Conferência Internacional
Energia Sustentável na Guiné-Bissau
Guinea Bissau Sustainable Energy International Conference
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Estudo de Base sobre o Potencial de Produção de Eletricidade a partir da Biomassa na Guiné-Bissau

Desenvolvido no âmbito do Projeto GEF "Promoção de Investimentos em Energias Renováveis no Sector Elétrico da Guiné-Bissau"

Gentjan Sema

Consultant, Department of Energy

UNIDO

The main objectives of the baseline study & project pipeline:

- ✓ **Determining the potential of bioenergy for the production of electricity in agro-industries and for rural electrification purposes in Guinea Bissau;**

- ✓ **Assessing the current status of the bioelectricity projects of SICAJU in Bissau, SAFIM in Safim, and LICAJU in Bolama; including an analysis of technical and non-technical problems, means and costs of revitalization or finalization of the projects, and documentation of lessons learned;**

- ✓ **Providing a pipeline of bioelectricity projects, including and provide basic technical and financial key indicators.**

Presentation Overview

1. Overview of biomass electricity production technologies
2. Biomass Resources in Guinea-Bissau
3. Technical potential for biomass electricity in Guinea-Bissau)
3. Economics and competitiveness of biomass electricity in Guinea Bissau Biomass electricity production costs
4. Analysis of two selected biomass electricity projects in Guinea Bissau
5. Barriers for the introduction of biomass electricity technologies
6. Recommendations and lessons learned

Overview biomass electricity production technologies

Steam turbine/alternator, Sicaju

Cashew nut shell combustion plant, Guinea-Bissau

25 kW rice husk gasifier in Indonesia

400 kWe ORC unit in Admont (Austria)

Electricity production and shell consumption for different conversion routes

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Guinea Bissau Sustainable Energy

	Unit	Steam engine [a]		Steam turbine [b]	
Net output	kWe	50	200	50	200
Net efficiency	%	5%	5%	3%	6%
Electricity production [c]	MWh/a	135	540	135	540
Annual shell consumption [d]	t/a	442	1767	690	1473
Specific shell consumption [d]	kg/kWh	3.3	3.3	5.1	2.7
Annual shell consumption [e]	t/a	512	2046	799	1705
Specific shell consumption [e]	kg/kWh	3.8	3.8	5.9	3.2

Electricity production and shell consumption for different conversion routes

Notes: [a]based on Benecke boiler / steam engine (16/1.2 bar(a) steam pressures)

[b] back pressure turbine (17/1 bar(a) steam pressures)

[c] based on 3600 h/a operation at 75% capacity

[d] steam cooked shell [e] oil cooked shell

Biomass resources in Guinea Bissau - I

Cashew apple

Cashew nut shell

Rice husk, AGROGEBA

Bagasse at Barros distillery, Bissau

Biomass resources in Guinea Bissau - II

Palm kernel

Ground nut shell

Cashew nut shell liquid (CNSL)

Livestock rearing (dung production)

Biomass resources in Guinea Bissau - III

Primary product	Production (t/a)	By-product	Production (t/a)	Typical scale (t/a)
Raw cashew nut	180,000	Cashew apple	**504,000**	small
	processed 6,000	Cashew nut shell	3,675	200-2,000
		CNSL	750	<300
Rice	gross 200,000	Rice husk	26,400	<300
	net 120,000	Rice straw	**120,000**	small
Palm fruit	80,000	Solid wastes	44,000	small
		Palm waste water	80,000	small
		Palm kernel shell	30,000	small
Peanut	46,000	Shell	22,080	small
		Straw	**105,800**	Small
Aguardente	2,750	Bagasse	30,000	1,500
		Cane trash	5,000	250
		Vinasse	15,000	750
Cattle (heads)	1,600,000	Dung	**1,176,000**	<1,000
Logging / sawmilling (m^3)	6,400	Forest residues	4,103	200-1,400
		Wood chips	4,014	200-1,400
		Sawdust	1,338	100-500

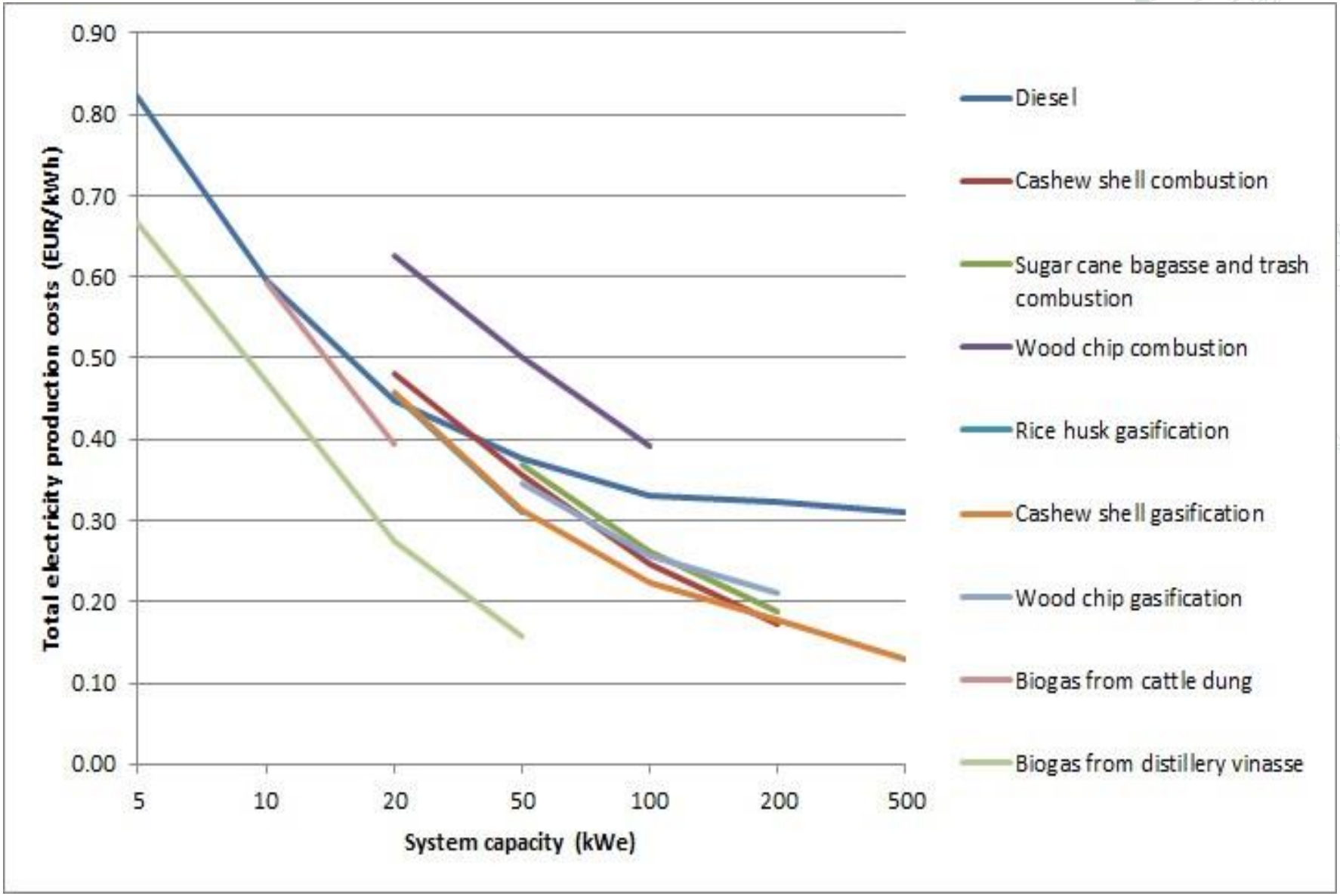
Theoretical & immediate biomass electricity production potentials

	Theoretical potential	Immediate potential		Scale range
	(GWh/a)	(GWh/a)	(MWe)	(kWe)
Cashew shell combustion	1.1	1.1	0.43	20-200
Sugar cane bagasse and trash combustion	5.1	5.1	1.87	50-200
Wood chip combustion	0.7	0.7	0.28	20-100
Rice husk gasification	14.7	0.2	0.08	20-50
Cashew shell gasification	2.4	1.4	0.50	20-500
Wood chip gasification	2.3	2.3	0.90	50-200
Biogas from cattle dung	49.0	1.5	0.97	10-20
Biogas from distillery vinasse	0.3	0.3	0.12	5-20
Cashew nut shell liquid	2.7	-	-	-
Rice straw combustion	48.0	-	-	-
Palm kernel shell gasification	22.5	-	-	-
Groundnut shell gasification	6.2	-	-	-
Biogas from palm oil waste water	3.3	-	-	-
Biogas from cashew apple	41.0	-	-	-
Total	197.5	10.8	4.44	5-500

Economics and competitiveness of biomass electricity - production costs

	Scale range (kWe)	Investment (EUR/kW)	Capital costs (EUR/kWh)	O&M costs (EUR/kWh)	Total costs (EUR/kWh)
Cashew shell combustion	20-200	6500-2500	0.12-0.32	0.05-0.16	0.17-0.48
Bagasse / trash combustion	50-200	5000-2500	0.12-0.24	0.07-0.13	0.19-0.37
Wood chip combustion	20-100	6500-3500	0.17-0.32	0.22-0.31	0.39-0.62
Rice husk gasification	20-50	4000-3000	0.22-0.29	0.10-0.17	0.31-0.45
Cashew shell gasification	20-500	4000-1500	0.09-0.29	0.04-0.17	0.13-0.46
Wood chip gasification	50-200	3000-2000	0.12-0.22	0.09-0.13	0.31-0.35
Biogas from cattle dung	10-20	3500-2500	0.18-0.32	0.21-0.28	0.40-0.59
Biogas from distillery vinasse	5-50	4500-1500	0.11-0.41	0.05-0.26	0.16-0.67
Diesel	5-500	1800-250	0.02-0.16	0.29-0.66	0.31-0.82

Cost comparisons



Existing biomass electricity projects
SAFIM (11°57'10.860"N 15°38'53.482"W)

Plant description

- Conceived by FUNDEI in 2007 and from UEMOA, and tested in 2012/2013
- Steam turbine plant of Indian make - 82 kVA
- Start-up diesel genset (12kW/15kVA) and Caterpillar backup diesel genset (150kVA)
- Net power plant output is approx. 42 kWe (58 kVA) – ***net plant efficiency is 3.1***
- *Cashew shell consumption 201 kg/h (4.8 t/d) - 1,408 t/a*


SAFIM power plant


SAFIM biomass boiler


SAFIM steam turbine

SAFIM (11°57'10.860"N 15°38'53.482"W)

Current status and challenges

- The power plant was started up and tested in 2013
- Technical problems with operation of the boiler on cashew shell – CNSL
- Grid access: AGROSAFIM holds the concession to supplying electricity in Safim
- Safim placed in the wrong area (no local biomass production, no electricity supply concession, in a residential area) and use of improper technology (low efficient steam turbine, improper combustion system).


SAFIM power plant


SAFIM biomass boiler


SAFIM steam turbine

SICAJU (Bissau)
(11°52'16.836"N 15°38'27.487"W)

Plant description

- 2007, under a World Bank credit scheme (PRDSP project)
- Steam engine (Benecke, type MVB-070) - **70 kWe** / 85 kVA
- Biomass boiler (Benecke, rated at 1.5 t/h at 12.4 kgf/cm^2)
- Net plant output is **56 kWe** (70kVA), and net plant efficiency is approx. **5.0%**


SICAJU power plant


SICAJU biomass boiler


SICAJU alternator

SICAJU (Bissau)
(11°52'16.836"N 15°38'27.487"W)

Current status and challenges

- The plant functioned well for about 2 years producing electricity and process steam for the SICAJU cashew factory - some 50% of its capacity
- The plant equipment in good condition, but the steam engine does not function anymore
- TA Benecke mission estimated cost 15,000 EUR


SICAJU power plant


SICAJU biomass boiler


SICAJU alternator

Barriers for introduction of biomass electricity technologies

- Dispersed and small scale production of biomass resources
- Irregularity of biomass supply
- Limited project development skills
- Limited access to technology and servicing
- Deteriorated electricity transmission and distribution systems
- Low awareness
- High investment costs / difficult access to funding
- Absence of effective institutional frameworks

Recommendations and lessons learned

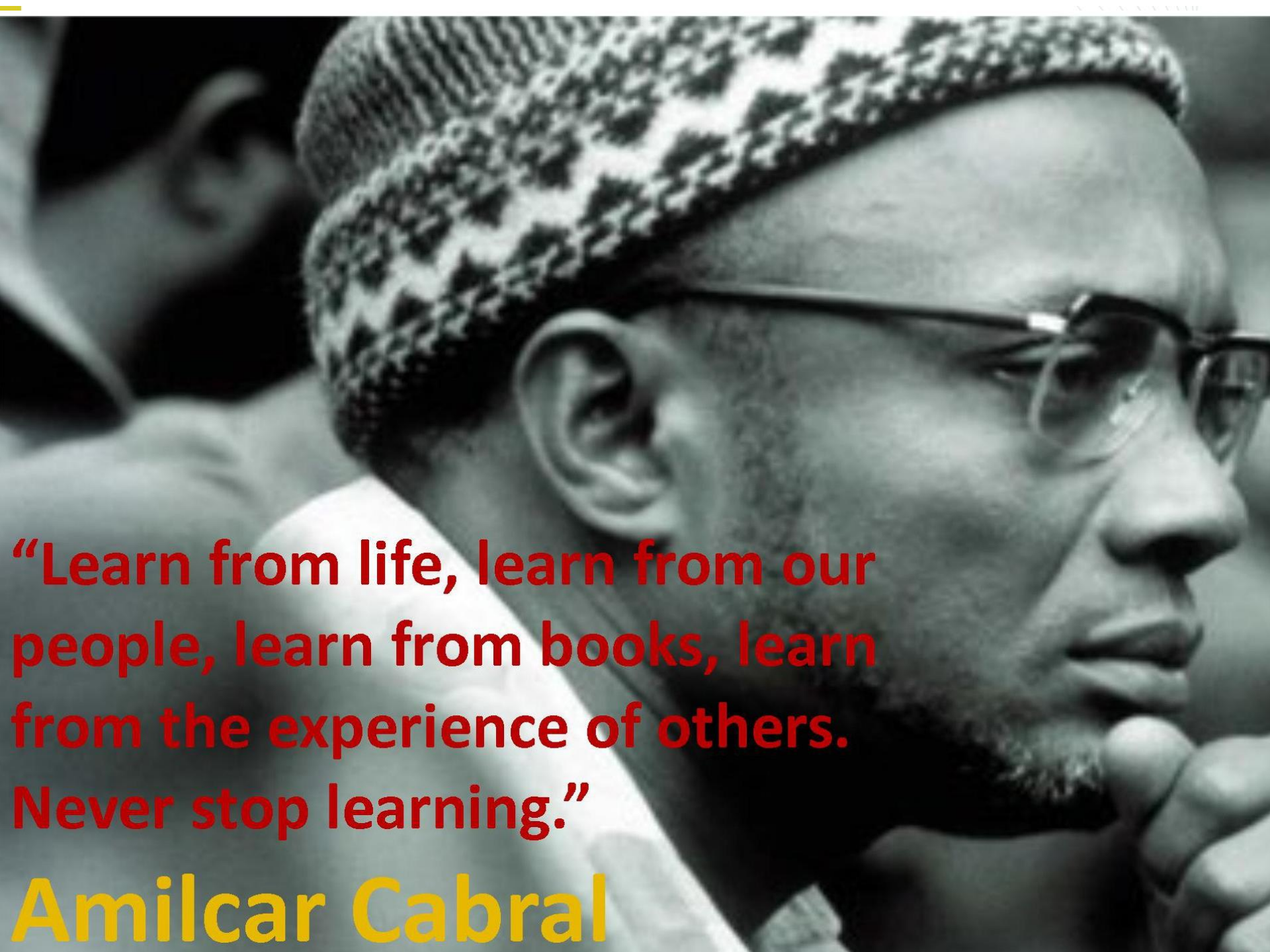
Project development: limited knowledge and experience

Proper plant scaling and technology selection: realistic assessment of proper plant scale and production costs

Selection of plant location: energy demand, fuel logistics, energy supply infrastructure and legal framework

Plant servicing: supplier warranty, technical trainings (including trouble shooting and problem resolving)

Owner commitment: a clear personal stake of the project owner should be secured


“Learn from life, learn from our people, learn from books, learn from the experience of others. Never stop learning.”
Amilcar Cabral

Gentjan Sema
g.sema@unido.org