GLOBAL BIO-ENERGY PARTNERSHIP (GBEP) SUSTAINABILITY INDICATORS FOR GHANA: PILOT STUDY ON SELECTED SUB-INDICATORS

CSIR-IIR GBEP PROJECT TEAM

PRESENTATION AT ECOWAS/GBEP WORKSHOP
MINISTRY OF FOREIGN AFFAIRS
PRAIA, CAPE VERDE

PRESENTER: MAWUENA AGGEY (CSIR-IIR)

$7^{TH}/8^{TH}$ NOVEMBER 2013

THE TEAM AND COLLABORATORS

CSIR-IIR GBEP PROJECT TEAM

- BEATRICE MENSAH (PhD)
- GABRIEL LARYE (PhD)
- MAWUENA AGGEY (MPhil)
- EBENEZER KOTEY (MPhil)
- FIIFI ANKAMA (MPhil)
- KOFI AMPOMA-BENEFO (MSc)

COLLABORATORS/SUPPORTERS

- GLOBAL BIOENERGY PARTNERSHIP (GBEP)
- THE DUTCH GOVERNMENT
- ECOWAS REGIONAL CENTRE FOR RENEWABLE ENERGY & ENERGY EFFICIENCY (ECREEE)
- GHANA CSIR-SECRETARIAT
- GHANA ENERGY COMMISSION
- PARTNERS FOR INNOVATION BV

PRESENTATION OUTLINE

- BACKGROUND
- INTRODUCTION
- OBJECTIVES OF CSIR-IIR STUDY
- STUDY APPROACH
- FINDINGS
  - CALCULATED VALUES (Productivity, Procession Efficiency, Net energy Balance, Logistics)
- LESSONS
  - APPROACH, DATA COLLECTION, DATA ASSESSMENT, BASELINE VALUES
- RECOMMENDATIONS
- NEXT STEPS

BACKGROUND

JUSTIFICATION:

- Much biomass used as energy
- Unsustainable traditional biomass harvesting;
- Unsustainable fossil energy production and use;
- Negative impact on livelihoods, economies, environment;
- Huge opportunity for modern-sustainable bio-energy production
- Increasing GLOBAL INCLINATION TO utilization of modern bio-energy and other re-newables

- **APPROPRIATE COMPREHENSIVE INDICATORS REQUIRED TO MEASURE/MONITOR AND FACILITATE SOUND NATIONAL POLICY DECISIONS FOR ADOPTING MODERN BIOENERGY**

BACKGROUND
GBEP SUSTAINABILITY INDICATORS

GBEPSI:

• 24 Measures/ values of quantitative/qualitative attributes of bioenergy resource production, delivery and use

• Indicator Groups –

Environmental (8), Social (8), Economic (8)

Utility:

•Measure state of bioenergy resource;

• Forecast trends in state of bioenergy resource;

•Benchmark/baseline criteria definition;

•Monitor Country movement to or from bioenergy resource sustainability (Changes in indicators between periods)

•Comprehensive bioenergy policy formulation

BACKGROUND
PILOT STUDIES

- GBEP Pilot studies launched to test:
  - Calculation
  - Application
  - Relevance

Japan, Indonesia, Netherlands, Germany, USA, Colombia.

- Ghana pilot - May/June-November, 2012:
  - 36 working days - GHC18,600
  - Results/Lessons
  - Input to policy/programmes
  - Share with ECOWAS

INTRODUCTION
ECONOMIC PILLAR INDICATORS

Indicator 17 Productivity (BASELINES = 4)

- 17.1 Productivity of bioenergy feedstocks
- 17.2 Processing efficiencies
- 17.3 Amount of bioenergy end product
- 17.4 Production cost per unit of bioenergy

Indicator 18 Net energy balance (BASELINES = 4)

- 18.1 feedstock production,
- 18.2 processing of feedstock into bioenergy,
- 18.3 bioenergy use; and/or
- 18.4 lifecycle analysis

Indicator 19 Gross value added (BASELINES = 0)

- 19.1 Gross value added per unit of bioenergy produced
- 19.2 GVA as percentage of gross domestic product

INTRODUCTION
ECONOMIC PILLAR INDICATORS

Indicator 20 Change in consumption of fossil fuels and traditional use of biomass (BASELINES = 2)

- 20.1-6 Substitution of fossil fuels with domestic bioenergy
- 20.7-12 Annual savings of convertible currency
- 20.13-18 Substitution of traditional use of biomass with modern domestic bioenergy

Indicator 21 Training and re-qualification of the workforce

- 21.1 Share of trained workers in the bioenergy sector out of total bioenergy workforce
- 21.2 share of re-qualified workers out of the total number of jobs lost in the bioenergy sector **(BASELINES = 0)**

Indicator 22 Energy diversity (BASELINES = 0)

- 22.1 Change in diversity of total primary energy supply due to bioenergy

INTRODUCTION
ECONOMIC PILLAR INDICATORS

Indicator 23 Infrastructure and logistics for distribution of bioenergy (BASELINES = 2)

- 23.1 Number routes for critical distribution systems
- 23.2 capacity of routes for critical distribution systems
- 23.3 proportion of the bioenergy associated with route

Indicator 24 Capacity and flexibility of use of bioenergy (BL = 0)

- 24.1 Ratio of capacity for using bioenergy compared with actual use for each significant utilization route
- 24.2 Ratio of flexible capacity which can use either bioenergy or other fuel sources to total capacity

TOTAL INDICATORS = 8

TOTAL SUB-INDICATORS = 36

TOTAL BASELINE VALUES = 12

INTRODUCTION
CSIR-IIR PRIORITY INDICATORS

CSIR-SECRETARIAT → Policy Stakeholder Group (PSG)

- Selection/Priority → 29 from 36 sub-indics -12/12 BL

Economic pillar		
Priority	Indicator	Number of Sub-indicators
1	17) Productivity	4
2	20) Change in the consumption of fossil fuels and traditional use of biomass	18
3	23) Infrastructure and logistics for distribution of bio-energy	3
4	18) Net energy balance	4

OBJECTIVES OF STUDY

- Objectives of pilot study:

  - Collect most appropriate available data, to calculate SUB-indicators (Task 1);
  - Assess usefulness, availability, quality of data (Task 2);
  - Make recommendations to improve data collection, creation and use (Task 3); and
  - Propose baseline values for most important (sub) indicators (Task 4).

- Exploratory Study focus on **existing data**
- **No actual** measurements, tests or surveys

CSIR-IIR Study Approach

- Team Formation
  - Energy, Environment, Economist
- Orientation
  - PSG member
- Brainstorm
  - Country energy profile scan
  - Country bioenergy profile scan
  - Selection Criteria

Criteria:

Representative Mix of Biofuel States/Forms

- Solid - Liquid - Gas

Furthest/Longest Conversion Pathway

- for insight into all possible bottlenecks
- Primary state to Used state

CSIR-IIR Study Approach

- Basket of Biofuel Conversion Pathways
- Selection
- Review of Definitions, Methodologies & Calculation Formulae
- Search Data/Information - Compilation
- Analysis & Calculations
- Filling In the Template
- Report Write-Up
- Technical Backstopping

Ghana Biofuel Conversion Basket

USED FORM	SOLID	LIQUID	GAS	NON MATERIAL
USED FORM EXAMPLES	CHARCOAL	BIODIESEL	BIOGAS (METHANE)	FACTORY ELECTRICITY HEAT
PRIMARY FORM EXAMPLES	FUELWOOD (FIREWOOD) BRIKETTES (SAWDUST)	SEEDS: JATROPHA SUNFLOWER JUICE: SUGAR CANE	HUMAN EXCRETA COW DUNG WASTE FROM: Hospital Theatre Slaughter House Kitchen MIXTURES	FUELWOOD (FIREWOOD) RESIDUE: SAW MILL FOREST CROP
Replacement for:	Firewood Saw mill residue Forest residue Farm residue Crop Residue - E. P. Bunch - spiklets/fibre - shells/cobs - straw/stalks	Fossil fuels	Charcoal Fuelwood Firewood Kerosene stoves	Fossil Fuels Hydro Electricity Thermal Electricity

CSIR-IIR SELECTED LINES OF INVESTIGATION

SELECTED BIOENERGY PATHWAYS:

- Solid, Liquid and Gas bioenergy pathways :

➢ Woodfuel	→	Charcoal
➢ Sunflower plant Jatropha plant	→	Biodiesel
➢ Human excreta ➢ Mixed Household Waste	→	Biogas

- SELECTED SUB-INDICATORS & CONVERSION TECHNOLOGY

Understand, Calculate, Data available in short time

ATTEMPT ALL

SELECTED (SUB) INDICATORS

- PRODUCTIVITY:
  - Productivity of bioenergy feedstocks by farm/plantation;
  - Processing efficiencies by technology, by feedstock;
  - Amount of bioenergy end product by mass, volume, energy content/ ha/year ;
  - Production cost per unit of bioenergy.

- CHANGE IN CONSUMPTION
  - Substitution of fossil fuels with domestic bioenergy;
  - Annual savings of convertible currency
  - Substitution of traditional use of biomass use by modern domestic bioenergy

SELECTED (SUB) INDICATORS

- Infrastructure and logistics
  - Number of critical routes
  - Capacity of routes
  - Assessment of proportion of bioenergy associated with each route
- Energy balance
  - Feedstock production
  - Processing feedstock
  - Bioenergy use
  - Life cycle analysis

FOR SINGLE CONVERSION PATH WITH SINGLE TECHNOLOGY

SELECTION/PRIORITY: 29 from 36 sub-indicators (12/12 BL)

CALCULATED VALUES: 26 from 29 sub-indicators (0/12 BL)

FINDINGS – INDICATOR 17: PRODUCTIVITY

SUB-INDICATOR 17.1 – PRIMARY YIELD

Indicator 17.1A:	1.44	tonne/ha/yr	Firewood Fuelwood
Indicator 17.1B:	8.75	tonne/ha/yr	Jatropha seed
Indicator 17.1C:	2.05	tonne/ha/yr	Sunflower seed
Indicator 17.1D:	0.55	m^3 per capita/yr	Fresh excreta (human)
Indicator 17.1E:	0.22	tonne/capita/yr	Mixed Household waste

FINDINGS - INDICATOR 17: PRODUCTIVITY

SUB INDICATOR 17.2 – PROCESSING EFFICIENCY

Indicator 17.2A	0.28	MJ charcoal/MJ wood	TRADITIONAL MOUND TECHNOLOGY
Indicator 17.2B1	0.60	MJ oil/MJ jatropha seed	Average high & low efficiency technology
Indicator 17.2B2	0.62	MJ biodiesel (jatropha)/MJ crude jatropha oil	Average high & low efficiency technology
Indicator 17.2C1	0.50	MJ oil/MJ sunflower seed	Average high & low efficiency technology
Indicator 17.2C2	0.90	MJ biodiesel (sunflower)/MJ sunflower oil	Average high & low efficiency technology
Indicator 17.2D	0.53	MJ biogas/MJ excreta	Anaerobic
Indicator 17.2E	0.96	MJ biogas/MJ kitchen waste	Anaerobic

FINDINGS - INDICATOR 17 : PRODUCTIVITY

SUB-INDICATOR 17.3 – AMOUNT OF BIOENERGY END PRODUCT

Indicator 17.3A	1,788,000	TONNE/YR	Charcoal
Indicator 17.3C	1	Tonne biodiesel /yr	Sunflower
Indicator 17.3DE	579,620	M^3 biogas/yr	Biogas

FINDINGS - INDICATOR 17 : PRODUCTIVITY

SUB-INDICATOR 17.4 – PRODUCTION COST VALUES

Indicator 17.4A	0.001	USD/MJ	CHARCOAL
Indicator 17.4C	0.016	USD/MJ	biodiesel from sunflower oil
Indicator 17.4D	NA	USD/MJ	Biogas from Human Excreta

FINDINGS - INDICATOR 18 - ENERGY BALANCE: Ratio

- SUB-INDICATOR 18.1 – FEEDSTOCK PRODUCTION
- SUB-INDICATOR 18.2 - PROCESSING FEEDSTOCK
- SUB-INDICATOR 18.3 - BIOENERGY USE
- SUB-INDICATOR 18.4 - LIFE CYCLE ANALYSIS

Sub Indicator	Process	Ratio
Indicator 18.1A:	Fuelwood production	11.31
Indicator 18.2A:	Processing fuelwood to charcoal	0.55
Indicator 18.3:	Bioenergy use	NA
Indicator 18.4:	Life cycle analysis	NA

FINDINGS -INDICATOR 20: Bioenergy Production/Substitution

Sub-Indicator	Bioenergy type/Pdn	TJ/yr	TOE Pdn National	Fossil fuel subst (TOE)
Indicator 20.1	Total bioenergy	104 .0	6,617,510.5	2,510.5
Indicator 20.2	Liquid fuels	0.04	0.9	0.9
Indicator 20.3	Gaseous fuels	0.3	33.3	33.3
Indicator 20.4	Solid fuels		6,615,000.0	0
	Firewood		2,870,000.0	0
	Charcoal		3,745,000.0	0
Indicator 20.5/6	Electricity, Heating and Cooling	103.7	2,476.3	2,476.3
	Co-generation (Timber Firms)	57.0	1,358.6	1,358.6
	Co-generation (Oil palm Firms)	46.7	1,117.8	1,117.8

FINDINGS - INDICATOR 20: Annual Savings from Bioenergy

Sub-Indicator	Biofuel type	Million USD/yr
Total		**1.6655**
Indicator 20.7:	Liquid fuels:	0.0006
Indicator 20.8:	Gaseous fuels:	0.0218
Indicator 20.9:	Solid fuels:	**1.6431**
Indicator 20.10:	Co-generation: Timber firms	0.8892
Indicator 20.11:	Co-generation: Oil palm firms	0.7316
Total		

FINDINGS - INDICATOR 23: INFRASTRUCTURE/LOGISTICS

SUB-INDICATOR 23.1: Number of critical routes:

Subindicator	Critical routes	Bioenergy
Indicator 23.1a	2	charcoal
Indicator 23.1b	0	biodiesel
Indicator 23.1c	0	biogas

SUB-INDICATOR 23.3: Proportion associated with routes (charcoal):

Indicator 23.3	1.0%	Charcoal/seaport
Indicator 23.4	0.2%	Charcoal/railway

LESSONS : Study Approach

- Team Formation
  - Agronomist
  - Bioenergy experts
  - All relevant expertise defined/included
- Orientation
  - PSG only
  - Detailed /Firm Orientation for Team
- Backstopping Focus
  - definitions, calculations, methods (AT START OF STUDY)
    - Boost confidence/reduce uncertainty in Team members
  - Template filling & Report format (AT MIDDLE OF STUDY)
    - Will minimize misconceptions/confusion in draft report

LESSONS : DATA COLLECTION

1.1 SELECTION OF SUB-INDICATORS

SINGLE FEEDSTOCK; SINGLE PATHWAY; SINGLE TECH

Selection/Priority: 29 from 36 subs; (12 from 12 BL) Calculated Values: 26 from 29 subs; (0/12 BL)

- **FEEDSTOCK/TECHNOLOGY VARIETY INCREASE MATRIX: Are there weighted baseline values?**
- **Why baselines excluded for Indicators 19, 21, 22, 24?**
- **CONCEPT OF CAPACITY OF PORTS/RAILWAY TO CARRY CHARCOAL NOT CLEAR : Original purpose not CHARCOAL**

1.2 SCOPE

- Geographic: National /Average Data scarce
  District/locality/Specie specific data for national;
- Feedstock: Fuelwood varieties wide BUT data not specific
- Year Valid; Sunflower valid for 2012; Data not updated for fuelwood, jatropha and human excreta

LESSONS : DATA COLLECTION

1.3 SELECTION OF UNITS - Followed template

- Sub-Indicator 17.1 – Feedstock Productivity;

"Tonnes ha per year" - (Tonne/ha/year or Tonne/ha-year)?

Same Units as 17.3 end product

- Indicator 17.2; Processing Efficiency;

"MJ/tonne" - But Ratio = $\frac{\text{Charcoal (MJ/T)?}}{\text{Fuelwood (MJ/T)}}$

- Single year or Moving Average data?

1.4 DATA SOURCES

- Readily accessible on internet, institutions, companies nationwide and by telephone and email: 42 sources cited
- 57% (2007-2012)
- 14% (1998-2006)
- 29% undated

LESSONS : DATA ASSESSMENT

2.1 METHODOLOGICAL APPROACH:

Secondary data:

- International/National/district level reports & literature, telephone interviews /email/internet;
- Physical constants (Calorific value) & conversion factors from standard reference

Primary data:

- Not clear if recommended methods used
- Recommended methods appropriate for Ghana

2.2 CALCULATIONS

- Standard mathematical, material and energy balance calculations necessary;
- Data not directly available for some sub-indicators

LESSONS: DATA ASSESSMENT

2.3 DATA AVAILABILTY

- Requirements generally met (17-80%)
- Deviations – Partially old; one off data; could not confirm data accuracy

2.4 EASE: Easy to collect secondary from internet, documents, Some primary data from personal visits & telephone calls

HISTORICAL: No historic trend data for most; one time estimates/measurements referenced in documents, Trend figures available for fuelwood and charcoal

INSTITUTIONS, MANDATE, CAPABILITIES & RESOURCES:

Energy Commission, Forestry Commission, CSIR, have mandate others don't; Resources and capacities need to be improved

LESSONS: DATA ASSESSMENT

2.5 DATA QUALITY:

- Accuracy; Except for physical constants, accuracy of some cannot be confirmed.
- Precision; Cannot be established for data
- Geographical coverage; National surveys were scarce, local/district values assumed for national

2.6 OVERALL ASSESSMENT

- Usefulness; Very useful (8 rating) for 3 indicators; 4 for one
- Availability; Concept new (3 to 5)
- Quality; Calculated sub-indicators affected by quality of input data – Quality rating of calculated figures (5 to 7.5)

LESSONS: BASELINE VALUES

- None found. Concept new in Ghana bioenergy . Energy Commission participating in pilot study.

- No Sub indicator baseline value established
  - National baseline survey for current authentic datum data
  - Similar to standards; appropriate stakeholder consultations
  - Resolve calculation of averages & data scope
  - Net energy balance calculations problematic
  - Critical route capacity calculations problematic
  - Benchmark values from other countries

Conclusions

- Provides very sound, fundamental and comprehensive framework for bioenergy resource measurement, monitoring and management;

- Possible to extract critical set of indices through factor analysis and other methods;

- Pilot study exploratory/tentative; requires critical review and scale - up studies to:
  - Identify & fill actual data gaps
  - Set up the full matrix of sub-indicator values
  - Simplify the matrix

RECOMMENDATIONS

3.1: IMPROVE DATA USEFULNESS, AVAILABILITY & QUALITY

- Priorities:

  Consistent/Comprehensive data collection; Regular updates for historic trends; Adequate resources: Relevant to Ghana context

- Collection methodology:
  - Best practice data collection strategy and protocol for each sub-indicator to be outlined, agreed and disseminated to stakeholder countries and Organizations;
  - Periodic data collection, update frequency/time to be defined
  - Reference should be made to GBEP methodology but can be simplified

RECOMMENDATIONS

3.2: IMPROVE DATA USEFULNESS, AVAILABILITY & QUALITY

- Human/Institutional Capacity:
  - Define data collection needs clearly & comprehensively
  - Clearly identify and mandate data collection Institutions;

  Eg Ghana Statistical Service, Energy Commission, EPA, MEST, CSIR, Universities
  - Train staff in data collection techniques, protocol and equipment use

RECOMMENDATIONS

- Technology/Equipment required:
  - Identify and approve appropriate equipment and instruments for data collection;
  - Ensure uniformity and comparability for accuracy
- Policy/regulatory changes:
  - Review existing policy, regulatory frame work and mandate of identified data collection institutions
  - Modify appropriately to accommodate new objectives for sub-indicators
- Financial resources:
  - Detailed financial requirement to be done by cost centre for each sub-indicator by consultants/appropriate institutions
  - Stakeholders to provide resources

Next steps

- CSIR-IIR desires to extend Indicator study:

  - Critical review of GBEP pilot steps covering all 8 indicators in Environment Pillar, identify & confirm all data gaps
    - map out situational analysis with authentic primary data (include energy diversity indicator);
    - Establish indicator bench-mark values for Ghana;
    - Local evidence based comparative advantages among conversion pathways, energy /food crops, waste stream bio-feedstocks
    - Integrate indicator studies into on-going IIR projects
      - ❖ 2nd Generation Biofuels Project
      - ❖ Sustainable Products from Waste Project
    - Collaborative comparative ECOWAS country studies

Thank you.

ɔ