Wood waste to energy : Economic feasibility and market potential of briquettes

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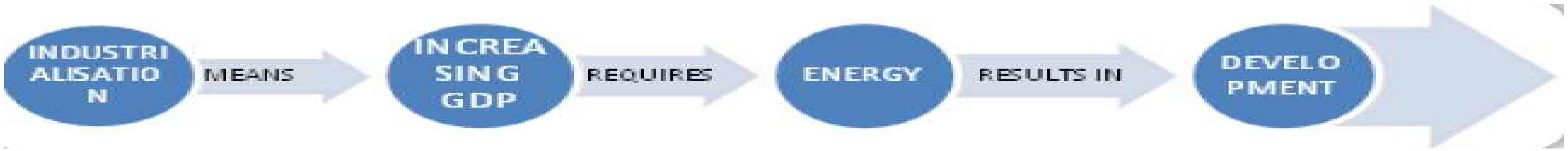
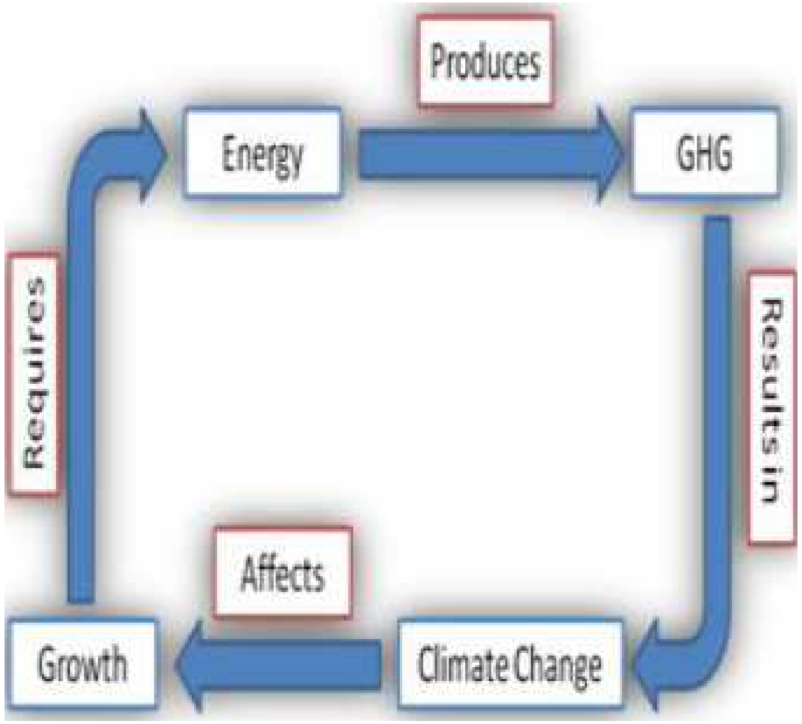
NEED FOR ENERGY??



Lateral relation between growth and Energy

- Sustainable development and industrialisation
  - Health security (emissions from fossil fuels, indoor air pollution from traditional biomass fuels)
  - Environmental security (climate change due GHG)
  - Economic security (volatile fossil fuel market)
- Emission trading
  - CO_2 markets
- Independence in energy supply



Growth, energy needs and GHG emissions are interdependent

BIOMASS; A POTENTIAL ENERGY SOURCE

- Biomass is one of the most common and easily accessible renewable energy resources.

- According to IRENA, global biomass supply could reach 95-145 EJ in 2030, with 65-108 EJ coming from residues, waste and forestry products.

- In a study by Kemausuor et. at., (2014),
  - maximum technical potential of bioenergy from biomass (crop residues, wood residues, animal manure, municipal solid wastes and municipal liquid waste) in Ghana is approximately 2,700M m^3 of biogas, equivalent to 97 PJ of heat energy, or 2,300M L cellulosic ethanol, equivalent to 52 PJ of liquid fuel energy.

Municipal waste

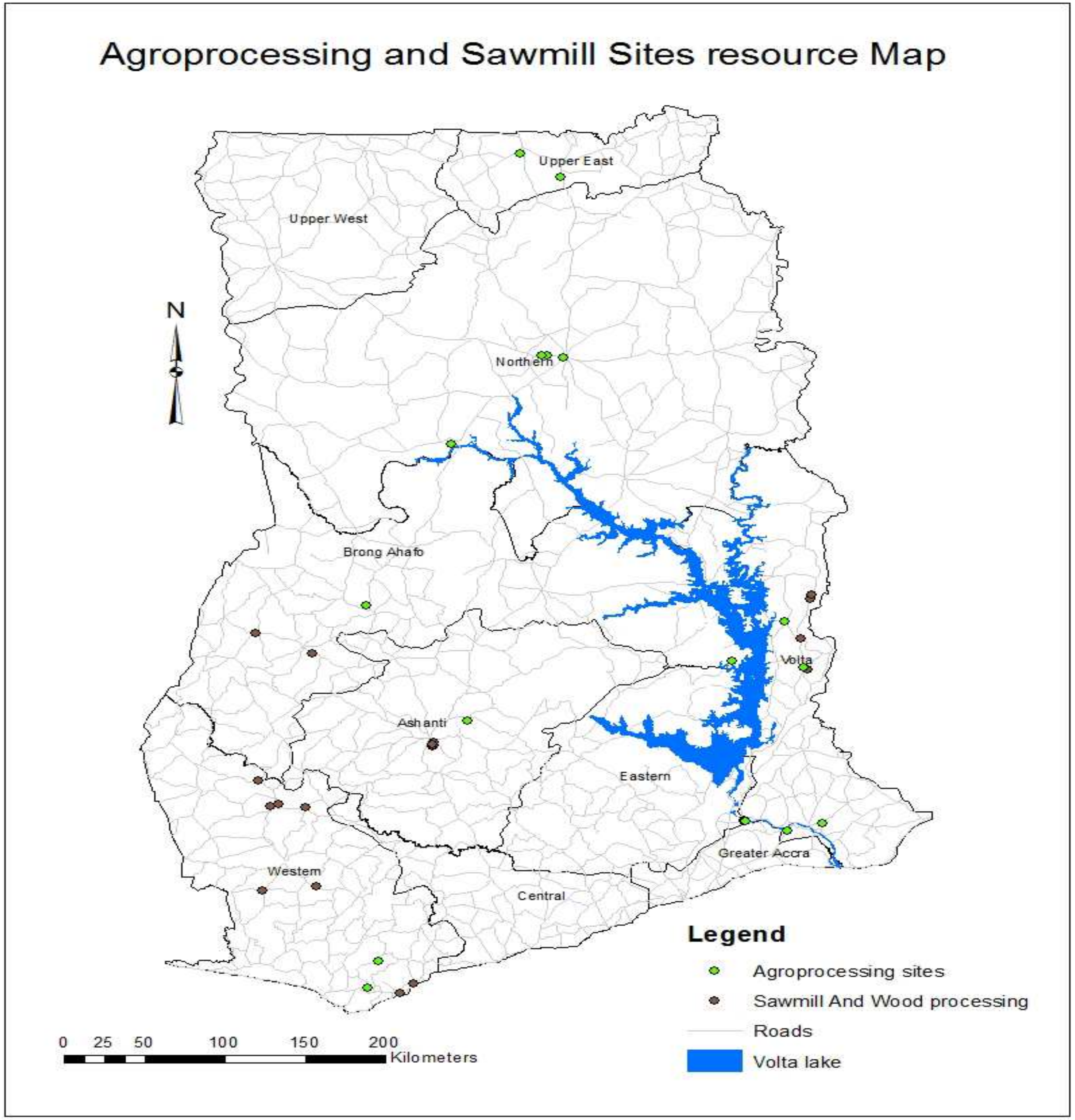
Wood waste- slabs

TYPES OF BIOMASS

Rice husk

wood waste -sawdust

Empty fruit bunches



Map used with permission from Ministry of Energy and Petroleum

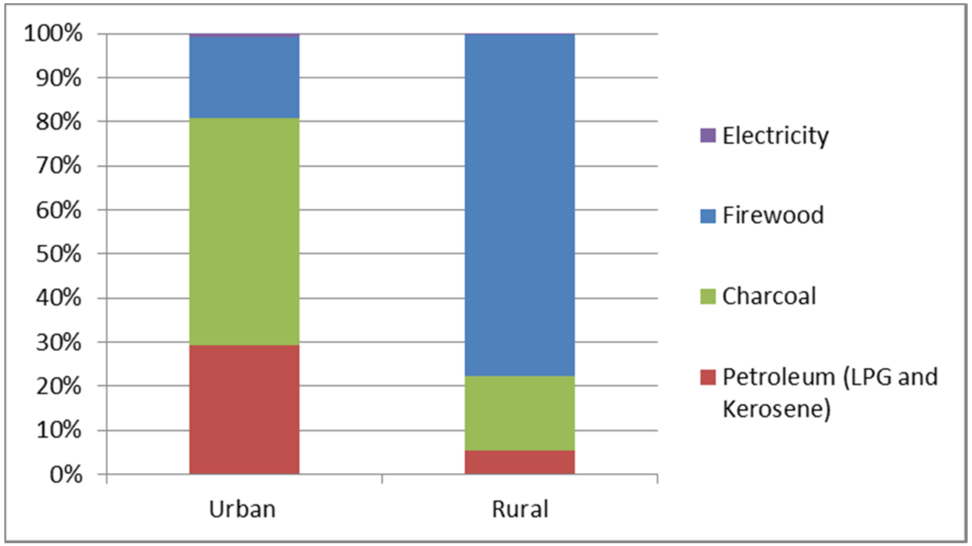
Few selected sites with best cogeneration potential

SITE	Type of biomass waste	Quantity T or M^3/day	Use	Disposal cost/week (GHS)
Sokoban wood village	Sawdust	150 t/day	Burnt	125 - 250
Buadac Enterprise	Sawdust	206 m^3/day	Burnt	150
Volta Forest Products	Sawdust	312 m^3/day	Fuel for boiler	N/A
Samatex Company Limited	Sawdust	504 t/day	Fuel for boiler	N/A
Ghana Rubber Estates Limited	Overaged plants	411 t/day	Firewood traders & carpenters	
Produce buying company, Buipe	Sheabutter cake	45 t/day	None	
Wetta irrigation project	Rice husk	25.7 t/day	Burnt on the field	
Juaben Oil Mills	Empty fruit Bunches, shells	41 t/day	Fuel for boiler	

Data used with permission from Ministry of Energy and Petroleum

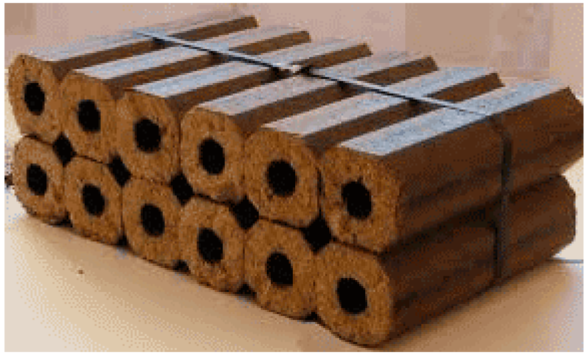
BIOMASS USES

- Biomass is the main cooking fuel source for about 2.6 billion people in developing countries (REN21, 2013).
  - Traditional biomass contributed close to 70% and is the cooking fuel source for 49% of the population in developing countries.
  - In Ghana, 74% of the total national energy consumption is accounted for by biomass (firewood and charcoal) (GSS, 2010).



Primary and leading source of cooking energy in Ghana for rural and urban (GSS, 2010)

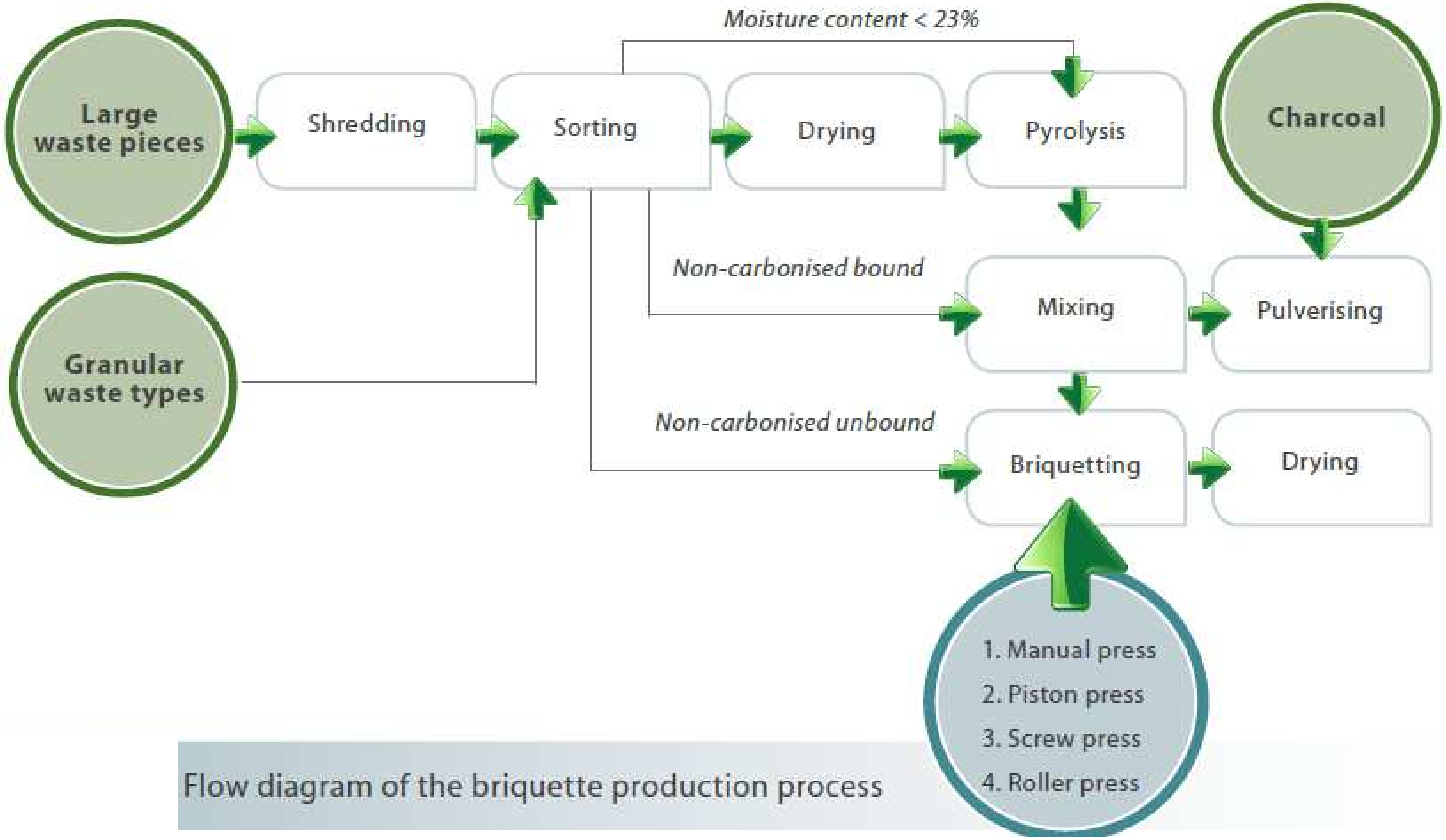
BIOMASS BRIQUETTING



- Inefficiencies associated with the use of biomass in traditional forms, as well as associated harmful environmental, health and social effects requires efforts to search for better application of biomass globally.

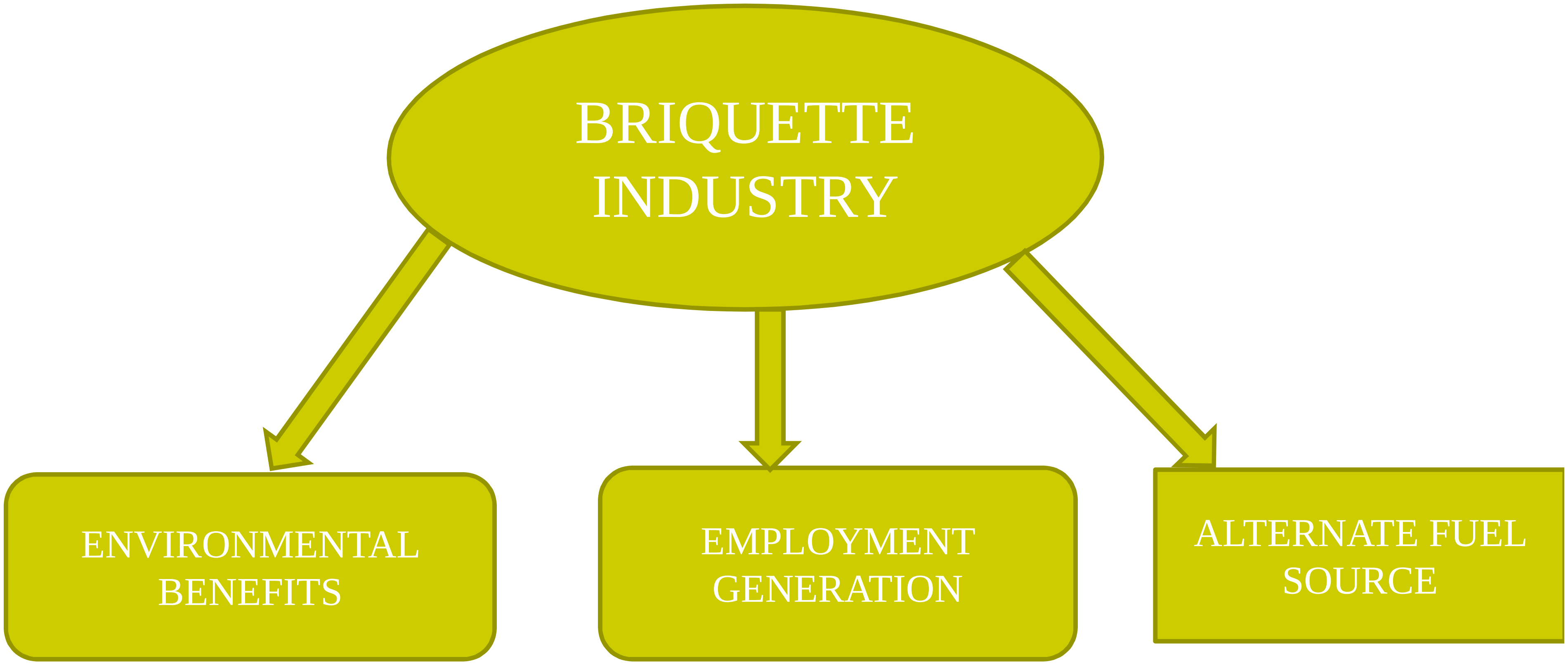
- Drawback overcome by **briquetting**: it helps improve
  - the physical and chemical properties, and
  - heat capacity of biomass materials by about 60%.

BRIQUETTE PROCESSING



Flow diagram of the briquette production process

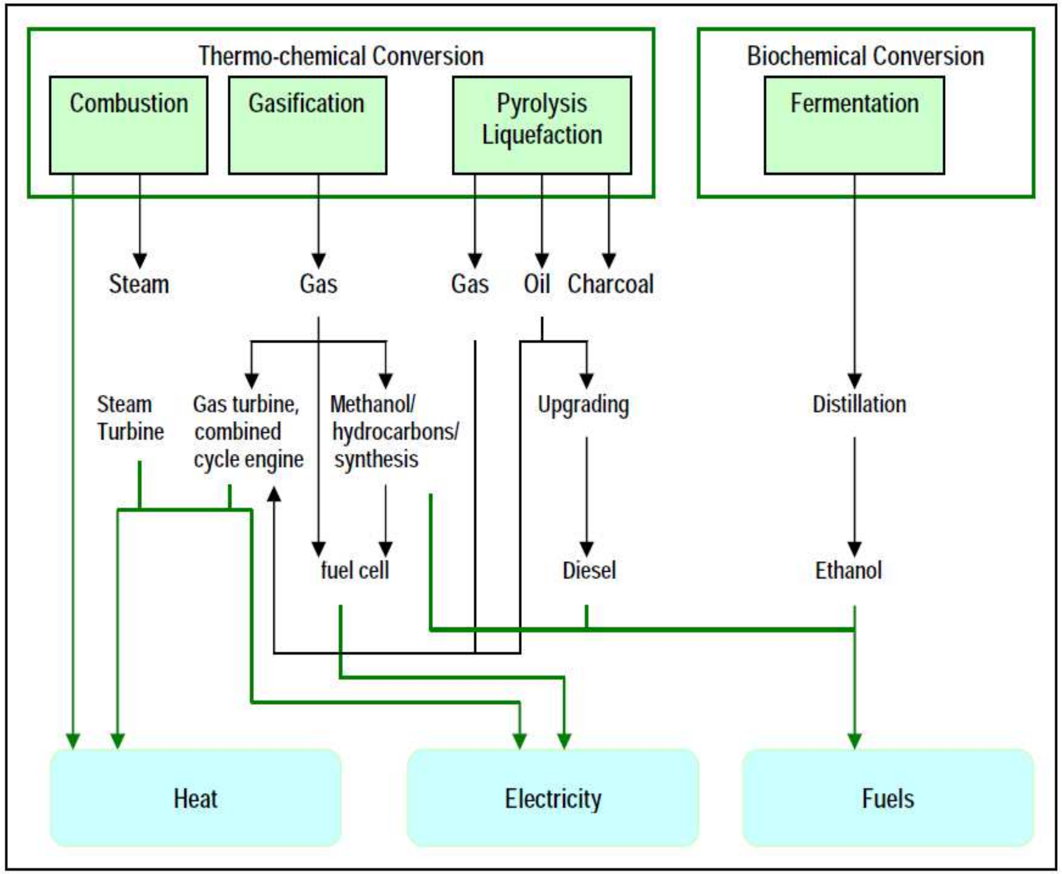
POTENTIAL OF A BRIQUETTING INDUSTRY IN GHANA



Alternative fuel source for energy production

Fuel type - Briquette	Heat value (MJ/kg)
Charcoal dust	16.86
Sawdust	20.17
Groundnut shells	19.87
Rice husk	15.48
Cocoa bean shells	30.73

Conversion routes for briquettes to energy



- Unmet electricity demand in 2013 was between 240–330 MW thermal plant equivalent (EC, 2014).
- If 60% of all available biomass waste is converted to fuel briquette it can generate 241 GJ (67MWh) of energy per year.
- On the low side, this is about 20% of average energy shortfall of the country in 2013.

Environmental benefits

- Biomass in its natural form contain high proportions of sulphur and nitrogen.
  - During combustion, it may lead to production of atmospheric pollutants (NO_x, SO_x) which pollutes the atmosphere.

- However, briquettes contain little or no sulphur and nitrogen. According to Akowuah et. al., (2012), briquettes of agro residues (groundnut, rice husk, coconut shell), sawdust and charcoal dust had low values for both sulphur and nitrogen.

- Using briquettes, limit the dependency on cutting wood for firewood or charcoal production, thereby reducing deforestation.

Employment potential of briquette industry

- The potential in terms of employment generation can be calculated by assessing the availability of biomass for briquette
- According to Kemausuor et. al., (2014), available biomass residues (crop and forestry residues) in 2011 was 19,934,000 tonnes.
  - Assuming 60% were available for briquetting, this amounts to 11,960,400 tonnes of raw material.
  - Assuming a briquette plant capacity of 1t/h
  - For 8h per day and 30 days in a month, there can be 6,645 briquetting plants across the country. This could generate **26,580** direct jobs, assuming 4 persons per plant.

Briquette Business Case

- The business case is developed for a briquette plant with 1t/h production capacity.

- **Economic analysis**

Economic indicators used for the analysis were:

- Net Present Value (NPV)
- Benefit Cost Ratio (BCR)
- Internal Rate of Returns (IRR)
- Payback Period

Assumptions

Average production per year (tonnes)	950
Replacement cost is the same along the lifetime of the project	
Plant life expectancy (year)	10
Raw material cost	0
Average machine capacity (t/h)	1
Annual use (h)	1,000
Total amount of briquette produced per year	1,000
Fuel consumption (kWh/tonne)	50
Oil and lubrication charges (% of fuel cost)	2
Losses during storage (%)	5
Amount of wood waste per hour to produce 1 tonne briquette (tonnes)	1.8
Average working hours per day (hr)	8
Total amount of wood waste per day (tonnes)	14.4
Total amount of residues required per year (tonnes)	1,800
Transportation cost per tonne per km (GHS) ($)	3.0 (0.94)

Values of different hands for economic analysis

Serial No.	Head (unit)	Value	
		(GHS)	($)
1	Initial cost of machine	100,000	31,250
2	Life (yr)	10	
3	Annual use (h)	1000	
4	Total fixed cost	133,850	41, 828
5	Variable costs	70,381	21,994
6	Total cost per year	204,231	63,822
Revenue (GHS), ($)			
1	Returns from 950 tonnes briquette @ GHS 350 ($ 109) per tonne	332,500	103,906
2	Total revenue per year	332,500	103,906
3	Total cost per year	204,231	63,822
4	Net profit per year	128,268	40,084
5	Payback period	11 months	

$1 = GHS3.2

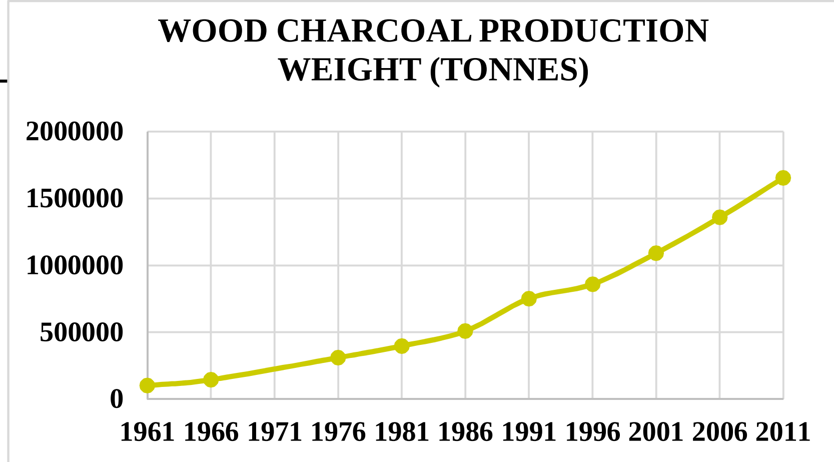
Financial feasibility of the project

Year	0	2	4	6	8	10
Discounted factor	1	0.80	0.64	0.43	0.33	0.25
Discounted Revenue ($)	0	82,833	66,034	44,921	33,967	25,683
Discounted cost ($)	63,822	17,533	13,978	11,265	8,518	6,440
Discounted Net cash flow ($)	- 63,822	65,300	52,056	33,656	25,449	19,243
Net Present value (NPV) ($)	-63,822	74,613	184,973	226,736	281,451	322,824
Internal Rate of Returns (IRR)	-	74%	92%	113%	114%	115%
Benefit cost ratio (BCR)	-	1.74	2.42	2.78	3.01	3.16

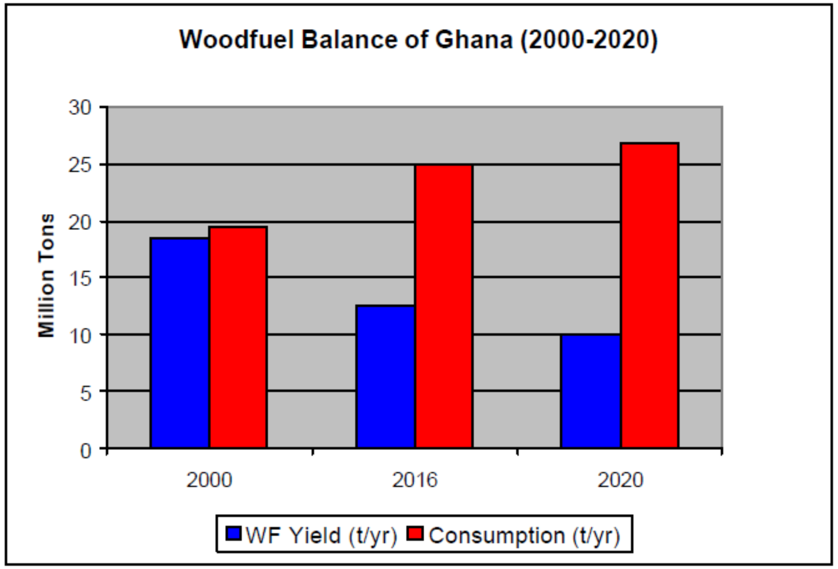
The calculation was done at a discount factor of 12%

Market potential of briquette

- Most briquette types are cheaper (per kilogram) when compared with other forms of energy (EEP 2013)
- Based on estimated cost of $1.12 per kg for briquette compared to $1.34 per kg of charcoal in Ghana (EC, 2014)
- Briquettes have the potential to displace charcoal in terms of energy for cooking and heating applications in urban households



Source: FACTFISH, (2014)



Market survey in Kumasi

Parameter	Response (%)		
Usage of product	Cooking	Grilling	Barbequing
	72	18	10
Ease of ignition	Easy	Difficult	
	97	3	
Convenience	Very good	Good	Poor
	27	68	5
Rate of devolatisation	Fast	Slow	Moderate
	6	85	9
Heat output intensity	High	Moderate	Low
	76	20	4
Burning time	Long time	Short time	
	78	22	
Ash generated	Low	High	
	100	0	
Smoke/sparks	Yes	No	
	0	100	
Eagerness to use	Willing	Not sure	
	93	7	

Conclusion

- If 60% of all available waste is converted into fuel briquette, it can generate 241 GJ (67 MWh) of energy per year.
- For a 1tonne/hr capacity briquetting plants using this resource
  - Could create about 26,580 direct jobs
  - Will have a pay back period of 11 months
  - NPV $322,824
  - IRR of 115% at 12% discount rate
- Based on a survey of potential users of briquette in Kumasi, there is market potential for briquette for cooking and heating applications.

THANK YOU

A waste to energy product: 100% recycling