Sustainable Lignocellulosic Biomass Potentials in Mozambique and Kenya – preliminary results

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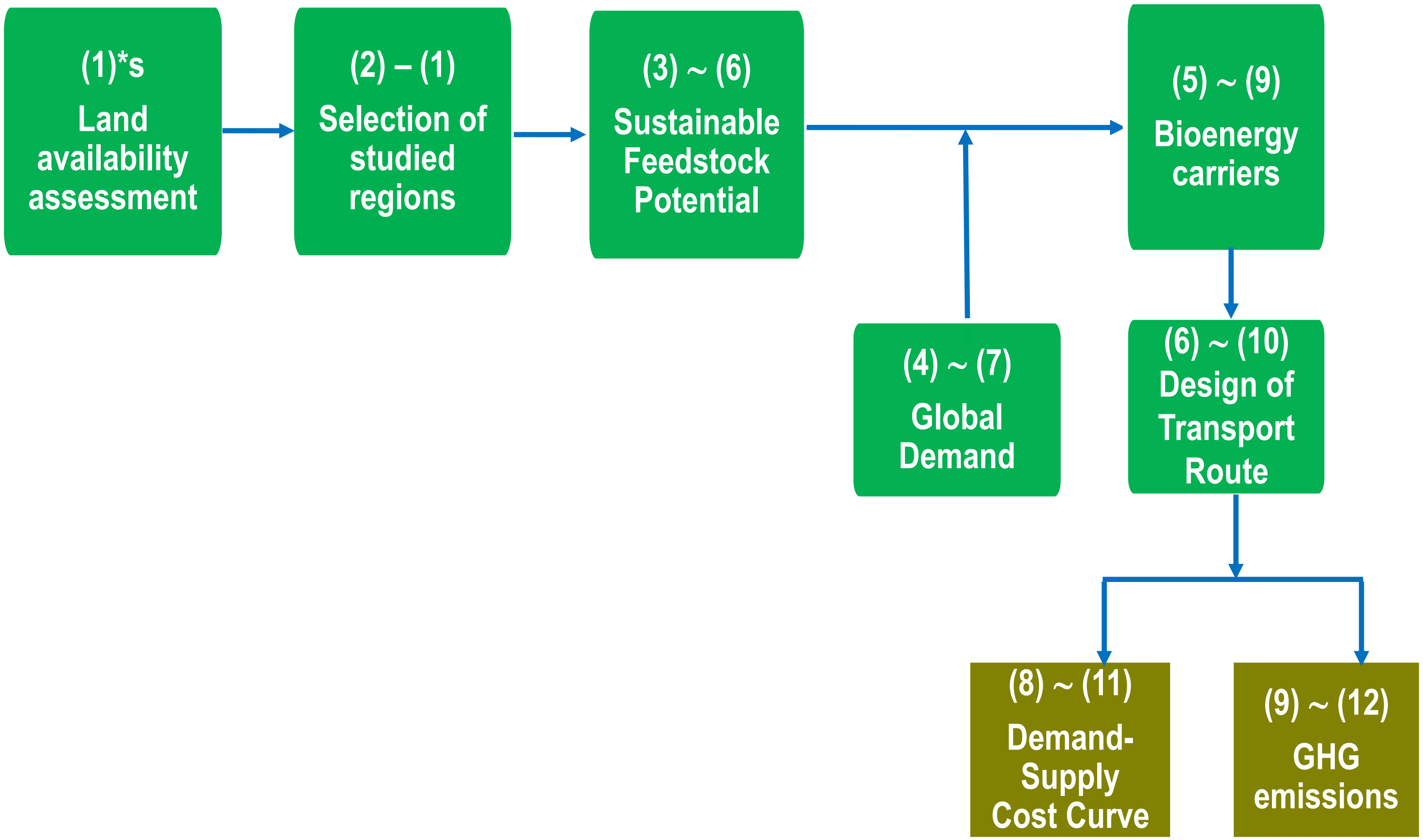
Mozambique

I. Methodology
II. Scenario approach
III. Results
IV. Conclusion & Discussion

I. Methodology Outline, Mozambique



Assessment of Sustainable Lignocellulosic Biomass Value Chain

III. Results

(1) Land availability assessment → (2) Selection of studied regions

(1) Assessment of land availability for bioenergy crops

Parameter	Unit	Current	BAU Scenario	Progressive Scenarios
Population	Million	22.9	33.9	
GDP	Growth rate (%)	8% (1994 – 2007)	6.6% (up to 2030)	
Diet	Kcal/cap/day	2050	2550	
SSR	Self sufficient	for most food crops	similar	
Farming practices	-	Farming system: subsistence farmers (95%) Cultivation area size of 0.5-1.4 ha in shifting cultivation, clearing by burning	Continuation of current practices, a modest shift towards commercial farming.	Shift towards commercial farming, shifting cultivation is progressively abandoned.
Technological adoption		Low	Low	Slightly increased
Agricultural productivity	Ton/ha-1	Very low	A modest increase in yield (0.6% p.a.) and cropping intensity (0.5% p.a.)	Higher agricultural productivity (3.5% p.a.) and increased cropping intensity (2% p.a.)

III. Results

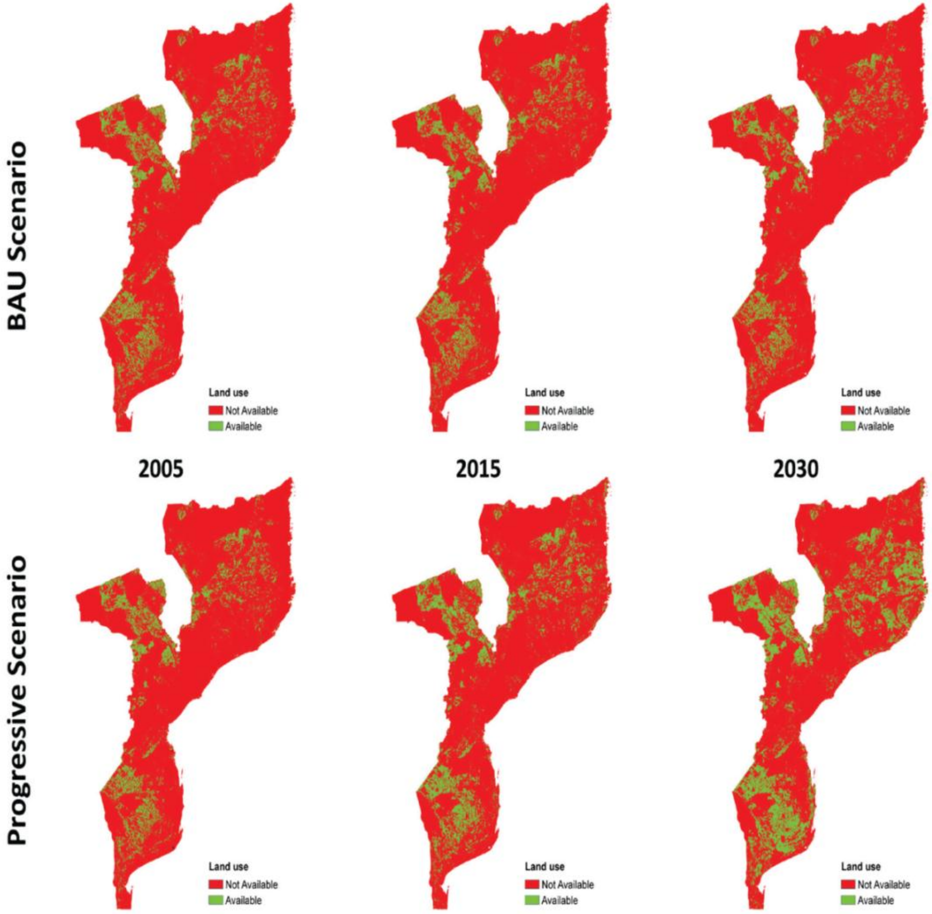
(1) Assessment of land availability for bioenergy crops (continued)

Parameter	Unit	Current	BAU Scenario	Progressive Scenarios
Livestock sector	-	Low, lack of disease control, low feed conversion efficiency	Partial shift from pastoral systems to mixed systems. Modest growth in feed conversion efficiency	Effective policies on disease control. Strong shift towards mixed systems. Increased feed conversion efficiencies.
Deforestation	-	High	High	Deforestation prevention
Bioenergy implementation	-	Bioenergy projects implemented in a developing institutional and regulatory framework	No major changes	Bioenergy is implemented in a controlled and sustainable environment.

III. Results

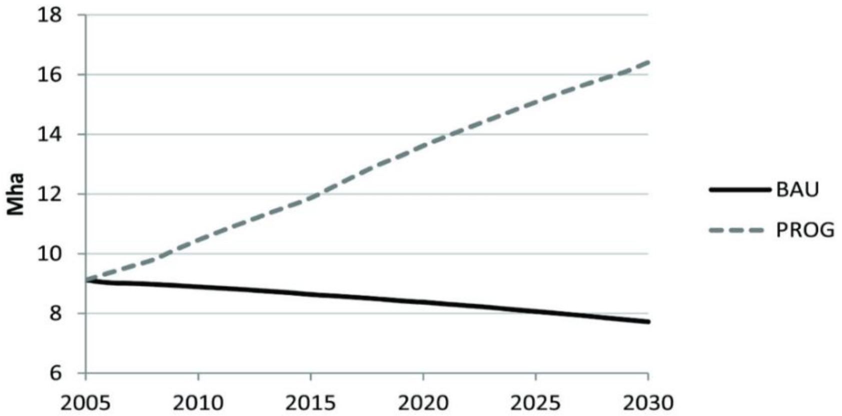
(1) Assessment of land availability for bioenergy crops (continued)

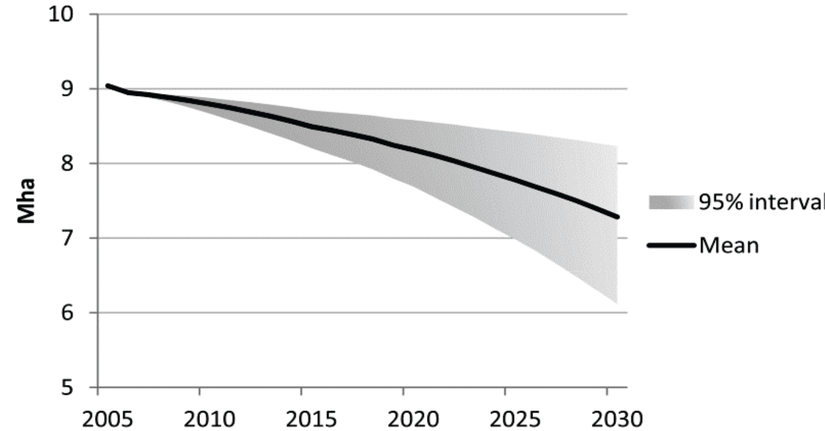
Land use dynamics up to 2030, BAU and Progressive scenarios

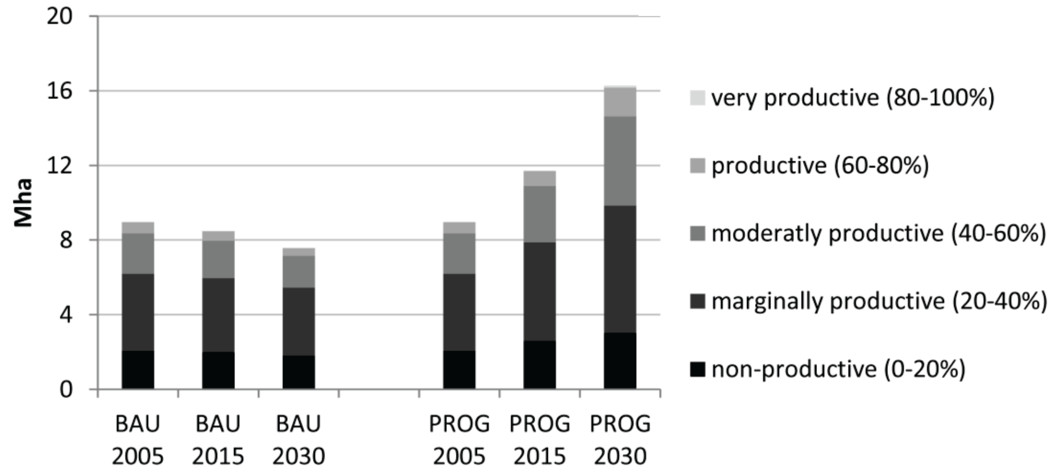


III. Results

(1) Assessment of land availability for bioenergy crops (continued)





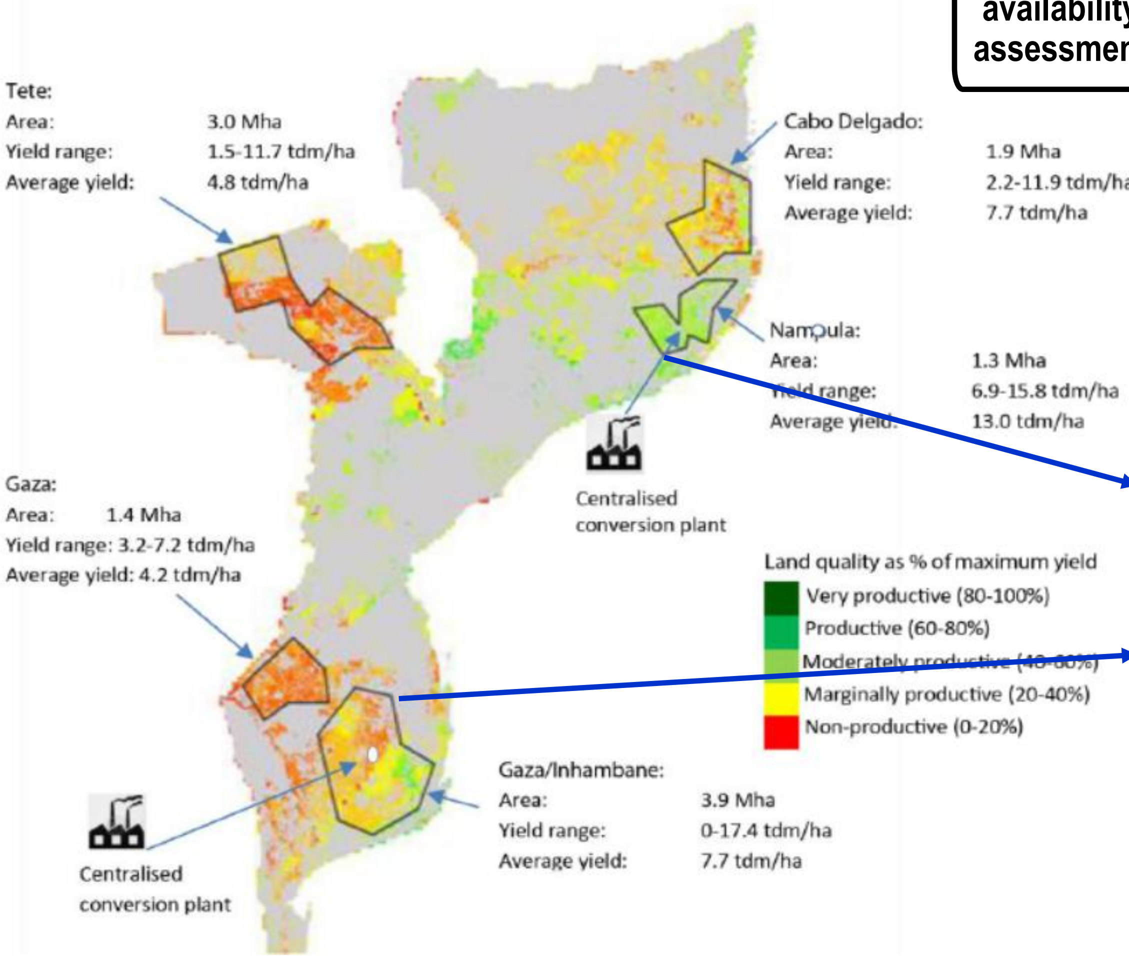


Development of land availability over time differentiated for suitability classes

III. Results

(2) Selection of studied regions

(1) Land availability assessment → (2) Selection of case studies → (3) ~ (6) Sustainable Feedstock Potential

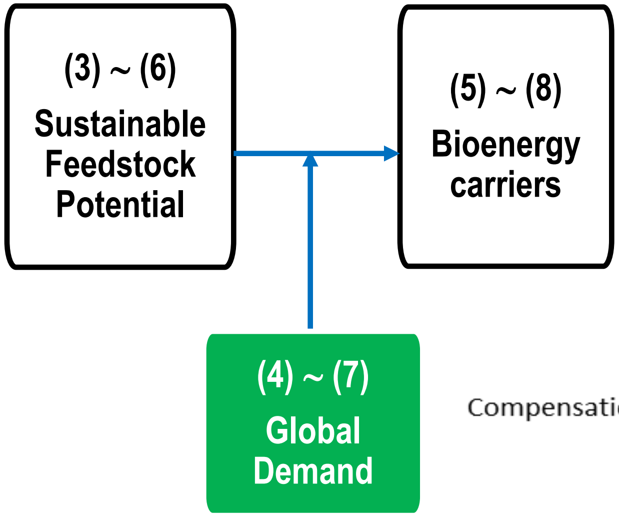


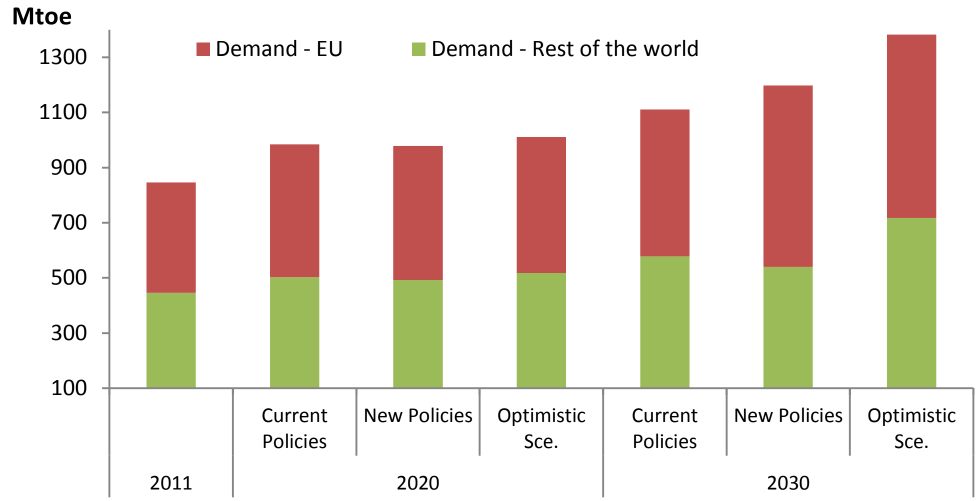
(3) Sustainable feedstock potential

	Gaza	Nampula
Total land (Mha)	9.18	7.88
Land quality	Marginal - moderate	Very productive
Land available (Mha)	**3.9**	**1.3**
Average land available	42.5 %	16.5 %
Biomass selection	Eucalyptus *Camaldulensis*	Switchgrass, Eucalyptus Grandis
Biomass yield (eucalyptus) Tdm/ha	2.7 – 17.4 Average 7.7	6.9 – 159.9 Average 13.0
Total production (MTdm)	**30.3**	**16.9**

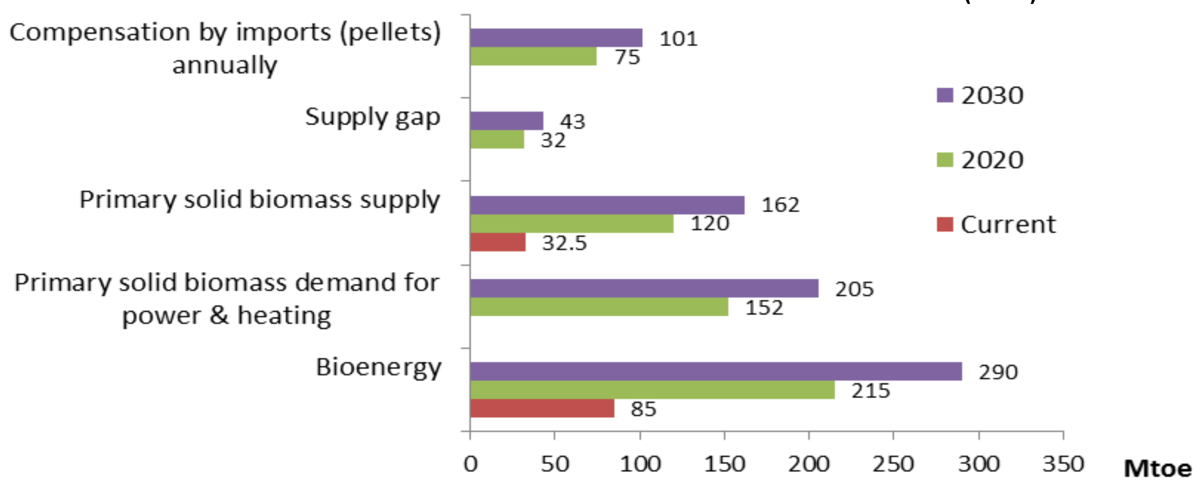
III. Results

(4) Global Demand





Calculation of Biomass Share of Renewable Energy Demand by Scenarios based on IEA data (2013)



Calculation of Biomass Supply and Demand in Europe based on Eurelectric data (2012)

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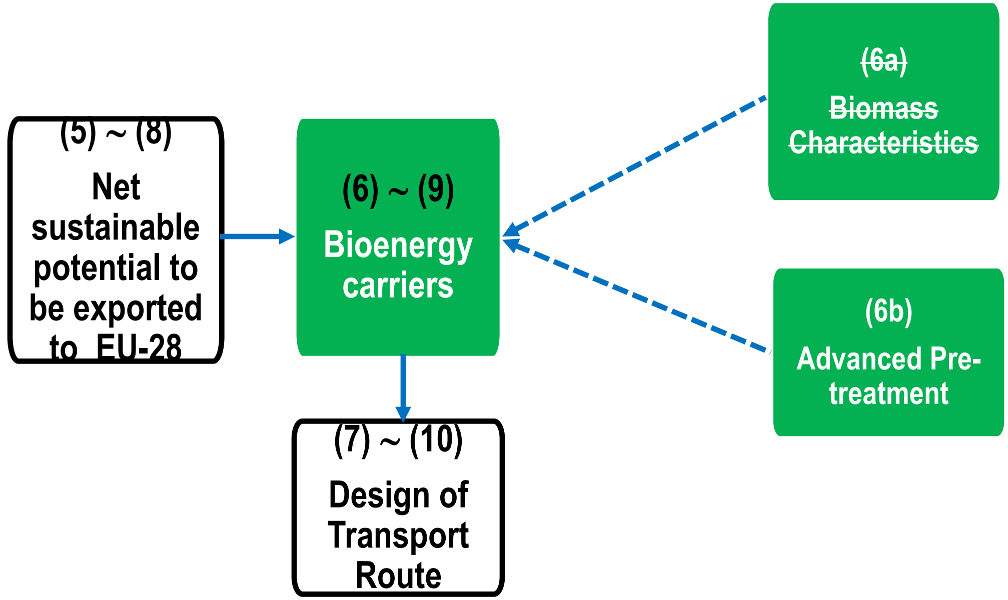
III. Results

(5) Bioenergy carriers

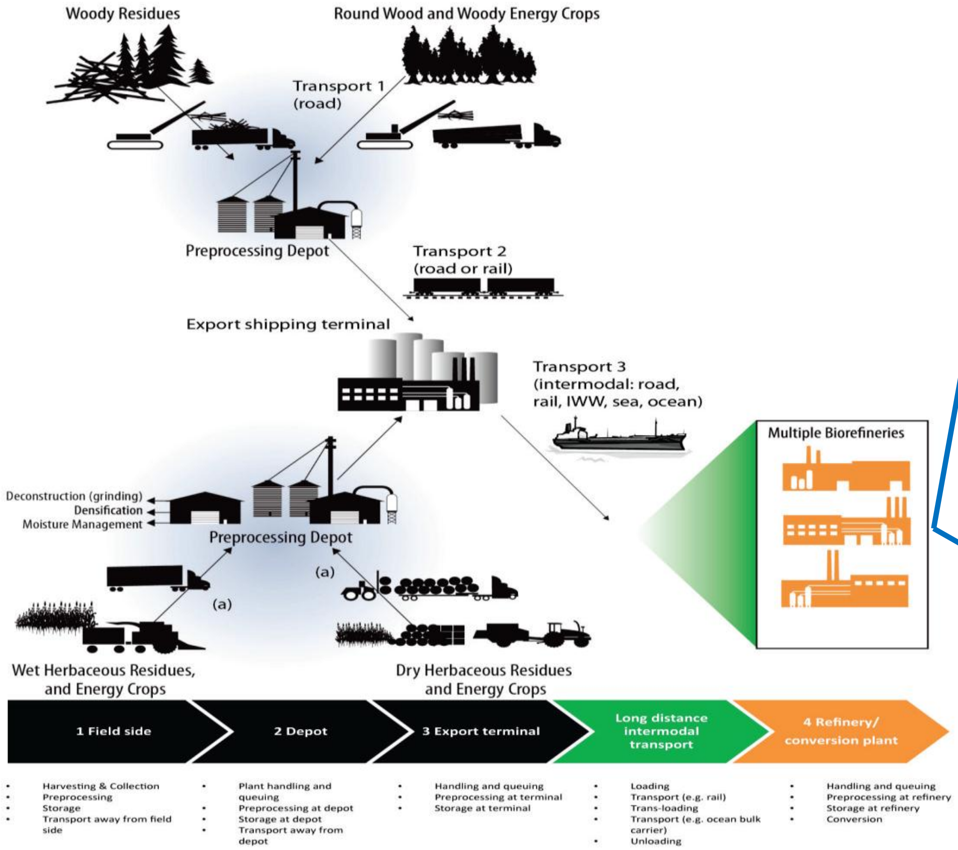


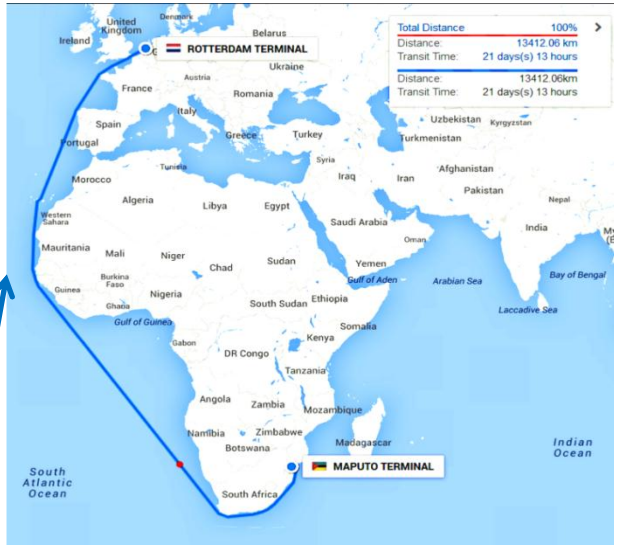
(5b) Advance pre-treatment

	Units	Wood pellets		Torrefied pellets	
		Most important traded biomass		Potentials to improve performance of supply chains	
		Eucalyptus	Switchgrass	Eucalyptus	Switchgrass
Wood input (wet basis – 30% mc)	T(wet)/ t (pellets)	1.72	1.46	1.34	1.07
Switchgrass (wet basis – 30% mc)	T (dry)/ t (pellets)	1.19	1.24	1.06	1.01

III. Results

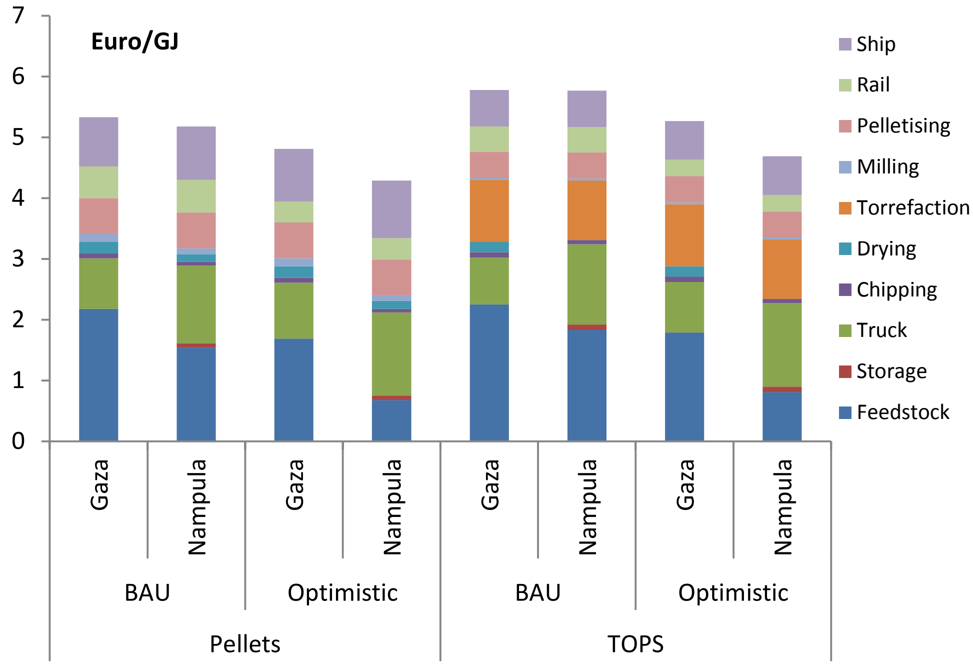
(6) Design of Transport routes

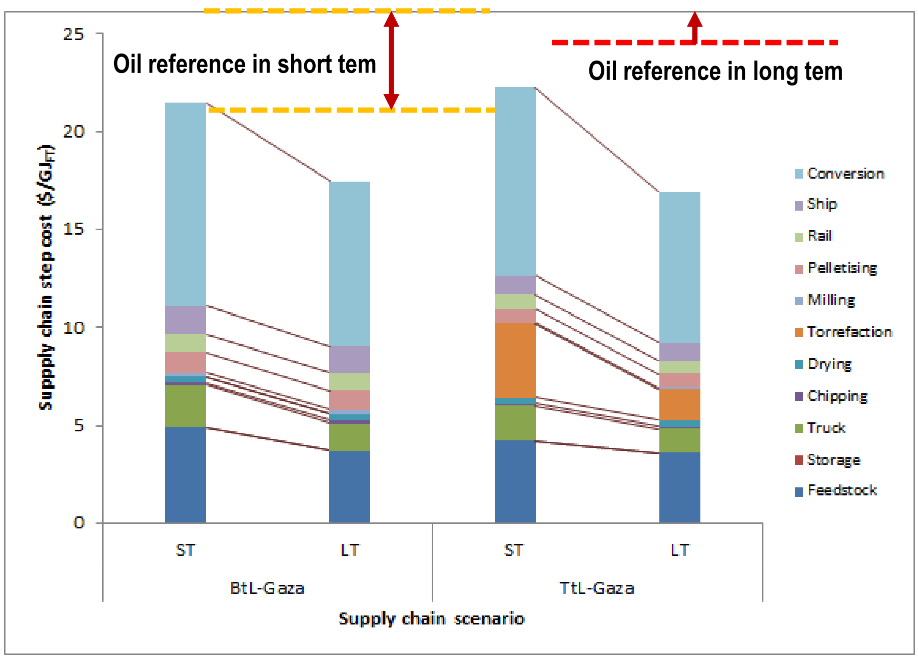




III. Results

(7) Demand – Supply Cost



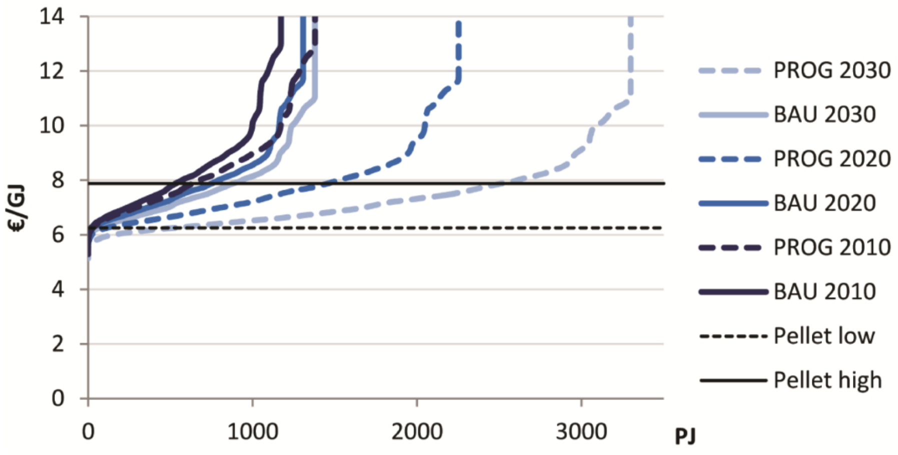


Supply chain cost from Mozambique to Rotterdam

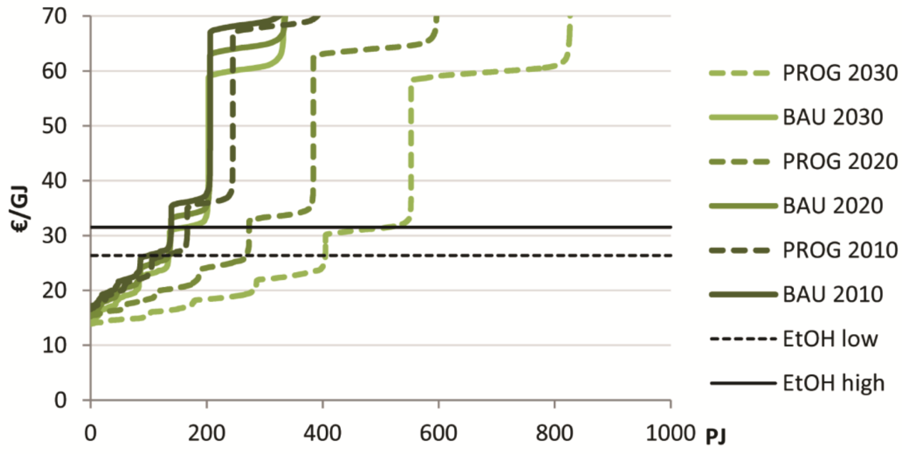
III. Results

(7) Demand – Supply Cost

Eucalyptus pellets



Sugar cane ethanol



Cost supply curves in timeframe 2010-2030 for 2 scenarios

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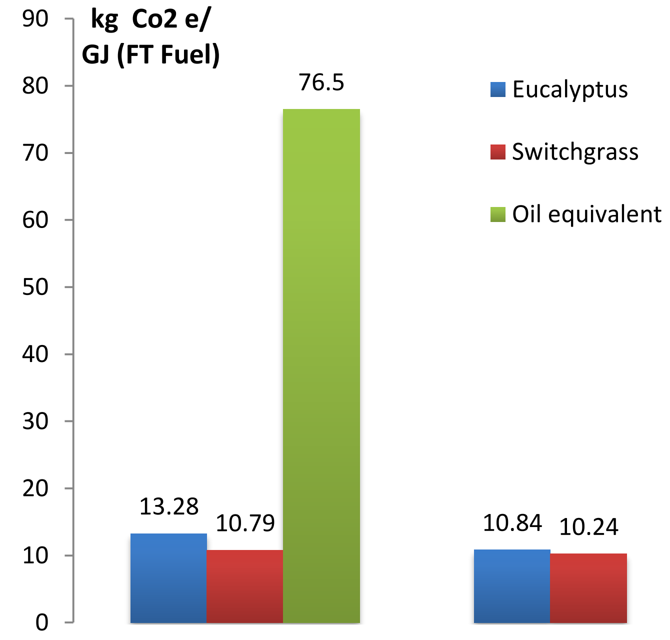
III. Results

(8) GHG emissions

Supply chain stage	WPs		TOPs	
	Eucalyptus	Switchgrass	Eucalyptus	Switchgrass
Feedstock production	6.65	3.48	6.21	3.39
- Fuel use at farm	0.69	0.89	0.65	0.87
- Fertiliser and pesticides emissions	5.96	2.58	5.56	2.52
First Truck transport	0.18	0.33	0.16	0.36
Chipping	0.002	0.002	0.002	0.001
Drying	0.005	0.002	0.003	-
Torrefaction	-	-	0.02	0.02
Milling	0.01	0.003	0.001	0.001
Pelletising	0.01	0.01	0.003	0.003
Second truck transport	0.70	0.72	0.55	0.55
Rail transport	0.30	0.31	0.24	0.24
International sea shipping	5.43	5.98	3.62	3.62
TOTAL (kg CO2e/GJ FT fuel)	**13.28**	**10.84**	**10.79**	**10.24**



GHG Emissions Balane for WPs and TOPs

1. Floor van der Hilst, Shades of Green (2012)
2. Bothwell Batidzirai, Design of Sustainable Biomass Value Chains (2013)

Kenya

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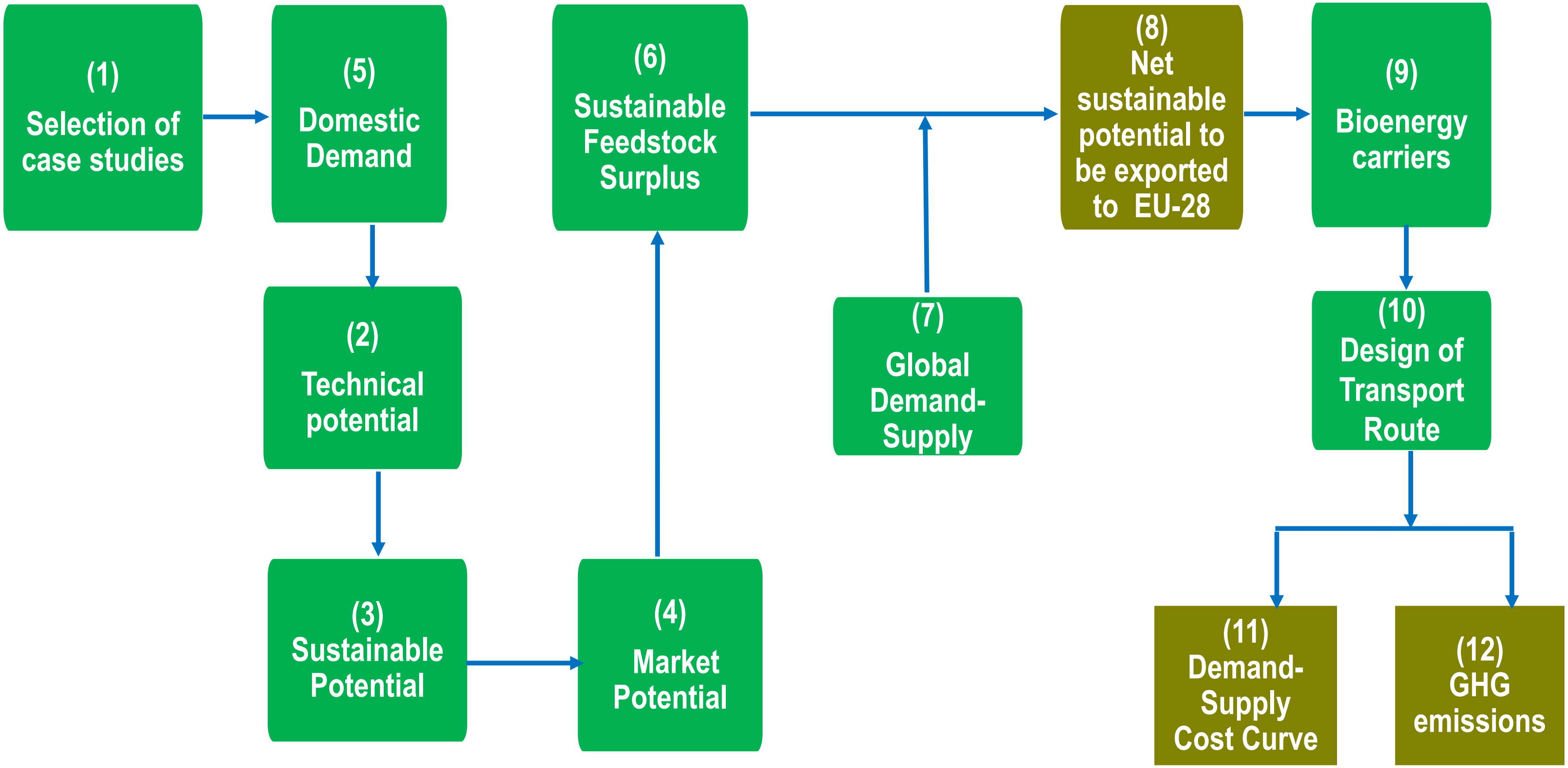
I. Methodology Outline, Kenya



II. Scenario approach

Scenarios	BAU			Optimistic		
Timeline	Current *	2020	2030	Current *	2020	2030

*: *Depending on data availability, current situation can be changed to previous year*

Aim	anticipate possible changes in local & global biomass market & trade at different time scales
Method	based on : - Data availability - Socio-economic development - Industrial development capacity - Policies on environment, climate and energy - Innovative pre-treatment technologies
Data requirements& data sources	- International & national databases (Faostat, National Statistics) - Field trip - Communication with local & international stakeholders
Expected outcomes	- BAU and Optimistic Scenarios for 3 timelines: Current, 2020 and 2030

III. Results

(1) Assessment of case study/ (5) Domestic Demand/ (2) Technical Potential

Method *(1) Review of national statistics*

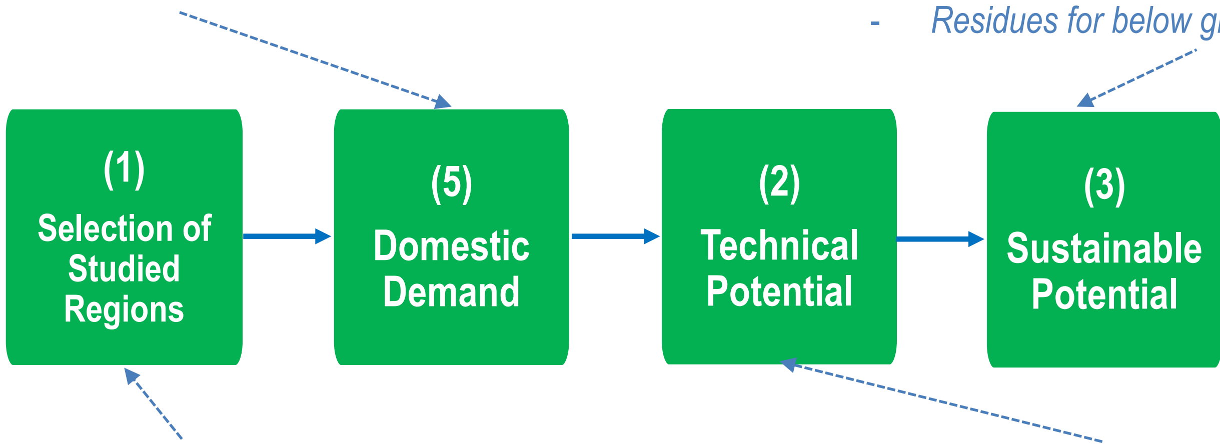
Data requirements *(1)*

- *Residues for feed*
- *Residues for household*

Method *(1) Practical calculation & application of sustainability criteria*

Data requirements *(2)*

- *Residues required for soil erosion control*
- *Residues required to maintain 2% SOC*
- *Residues for below ground biomass*



Method *(1) Review of national statistics*

Data requirements *(1)*

- *Productions in tonnes dry mass/county*
- *Areas (hectares)*
- *Yield (tonne/ha)*
- *Logistics consideration*

Method *(2) Practical calculation*

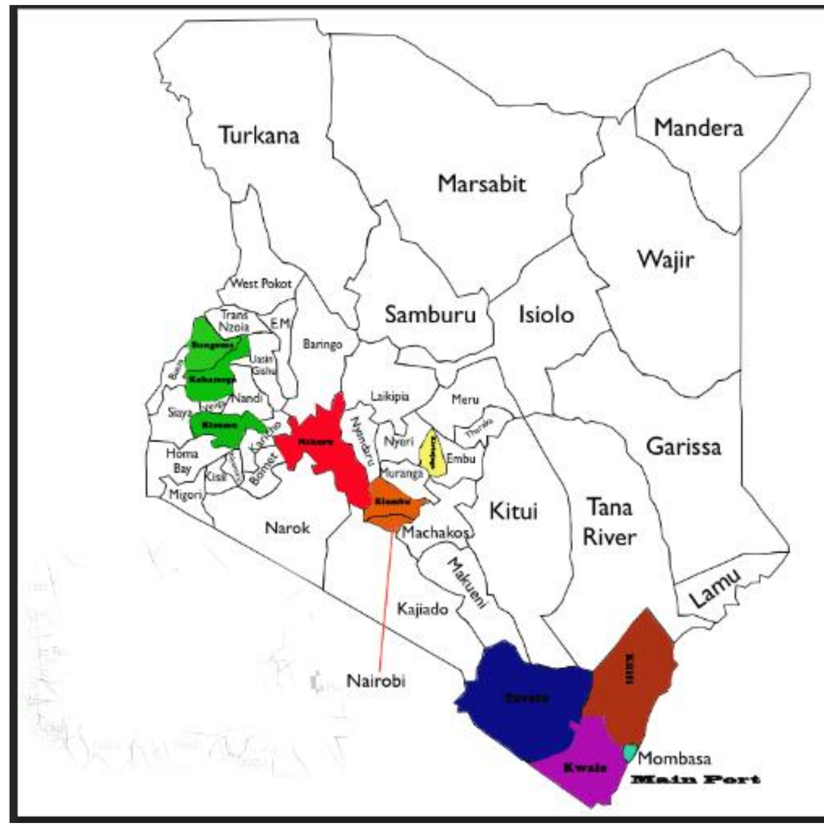
Data requirements *(2)*

- *Residues to product ratio (RPR)*
- *Low heating values (MJ/kg)*

III. Results

(1) Assessment of case study/ (5) Domestic Demand/ (2) Technical Potential/ (3) Sustainable Potential

Products	Production (Tdm)	Total residues (T)	Total residues (PJ)	Residues surplus (PJ/yr)
Agriculture				
Maize	3,766,159	16,062,669	216.85	**-0.82**
Sugar	5,822,633	2,416,393	32.62	**12.72**
Irish potatoes	2,915,067	1,049,424	14.17	**-2.36**
Mangoes	2,781,706	5,563,412	75.11	**-2.13**
Bananas	1,394,412	2,649,383	35.77	**-2.05**
Cassava	893,122	518,011	6.99	**-5.56**
Rice	126,399	311,574	4.21	**1.60**
Coffee	49,000	1,029,000	13.89	**(?)13.80**
Sisal	27,866	799,754	10.80	**10.79**
Coconut (shell&husk)	120,068	193,309	2.61	**2.60**



III. Results

(1) Assessment of case study/ (5) Domestic Demand/ (2) Technical Potential

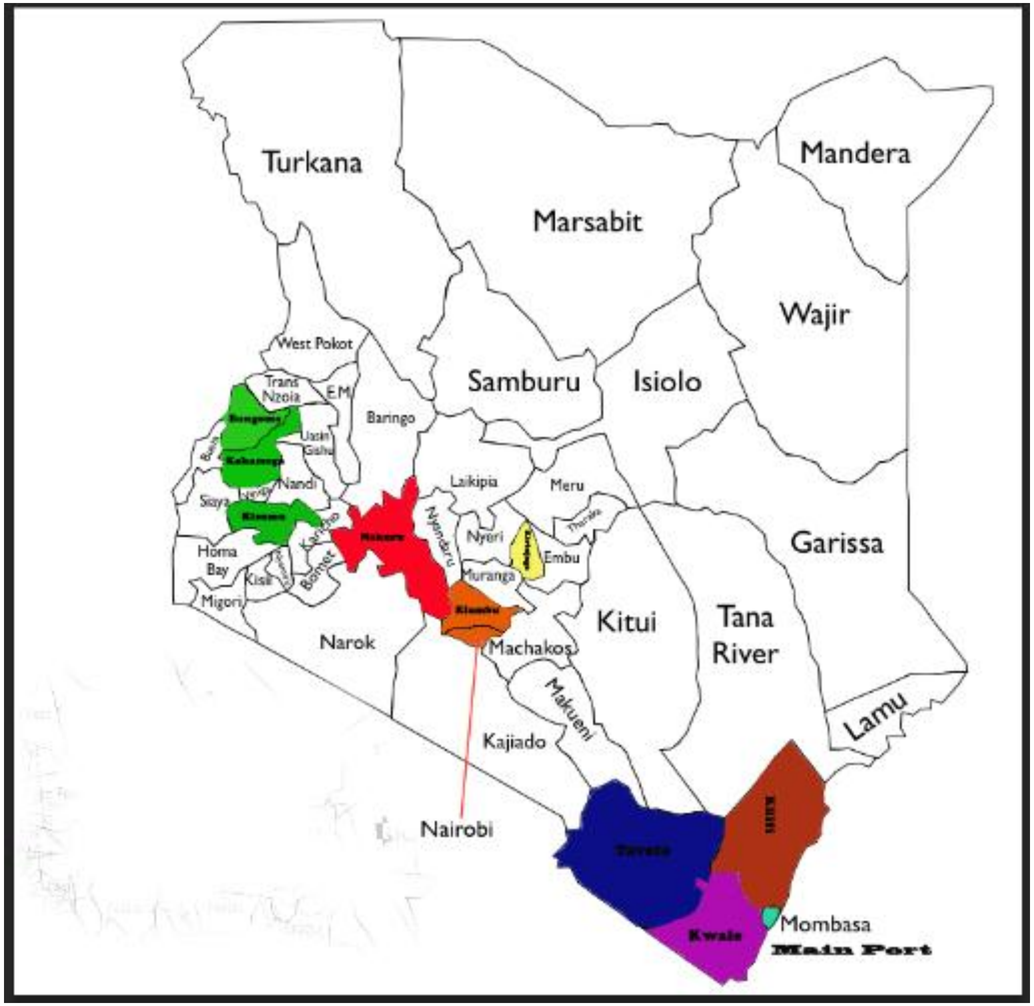
Type of Forest Land	Area in 1000*Hectares			
	1990	2000	2005	2010
Indigenous closed Canopy	1,240	1,190	1,165	1,140
Indigenous Mangroves	80	80	80	80
Open woodlands	2,150	2,100	2,075	2,050
Public Plantation Forests	170	134	119	107
Private Plantation Forests	68	78	83	90
Bush-land	24 800	24,635	24,570	24,510
Grasslands	10 730	10,485	10,350	10,350
Settlements	8 256	8,192	8,152	8,202
Farms with Trees	9 420	10,020	10,320	10,385

Forestry per County	Timber	Poles	Firewood	Charcoal	Total (m^3)	Local demand (m3)	Woody surplus (m3)
Baringo	386,667	127,659	524,117	282,217	1,320,659	600,031	720,628
Bomet	120,574	52,869	283,145	152,463	609,051	963,223	-354,172
…	…	…	…	…	…	…	…
Wajir	41,907	20,954	61,290	33,002	157,153	714,928	-557,775
West Pokot	256,643	93,760	580,112	312,368	1,242,883	553,729	689,154
Total national	7,358,446	3,029,655	13,639,884	7,344,553	31,372,538	41,700,667	**-10,328,129**

→ No land available for bioenergy crops

III. Results

(3) Sustainable potential *(continued)*



Sector		Net sustainable residues surplus (T/yr)
Agriculture		
Coconut		
	Husks	103,821
Sisal		
	Balls	229,506
	Bogas	0
Sugarcane		
	Molasses	0
	Straw and leaves	102,155
	Bagasses	
Rice		
	Straw	44,478
	Husk	35,211
Coffee		(to be further investigated)
		515,171
Forestry		
Primary residues		
Secondary residues & sawmill wastes		
	Sawdust	345,057
	Firewood	0
	Off-cuts	0
Tertiary forest waste & residues		
		345,057
Total		***860,229***

IV. Conclusion & Recommendations

Mozambique	Kenya

A. Conclusion

Methodological approach different

Mozambique	Kenya
1. More time consuming and more data intensive	1. Simpler approach and easier to implement
2. Results are more comprehensive	2. Results are rougher and more uncertain

B. Further work

Mozambique	Kenya
Additional study on sustainable residue potentials in agriculture & forestry sector (with future improved yield)	Continue with the supply chain management: 1. GHG emission calculation 2. Future scenarios

Thank You!

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