IRENA
International Renewable Energy Agency

Collecting bioenergy data through household surveys

Offgrid Renewable Energy Statistics Conference (Virtual)
15 – 18 February 2021

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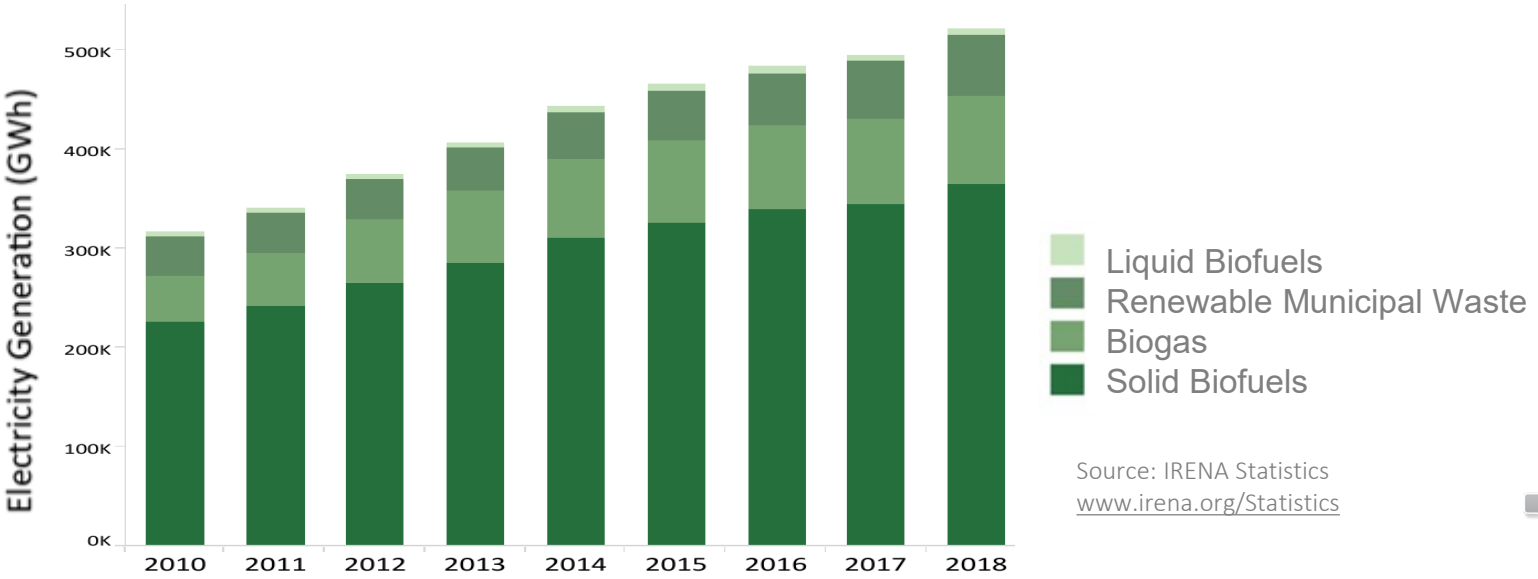
Outline

- Bioenergy: Background and definitions
- Who produces and uses bioenergy?
- Using household surveys to collect data
- Sample design and strategy
- Questionnaire design
- Survey fieldwork and logistics
- Estimation and results interpretation
- Country example: Nigeria WFS
- Country example: Ethiopia WFS
- Lessons learned and conclusions

Bioenergy: Background

- Bioenergy today accounts for approx.10% of the global TPES
  - Solid biomass (mostly wood) represents the bulk of bioenergy consumed
- Bioenergy is arguably the most versatile of renewable energy sources (only source that's comes in solid, liquid and gaseous form!)
- Uses of biomass for energy are very diverse e.g., 'traditional' uses of woodfuel, 'modern' use of wood pellets ..etc.



Source: IRENA Statistics
www.irena.org/Statistics

Bioenergy: Definitions

- IRENA definitions broadly in-line with the International Recommendations for Energy Statistics (greater detail for bioenergy)

- Data is collected directly from countries through the IRENA questionnaire.

		Solid Biofuels and Renewable Waste													Biogas					Liquid Biofuels						
Supply and consumption 2015		Renewable municipal waste	Wood fuel	Energy crops	Wood waste	Black liquor	Straw	Bagasse	Rice husks	Other vegetal and agricultural waste	Renewable industrial waste	Animal waste	*Other primary solid biofuels n.e.s.*	Biomass pellets and briquettes	Charcoal	Landfill gas	Sewage sludge gas	Other biogases from anaerobic fermentation	Biogases from thermal processes	*Biogas n.e.s.*	Conventional biogasoline	Advanced biogasoline	Conventional biodiesel	Advanced biodiesel	Bio jet kerosene	Other liquid biofuels	Other renewable energy (e.g. heat pumps)
		Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	TJ	Tonnes	Tonnes	TJ (NCV)	TJ (NCV)	TJ (NCV)	TJ (NCV)	TJ (NCV)	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	TJ
Production	(+)	1,745,335	3,734,304		8,608,820	3,132,657				903,008				791,407	1,447	186	1,544	10,899			209,739		342,311			7	10,653
Imports	(+)		603,053											485,475	14,473						55,224		554,997				
Exports	(-)		9,066											597,522	732						175,076		198,531				
Stock changes	(+)													18,215							-270		4,362				
International Bunkers	(-)																										
Domestic supply	(=)	1,745,335	4,328,291		8,608,820	3,132,657				903,008				697,575	15,188	186	1,544	10,899			89,617		703,139			7	10,653
Transfers																											
Statistical Differences																											
Power plants		969,502			828,453	204,562				130,763						186	133	9,928									
CHP plants		594,312			2,086,212	645,813				242,853							69	278									
Commercial heat plants		181,522	3,670		2,338,181					31,770				3,811				74								7	
Charcoal production			7,632																								
Biomass pellet and briquette production					1,271,135																						
Other transformation																											
Energy sector and own use																											
Distribution losses																											
Total final consumption			4,316,989		2,134,839	2,282,282				497,622				693,764	15,188		1,341	619			89,617		703,139				10,653
Industry sector			415,930		1,892,392	2,282,282				497,534				16,518	329		1,341	190					14,883				163
Transport sector			20															17			89,617		669,770				
of which road transport																		17			89,617		667,003				
Commercial and public services			58,013		25,000					88				62,585	5,944			311					1,554				4,675
Residential			3,675,902		217,447									402,648	8,915			99									5,727
of which traditional uses																											
Other			167,124											212,013				1					16,932				87
Net calorific value (MJ/t)		4,320	14,311		10,761	9,112				9,896				17,284	30,000						27,959		37,087			35,153	

Transformation

Austria energy balance (bioenergy) for 2015

Who produces and uses bioenergy

FLOW	SECTOR						
	Energy	Industry	Commerce	Services	Other (AFF)	Transport*	Households
Commodity production	Primary and secondary fossil fuels and primary renewable heat	Secondary fossil fuels, primary renewable heat, biofuels and waste		Waste, biofuels (solids, biogas)	Biofuels (solids, biogas)		Biofuels (solids, biogas) and primary renewable heat (solar water heating)
Commodity trade, stock changes and bunkers	Primary and secondary fossil fuels and biofuels	Primary and secondary fossil fuels and biofuels	Primary and secondary fossil fuels and biofuels	Primary and secondary fossil fuels and biofuels	Primary and secondary fossil fuels and biofuels	Primary and secondary fossil fuels and biofuels, international bunkers	
Electricity and heat production and associated transformation	Electricity and heat from all sources [MAIN ACTIVITY PRODUCERS]	Electricity and heat from all sources	Electricity from renewables (small-scale devices, such as solar PV, wind)	Electricity and heat from all sources, especially waste, biogas and solar PV	Electricity and heat from all sources, especially biofuels	Electricity from all sources (for rail)	Electricity from renewables (small-scale devices, such as solar PV, wind)
Other transformation	Primary to secondary fuel transformation	Primary to secondary fuel transformation					Charcoal production
Distribution losses	Electricity, heat and fuel losses	Electricity, heat and fuel losses		Electricity, heat and biogas losses	Electricity, heat and biofuel losses	Fuel losses	
Final consumption by sector	Own use and final sales of all energy types	Own use and final sales of all energy types	Own use of all energy types and final sales of fuels	Own use of all energy types and final sales of waste, biofuels, electricity and heat	Own use of all energy types and final sales of biofuels, electricity and heat	Own use of all energy types and final sales of secondary fossil fuels and biofuels	Own use of all energy types and final sales of biofuels

Biofuel survey

Trade data

Energy company survey

Enterprise survey

Household survey

* Transport includes fuel retailing, as well as road, rail, air and shipping operators

Most energy data can be collected from four surveys

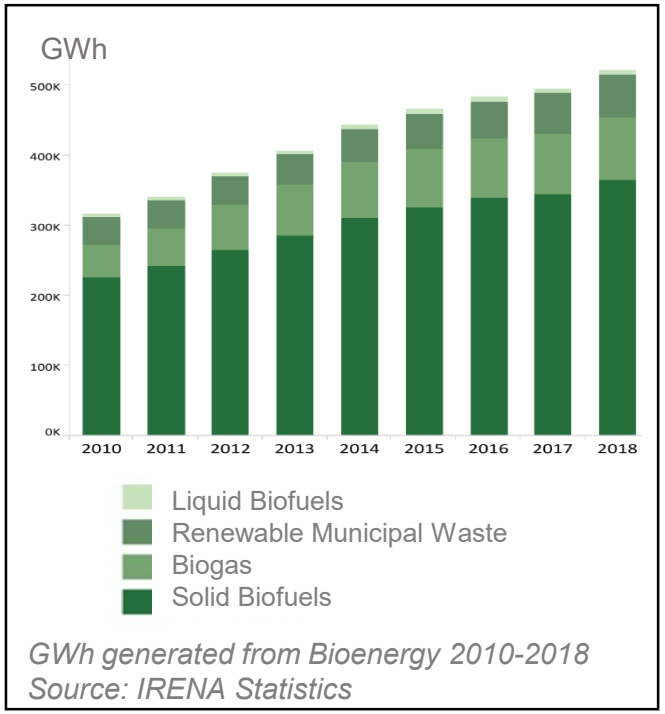
HH surveys to collect bioenergy data

Info on HH energy essential to:

- Identify residential energy issues and trends
  e.g. national consumption of WF in a year
- Monitor progress in existing targets
  e.g. # of HHs (+installed MW) using biogas
- Develop effective policies and programs

Useful for:

- Biofuel production and consumption
- Off-grid solar and wind, solar water heating and cooking fuel



GWh generated from Bioenergy 2010-2018
Source: IRENA Statistics

✓ *HH surveys could be complex, expensive, time consuming and demanding of skilled personnel, especially in remote areas and harsh terrains.*

Is it *necessary* to conduct a HH survey?

Identify data needs and how info will be used?

Accordingly determine which info will be useful, e.g energy reporting → national aggregates for energy balance flows

Data availability

Do not 're-invent the wheel'! Check existing surveys and administrative data

Review of the data available across institutions

Usually, no specific entity responsible for collecting bioenergy data
E.g., Forestry/Trade ministries..etc.

Other factors to consider

- availability of human and financial resources
- time frame of data to be collected

- If necessary -> stand alone or part of another survey-plan accordingly!
- Make use of admin. data & other sources for survey development

Choice of the data collection method is specific to the national situation!

Sample Design and Strategy

- Sample should be ‘representative’ and carefully designed

- Use administrative data to help design the sample
e.g. info about the # of biogas plants can be used to select survey locations.

- Sample stratification should be considered to analyze other factors in greater detail

- Sample size should be calculated carefully to enable deriving estimates at the national and rural-urban level

- Sampling methodology will be decided based on:
    - survey objectives,
    - level of data accuracy and disaggregation required
    - available human and financial resources…..and more

→ *involvement of NSOs is crucial!*

Questionnaire Design

- Formulating simple questions
- Clear structure and flow of questionnaire
- CAPI Versus PAPI

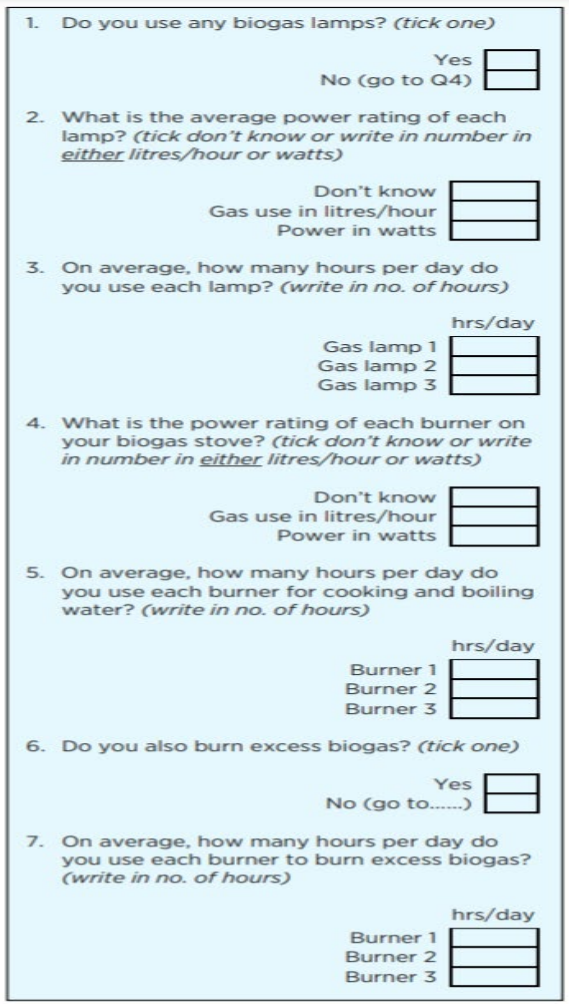
    e.g. easy to fill-in design for PAPI

- Include control questions and data validation Qs
- Use of local language and units of measurement
- Include elements from other topics/surveys

    e.g. clean cook stoves

- 'pre-test' questionnaire in pilot test phase

    → update questionnaire accordingly!



1. Do you use any biogas lamps? *(tick one)*

   Yes ☐
   No (go to Q4) ☐

2. What is the average power rating of each lamp? *(tick don't know or write in number in either litres/hour or watts)*

   Don't know ☐
   Gas use in litres/hour ☐
   Power in watts ☐

3. On average, how many hours per day do you use each lamp? *(write in no. of hours)*

   hrs/day
   Gas lamp 1 ☐
   Gas lamp 2 ☐
   Gas lamp 3 ☐

4. What is the power rating of each burner on your biogas stove? *(tick don't know or write in number in either litres/hour or watts)*

   Don't know ☐
   Gas use in litres/hour ☐
   Power in watts ☐

5. On average, how many hours per day do you use each burner for cooking and boiling water? *(write in no. of hours)*

   hrs/day
   Burner 1 ☐
   Burner 2 ☐
   Burner 3 ☐

6. Do you also burn excess biogas? *(tick one)*

   Yes ☐
   No (go to.....) ☐

7. On average, how many hours per day do you use each burner to burn excess biogas? *(write in no. of hours)*

   hrs/day
   Burner 1 ☐
   Burner 2 ☐
   Burner 3 ☐

Survey on HH appliances using biogas. Objective: estimating biogas production by using collected info on appliances use.

Example: FAO WSM

Main topics include:

- Fuelwood use, collection and sales
- Charcoal use, production and sales
- Cooking and heating health problems
- ‘ Long’ and ‘short’ version available

1. IN THE **LAST WEEK**, DID YOU OR ANY MEMBER OF YOUR HOUSEHOLD **USE FUELWOOD** FOR ANY DOMESTIC, AGRICULTURAL, COMMERCIAL, CULTURAL OR RELIGIOUS USE? Yes ☐ No ☐ → **Q. 3**

1.a For which of the following purposes was fuelwood used?	**1.b** In how **many days**?	**1.c** Type of wood mostly used	**1.d Usual daily amount** No. of bundles	Kg per bundle	Total (kg)
COOKING …… ☐ Yes ☐ No	_|	_|			
SPACE HEATING ……... ☐ Yes ☐ No	_|	_|			
OTHER DOMESTIC USES …… ☐ Yes ☐ No	_|	_|			
AGRICULTURAL USES …… ☐ Yes ☐ No	_|	_|			
COMMERCIAL USES…… ☐ Yes ☐ No	_|	_|			
CULTURAL/RELIGIOUS USES … ☐ Yes ☐ No	_|	_|			

HOW TO WEIGH WOOD: The first time wood is weighed, form a **bundle** (or fill a sack for pellets, briquettes) and weigh it with the provided **scale**. For the following quantities, express them in number of bundles like the one just weighed (i.e.: wood should be weighed only once).

TYPE OF WOOD: 1 = split stems and branches **(DIRECT-CONVENTIONAL)**; **2 =** twigs, brushwood, leaves **(DIRECT-MARGINAL)**; **3 =** wood chips, sawdust, etc. **(INDIRECT)**; **4 = USED/RECOVERED** (from old furniture, construction material, etc.); **5 =** pellets, briquettes… **(IMPROVED)**.

OTHER DOMESTIC USES: Lighting, boiling water for bathing, laundering, ironing, smoking against insect.

AGRICULTURAL USES: Roasting coffee; curing tobacco; pasteurizing milk; preparing feed for animals; heating greenhouses, poultry-houses or swine-houses; drying tea, herbs, tapioca.

COMMERCIAL USES: baking bread; smoking fish; brewing alcoholic beverages; street food vending; lodges and restaurants; artisanal workshops; micro-industries.

CULTURAL AND RELIGIOUS USES: cremations, other religious rituals; incense burning; other cultural traditions

2. WHAT IS THE MAIN **PLANT SPECIES** USED FOR FUEL? (Use local name of plants) … _____

2.a [ENUMERATOR: take the hygrometer provided to you and measure the water content of wood] … _____

✓ *IRENA recommends the use of FAO WFSM for collecting data on woodfuel consumption + national ‘customisations’*

Survey fieldwork and logistics

- Check availability of equipment and supplies required for survey fieldwork e.g., hygrometers, e-pads
- Training on the use of equipment, measurements and conducting interviews is crucial
- Develop/use an interviewer's manual to minimize errors
- Assign supervisors to each group of enumerators
- Check if legal clearance is required
- Budget for travel, meals and other expenses
- Pre-code the questionnaires to speed up data entry and analysis
- Coordinate with local /regional officials and community leaders

→ *Anticipate delays and budget your resources accordingly, e.g. COVID-19, political situation*

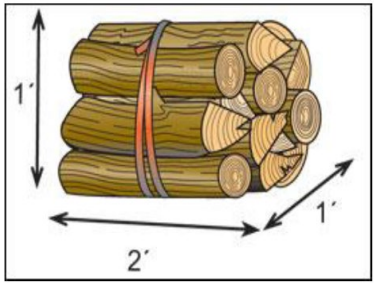


Figure 1 Bundle of fuelwood


Figure 2 Hygrometer


Figure 3 Spring scale

Estimation and Results Interpretation

- Weight to volume conversion factors
  - 1 m3 of woodfuel -> 0.75 tons of woodfuel
- Transformation conversion factors
  - 6 m3 of woodfuel -> 4.5 tons of charcoal
- Conversion to energy units via net calorific values
  - Measure moisture content when possible for solid biofuels
  - Use 'national' NCVs if no other data is available

Biogas Conversion Factors

- 1 m^3 of biogas = 0.65 m^3 of methane
- 1 m^3 of methane = 34 MJ of energy
- 1 m^3 of biogas = 22 MJ of energy
- 1 m^3/day of biogas = 8,060 MJ/year

Source: IRENA 2016, Measuring small-scale biogas capacity and production, IRENA

- Convert commonly used units into standard ones by taking physical measurements: by weight and *moisture content* (solid fuels) and volume (liquid fuels)

- Use country-specific info to support estimations e.g. most common biogas digester brand→ gives indication of avg size

- Sampling strategy adopted must be considered when analyzing/ extrapolating results (admins. data useful!)

- Use computer analysis and statistical software

✓ *Ensure assumptions and estimations are properly documented*

Nigeria Woodfuel Survey

Survey: Standalone FAO WFMS covered the North-west geopolitical zone (one of the largest six zones) in Nigeria

Objective(s): The project aimed to improve data on residential woodfuel use and provide grounds for national policy formulation on topics on clean cooking, environmental challenges etc

Sample size and methodology

- 125 EAs covered
- 799 questionnaires (only 20 refused)
- States in 'Great Green Wall Programme'

Table 3.2.1: Selection of Enumeration Areas

LGA	Enumeration Areas			Remarks
	Total	Initial	Final	
Jigawa	27	21,070	29	28	An enumerator per
Kaduna	23	21,791	30	15	enumeration area per day.
Kano	44	36,302	50	45	
Katsina	34	33,316	46	15	Two (2) enumerators per
Kebbi	21	16,641	23	15	enumeration area per day.
Sokoto	23	12,779	18	7	
Zamfara	14	17,025	24	0	
Total	186	158,924	220	125	
Sampling Interval = 722					

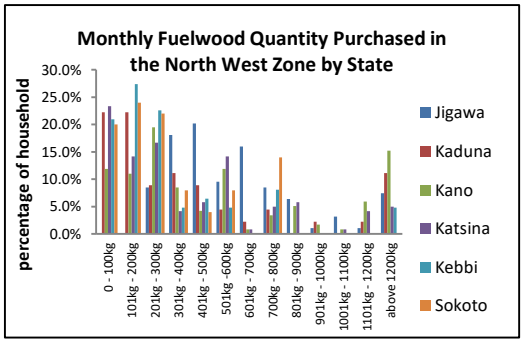
Survey design and questionnaire

- Qs on production, modes of acquisition, trade and consumption of fuelwood and charcoal used from the FAO WFMS as is
- Qs on clean cook stoves and the 'Great Green wall' deforestation programme
- Minor sections were modified to national conditions but mostly unchanged
- Uncommon terms in the QST were translated to local language
- Both classroom and field training has been carried out

Nigeria Woodfuel Survey

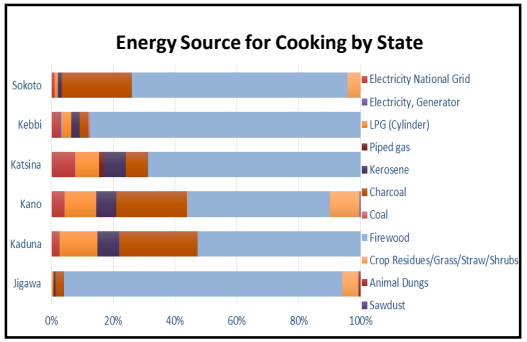
Assumptions made and estimations

- average HH size of 10.58
- population size of 48.9 million



Main survey results (related to the NW zone)

- Confirmed the suitability of the FAO survey
- 64% of all FW consumed is purchased
  - 388kg/month avg (=$20/month)
- Consumption of 1.185, 0.27kg/day/capita reported for FW & CC respect. < national avg!
- Inefficient three-stone open fire stoves mostly used
- Almost 74% of respondents reported being affected by injuries and health issues resulting from FW collection and usage



Lessons learned:

- Emphasis of practical and ‘hands on’ training. Ensure participation of all enumerators in the training programme (classroom + field training)
- Importance of coordinating with community leader/local guide upon arrival for interviewing for ease of facilitation, security and safety

Ethiopia Woodfuel Survey

Survey: Standalone FAO WFMS in Gambela and Somali regions and to be expanded to cover other regions. To be conducted by the MoE of Ethiopia.

Objective(s): for energy reporting and planning purposes.
- Different studies reported different figures for woodfuel consumption figures.
- Existing surveys and literature reviewed prior to initiating work on survey

Sample size and methodology
- Revised by the CSA to cover 375 number of HHs
- 2-stage stratification: 1st stage will use cluster sampling to identify woredas and kebeles (EAs). 2nd stage uses simple random sampling

No.	Region	No. of Woredas	Number of EAs			Total No. of HHs
			Urban	Rural	Total	
1	Somali	6	5	6	11	275
2	Gambela	2	2	2	4	100

Ethiopia Woodfuel Survey

Survey design and questionnaire

- 'National' customisations made e.g. added injera baking as an end use
- Quality control questions incorporated in the QST
- Qs from other topics such as electricity access, gender were added
- Some terms in the QST might be translated to local language
- Conversion to CAPI version
- SPSS will be used for data analysis
- Interviewer manual will be developed

No.	Activities	Wood fuel Pilot Survey in Year 2020			
		Sept	Oct	Nov	Dec
1	Review, Update and Approval of the Questionnaire				
2	Test Running				
3	Procurement (purchasing of equipment)				
4	Preparing progress Project Report				
5	Conducting relevant stockholders workshop				
6	Formulate the training				
7	Develop data entry interface				
8	Filed data collection				
9	Data processing and analysis				
10	Report writing				
11	Project Report and validation Seminar				
12	Final Project Report				

Overall plan for Ethiopia's WF survey

Lessons learned (*in progress*)

- Importance of involving NSO
  → sample design revised by CSA
- Building on existing expertise
  e.g. CAPI software used in other surveys
- Importance of planning for time-demanding processes such as purchasing equipment & allocate resources by official entities

Lessons Learned and Conclusions

- Administrative data can be used to provide insight on: whether 'readily' available data suffice, sample design, interpretation/extrapolation of survey results and more.
- The most crucial activity in conducting HH surveys is sample design and methodology selection.
- 'Pilot testing', conducting trainings and proper planning for equipment needed and other 'logistical' requirements are all essential elements of conducting successful HH surveys.
- Estimates/assumptions made when interpreting /extrapolating survey results should be clearly documented.
- Availability of accurate data on WF HH energy use is essential for developing countries such as Nigeria and Ethiopia and involvement of national NSO is essential!
- While it is crucial to collect accurate bioenergy HH energy use data, there is still a large portion of non-HH energy uses that is not recorded. **…..more work needs to be done!**

Thank you

Contact: statistics@irena.org
www.irena.org/statistics