual policy measures

- *To achieve above objective, support is required for improved data collection, resource assessment, technology evaluation, capacity building and policy guidance*
- *IRENA is trying to cover these area to collect / share information, exchange best practice, provide policy support*

IRENA activities and Resource assessment

Bioenergy potential and deployment support	<ol style="list-style-type: none">1. Remap20302. <u>Global Atlas</u>3. <u>Valo-BRES</u>4. Resource assessment tool for municipality
Bioenergy Statistics	<ol style="list-style-type: none">5. <u>IRENA Statistics Questionnaire</u>6. <u>RE Statistics Manual</u>
Technology and Cost Assessment	<ol style="list-style-type: none">7. IRENA costing reports8. Technology briefs9. Project Navigator10. Advanced biofuel study
Capacity building	<ol style="list-style-type: none">11. Capacity building for Entrepreneurs in Western Africa
Policy support	<ol style="list-style-type: none">12. Bioenergy How2Guide (IEA/IRENA/FAO)

Bioenergy Statistics

Bioenergy Statistics: Data Collection

	A	B	G	H	I	J	K	L	M	N	O
			Renewable Municipal Waste	Wood and straw pellets/briquettes	Fuelwood	Wood waste	Charcoal	Sewage sludge gas	Other biogases from anaerobic fermentation	Conventional bioethanol	Conventional biodiesel
			tonnes	tonnes	tonnes	tonnes	tonnes	TJ (net)	TJ (net)	tonnes	tonnes
1											
2	2012			512695	2346700	149157	5034	112	367	2047	39091
3	Production	(+)		3477	5000		2003				1914
4	Imports	(+)		387871	391100		3640				389
5	Exports	(-)		3700			165				-831
6	Stock changes	(+)									
7	International bunkers	(-)									
8	Domestic supply	(=)	0	142001	1960600	149157	3562	112	367	2047	39785
9	Transfers									15	
10	Statistical Differences		0	0	0	0	0	0	0	0	0
11	Power plants							112	310		
12	of which off-grid			80024			4700				
13	CHP plants										
14	Commercial heat plants				39000						
15	Charcoal production plants									26	
16	Other transformation									16	
17	Own use								0	0	2047
18	Losses		0	61977	1921600	144467	3562	0	0	2047	39785
19	Total final consumption		30789	48600	144467					2047	39685
20	Industry sector									2047	39685
21	Transport sector										
22	of which road transport							216			
23	Commercial and public services			1874	13000		3346				
24	Residential			29514	1860000						100
25	of which traditional uses										
26	Other										
27	Non-energy use										

IRENA Renewable Energy Statistics Questionnaire sent annually to membership to improve level of detail of internationally reported statistics.

Key Features

- Bioenergy disaggregated into 20 products (11 solid, 5 liquid, 4 gaseous)
- Allows reporting of off-grid electricity generation and traditional uses of biomass in the residential sector
- Allows reporting of small scale systems such as capacity of biogas digesters

IRENA Bioenergy Statistics Activities:

- *Data Collection: Bioenergy statistics collected using IRENA Renewable Energy Statistics Questionnaire*
- *Data Dissemination: Bioenergy statistics to be publically available on RESource*
- *Capacity Building: Bioenergy module of IRENA Renewable Energy Statistics Manual to be published late 2015*

Bioenergy Statistics: Data Collection

During the initial data collection cycle a number of countries were able to report a detailed breakdown of their solid bioenergy products.

	Detailed solid bioenergy products reported
Ecuador	Fuelwood, Bagasse
Latvia	Wood and straw pellets, Wood and straw briquettes, Fuelwood, Wood waste, Wood chips, Straw
Lithuania	Wood and straw pellets/briquettes, Other vegetal and agricultural waste
Luxembourg	Wood and straw pellets/briquettes, Fuelwood, Wood waste, Other primary solid biomass
Mauritius	Fuelwood, Bagasse
Nicaragua	Fuelwood, Wood waste, Bagasse, Other vegetal and agricultural waste
Niger	Fuelwood, Other vegetal and agricultural waste, Other primary solid biomass
Sri Lanka	Fuelwood, Bagasse, Rice husks
Swaziland	Fuelwood, Other vegetal and agricultural waste
Turkey	Wood and straw pellets/briquettes, Fuelwood, Other vegetal and agricultural waste
Uruguay	Fuelwood, Wood waste, Rice husks, Other primary solid biomass, Black liquor

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- In late 2015 IRENA will publish new guidance on biomass data collection and estimation methods
- Special focus on traditional uses of biomass as energy generated and consumed at the residential level is often not accurately reflected in statistics
- The manual will include case studies drawing on practices from countries and organizations in the following areas:
 - Data collection methods
 - Comparison of existing biomass consumption models
- IRENA welcomes input from countries and organizations on the manual content as well as case study contributions

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Global Atlas

Bridge the gap between nations having access to the necessary funding, technologies, and expertise to evaluate their national potentials, and those deprived of those elements.



Global Atlas – Scope and Partnerships

Bridge the gap between nations having access to the necessary funding, technologies, and expertise to evaluate their national potentials, and those deprived of those elements.

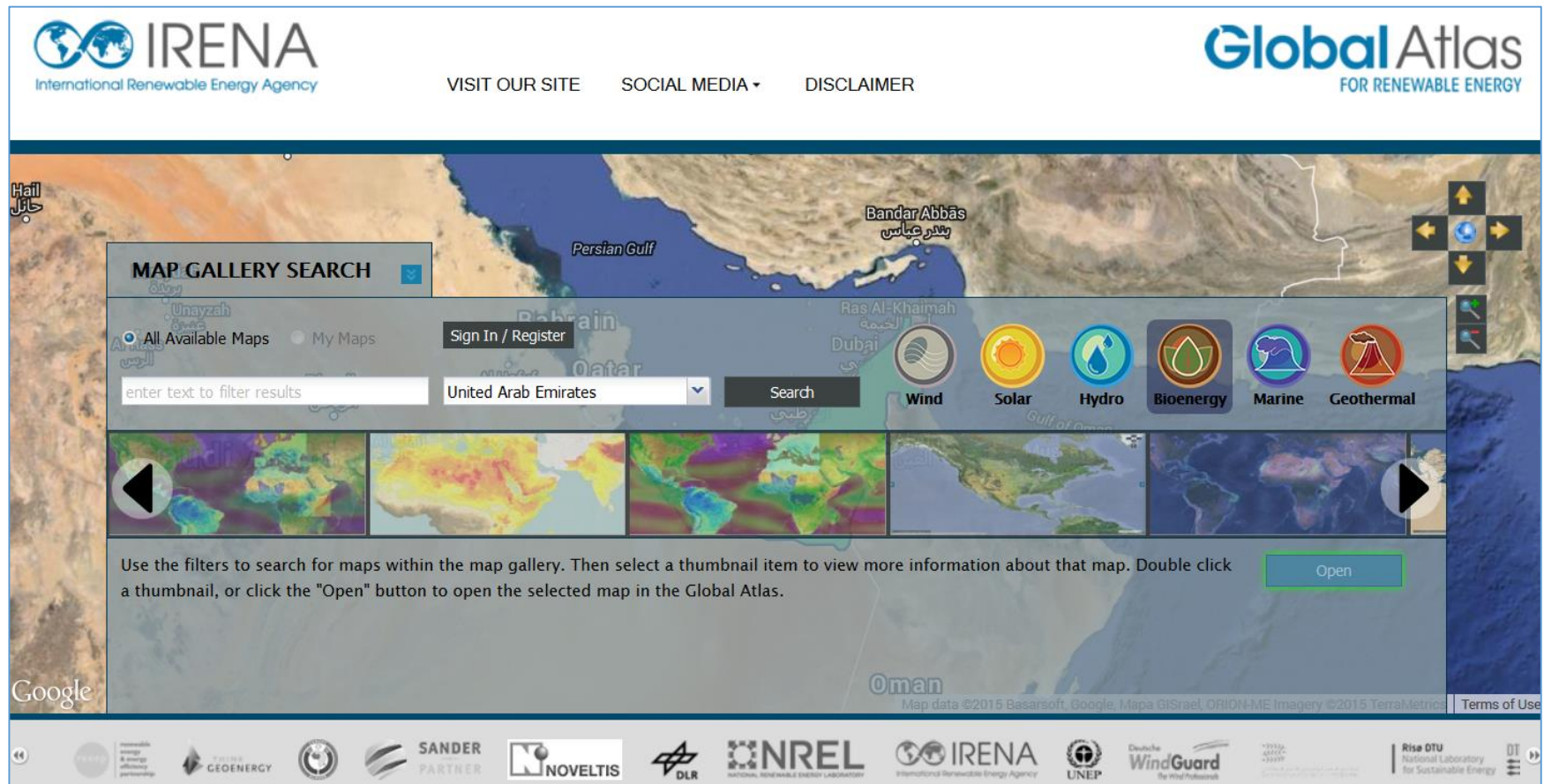
- Access to data and methods
- Building capacities on strategic planning
- Mobilizing technical assistance



Global Atlas – Countries involved



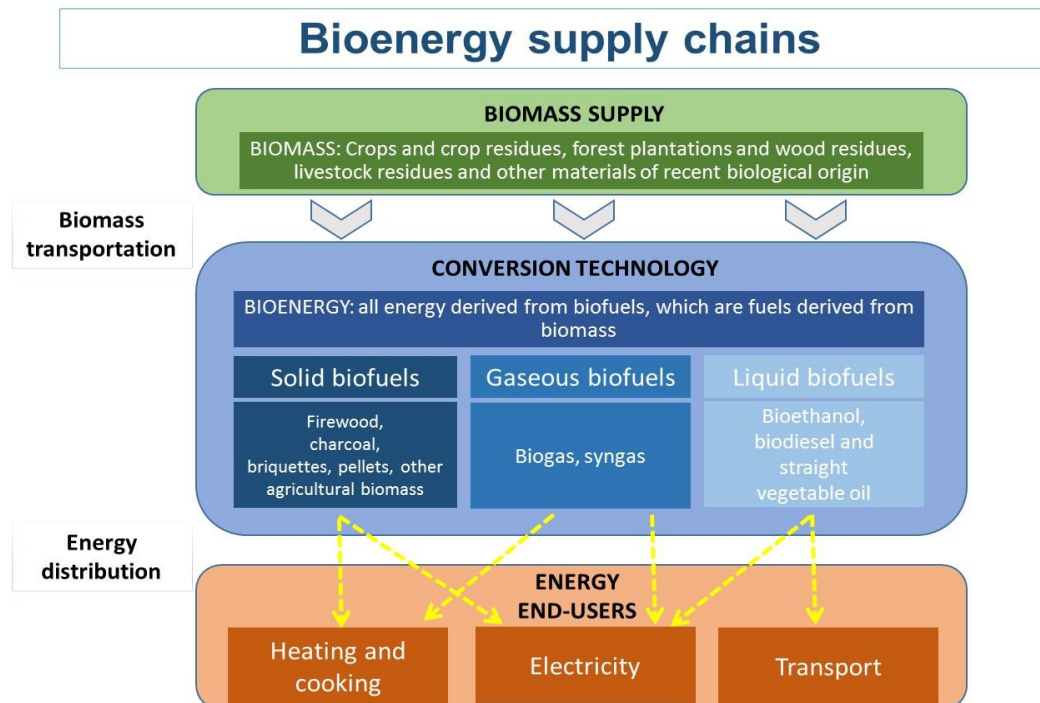
Albania, Australia, Austria, Belgium, Colombia, Denmark, Egypt, Ethiopia, Fiji island, France, Gambia, Germany, Greece, Grenada, Honduras, India, Iraq, Iran, Israel, Italy, Kazakhstan, Kenya, Kiribati, Kuwait, Lithuania, Luxembourg, Maldives, Mali, Mauritania, Mauritius, Mexico, Mongolia, Montenegro, Morocco, Mozambique, Namibia, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Peru, Philippines, Poland, Portugal, Qatar, Saudi Arabia, Senegal, Seychelles, South Africa, Spain, Sudan, Swaziland, Switzerland, Tonga, Tunisia, Turkey, UAE, Uganda, UK, United Republic of Tanzania, Uruguay, USA, Vanuatu, Yemen, Zimbabwe.



The Global Atlas is online integrated Geographic Information System (GIS) platform which enables users to visualize renewable energy resource maps, and to overlay additional information on, for example, protected areas, roads or infrastructure. The platform allows users to create and save thematic maps.

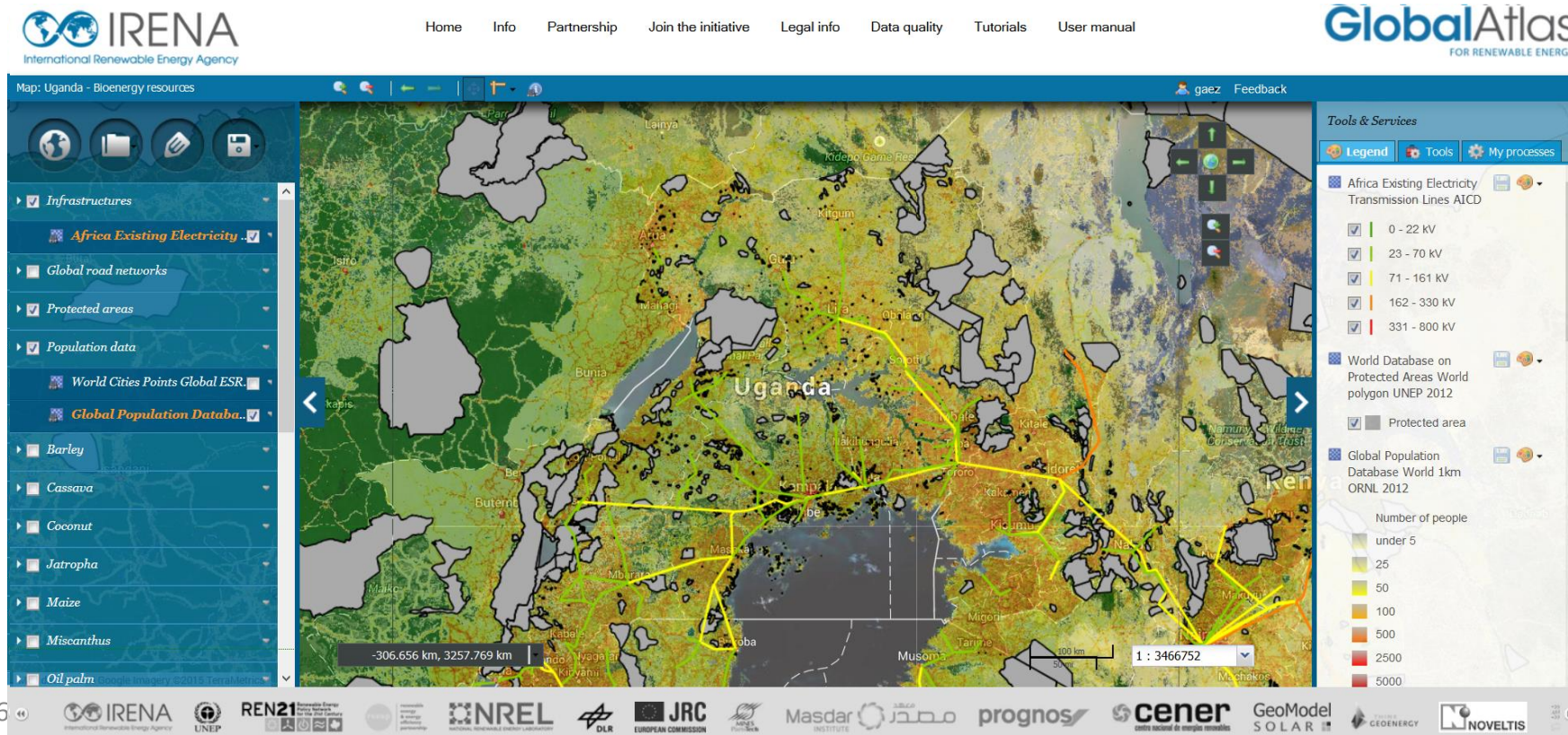
Main objectives:

- support policy discussions on the subject;
- prospect opportunities before ground exploration;
- simulate localized bioenergy scenario.



Work streams:

- Integrating existing datasets
- Create new maps

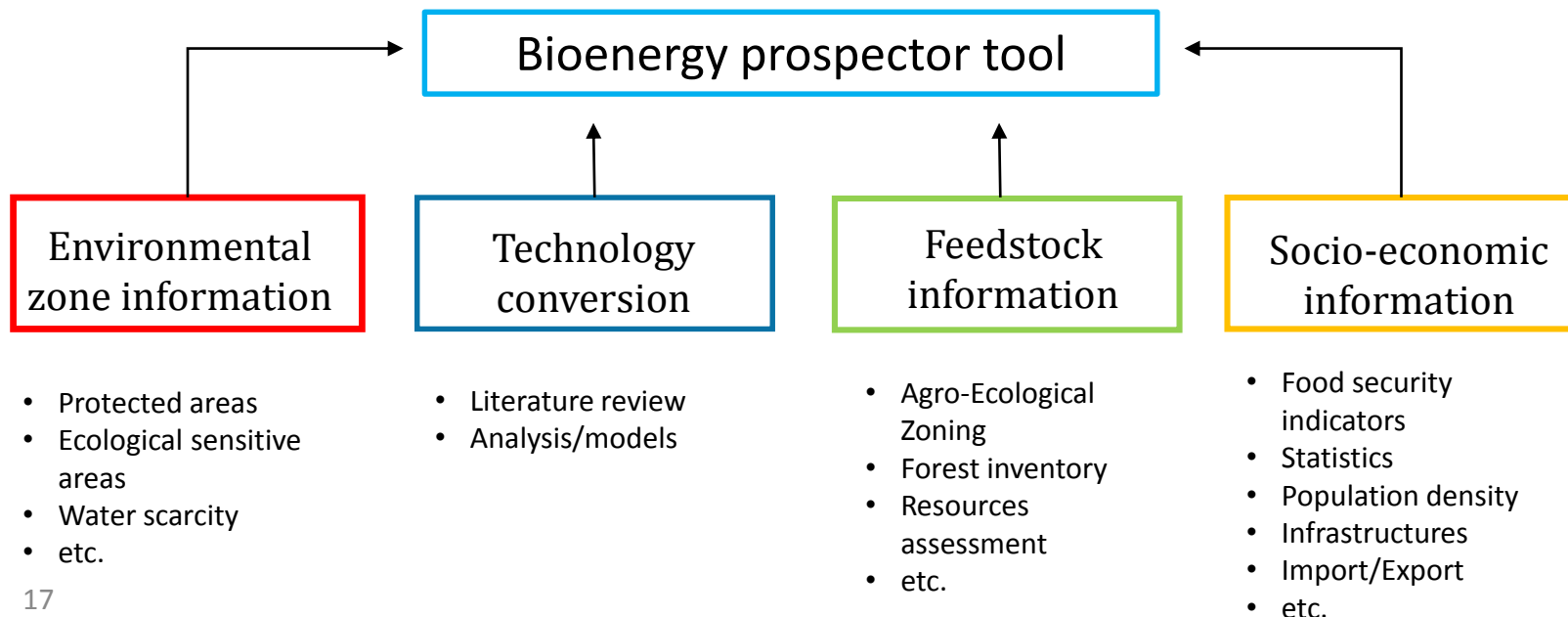


The screenshot displays the IRENA Global Atlas interface for the 'Uganda - Bioenergy resources' map. The interface includes a navigation menu on the left with categories like Infrastructures, Africa Existing Electricity, Global road networks, Protected areas, Population data, and various crops (Barley, Cassava, Coconut, Jatropha, Maize, Miscanthus, Oil palm). The central map shows Uganda with overlaid data layers, including electricity transmission lines and population density. The right panel contains a legend for 'Africa Existing Electricity Transmission Lines AICD' with voltage ranges (0-22 kV, 23-70 kV, 71-161 kV, 162-330 kV, 331-800 kV) and 'Global Population Database World 1km ORNL 2012' with population density categories (under 5, 25, 50, 100, 500, 2500, 5000). The bottom of the interface features a footer with logos of partner organizations: IRENA, UNIP, REN21, NREL, DLR, JRC, Masdar, prognos, cener, GeoModel SOLAR, and NOVELTIS.

Next steps:

➤ Development of bioenergy prospector to simulate scenario for a selected area

- What type of biomass feedstock was identified suitable by existing datasets
- Major sustainability alerts to be considered as food security, water scarcity, sensitive ecosystems, etc.
- What conversion technology options could be available for the selected feedstock
- How much energy could be generated considering empirical conversion factors



Valo-BRES:

Valorization of **B**iomass **R**esidue as **E**nergy **S**ource

Summary of the project

1. Implementation body:

IRENA in collaboration with Japan International Research Center for Agricultural Sciences (JIRCAS)

2. Implementation period: 2013 – 2017

3. Type of biomass: agro-processing residue

Agro-processing residue are abundant but not effectively utilized in African countries, while many industry sector suffer energy shortage

4. Objective

To develop technologies suitable for African countries, which utilize agro-processing residue for energy generation in order to mitigate climate change

- *Valo-BRES try to develop a tool which can assess location specific bioenergy potential and its impact on economy/environment/society*
- *This information can be used for site screening of bioenergy project*

How to measure biomass potential?

- Bottom-up approach and Top-down approach

- **Bottom-up approach (Valo-BRES)**

- Estimate national bioenergy potential by adding up data from agro-processor
- Sampling survey is conducted since it is impossible to cover all the agro-processor in the country
 1. Develop comprehensive list of agro-processor (name, location, scale)
 2. Select representative agro-processor from each region. Conduct sampling survey to get data on residue generation and utilization
 3. National biomass potential is estimated using the formula below
$$\Sigma(\text{residue coefficient} * \text{recoverable fraction} * \text{annual production volume})$$

- **Top-down approach (REmap)**

- Estimate national bioenergy potential by using national/regional statistics
- National biomass potential is estimated using the formula below
$$\text{residue coefficient} * \text{recoverable fraction} * \text{national production volume}$$

6 steps in the project

1. Commodity selection

- Prioritize agro-processing commodities based on national statistics

2. List of processors

- Develop a list of major agro-processors in the country

3. Data collection from selected processor

- Conduct sampling survey for representative processor for each target commodity

4. Extrapolation to national level

- Apply parameters collected from survey to estimate national / regional potential

5. Technology assessment

- Impact assessment of bioenergy utilization by applying BEFS-RA (economy / social / environmental aspect)

6. Mapping

- Map each processor with biomass potential and conversion technology

Current status of country data collection IRENA International Renewable Energy Agency

Country	Status
Nigeria	Initial survey completed focusing on Cassava. Second round data collection is planned in 2015 focusing on processor level potential and supply cost of cassava residue
Cameroon	Result of second round data collection submitted and under verification. There are still significant data gap between top-down and bottom-up approach
Ghana	Result of second round data collection submitted and under verification. Significant data gap. District level detail agricultural statistics is collected and it may be utilized to fill the gap.
Uganda	Initial survey completed. Coverage of processor is too few and planning second round data collection in 2015, focusing on district level statistics
Senegal	Initial survey completed. Collected data is not sufficient to conduct assessment. Follow-up survey is being considered.
Ecuador	Draft data set submitted for initial survey and being verified, however company level information is still very limited
Costa Rica	Draft data set submitted for initial survey and being verified, however company level information is still very limited

Overview of agro-processors surveyed in Ghana

No.	ID_Crop	Company name	Region	District/city	Scale	Production volume (1,000t)	Production volume (t, median)	Employment (person)
1	Oil Palm	Ghana Oil Palm Development Corporation (GOPDC)	Eastern	Kwaebibirem District/ Kwaie	Large	120	120,000	200
2		Twifo Oil Palm Plantations Ltd (TOPP)	Central	Twifo-Herman-Lower Denkyira District /Twifo Ntafrewaso	Large	100	100,000	1,500
3		Benso Oil Palm Plantations (BOPP)	Western	Wassa Mpohor East District/ Adum Banso	Large	83.92	83,920	400
4		Norpalm Ghana Limited	Western	Ahanta West District/ Prestea	Medium	36.06	36,060	100
5		Juaben Oil Mills	Ashanti	Ejisu-Juaben Municipal District/ Juaben	Medium	30	30,000	250
6		AOMIL	Western	Mpohor District/ Mpohor	Medium	30-40	35,000	
7		Ayiem Oil Mills	Western	Mpohor District/ Ayiem	Medium	30-40	35,000	100
8		Adansi Oil Mills	Ashanti	Adansi North District/ Dompoase	Medium	30-40	35,000	100
9		Anyinase Oil Mills	Western	Nzema East/ Anyinase	Medium	30-40	35,000	80
10		Amen Sangari Industries Ltd	Central	Cape Coast Metropolitan/ Cape Coast	Medium	40-50	45,000	N.A.
11	Soybean	Bosbel Oil Mill	Northern	Tamale Metropolitan/ Tamale	Large	14.4	14,400	70
12		Deer Soya Bean Oil	Greater Accra	Tema Metropolitan/ Tema	Medium	0.3-0.5	400	N.A.
13		Generation Plus Food Co Ltd. - Victory Soy Milk	Greater Accra	Ga-South District/ New Weija	Medium	0.3-0.5	400	N.A.
14		Sunshine Industry Ltd. - Bebeans (Soy milk drink, bean curd, dried bean curd)	Greater Accra	Tema Metropolitan/ Tema	Medium	0.3-0.5	400	N.A.
15		Wagazi Ventures - Strongman Soya Milk	Greater Accra	La Dade Kotopon Municipal District/ La	Medium	0.3-0.5	400	N.A.
16		Triune Inspirational Network Ltd - Truine Soybean Oil	Eastern	Akuapim North District/ Akropong - Akwapim	Medium	0.3-0.5	400	N.A.
17	Cassava	Caltech Ventures Limited	Volta	Ho Municipal District/ Ho	Medium	3.7	3,700	80
18	Maize	General Mills Co. Ltd - Maize Grits, Fortified Corn Soya Blend	Ashanti	Kumasi Metropolitan/ Accra	Medium	10-15	12,500	140
19	Wheat	Takoradi Flour Mill - Soft wheat Flour, Selected Hard Spring Wheat Flour	Western	Sekondi-Takoradi Metropolitan/ Sekondi-Takoradi	Large	100	100,000	350
20		Irani Brothers & Others Ltd - GMG Selected Hard Spring Wheat flour	Greater Accra	Accra Metropolitan/ Accra	Large	150	150,000	350
21		Ghana China Food Company Limited	Greater Accra	Tema Metropolitan/ Tema	Large	50	50,000	
22		Olam Ghana Flour Mill	Greater Accra	Tema Metropolitan/ Tema	Large	115	115,000	100
23	Cocoa	West African Mills Co. Ltd - Natural Cocoa, Cocoa Butter, Cocoa Cake	Western	Sekondi-Takoradi Metropolitan/ Sekondi-Takoradi	Large	75	75,000	500
24		Cocoa Processing Co. Ltd. - Chocolate Drink/ Spread, Cocoa Cake/ Powder	Greater Accra	Tema Metropolitan/ Tema	Large	64.5	64,500	430
25	Fruit Juice	Blue Skies Products Ltd.- Freshly Squeezed Juice	Greater Accra	Accra Metropolitan/ Accra	Medium	10	10,000	1,500
26	Shea Butter	Bosbel Vegetable Oil Ltd	Northern	Sagnarigu District/ Kasaligu	Medium	2.4	2,400	N.A.
27		Tunteiya Sheabutter Processing Women Group	Northern	Gushegu District/ Gushegu	Medium	0.1	100	N.A.

List of 27 agro-processors conducted interview survey out of 129 major agro-processors

Parameters identified for agro-processing residue

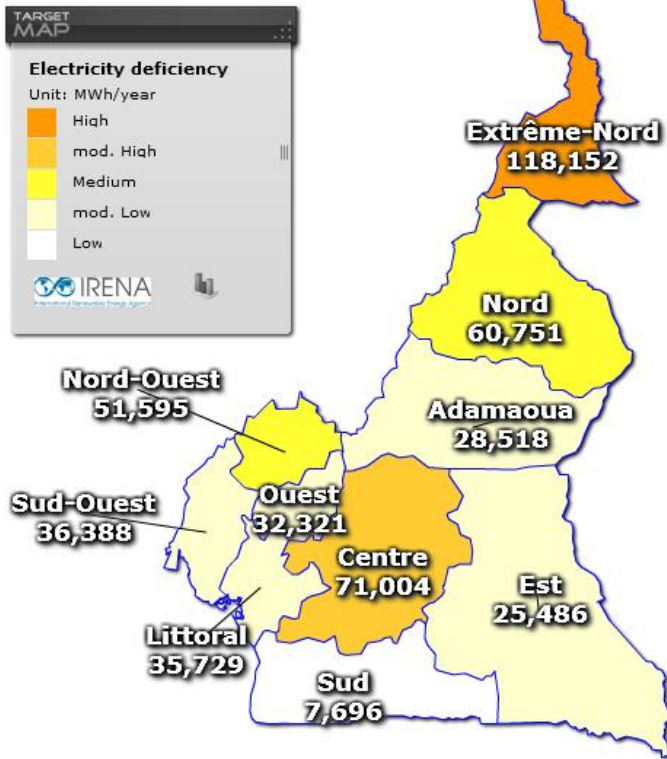
Ghana

Commodity	Residue type	Industry raw material consumption (ton)	Crop yield (ton/ha)	Residue to product ratio	Range of residue to product (Raw material)	Potential residue (ton)	Potential residue yield (ton/ha)	Potential Energy (TJ)	LHV	Reuse rate
Oil Palm	Empty bunches	554,980	5.76	0.46	0.23-0.27	254,181	2.64	4,682	18	0.9
Oil Palm	Fibre	554,980	5.76	0.17	0.11-0.15	92,682	0.96	1,059	11	0.9
Oil Palm	Shell	554,980	5.76	2.44	0.06-0.09	1,353,041	14.03	24,332	18	0.9
Soybean	Shell	16,400	0.00			0	0.00			0.9
Cassava	Peel	3,700	15.11	0.80	0.8	2,960	12.09	54	18	0.9
Wheat	Husk	415,000	1.59	0.18	0.15-0.2	72,625	0.28	1,089	15	0.9
Cocoa	Pods	139,500	0.69	0.22		30,327	0.15	469	15	0.9
Cocoa	Husk	139,500	0.69	0.78		109,173	0.54	1,687	15	0.9
Shea Butter	Cake	2,500	0.04	1.25	0.55	3,125	0.04	41	13	0.9

Commodity	Residue types	Moisture (%)	Particle size (mm)	C (%)	H (%)	O (%)	N (%)	S (%)	HHV (MJ/kg)	LHV (MJ/kg)
Cacao	Pods	8%	44	0.506	0.067	0.387	0.018	0.022	22	20
Cassava	Stalk	12%	77	0.537	0.071	0.379	0.012	0.001	23	21
Coconut	Husk	7%	56	0.395	0.061	0.540	0.004	0.001	15	14
Coconut	Shell	6%	77	0.539	0.057	0.394	0.001	0.000	21	20
Coffee	Husk	8%	56	0.506	0.067	0.387	0.018	0.022	22	20
Cocoa	Pods	15%								15
Cocoa	Husk	15%								15
Groundnut	Shell	8%	59	0.506	0.067	0.387	0.018	0.022	22	20
Maize	Cob	15%	59	0.466	0.059	0.455	0.005	0.000	18	17
Maize	Husk	11%	38	0.463	0.067	0.454	0.016	0.000	19	17
Oil palm	Empty bunches	2%	25	0.538	0.044	0.415	0.004	0.000	19	18
Oil palm	Fibre	35%								11
Oil palm	Shell	8%	61	0.444	0.050	0.347	0.003	0.156	19	18
Rice	Straw	8%	52	0.392	0.051	0.358	0.006	0.001	16	15
Rice	Husk	9%	30	0.385	0.057	0.398	0.005	0.000	16	14
Sugarcane	Bagasse	15%	51	0.449	0.054	0.396	0.004	0.000	18	16
Shea Butter	Cake	5%		0.590			0.334	0.450		13
Wheat	Husk	6%		0.749		0.224				15
Wood Processing Residues		15%	40	0.469	0.052	0.378	0.001	0.000	18	17
Coffee	Pulp	4.5%		0.430	0.018	0.383	0.080		17	17
Cassava	Peel	35.34%		0.519	0.059	0.418			20	48

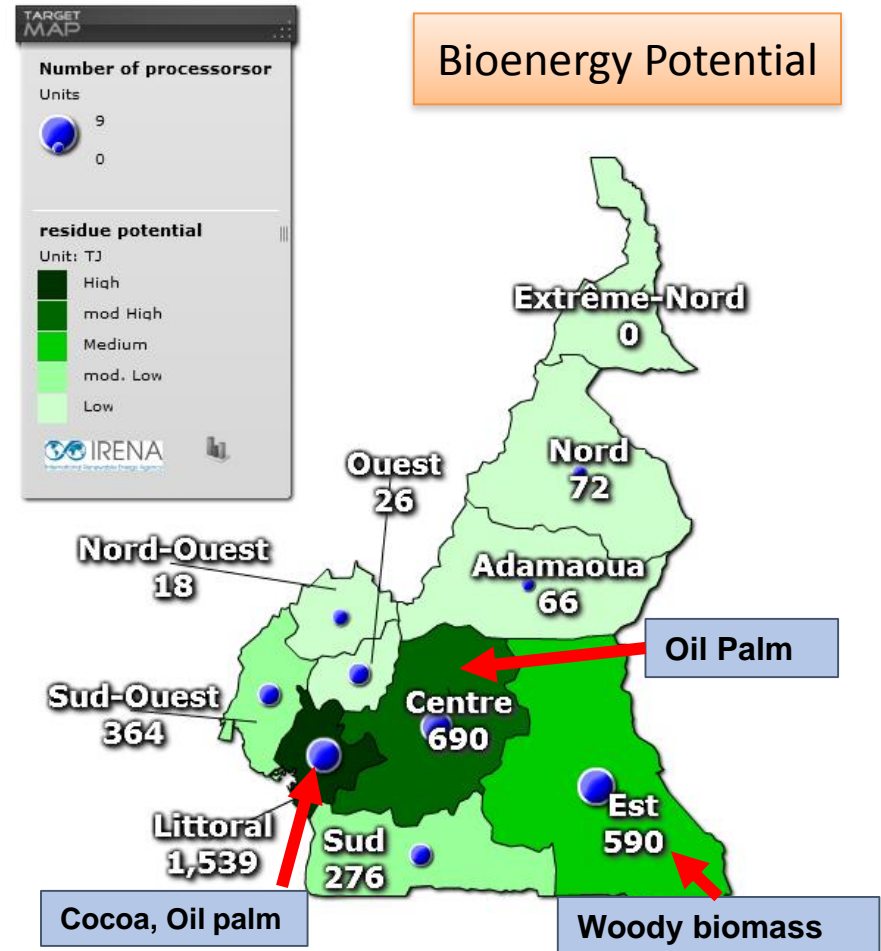
Distribution of power demand and bioenergy potential

Power demand



Cameroon

Bioenergy Potential



- Power demand = (determinant) Population, Economic activity, Infrastructure
- Supply potential = (determinant) Productivity, food demand-supply
- Supply and demand does not necessary match

Bioenergy potential from Agro-processor

Cameroon		Ghana		Uganda	
Overall Potential (TJ)	12,626	Overall Potential (TJ)	33,714	Overall Potential (TJ)	44,901
Oil palm EFB	2,058	Oil palm EFB	4,217	Sugarcane Bagasse	26,303
Timber Residues	1,302	Cocoa Husk	1,518	Maize Cob	7459
Oil Palm Shell	502	Wheat Husk	980	Groundnut Shell	1,166
Sugarcane Bagasse	473	Oil Palm Fibre	952	Coffee Pulp	611
Maize Cob	83	Oil Palm Shell	539	Coffee Husk	320
Cotton Hull	71	Cocoa Pods	422	Rice Husk	89
Cacao Pods	43	Shea Butter Cake	37	Timber Residues	3,376
Cassava Small Scale	8,092	Cassava Small Scale	25,050	Cassava Small Scale	5,220

Green colored cell represents biomass potential calculated using top-down approach. This is because processor is very small scale and distributed. Simple comparison indicates cassava residue is abundant in most of the country, however there is no supply chain to collect and transfer them.

Bottom up
 Top down

Significant gap between top-down and bottom-up

Region	Biomass potential (PJ) Top down (A)	Biomass potential (PJ) Bottom up (B)	Share (B/A)	Plant surveyed	Plant listed
Cameroon	81.4	4.5	5.6%	31	41
Ghana	304.5	8.7	2.9%	26	128
Uganda	57.7	44.9*	77.8%*	9	9

*: for Uganda, regional production data was used instead of data from processor since plant list was not extensive enough to capture whole nation

- More than 10 times gap between top-down and bottom-up
 ⇒sum of all the surveyed agro-processor is much less than national total production
 ⇒list of agro-processor seems not to be comprehensive

 Bottom up

 Top down

1) *Biomass potential from agro-processor*

13 to 45 PJ of agro-processing residue were identified in Ghana, Cameroon and Uganda, which can supply power to 190 to 700 thousand household in off-grid area

2) *Uneven local distribution*

Biomass residue is unevenly distributed depending on agro-environmental condition, market situation (export/domestic).

3) *Methodology*

Data collection from private sector is very difficult. List of agro-processor is not available at national/local government nor industry association. Agriculture statistics from local government may compensate data unavailability (available for Ghana, Uganda, non available for Cameroon)

4) *Scale of the processor*

Cassava have the highest potential in most of country, however scale of processor is very small and distributed. No collection/transport system is in place yet

- ***Combine plant base information and statistics based information (two way approach)***
 - For the large to medium scale processors, expand survey to increase comprehensiveness
 - For small scale processor, use region/district agricultural statistics instead of plant information (district level statistics are available for Ghana, Uganda)
- ***Expand country coverage***
 - Second round data collection: Nigeria, Uganda
 - Follow up for other countries: Senegal, Ecuador, Costa Rica
- ***Report writing***
 - Summarize output from first group of countries (Cameroon, Ghana, Uganda)



Thank you !

