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ESMAP
Energy Sector Management Assistance Program

Biomass Resource Mapping in Pakistan

INCEPTION REPORT

December 2014

This report was prepared by Full Advantage Co., Ltd. [Lead Consultant], Simosol Oy, VTT Technical Research Center of Finland, and PITCO (Private) Ltd., under contract to The World Bank.

It is one of several outputs from the biomass resource mapping component of the activity '*Renewable Energy Resource Mapping and Geospatial Planning – Pakistan*' [Project ID: P146140]. This activity is funded and supported by the Energy Sector Management Assistance Program (ESMAP), a multi-donor trust fund administered by The World Bank, under a global initiative on Renewable Energy Resource Mapping. Further details on the initiative can be obtained from the ESMAP website.

This document is an **interim output** from the above-mentioned project. Users are strongly advised to exercise caution when utilizing the information and data contained, as this has not been subject to full peer review. The final, validated, peer reviewed output from this project will be a Pakistan Biomass Atlas, which will be published once the project is completed.

RENEWABLE ENERGY RESOURCE MAPPING:
BIOMASS [PHASES 1-3] - PAKISTAN

INCEPTION REPORT

Prepared by:
Full Advantage Co., Ltd. (FA), Thailand (Lead Consultant)
Simosol Oy, Finland
VTT Technical Research Center of Finland (VTT)
PITCO (Private) Limited, Pakistan

Date: 5 December 2014

Country:

Pakistan

Project title and ID:

Renewable Energy Resource Mapping: Biomass [Phases 1-3] - Pakistan
Project ID: P146140

Implementing agency:

The World Bank (Pakistan) in close coordination with the Alternative Energy Development Board (AEDB) of Pakistan

Team of Consultants:

Dr. Ludovic Lacrosse, Team Leader/Biomass Energy Expert (Full Advantage Co., Ltd.)
Dr. Tran Quang Cu, Training Coordinator (Full Advantage Co., Ltd.)
Dr. Jussi Rasinmäki, Remote Sensing/GIS Expert (Simosol Oy)
Mr. Omar Malik, Country Coordinator (PITCO Pvt., Ltd.)
Mr. Qazi Sabir, Local Project Manager (PITCO Pvt., Ltd.)
Mr. Rashid Ahmed, Event Coordinator (PITCO Pvt., Ltd.)

Mission dates:

19th – 26th November 2014

Date of report:

5th December 2014

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1. PROJECT INTRODUCTION AND BACKGROUND

Pakistan is facing a large deficit in electricity supply. A report published by the Government of Pakistan (GoP) in 2013[1] showed that the electricity supply-demand gap has continuously grown over the past five years and has reached 4,500 to 5,500 MW in 2013. Such an enormous gap has led to load-shedding of 12-16 hours across the country.

GoP has set a target to reduce the electricity supply-demand gap to zero by 2017. In order to attain such ambitious target, the GoP has been endeavoring to exploit various options to meet the current and future anticipated electricity needs of the country. Conventional power generation has been the focus of the power master planning that includes large hydro power and fossil fuel-based thermal power projects. As Pakistan has a huge potential of renewable energy resources, the GoP is also promoting the use of renewable energies to increase their shares in total electricity mix of the country.

In order to support the GoP, the World Bank (WB) has been providing assistance towards continued development of renewable power (RE) generation (hydro, biomass, solar and wind), so that the energy sector meets electricity demand in an efficient, affordable and environmentally sustainable manner. One of these assistances is to develop RE resource maps for Pakistan. This project is being implemented by the World Bank in Pakistan in close coordination with the Alternative Energy Development Board (AEDB), a government agency of Pakistan. The project is funded by the Energy Sector Management Assistance Program (ESMAP), a global knowledge and technical assistance program administered by the WB and supported by 11 bilateral donors, and is part of a major ESMAP initiative in support of renewable energy (RE) resource mapping and geospatial planning across multiple countries.

Biomass resource mapping (Phases 1-3) is one component of the ongoing RE resource mapping project in Pakistan. The objective of this biomass mapping component is to support the sustainable expansion of electricity generation from biomass by providing the national government and provincial authorities in Pakistan, and commercial developers, with an improved understanding of the location and potential of biomass resources.

For this purpose, the World Bank has assigned a consulting consortium, including Full Advantage Co., Ltd. (Thailand) as a lead consultant, Simosol Oy (Finland), VTT Technical Research Center of Finland, and PITCO Private Limited (local consultant) to develop a Biomass Atlas for Pakistan with a focus on Punjab and Sindh provinces as the starting points.

2. OBJECTIVES OF THE INCEPTION MISSION

In order to successfully initiate the work, the consulting consortium undertook an inception mission to Pakistan from 19th to 26th November, 2014.

The main objectives of the mission were:

[1] *National Power Policy. Government of Pakistan, 2013.*

- to engage with the Client and the WB/AEDB project team to explain and refine the proposed methodology and timeline;
- to conduct the inception meetings to officially kick off the project;
- to carry out the stakeholder identification and team building exercises;
- to identify and assess sources of data;
- to identify and assess potential competing uses of biomass; and
- to identify and assess potential conflicts with other land-uses or other proprietary issues.

3. PROJECT INCEPTION MISSION

In order get prepared for the project inception mission, the consulting consortium reviewed the relevant existing documentation, especially the reports and publications on the status of biomass energy development and any previous biomass mapping work in Pakistan. The inception mission started in Islamabad for meetings with WB/AEDB representatives and mainly public sector/governmental stakeholders during the Inception Meeting before moving to Lahore (provincial capital of Punjab) and Karachi (provincial capital of Sindh). Inception Meetings were also organized in the two provincial capitals. It allowed meetings with provincial officials, private sector/non-governmental representatives. Several face-to-face meetings with potential data providers were also carried out. A site visit to a paper & board mill in Gujranwala, Punjab province was organized in order to allow the consultants to better understand the current use of biomass in industry. The inception mission itinerary is provided in Annex 1.

3.1. Inception Meetings

3.1.1. Dates and Venues

Three inception meetings were organized in Islamabad, Lahore and Karachi. The dates and venues of these meetings are shown in Table 1.

Table 1: Dates and venues of the inception meetings

No.	Location	Date	Venue
1.	Islamabad	21 Dec 2014	Islamabad Serena Hotel Khayaban-e-Suhrawardy, Sector G5, Islamabad, 44000 Pakistan
2.	Lahore	24 Dec 2014	Avari Hotel 87, Shahrah-e-Quaid-e-Azam, Lahore, 54000 Pakistan
3.	Karachi	26 Dec 2014	Karachi Marriott Hotel 9 Abdullah Haroon Road, Karachi, 10444 Pakistan

3.1.2. Participants

The inception meetings were well attended. The meetings attracted a total of 74 participants (29 in Islamabad, 20 in Lahore and 25 in Karachi), excluding the representatives from the consulting consortium and the clients, i.e. World Bank and AEDB. The participants consisted of government officers (27.0%), universities and research institutions (23.0%), potential project developers and investors (21.6%), international organizations such as UNIDO, WWF, GIZ (10.8%), power utilities (9.4%), professional associations (4.1%) and others, e.g. waste management and advocate companies (4.1%). The list of participants with their contact details is provided in Annex 2.

3.1.3. Contents of the Inception Meetings

The inception meetings are actually information seminars. The three inception meetings have the same agenda as provided in Annex 3.

The inception meetings were opened with a recitation of the Holy Quran. Welcome remarks were then delivered by AEDB and World Bank representatives. Following the introduction of the participants from the Consulting Consortium, Dr. Ludovic Lacrosse (FA) presented the *"Objectives, tasks, activities and outputs of the biomass resource mapping for Pakistan"*. The presentation provided the participants with an overall picture of this one year biomass mapping exercise and of the final expected outputs of the project.

Dr. Jussi Rasinmäki (SIMOSOL) presented the *"Benefits, approach and methods, and required input data for the biomass atlas for Pakistan*." Dr. Jussi Rasinmäki started his presentation with a statement that the final deliverable of the project (i.e., Biomass Atlas for Pakistan) should help commercial project developers in making their decision in building biomass-based power generation plants with specific emphasis on avoiding side effects on food security and existing alternative uses of biomass. This can be simplified as three questions: (1) where to build the biomass-based power plant, (2) with which biomass feedstock and (3) with which biomass-to-electricity conversion technology? Then, Dr. Jussi Rasinmäki presented the approaches and methods which should be used for collecting required data and for producing the biomass atlas.

It was followed by a presentation by PITCO (Mr. Omar Malik/Mr. Qazi Sabir) on the "*Status of biomass resource assessment in Pakistan"*. The main results of several studies financed by various institutions such as the Global Environment Facility (GEF), the United Nations Industrial Development Organization (UNIDO), and the German International Cooperation (GIZ) were presented. These studies focused on the assessment of biomass availability and on the development of a sustainable biomass supply chain for biomass-based electricity and heat generation in Pakistan.

After that, an *"Assessment of current mapping work and status of biomass development in Pakistan"* was jointly presented by Dr. Jussi Rasinmäki (SIMOSOL) and Mr. Qazi Sabir (PITCO). Three key previous studies related to biomass mapping in Pakistan were assessed and presented: (1) Mapping crop type using hyperspectral and multispectral datasets conducted by the National Space Agency of Pakistan (SUPARCO), (2) Survey on the availability of biomass in Punjab and resource mapping study conducted by the Center for Advanced Studies in Energy (CAS-EN) of the National University of Sciences and Technology (NUST) of Pakistan, and (3) a study on sustainable biomass production and biomass mapping for electricity in Pakistan (Scoping Phase) conducted by the Food and Agriculture Organization (FAO).

This presentation was followed by a team exercise on the biomass data sources and their competing and conflicting uses. The discussions were facilitated by Dr. Jussi Rasinmäki and Dr. Ludovic Lacrosse.

In the afternoon, a presentation on implementation methodology and plan was jointly delivered by FA and SIMOSOL. The consultants introduced the organization of the project implementation, its timeframe, work schedule and milestones. They also presented the methodology and plan for

biomass mapping as well as the plan for capacity building and training to transfer technology and knowledge to local counterparts.

A discussion panel was opened for the participants to give their comments and suggestions on the implementation of the project. The inception meeting was closed with the conclusion remarks delivered by the World Bank representative.

The presentations are provided in Annex 4 while selected photos of the inception meetings can be found in Annex 5.

3.1.4. Feedback of Participants

A feedback form was prepared and distributed during the inception meetings in order to get the participants' feedback about the event itself but also about the biomass mapping project. This helped identify some possible roles of the stakeholders in implementation of the project. The template of the feedback form is provided in Annex 6.

Fifty (50) responses (67.6% of total participants in the three inception meetings) were received (17 in Islamabad, 14 in Lahore and 19 in Karachi). The summary of feedback from the participants is provided in Annex 7.

The participants' ratings of the topics relevance and of the meeting in general were analyzed and the results are presented in Tables 2 and 3.

Table 2: Responses on the relevance of the topics presented during the meeting

Rating	No. of responses (% of total responses)			
	In Islamabad	In Lahore	In Karachi	Total
Not so relevant	0 (0.0%)	0 (0.0%)	0 (0.0%)	***0 (0.0%)***
Fairly relevant	2 (11.8%)	1 (7.1%)	2 (10.5%)	***5 (10.0%)***
Relevant	4 (23.5%)	5 (35.7%)	12 (63.2%)	***21 (42.0%)***
Very relevant	9 (52.9%)	7 (50.0%)	2 (10.5%)	***18 (36.0%)***
No answer	2 (11.8%)	1 (7.1%)	3 (15.8%)	***6 (12.0%)***
Total	***17 (100%)***	***14 (100%)***	***19 (100%)***	***50 (100%)***

Table 3: Responses on the overall rating of the meetings

Rating	No. of responses (% of total responses)			
	In Islamabad	In Lahore	In Karachi	Total
Poor	0 (0.0%)	0 (0.0%)	0 (0.0%)	***0 (0.0%)***
Fair	2 (11.8%)	0 (0.0%)	0 (0.0%)	***2 (4.0%)***
Good	6 (35.3%)	7 (50.0%)	15 (78.9%)	***28 (56.0%)***
Excellent	9 (52.9%)	7 (50.0%)	3 (15.8%)	***19 (38.0%)***
No answer	0 (0.0%)	0 (0.0%)	1 (5.3%)	***1 (2.0%)***
Total	***17 (100%)***	***14 (100%)***	***19 (100%)***	***50 (100%)***

It can be seen from the results of analysis that the topics were rated as "relevant" or "very relevant" in 78.0% of the responses (76.4% in Islamabad, 85.7% in Lahore and 73.7% in Karachi). Six participants (12% of total responses in three locations) did not rate the relevance of the meeting topics (see Figure 1).

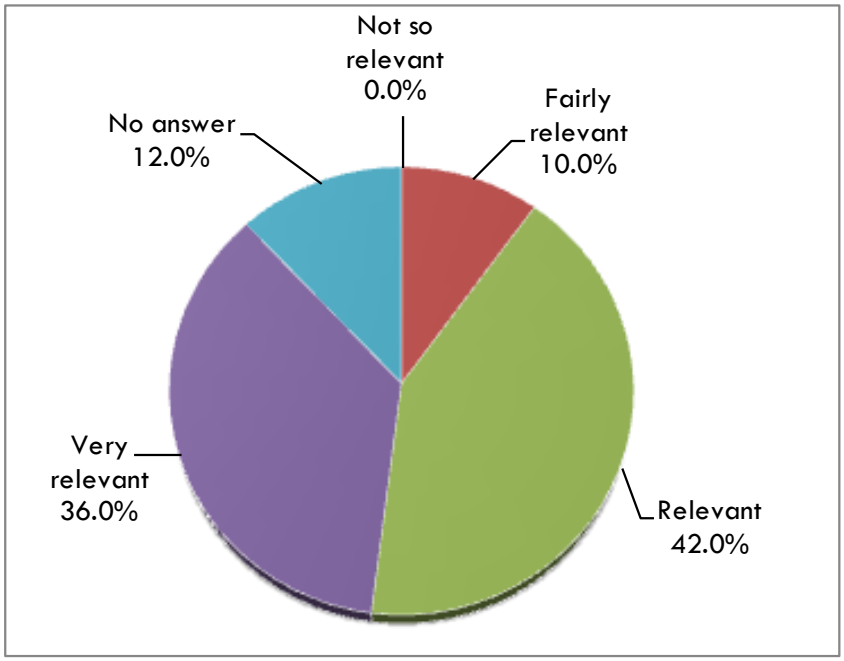

Figure 1: Ratings of relevance of the topics presented in the meetings

The ratings of the inception meetings varied from Islamabad to Lahore and Karachi. In total, the inception meetings were rated "good" by 56.0% and "excellent" by another 38.0% of the respondents (see Figure 2).

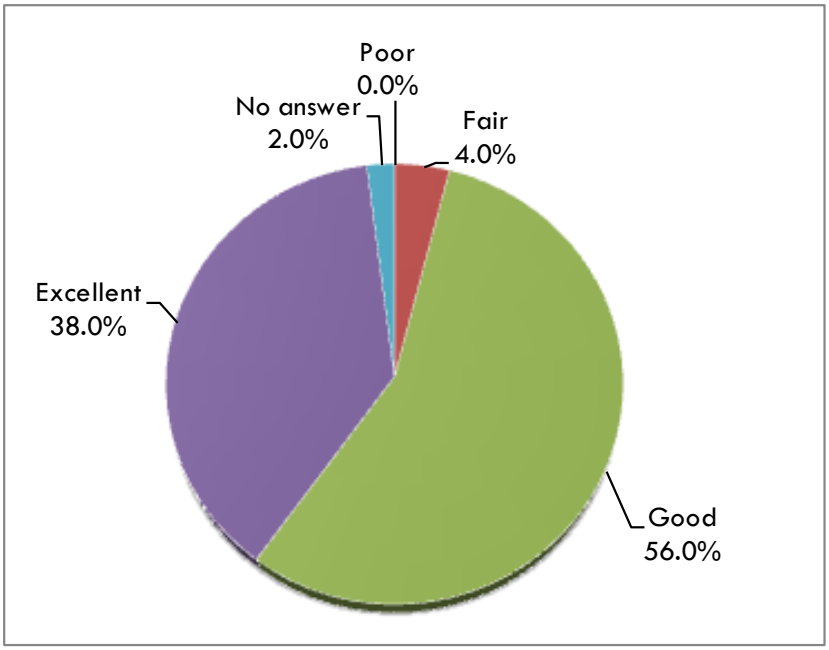

Figure 2: Ratings of the inception meetings in general

Only four respondents from NUST, SUPARCO, Renewable & Alternative Energy Association and Metrological Department (8% of a total of 50 responses) said that they had been involved in renewable energy mapping. The remaining respondents had no knowledge of renewable energy mapping in general and biomass resource mapping in particular. However, most of them (30 of 46 remaining respondents) said that they had experience in planning, development and implementation of renewable energy projects, including biomass power generation projects.

About 90% of the respondents expressed their willingness to participate in implementation of this project. However, the levels of involvement are variable. In relation to the provision and collection of required data for biomass resource mapping, some feedbacks are to be further investigated. They are presented and discussed in Section 4.2.

Some respondents made several important recommendations related to the project which could be summarized as follows:

- Wheat straw should not be considered for energy generation because it is being used as cattle feed;
- Only a part of rice husk, rice straw, corn stalk, cotton sticks could be collected for energy generation;
- Competing uses of biomass must be carefully studied during this study;
- Capacity building of the private sector is required because they will be key players at the end of the day;
- Data on cattle manure and municipal solid waste should be included;
- The field data should be carefully collected and analyzed to ensure the accuracy of the developed biomass atlas.

3.2 Site Visit to Best Paper & Board Mills

A site visit to Best Paper & Board (BPB) Mill in Gujranwala was conducted on 25 November 2014.

The participants were:

- Klas Sander (World Bank)
- Nafees A. Khan (AEDB)
- Ludovic Lacrosse (Full Advantage)
- Jussi Rasinmäki (Simosol)
- Qazi Sabir and Rashid Ahmed (PITCO)
- Ch Abubaker Siddique (Best Paper & Board Mills)
- Muhammad Imran & Arshad Habib (TIE)

Best Paper and Board Mills (BPBM) are producing packaging cardboard (single sheet, not corrugated) from recycled paper.

They have recently invested in a cogeneration plant that produces 4 MW of electricity and 20 tonnes of process steam at 10 bar. They use 100% rice husk as a fuel, except for start-up of the plant when they sometimes use coal. Back-up fuel can be corn cobs or wood chips.

The boiler was supplied by a local company TIE. Its capacity is 40 tonnes of steam at 65 bar. The boiler is coupled to an eleven-stage Triveni extraction steam turbo-generator. Up to 25 tonnes of steam at 10 bar can be extracted for the process.

Rice husk is purchased from three traders on the spot market. It is available all year round. Its price fluctuates from 7 US cents/kg during the rice milling season to 12 US cents/kg during the off-milling season. The mill has an on-site storage capacity of 1 month.

Corn cob's price varies from 7 US cents to 18 US cents/kg. The cost of coal is around 18 US cents/kg.

According to Mr. Ch. Abubaker Siddique, BPBM CEO, the cardboard mill fully relies on the cogeneration plant for steam and electricity. There is no back-up source of energy (electricity and steam). The mill is not connected to the grid. This is current practice for local industries as they wish to be independent from a very unstable grid.

Other mills might be tempted to invest into oil-fired or coal-fired boilers as the current price of these fossil fuels is rather low.

In the past, in order to cover their energy requirements, the mill used diesel gen-sets and small biomass fired steam boilers.

The new cogeneration plant has been operated smoothly on a 24 h/day basis for the last 8 months, having direct positive impact on the production of the mill.

BPBM also envisages organizing the whole fuel supply chain in order to be independent from traders and from the rice husk cost volatility. They plan to make direct contracts with rice mills in the coming year. Rice husk or biomass pellets could also be imported from neighboring countries, while keeping an economical operation of the cogeneration plant.

Two other sister mills in the vicinity are undergoing similar conversion. The simple payback period of such energy investments is around 3 years.

Their investment in this cogeneration plant had no impact on the market price of rice husk, even though they had anticipated some.

Ash is currently dumped and used as ground leveler in the back yard of the mill where a warehouse shall be erected.

The mill and the cogeneration plant supply chains are completely separate. No synergies are expected between the two. The process raw material is sourced from domestic printers & packagers.

4. DATA SOURCE IDENTIFICATION

The objective of this activity was to identify and assess the data sources from existing relevant documentation and from various government agencies, private sector and non-government organizations (NGOs).

4.1. Desk study of existing relevant documentation

The consulting consortium, in coordination with the WB/AEDB project team obtained all existing reports and publications relevant to the biomass resource assessment and mapping in Pakistan. The reviews of these documents are summarized in Table 4.

Table 4: Summarized reviews of existing relevant documents

No.	Title, Author(s) and Reviews
1.	***Sustainable biomass production and biomass mapping for electricity in Pakistan (Scoping Phase), by Ana Kojakovic & Irini Maltsoglou, FAO, 2014*** The study provides an overview of the agriculture and energy context in Pakistan, especially in relation to potential biomass resource use. Furthermore it provides recommendations on suitable methodological approaches for biomass mapping and issues to be considered in the mapping process. It reviews the available national and international data required for the biomass resource assessment and mapping process, and identification of data gaps. It also provides an overview of relevant research and of related previous or existing activities and key institutions and organizations relevant for bioenergy sector. The report does not provide any specific statistics about the quantities of various types of biomass residues available, their utilization, etc., as it is beyond its objectives. However, the detailed methodology and the guidelines provided in the report (regarding collection of biomass residue data and its mapping) can be effectively utilized to fine-tune the project specific data collection plan and mapping methodology.
2.	***Promoting Sustainable Energy Production and Use from Biomass in Pakistan, by Global Environmental Facility (GEF)-UNIDO, 2012*** The study involved assessment of the biomass potential for electricity and biogas generation in Pakistan. It gives an overview of the biomass conversion technologies and biomass gasification for power and heat generation, biomass resource data of the country, and estimation of power and heat generation. The study also elaborates on the technical and financial parameters for SMEs. The report provides a good overview of various types of biomass gasification technologies and presents three demo cases for biomass based power generation using biomass residues of different types. The investment costs associated with different types of technologies are also discussed in detail. This is quite useful information which the Biomass Mapping Project can refer to while recommending similar technologies for different regions in Pakistan. However, the report has lot of deficiencies as far as biomass resource potential is concerned. For instance, the assessment of biomass residues is purely based on desktop survey, which utilizes historical crop data for estimation of different residue types. It does not involve any field survey to investigate the actual/net potential of residues after taking into account their competing uses. Hence, the biomass residue potential and the power generation potential from these residues cannot be considered reliable. The same holds true for forest residues and cattle manure.

3.	***Development of Improved Biomass Applications in Industrial Power Generation, by Internationale Zusammenarbeit (GIZ) GmbH, 2014*** The objectives of the study was to assess the existing biomass supply chain and propose the recommendations for its improvement, and to assess the existing systems using biomass for heat generation and propose recommendations for improved biomass utilization for power generation. The report integrates and presents the key findings and recommendations which All Pakistan Textile Mills Association (APTMA) can use to develop a framework for efficient and sustainable biomass applications for power generation in all APTMA member textile mills. The synthesis report also presents the next steps which could be undertaken by GIZ and APTMA to promote the use of biomass for energy generation in the textile industry of Pakistan. The biomass mapping project can take benefit from the recommendations made in the report for technology use and supply chain mechanism.
4.	***Feasibility study for five biomass based power plants in Punjab Province, by Full Advantage and PITCO, 2014*** The objective of this assignment was to develop the techno-economic feasibility study for low cost power generation for five (5) sites from crop biomass, keeping in view the availability of biomass, biomass supply chain mechanism, zoning, possible generation, cutting edge technology, option to invite private sector, use of electricity, risks and sensitivity analysis, regulatory issues and way forward. The components included: • Biomass resource potential • Biomass preparation • Supply chain mechanism • Biomass feedstock handling and storage • Technological options and business model • Legal aspects • Risk analysis The feasibility studies involved in-depth analysis and validation of the biomass residue data collected by Punjab Agriculture Department for 37 districts of Punjab. So it is an important data source which the project can make use of as far as data collection, verification and mapping of biomass residues in Punjab are concerned.
5.	***Development of Biomass/Bagasse Upfront Feed-in Tariff in Pakistan, by Full Advantage Co., Ltd, 2013*** The scope of work of this assignment was to develop and propose the upfront feed-in tariff model for utility-scale grid-connected bagasse-based power/cogeneration projects. The model has been developed through three major stages: • Technical analysis of bagasse-based power generation/cogeneration projects; • Financial modeling and analysis of bagasse-based power generation/cogeneration projects; • Feed-in tariff modeling and analysis and elaboration of fuel pricing mechanisms for bagasse-based power generation/cogeneration projects.

	The study can be utilized by the project to make technical as well as investment related recommendations for biomass based power generation in Pakistan.
6.	Feasibility Study of High Pressure Cogeneration in a Sugar Mill of Pakistan, by Full Advantage and PITCO, 2014 The High Pressure Cogen-Pak project under the EU funded Switch-Asia Programme aims to promote export of surplus electrical power to the national grid or to allied industrial units, through replication of high pressure cogeneration technologies in the sugar sector by supporting sugar mills through technology standardization, enabling access to finance, and mobilization of relevant public sector authorities. The project is spread among three major components: • Training and Capacity Building of the Sugar Sector and Technology Providers • Improving Access to Finance • Development of a conducive Regulatory Regime Under this project 85 pre-feasibility studies (for all the sugar mills) and 10 detailed feasibilities studies for high pressure cogeneration system will be prepared. The first component of the project would involve detailed data gathering regarding existing configuration of technology and usage of bagasse in the sugar mills. These data can also be utilized by the project for assessment of availability of bagasse for power generation after taking into account its competing usage.
7.	***Biomass Power Plant and Waste Heat Recovery for Cement Producer, by IRG, Engility Group, and PITCO, 2014*** The project aimed to resolve the unreliable electricity supply issues through the following environmentally friendly measures: • Installation of 35-50 MW Coal-cum-Biomass Based Power Plant • Installation of 7 MW Waste Heat Recovery Unit • Replacement of Inefficient Motors with High Efficiency Motors The major tasks undertaken under this assignment were: • Review of Existing Technical Conditions and Operations of the Plant • Preliminary Environmental Overview • Availability assessment of biomass residues (Desktop Study and Field Surveys) • Ultimate analysis of biomass residues • Development of complete biomass fuel supply chain • Assessment of biomass storage requirements • Carbon Credit Analysis • Grid Interconnectivity Analysis The project can take benefit from the data collection approach/methodology utilized in this assignment for assessment of biomass potential in 6 districts (Khushab, Sargodha, Mianwali, Bhakkar, Hafizabad and Mandi Bahauddin) of Punjab. The data already gathered under this project can be used to cross-check the data/information collected for the biomass mapping project.

8.	***Project Design Document for 41 MW biomass based power project, by Packages (Pvt) Limited, 2012*** The project activity involved installation of a new 150 tph steam boiler fired by biomass. Steam from the newly installed biomass boiler is supplied to a steam turbine and generator (rated capacity 41 MW) to provide electricity and heat to paper machines at the Bulleh Shah Paper Mill in Kasur (50 km south of Lahore), Pakistan. Prior to implementation of the project activity, steam was provided by a 200 tph high-pressure boiler and supplemented by a 65 tph low-pressure boiler which used either natural gas or heavy fuel oil. Electricity was supplied from the grid operated by Pakistan Water and Power Development Authority (WAPDA). The PDD provides good information regarding potential biomass residues in the region of the project activity. However, it does not provide any clear-cut approach as to how the competing use of biomass has been evaluated. Hence, its utility with regard to the biomass mapping project is limited.
9.	***Survey on the Availability of Biomass in Punjab Pakistan: Resource Mapping Study by NUST, 2013*** The main objective of the activity was to identify the availability of different biomass in various agriculture areas/regions of Pakistan and to categorize the current and potential usage of biomass in each area depending on the neighborhood industry and residential consumer groups. The data was collected through literature survey, government agencies and through field surveys and industry visits (crop residues in 17 tehsils and rice husk data from 20 rice mills). The biomass mapping project, after due verification, can utilize this data for cross-checking, cross-referencing purpose.
10.	***Crop reports (for last five years) prepared by Provincial Agriculture Departments*** The provincial agriculture departments publish yearly estimates of production data for major and some minor crops in the region. The production data is available for each district in the province. The data is available online and can be collected from the relevant governmental department as well. The data provided in these reports can be utilized to come up with high level (theoretical) assessment of biomass residues in various regions of Pakistan which can be further utilized to prepare initial biomass map and detailed field survey plan for collection of actual on-ground data.

4.2. Interaction with relevant stakeholders

The consulting consortium individually interacted with several relevant stakeholders during the inception mission in order to obtain data needed for the assignment. The names of stakeholders and the possible data which can be provided and/or collected by them are presented in Table 5.

Table 5: Interaction with stakeholders during the inception mission

No.	Name of Stakeholder	Location	Data which can be provided and/or collected by the stakeholder for biomass mapping
1.	National University of Science and Technology (NUST)	Islamabad	- Can provide available data on crop residues (in 17 tehsils) and rice husk (at 20 rice mills) in Punjab - Can collect onsite data for all types of biomass
2.	SUPARCO	Karachi	Following data may be provided: - Vector data for roads, settlements, etc. on high resolution - Quick estimates of different crops types cultivated in different areas of Pakistan twice in a year - Crop mask - Crop production estimates - Land cover (the areas under crops, saline, barren and covered by settlements, etc.) - 2.5 m satellite imagery
3.	University of Agriculture	Peshawar	The university has the capacity and facility to collect the required data on various types of biomass residues in KPK province.
4.	Renewable & Alternative Energy Association of Pakistan (REAP)	Islamabad	- Being an Association, REAP could play a very productive role by involving its members in the project. - REAP is available for any field research - It can assist in organization of workshops, etc.
5.	Pakistan Sugar Mills Association (PSMA)	Islamabad	- It can provide data/information on available resources with respect to production in the sugar sector - It can assist in collection of biomass data related to the sugar sector.
6.	Lahore Waste Management Company (LWMC)	Lahore	- Latest waste related data can be shared for GIS modelling. - Can assist in data collection
7.	Gujranwala Electric Power Company (GEPCO)	Gujranwala	- It can help & assist, share, knowledge, pros, cons of existing installed plants in Muridkay and Kamoky
8.	Nishat Group	Lahore	- Share knowledge on biomass residue data availability - Arrangement of on-site visits for existing biomass plants
9.	University of Agriculture	Faisalabad	- Can provide recommendations with regard to design, research and development of biomass-based power generation technologies.
10.	Central Power Purchase Authority (CPPA) under National	Lahore	- Facilitate mapping through provision of grid availability data

	Transmission and Dispatch Company (CPPA)		
11.	Pakistan Agriculture Research Council	Karachi	- Assist in collection of data from cattle colony
12.	Energy Department, Government of Sindh	Karachi	- Assist the project team for co-ordination among Government departments and Growers/stakeholders for gathering project related data
13.	Karachi Electric	Karachi	- Can provide transmission and distribution network data in GIS format
14.	World Wide Fund - Pakistan	Karachi	Can assist in - Biomass Resource Surveying - EIA
15.	Institute of Space Technology (IST)	Karachi	- Can organise capacity building activities on remote sensing and GIS. - Students may be involved in field data collection

5. TEAM BUILDING

The objective of this activity was to identify and assess the capability of the local counterparts who can help collect onsite data for biomass mapping.

5.1. Potential Local Counterpart(s) for Onsite Data Collection

Two main local counterparts were identified during the inception mission; Pakistan Space & Upper Atmosphere Research Commission (SUPARCO), including the Institute of Space Technology (IST), and the National University of Sciences and Technology (NUST). SUPARCO has two parallel activities for nationwide land use mapping of Pakistan, which are possibly directly applicable for the Biomass Atlas generation. NUST has been conducting a research project in parts of the Punjab province that is a direct match for the methodology planned for this project.

Specific meetings were organized with both SUPARCO/IST and NUST during the inception mission as reported in section 5.2. In addition to this, as mentioned in section 3.1.4, a feedback form was used at the inception meetings to allow interested parties to express their interest in being involved at the execution phase of the project, these parties included:

- National Transmission and Dispatch Co., Ltd.
- Pakistan Agriculture Research Council (PARC)
- K-Electric
- Sindh Forest Department
- University of Agriculture of Peshawar
- Pakistan Sugar Mills Association
- Renewable & Alternative Energy Association of Pakistan
- Lahore Waste Management Company
- Agriculture University Faisalabad

- Bahria University (in Karachi)
- Faran Sugar Mills Ltd. (FSML)

5.2. Meetings with Local Counterpart(s)

5.2.1. Meeting with the National University of Science and Technology (NUST)

Date: 22 November 2014

Participants: Six (6) representatives from the Center for Energy System (CES) of NUST participated in the meeting:

- Dr. Ehsan Ali, Associate Professor
- Mr Shahid Ansari, Assistant Professor
- Ms. Nafeesa Irshad, Research Associate
- Ms. Rabia Shaukat, Research Assistant
- Mr. Faisal Mahmood, Research Scholar
- Mr. Muneeb Auyyum, Research Scholar

Presentation of NUST: Dr. Ehsan and his colleagues presented the study, "Survey on the Availability of Biomass in Punjab Pakistan: Resource Mapping Study". The study is being executed for International Finance Corporation-World Bank Group (IFC-WBG) by Centre for Energy Systems (CES) & Corporate Advisory Council (CAC) of NUST. It is still being finalized

.

In the study, 17 Tehsils (sub-districts) in Punjab were mapped for biomass availability for energy production. The mapping was a combination of remote sensing based land use classification, field survey of harvest residue production levels and existing use of residues. The field survey was conducted as on-site interviews of the farmers by NUST students, assisted by the local extension officers of the Agricultural department. On-site interviews at rice mills were also organized.

Discussions: the following topics were addressed during the meeting:

- How was the field survey arranged and executed in practice: one of the main recommendations of the team was that from the point of view of having access to the farmers, the time period from mid-March to late May would be advisable instead of the previously planned May-July period, during which farmers are very busy and would not have time for interviews.
- Access to the satellite images, provided by SUPARCO: this had not been a straightforward issue, several contact requests and a long negotiation period were needed before the NUST team could get access to the imagery.
- Access to the industrial users of biomass: these were mainly based on personal relationships between the NUST team and the rice mill industry representatives.
- Analysis of results: as the final analysis of the results of the project is still ongoing, the way they are delivered, and the basis on which they are formulated was discussed at length, and some corrections and changes were agreed on between the teams.

Preliminary Assessment and Findings: The methodology applied in the study matches the methodology proposed for this project for the mapping part, i.e. use of satellite images for land use classification, and personal interviews with the farmers and industry representatives for converting the land use classification results to biomass availability information. For the analysis part, differences exist with the NUST study concentrating at delivering the results at the Tehsil level as "at the site of production" resource information without analysis of the feasibility of industrial level utilization of these resources

Having already executed the data collection phase of their project, the NUST team is in a good position to repeat the exercise for this project. However, the effort needs to be scaled to cover the Punjab province in more detail, and extending the field survey to other provinces. Dr. Ehsan proposed to use NUST network with other universities to scale the field survey coverage. This does indeed seem to be a feasible solution, provided that the NUST team can transfer the methodology the other university teams in the network.

The execution of the industrial part of the survey, i.e. producers of secondary crop residues and industrial users of biomass for energy should rather be handled by an organization already having existing links to the industry, such as PITCO.

5.2.2. Meeting with SUPARCO and Institute of Space Technology (IST)

Date: 26 November 2014

Participants: Two (2) representatives from the Institute of Space Technology (IST) and one representative of SUPARCO participated in the meeting:

- Dr. Badar Munir Khan Ghauri, Head of Department, RS & GIS, IST
- Dr. Arjumad Zaidi, Assistant Professor RS & GIS, IST
- Ms. Saadia Naeem, General Manager, SUPARCO

Presentation of SUPARCO/IST: SUPARCO carries on two activities that are of high interest for this project: the Pakistan Land Cover Mapping initiative in collaboration with FAO, and the Crop Situation and Forecast monthly bulletin.

The land cover mapping initiative has produced high-resolution (using SPOT-5 5 m resolution images) land cover classifications for the Punjab and Sindh provinces, Work is currently done for Baluchistan and KPK provinces. The classification uses 13 main land cover classes with total of 36 sub-classes.

The Crop Situation and Forecast monthly bulletin is an operational satellite image based system that has been in production use since the beginning of 2011. It delivers monthly country wide crop situation reports and forecasts based on MODIS and SPOT-5 imagery.

Discussions: A difference between the land cover mapping initiative and this WB/AEDB project was identified when it comes to the target for classification. The mapping initiative aims at categorising the agricultural land use at different types of crop production systems level (irrigated,

flood plain, rain fed), not at crop species level, whereas for this project the identification of crop species over the Kharif-Rabi season rotation is important.

While the Crop Situation and Forecast monthly bulletin was identified as a potentially very promising data source for the project, the discussion did not go into technical details regarding the way it is produced, as none of the participants were directly involved in its production.

The possibility of accessing high-resolution SPOT imagery through SUPARCO was discussed: a formal request for the data needs to be submitted to SUPARCO in order to get an official quotation for the data.

Preliminary Assessment and Findings: The results of both activities of SUPARCO hold great potential for this project, should the raw result data be available i.e. the land cover classification results at the SPOT-5 5 m pixel resolution level, or at the primary segmentation result level.

While the land cover mapping results for the agricultural land are not directly relevant, they could be directly utilised for the rest of the land use classes of this project. For the agricultural land, the Crop Situation and Forecast would seem like an ideal starting point for the Biomass Atlas. Being a continuous process, it would solve one of the primary problems of the Atlas, which is to have up-to-date information content. Should the Biomass Atlas be built based on the Crop Situation and Forecast data, the primary agricultural data could be continuously updated by that process.

6. NEXT ACTIVITIES OF PHASE I

The main remaining activity of Phase I is to prepare a detailed Project Implementation Plan and to revise the overall Work Schedule and Budget accordingly.

Therefore, agreements should be reached with the various stakeholders after defining the extent of their role in Phase II of the project. That includes the provision of existing high resolution land cover classifications, or failing that, the high resolution SPOT satellite images for land cover classification, as well as field and industry data collection.

It is clear that the involvement of SUPARCO would be a huge plus to the project. There is urgent need to contact them via official channels (AEDB/WB) to confirm the availability of their two existing data sources of land cover classifications as the starting points for the project. It is also essential to analyze the feasibility of the Biomass Atlas generation being integrated to the Crop Situation and Forecast program as deployment and continuous update vehicle.

NUST and IST shall be re-contacted by PITCO in order to find out how they will organise the field data collection and what resources would be needed for carrying out these activities.

7. CONCLUSIONS AND RECOMMENDATIONS

There are already a lot of competences in Pakistan in the field of Remote Sensing and GIS that can be tapped. This AEDB/WB project shall build on the strengths of the key identified stakeholders, i.e. SUPARCO, IST, NUST and PITCO.

SUPARCO is definitely the most appropriate partner for the provision of existing land cover classifications.

NUST shall be in charge of the overall co-ordination of the field surveys in close collaboration with IST and the University of Agriculture of Peshawar. This activity will be under the supervision of PITCO and the consortium partners. PITCO will be responsible for the monitoring, evaluation and validation of the field survey activities. The field surveys will be carried out by several universities and institutes across the country, which are part of NUST network. The organization of the capacity building for the field surveys, data collection and use of smart phones services shall be under the responsibility of PITCO with a strong involvement of NUST and IST.

Given its close collaboration with SUPARCO, IST shall organize the capacity building on remote sensing, especially the training to be organized at the end of the project on the Biomass Atlas utilization and updating.

PITCO has a strong relationship both with the public and private sector, more specifically with the industries that produce and/or consume biomass residues and the waste management companies in various municipalities who are already involved in waste (MSW) to energy projects. Therefore, PITCO would be the most appropriate partner for carrying on the industry/municipality survey.

The already existing remote sensing based projects at SUPARCO are promising starting points for this project, potentially allowing shift of focus from baseline land cover mapping to generating a more operationally ready biomass atlas with an updating process that could ideally be coupled with the existing processes at SUPARCO. This opportunity should be explored as a first priority, and institutional support from the relevant parts of the government of Pakistan secured.

Practically, AEDB & WB should negotiate with SUPARCO to get access to:

(i) The segment-based land use classification executed for FAO as a vector dataset from the Pakistan Land Cover Mapping initiative. The current coverage of the classification, i.e. Sindh and Punjab, and access to the further results as they are delivered to FAO.

(ii) The Rabi and Kharif crop species level classification/mask raster (or in vector format if this classification was also segment-based) dataset based on the pan-sharpened multispectral SPOT-5 data classification from the Crop Situation and Forecast monthly bulletin. Latest available results are needed. In relation to this, already at early stage of negotiations, the possibility of having continuous access to the base crop classification results should be raised in order to establish a process that enables to keep the Biomass Atlas up to date by the Atlas hosting party within GoP.

(iii) High resolution digital elevation model (DEM), preferably better than 30m spatial resolution.

(iv) Nation-wide road dataset at highest existing detail level, vector dataset.

(v) Natural water body network and irrigation channel network, vector dataset.

(vi) Power Transmission system infrastructure, vector dataset

(vii) Urban area delineations, vector or raster dataset. (part of (i) for Punjab and Sindh).

(viii) Security area delineations, vector dataset.

(ix) Protective and conservation area delineations, vector dataset.

8. ANNEXES

Annex 1: Completed Inception Mission Itinerary

Day	Date	Time	Activity	Location/Flight	Persons Involved
Tuesday	18-Nov	07.00-02.29 (19-Nov)	Travel (Helsinki to Islamabad)	EY 1538, AB 1752, EY 231	SIMOSOL (1)
Wednesday	19-Nov	18.50 - 22.25	Travel (Bangkok to Islamabad)	TG 349	FA (2)
Thursday	20-Nov	10:30 - 12:00	Consortium Internal Meeting	Rakaposhi Café, Serena Hotel, Islamabad	FA (2), SIMOSOL (1) and PITCO (3)
		15:00 - 17:00	Meeting with WB Islamabad	WB Office, Islamabad	FA (2), SIMOSOL (1) and PITCO (3)
Friday	21-Nov	09.30 - 16.00	Inception Meeting - Islamabad	Shamadan Hall, Serena Hotel, Islamabad	Consortium, WB, Client/Stakeholders in Islamabad
		17.00-21.30	Travel (Islamabad to Lahore)	By road	PITCO (1)
Saturday	22-Nov	10.00 - 14.00	Team Building with NUST	NUST Campus	Consortium, NUST
		14.00-20.00	Travel (Islamabad to Lahore)	By road	FA (1), SIMOSOL (1) and PITCO (2)
		23.55-06.30	Travel (Islamabad to Bangkok)	TG 350	FA (1)
Sunday	23-Nov	18.00-20.00	Consortium Internal Meeting	Avari Hotel Lahore	FA (1), SIMOSOL (1)
		20.00-23.30	Finalization of event and arrangements at Avari Hotel	Indus Hall, Avari Hotel Lahore	PITCO (2)
Monday	24-Nov	09.30 - 16.00	Inception Meeting - Lahore	Indus Hall, Avari Hotel, Lahore	Consortium, WB, Client/Stakeholders in Lahore
Tuesday	25-Nov	08.30 - 15.30 18:00-19:45	Site(s) Visit(s) Travel (Lahore to Karachi)	Best Paper & Board Mill, Kamoke PK 305	Consortium, WB/Client FA (1), SIMOSOL (1) and PITCO (3)
Wednesday	26-Nov	09.30 - 16.00	Inception Meeting - Karachi	Marriott Hotel, Karachi	Consortium, WB, Client/Stakeholders in Karachi
		19.00-20.45	Travel (Karachi to Lahore)	PK 306	PITCO (3)
		23.55 - 06.30	Travel (Karachi to Bangkok)	TG 342	FA (1)
Thursday	27-Nov	13.55-17.25	Travel (Karachi to Helsinki)	TK 709, TK 1763	SIMOSOL(1)

Annex 2: List of Participants

November 21, 2014, Serena Hotel, Islamabad					
#	**Name**	**Cell No.**	**Email**	**Designation**	**Organization Name**
1.	Nafees Ahmad	0300-9808858	nafees.kundi@gmail.com	Advisor-I.C	Alternative Energy Development Board
2.	Jussi Rasinmaki	00358-400382364	jussi.rasinmaki@simosol.fi	Chief Operating Officer	Simosol Oy
3.	Rashid Ahmed	0300-2308768	rashid.ahmed@pitcopk.com	Event Coordinator	PITCO (Pvt.) Ltd.
4.	Klas Sander	001(571)2656918	ksander@worldbank.org	World Bank Representative	World Bank
5.	Ludovic Lacrosse	0066-25647923	ludo.l@full-advantage.com	Team Leader	Full Advantage Co., Ltd
6.	Tran Quang Cu	0066-25647921	tran.homeoffice@gmail.com	Training Coordinator	Full Advantage Co., Ltd
7.	Tasleem Akhtar	0315-8859265	tasleemakhtar@gmail.com	General Manager	Bio Energy Technology Application Pakistan (Beta, Pak)
8.	Muhammad Yaseen	0334-2892242	yaseen_ibupoto@yahoo.com	Assistant Director (BE)	Alternative Energy Development Board
9.	Omar M Malik	0300-8463743	omar.malik@pitcopk.com	Country Manager	PITCO (Pvt.) Ltd.
10.	Inayat Ullah Khan	0300-9779206	iukhan_51@yahoo.com	Secretory General	Pakistan Sugar Mills Association
11.	Attiq-ur Rehman	051-910655	attiqurehman@pbs.gov.pk	Director	Pakistan Beuru of Statistics
12.	Prof. Dr. M. Afzal	0333-9406090	afzal@aup.edu	Professor	The University of Agriculture of Peshawar
13.	Prof. Dr. M. Akmal	091-9218597, 0300-5883292	akmal@aup.edu, akmal_m@hotmail.com	Professor	The University of Agriculture of Peshawar
14.	Farhan Manzar Ahmed	051-8454740	farhanahmed@ffc.com.pk	Business Development Executive	FFC Energy Limited
15.	Nayyar Iqbal	051-9252905	iesco@iesco.com.pk	Additional Chief Executive	Islamabad Electric Supply Company
16.	Anjum Ahmed	051-2279641-6	aahmad2@worldbank.org	Senior Energy Specialist	World Bank
17.	Nadeem Ahmad	051-9100111	nadeem@ppib.gov.pk	Senior Manager	Private Power & Infrastructure

					Board
18.	Joudent Ayaz	051-9205792, 9008313	support@aedb.org	Director General	Alternative Energy Development Board
19.	Mir Ahmad Shah	0300-5221718	mirshah56@gmail.com	Exective Secretary	Renewable & Alternative Energy Association of Pakistan
20.	Shahid Bokhari	0308-5242209	shahid.bokhari@yahoo.com	General Secretary	Renewable & Alternative Energy Association of Pakistan
21.	Haseeb Ur Rehman	051-9106515	pbs@pbs.gov.pk	Statstical Officer	Pakistan Beurue of Statistics
22.	Dr. Ehsan Ali	0313-5520950	dr.ehsan@ces.nust.edu.pk	Assistant Professor	National University of Science & Technology
23.	Qazi Sabir	0300-6252122	qazi.sabir@pitcopk.com	Project Manager	PITCO (Pvt.) Ltd.
24.	Asjad Imtiaz Ali	051-9222365, 9222360-63	ceo@aedb.org	Chief Operating Officer	Alternative Energy Development Board
25.	Dr. Naveed Akhtar	0345-9652285	urwanaveed@yahoo.com; ariturnab@hotmail.com	Senior Director	Agriculture Research Institute, Tarnab, Peshawar
26.	Dr. M. Aslam Gill	051-9204650	aslamgill@hotmail.com	Food Security Commissioner-I	Ministry of National Food Security & Research (NFS&R)
27.	Mohammad Saeed	0300-5191617	mohammad.saeed@giz.de	Technical Advisor	GIZ REEE Project
28.	Mohammad Irshad Khan	051-2851175	mohammad.irshad@giz.de	Chief Technical Officer	GIZ REEE Project
29.	B. Meyeofer	0300-5041724	Meyhoefer@giz.de	Principal Advisor (PA)	GIZ REEE Project
30.	Frunk Fecher	051-2851175	giz-pakistan@giz.de	Social Advisor (SA)	GIZ REEE Project
31.	Asif Farid	0302-8566393	asif.farid@giz.de	Technical Advisor	GIZ REEE Project
32.	Amin Butt	051-8354821	amin.butt@unido.org	Biomass Expert	United Nation Industrial Development Organization (UNIDO)
33.	Muhammad Ahmad	0331-5311146	m.ahmad@unido.org	National Project Manager	United Nation Industrial Development Organization
34.	Dr. Munir Ahmed	0345-4055200	drmunir.dbei@hotmail.com	Director General	Pakistan Agriculture & Research Center, Islamabad

35.	Dr. Tayyaba Noor	051-90855105	tayyaba.noor@ces.nust.edu	Lecturer	National University of Science & Technology
36.	Dr. Arshad Hussain	0333-5305800	arshad.hussian@ces.nust.edu.	Head of Chemical Department	National University of Science & Technology
37.	Noor Saleem Khan	0345-5132212	noorsaleem@nepra.org.pk	Assistant Director	National Electric & Power Regulatory Authority
38.	Imtiaz Hussain Balouch	0306-5417747	ihussain@nepra.org.pk	Director (Licensing)	National Electric & Power Regulatory Authority
39.	Dr. Basharat Hussain	0333-5768438	basharathasan@gmail.com	Director General (Power)	Alternative Energy Development Board
40.	Faiza Lodhi	051-2099500, 2800028-31	pmpk.info@pmi.com	GAP Coordinator	Philip Morris International
41.	Muhammad Jawad	0332-5163625	geojawad@hotmail.com	Assistant Manager	SUPARCO
42.	Engr. Khurram Durrani	091-9223631	khurram.durrani@kpkep.gov.pk	Manager	Energy & Power Dept., KPK
43.	Nadeem Khan Lodhi	0322-4358964	asst.admin@etrisoft.com	Assistant Admn Manager	PITCO (Pvt.) Ltd.
November 24, 2014, Avari, Lahore					
#	**Name**	**Cell No.**	**Email**	**Designation**	**Organization Name**
1.	Muhammad Munir Anjum	0334-4221200	muniranjum@nishatmail.com	General Manager (Operation)	Nishat Group (Power Division)
2.	Dr. Anjum Munir	0345-4055200	anjum.munir@uaf.edu.pk	Coordinator for Energy System Engineering	Agriculture University Faisalabad
3.	Syed Muhammad Ahmad	0335-6152222	ahmad@nishatmail.com	Deputy Manager Electrical	Nishat Group (Power Division)
4.	Jussi Rasinmaki	00358-400382364	jussi.rasinmaki@simosol.fi	Chief Operating Officer	Simosol Oy
5.	Wasif Azhar	0307-4363288	wasifazhar@hotmail.com	Senior Manager-Operations (WTE)	Lahore Waste Management Company
6.	Rana Faisal	0321-5424244	ranafaisal101@gmail.com	Assistant Manager (WTE)	Lahore Waste Management Co.
7.	Muhammad Riaz	0300-8026286	riaz1962@hotmail.com	Chief Merologist	PMD Flood Forecasting Division, Lahore
8.	Nazakat Hussain	0301-5292553	obm.nazakat@gmail.com	Technical Manager	Chionot Power Limited

9.	Nafees Ahmad	0300-9808858	nafees.kundi@gmail.com	Advisor-IC	Alternate Energy Development Board
10.	Ludovic Lacrosse	0066-25647923	ludo.l@full-advantage.com	Team Leader	Full Advantage Co., Ltd
11.	Qazi Sabir	0300-6252122	qazi.sabir@pitcopk.com	Project Manager	PITCO (Pvt.) Ltd
12.	Anjum Ahmed	051-2279641-6	aahmad2@worldbank.org	Senior Energy Specialist	World Bank
13.	Engr. Muhammad Hanif Memon	042-99201487, 0300-3976720	hurryboy38@hotmail.com	Manager-III	National Transmission & Dispatch Company Ltd. (CPPA)
14.	Bilal Hussain	0331-4708016	gillani_89@yahoo.com	Assistant Manager (Tech)	National Transmission & Dispatch Company Ltd. (CPPA)
15.	Mahmood Alam	0347-0010120	dirtech@lesco.gov.pk	Director S&I	Lahore Electric Supply Company
16.	Muhammad Asghar	0345-7734444, 061-9220192	eepemepco@gmail.com, asgharghallo@gmail.com	Additional Director (P&E)	Multan Electric Power Company
17.	Amir Janjua	042-35811960	amir.janjua@bullehshah.com.pk	Supply Chain Management Director	Bulleh Shah Packaging Ltd.
18.	Ansar Mehmood Chatta	042-99212374	fishdept@hotmail.com	Deputy Director Fisheries	Fisheries Department, Punjab
19.	Muhammad Imran	042-99212374	Imranadf@gmail.com	Assistant Director	Fisheries Department, Punjab
20.	Klas Sander	001(571)2656918	ksander@worldbank.org	World Bank Representative	World Bank
21.	Malik Muhammad Mukhtar	0340-0001087	mktgepco@gmail.com	Director Marketing	Gujranwala Electric Power Company
22.	Mansoor Nasir	0346-4442630	mnr_nsr@yahoo.com	Chief Engineer CPPA	National Transmission & Dispatch Company Ltd. (CPPA)
23.	Shaukat Ali Gill	055-9200570, 0340-0001007	dm(o,m)@gmail.com	Chief Executive (Operation Director)	Gujranwala Electric Power Company
24.	Rashid Ahmed	0300-2308768	rashid.ahmed@pitcopk.com	Event Coordinator	PITCO (Pvt.) Ltd.
25.	Dr. M. G Dogar	0300-81810941	drmgdns786@gmail.com	Project Coordinator	Agriculture Department
26.	Sajid Nasir	042-99200705	fieldwing@gmail.com	Assistant Agriculture Engineer	Agriculture Department
27.	Salis Usman	0334-9703178	salisusman@yahoo.com	Additional Manager CPPA	Centre Power Purchase Authority

28.	Nadeem Khan Lodhi	0322-4358964	asst.admin@etrisoft.com	Assistant Admn Manager	PITCO (Pvt.) Ltd.
November 26, 2014, Marriott Hotel, Karachi					
#	**Name**	**Contact #**	**Email**	**Designation**	**Organization Name**
1.	Niaz Ali Shaikh	0300-3112295	Directorpowerdevelopementsindh @gmail.com	Director, Power Division, Sindh	Energy Department Sindh
2.	Jussi Rasinmaki	00358-400382364	jussi.rasinmaki@simosol.fi	Chief Operating Officer	Simosol Oy
3.	Nafees Ahmad	0300-9808858	nafees.kundi@gmail.com	Advisor-IC	Alternate Energy Development Board
4.	Rashid Ahmed	0300-2308768	rasid.ahmed@pitcopk.com	Event Coordinator	PITCO (Pvt.) Ltd.
5.	Ludovic Lacrosse	0066-25647923	ludo.l@full-advantage.com	Team Leader	Full Advantage Co., Ltd
6.	Qazi Sabir	0300-6252122	qazi.sabir@pitcopk.com	Project Manager	PITCO (Pvt.) Ltd.
7.	Akhlaqullah	0314-2357878	akhlaq.ullah@ssjdgroup.com	General Manager	SSJD Bioenergy Ltd.
8.	Areesha Haider	0346-2070706	arisha.haider@ke.com.pk	Manager	K-Electric
9.	Waqar Azeem	0345-8217039	waqar.azeem@ke.com.pk	Deputy Manager	K-Electric
10.	Shakil Ahmad Shaikh	0300-8200064	shakil_aewm@hotmail.com	Deputy Director Agriculture	Agriculture Department
11.	Mohammad Sultan	0333-2616320	akhterp_dr@yahoo.com	Additional Officer Incharge	PCRET
12.	Klas Sander	001(571)2656918	ksander@worldbank.org	World Bank Representative	World Bank
13.	Nadeem Khan Lodhi	0322-4358964	asst.admin@etrisoft.com	Assistant Admn Manager	PITCO (Pvt.) Ltd.
14.	Sardar Abdul Nabi Taheem	021-99218365	sheranpur@hotmail.com	Sr. Chief Energy	P&D Department, Sindh
15.	Sardar Sarfaraz	0334-3204566	sarfarazmet@hotmail.com	Director	Metrological Department
16.	Fatima Hafsa	0322-3015407	fhafsa@wwf.pand.org	PD Officer	WWF (South) Karachi
17.	Aziz Ali Khawaja	0300-8372307	ncppspp@gmail.com	Manager (PPP)	Hyderabad Electric Supply Company, Hyderabad
18.	Khalid Hayat Khan	0336-3089332	khalid.hayat@faran.com.pk	Chief Operating Officer	Faran Sugar Mills Ltd.
19.	Hina Ali	021-36619110	hali@gmail.com	Advocate	A&A Associates

20.	Ghazanfar Ali	0345-2326838	ghazanfar.ali9@gmail.com	Researcher/ Student	Dadabhouy Institute , Karachi
21.	Kamran Soomro	0300-2371506	kamisoomro75@hotmail.com	Senior Engineer	Pakistan Agriculture Research Council
22.	Ibad Ur Rehman	0333-2136070	ebad.rehman@nec.com.pk	Manager	Cleaner Production Institute
23.	S. Ayaz Ahsan	0300-9207906	ayaz.ahsan@nec.com.pk	Consultant	Cleaner Production Institute
24.	Saadia Naeem	21-34690765	abmaajid@yahoo.com	General Manager	SUPARCO
25.	Dr. Badar Ghauri	0300-2731902	b_ghauri@yahoo.com	Head of Deptt. IST, RS GIS	Institute of Space Technology
26.	Arjumand Zaidi	0333-3879981	arjzaidi@gmail.com	Assistant Professor	Institute of Space Technology
27.	Bilal Bawany	021-111-229-269	bilal@bawany.com.pk	Executive Director	Faran Sugar Mills Ltd.
28.	Syed Ghulam Mehdy Shah	0331-3452540		Assistant Chief Engineer	P&D Department, Sindh
29.	Syed Shabir Raza Zaidi	0331-3452540	fisheriespublicity@hotmail.com	Deputy Director Fisheris	Director General Fisheries
30.	Faisal Sadiq	022-9260209	doforesthyd@hotmail.com	Deputy Forest Officer	Sindh Forest Department
31.	Syed Waqas Qadri	0321-8717817	syedwaqasqadri@gmail.com	Researcher	Bahria Unversity, Karachi
32.	Abdul Hameed			Sr. Metrologist	Sustainable Energy S.I

Annex 3: Agenda of the Inception Meetings

09:30 - 10:00	Arrival of participants and registration
10:00 - 10:05	Recitation of the Holy Quran
10:05 - 10:15	Welcome remarks - Alternative Energy Development Board (AEDB), Government of Pakistan, and the World Bank
10:15 - 10:30	Introduction of the Participants - WB, AEDB, Consulting Consortium
10:30 - 10:40	Introduction of the consulting consortium by Dr. Ludovic Lacrosse (FA)
10:40 - 11:00	Biomass Resource Mapping - Objectives, Tasks, Activities and Outputs by Dr. Ludovic Lacrosse (FA)
11:00 - 11:20	Tea/Coffee Break
11:20 - 11:45	Biomass Resource Mapping for Pakistan: Benefits, Approach and Methods, and required Input Data for Biomass Atlas by Dr. Jussi Rasinmaki (SIMOSOL)
11:45 - 12:10	Status of Biomass Resource Assessment in Pakistan by Mr. Omar Malik (PITCO)
12:10 - 12:40	Assessment of Current Mapping Work and Status of Biomass Development in Pakistan by Dr. Jussi Rasinmaki (SIMOSOL) and Mr. Qazi Sabir (PITCO)
12:40 - 13:10	Team Exercise (Session 1): Biomass - Data Sources, Competing Uses and Conflicts by Dr. Ludovic Lacrosse (FA) and Dr. Jussi Rasinmaki (SIMOSOL)
13:10 - 14:00	Lunch
14:00 - 14:40	Team Exercise (Session 2): Biomass - Data Sources, Competing Uses and Conflicts by Dr. Ludovic Lacrosse (FA) and Dr. Jussi Rasinmaki (SIMOSOL)
14:40 - 15:10	Implementation Methodology and Plan by Dr. Ludovic Lacrosse (FA), Dr. Jussi Rasinmaki (SIMOSOL) and Dr. Tran Quang Cu (FA)
15:10 - 15:30	Tea/Coffee Break
15:30 - 15:50	Team Exercise: Implementation Methodology and Plan by Dr. Ludovic Lacrosse (FA) and Dr. Jussi Rasinmaki (SIMOSOL)
15:50 - 16:00	Concluding Remarks by WB

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ESMAP
Energy Sector Management Assistance Program

BIOMASS RESOURCE MAPPING – PAKISTAN [PHASES 1-3]

BIOMASS RESOURCE MAPPING FOR PAKISTAN
OBJECTIVES, TASKS, ACTIVITIES AND OUTPUTS

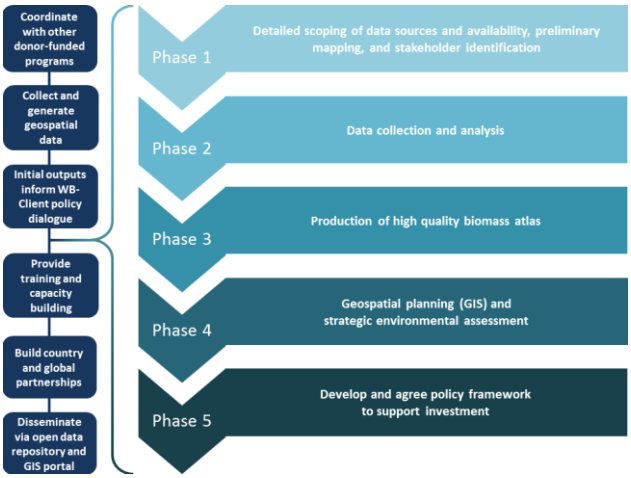
Dr. Ludovic Lacrosse
Team Leader and Biomass Expert

FULL ADVANTAGE SIMOSOL VTT PITCO

CONDITIONS OF USE

2

Five Phases of Biomass Resource Mapping



- This assignment covers the first three phases

Background Information

- **Project title:** Renewable Energy Resource Mapping: Biomass [Phases 1-3] – Pakistan
- **Funded by:** World Bank
- **Implementing agency:**
  - World Bank (Pakistan) in close collaboration with the Alternative Energy Development Board (AEDB) of Pakistan
- **Project timeframe:** 12 months (Nov 2014 – Nov 2015)
- **Consultants:**
  - Full Advantage Co., Ltd. (FA), Thailand (Lead)
  - SIMOSOL Oy, Finland
  - VTT Technical Research Center of Finland (VTT)
  - PITCO (Private) Limited, Pakistan

Project Objectives

- **Overall objective:** to support the sustainable expansion of electricity generation from biomass by providing the national government and provincial authorities in Pakistan, and commercial developers, with an improved understanding of the location and potential of biomass resources.

- **Specific objective:** to support renewable energy mapping and geospatial planning for biomass resources in Pakistan

Phase 1: Tasks and Activities

- ***Task 1.1: Project Inception***
  - Inception meetings
  - Individual meetings with key stakeholders
  - Site visits to existing biomass users
- ***Task 1.2: Data Source Identification***
  - Desk study of existing documentation
  - Interact with relevant government stakeholders to obtain data for biomass resource mapping
  - Interact with relevant non-government stakeholders to obtain additional data

Phase 1: Tasks and Activities (Cont.)

- ***Task 1.3: Team Building***
  - Identify potential local counterpart(s) for onsite data collection (to be done in Phase 2)
  - Meet with and agree on local counterpart(s) for the scope of work, budget and timeframe for onsite data collection
- ***Task 1.4: Implementation Planning***
  - Develop an Implementation Plan
  - Develop a Work Schedule

Phase 1: Expected Outputs/Deliverables

1) Inception Report (Dec 2014)
2) Implementation Plan including a Work Schedule (Dec 2014)

Phase 2: Tasks and Activities

- ***Task 2.1: Remote Data Collection***
  - Gather available satellite images
  - Images analysis
  - Preparation of smartphone inventory system and software menus for on-site data collection
- ***Task 2.2: On-site Data Collection***
  - Conduct a training workshop on on-site data collection
  - Conduct on-site data collection
  - Acquire GIS data of other driving components (e.g., transport infrastructure network, water supply network, power T&D system, etc.)

Phase 2: Tasks and Activities (Cont.)

- ***Task 2.3: Data Analysis and Mapping***
  - Conduct data analysis and integration
  - Product a draft biomass resource map(s)
- ***Task 2.4: Stakeholder Validation Workshop***
  - Conduct a one-day multi-stakeholder workshop for validation of the data and draft biomass resource map(s)

Phase 2: Expected Outputs/Deliverables

1) A comprehensive database necessary for biomass resource mapping (including raw data files)
2) Draft biomass resource map(s)
3) A stakeholder workshop for data validation to identify any data/knowledge gaps

Phase 3: Tasks and Activities

- ***Task 3.1: Final Analysis and Mapping***
  - Conduct final analysis of the data and the map(s) based on stakeholder feedback
- ***Task 3.2: Production of Final Biomass Atlas and Associated Datasets***
  - Produce final datasets in digital format
  - Produce final Biomass Atlas for Pakistan

Phase 3: Tasks and Activities (Cont.)

- ***Task 3.3: Dissemination Workshop and Training***
  - Conduct a one-day multi-stakeholder workshop to disseminate the results of the study
  - Conduct a two-day training for the selected local counterparts in using the biomass atlas and the mapping methodology

Phase 3: Expected Outputs/Deliverables

1) Biomass Atlas report including associated GIS files and datasets
2) Dissemination workshop and training

Thank you!

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BIOMASS RESOURCE MAPPING – PAKISTAN [PHASES 1-3]

BIOMASS RESOURCE MAPPING FOR PAKISTAN
BENEFITS, APPROACH AND METHODS, AND REQUIRED INPUT DATA FOR THE BIOMASS ATLAS

Dr. Jussi Rasinmäki (Simosol)

FULL ADVANTAGE SIMOSOL VTT PITCO

CONDITIONS OF USE

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Benefits

- The final deliverable should help commercial developers in aiming their efforts in building biomass based electricity generation capacity
  - With specific emphasis on avoiding side effects on food security and existing alternative uses
- This can be simplified as three questions:
  - Where to build the power plant?
  - For which feedstock?
  - Using which conversion technology?

Approach

- Where?
  - We need to use spatial mapping, i.e. produce maps that are useful for the project developers
- Which feedstock?
  - We need to put the feedstock resources on the map by type of feedstock, i.e. land use mapping down to crop species level for agricultural land

Approach (Cont.)

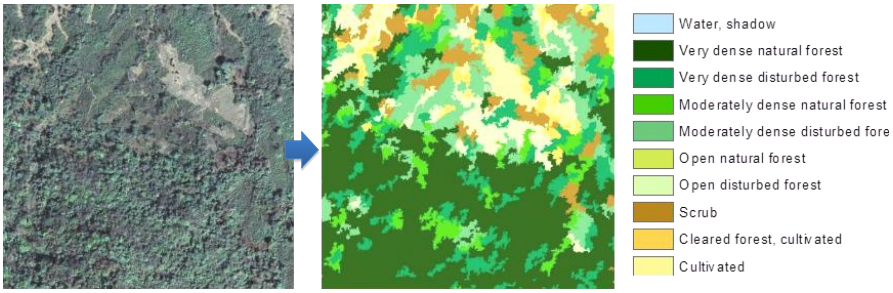
- Which technology?
  - Combine the different aspects:
    - Feedstock supply information
    - Technical and investment profile of the technology
    - Infrastructure
  - ➢ Potential for the given technology at the given place, the final output

Methods

- Which feedstock, i.e. biomass resource potential?
  - Satellite image based land use classification
  - For agricultural crops, regional field survey on
    - Productivity
    - Residue-to-crop ratio
    - Farming practises (residues utilised in farming, animal husbandry)
    - Other uses of harvest residues
    - Market prices
    - Field reference data for the satellite image inventory

Methods – Satellite image inventory

- From a satellite image to land use classification:



Original satellite image

Complete classification of land use classes for the same area

Methods – Satellite image inventory

- Based on Landsat 8 images
  - Free, frequent revisit times, reasonable spatial resolution for the purpose
  - Defines the spatial mapping unit for the project, 30 m x 30 m
- Time series analysis of images over a year to cover Kharif-Rabi crop rotation

Methods – Field survey

- Serves two purposes:
  1. The satellite image interpretation needs very accurately located field observations; the results for it are only as accurate as the field data
  2. Information for converting the *theoretical biomass potential* to *sustainable technical potential* for crops
- To be executed by a local partner
- Done with the help of inventory software on smart phones (cf. the "very accurately located field observations")

Concept – Biomass Potential

- Crop yield -> amount of harvest residues = ***Theoretical biomass potential***
  - Minus own use of the harvest residues (fodder, fertilizer, …)
  - Minus other existing uses of the harvest residues
  - Minus amount not feasible for collection & delivery

  = **Sustainable technical potential**

Required Data

- Besides the field survey data, additional data are needed from official statistics and GIS data sets:
  - Location and size mapping of other biomass resources, not detectable from satellite images, using available statistics:
    - Processing site producing secondary crop residues like bagasse, rice husk
    - Stable based feeding sites for cattle & poultry
    - Industrial wood processing sites
    - Municipal solid waste
    - Existing biomass based power plants

Required Data (Cont.)

- Location and size of current biomass resource users:
  - Sugar mills
  - Textile industry
  - Cement industry
  - Paper industry
  - …

Required Data (Cont.)

- GIS data for
  - Geography
  - Transport infrastructure network
  - Water supply network
  - Security areas
  - Protective and Conservation areas
  - Urban areas
  - Power Transmission system infrastructure

Methods – Biomass For Electricity Modelling

- The final step is the GIS model building, combining the different data sets:
  - Feedstock supply information from the satellite image analysis and field survey (=>***Biomass Atlas: sustainable technical potential***)
  - Technical and investment profile of the technology
  - Infrastructure
- ➢ Potential for the given technology at the given place (=> ***Biomass Atlas: investment potential***)

Deliverables

- The GIS datasets produced during the project
  - Raw GIS datasets
  - **Biomass Atlas:** sustainable technical potential
  - **Biomass Atlas:** investment potential
- The GIS model used to generate the Biomass Atlas datasets
  - Transparent parameterisation
  - Ability to update the Atlases as conditions change
    - E.g. financial parameters, new power plants, change in cultivated crops, change in other uses

Thank you!

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BIOMASS RESOURCE MAPPING – PAKISTAN [PHASES 1-3]

CURRENT STATUS OF BIOMASS RESOURCE ASSESSMENT

Omar Malik
Project Coordinator

FULL ADVANTAGE

SIMOSOL

VTT

PITCO

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Brief Description of Agriculture Sector in Pakistan

- Pakistan is a country which is heavily dependent on Agriculture Sector in term of its GDP growth.
- Agriculture Sector being the dominant sector contributes 21.4% to GDP.
- More then 45% of the labor workforce is associated with the Agriculture Sector.
- It also contributes in the growth of other sectors of the economy.
  - Pakistan is 5th largest sugarcane producer in the world
  - Pakistan is 4th largest cotton producer in the world
  - Pakistan is 8th largest wheat producer in the world

Major Crops, Yields and Area under cultivation in Pakistan*

	2008-2009		2009-2010		2010-2011	
Name of Crops	Yield (000 tons)	Area Under Cultivation (000 Hectares)	Yield (000 tons)	Area Under Cultivation (000 Hectares)	Yield (000 tons)	Area Under Cultivation (000 Hectares)
Wheat	24,032.9	9,046.0	23,310.8	9,131.6	25,213.8	8,900.7
Rice	6,952.0	2,962.6	6,882.7	2,883.1	4,823.3	2,365.3
Maize	3,593.0	1,052.1	3,261.5	935.1	3,707.0	974.2
Sugarcane	50,045.4	1,029.4	49,372.9	942.8	55,308.5	987.6
Cotton	11,819.0	2820.0	12,913.4	3,105.6	11,560.1	2,689.1
All Pulses**	992.4	1,464.8	763.3	1,394.8	656.0	1,328.8

* Data Source: Agricultural Statistics of Pakistan 2010-11 by Pakistan Bureau of Statistics
** All Pulses include Gram, Mung, Mash, Masoor(Lentil), Mattar, Other Kharif & Rabi Pulses

Biomass Estimates of Pakistan

Name of Crops	Yield (000 tons) 2010-2011	Biomass Residue (Residue-to-Crop Ratio)	Biomass Production (000 tons)	Biomass Collection efficiency (000 tons) (65%)	Available Biomass for Electricity Generation (000 tons) (10%)
Wheat	25,213.8	Wheat Straw 100%	25,213.8	16,389	1,638.9
Rice	4,823.3	Rice Straw & Rice Husk (130%)	6,270	4,076	407.6
Maize	3,707.0	Maize Straw & Maize Cob (225%)	8,341	5,421	542.1
Sugarcane	55,308.5	Sugarcane Trash (20%)	11,062	7,190	719.0
Cotton	11,560.1	Cotton Sticks (400%)	46,240	30,056	3,005.6

Previous Biomass Resource Assessments in Pakistan

Previously many activities/projects have been undertaken to estimate the biomass assessment, consumption and supply chain development for sustainable biomass based electricity and heat generation in the country.

Some of the activities relevant to ESMAP are:

- *Feasibility study for 5 biomass based power plants in Punjab Province* by FA/PITCO
- *Biomass based power generation at Pioneer Cement limited* by IRG/PITCO
- *Development of market based approach for utilization of biomass in industrial power generation* by GIZ
- *Promoting Sustainable Energy Production and Use from Biomass in Pakistan* by Global Environmental Facility (GEF)-UNIDO

Feasibility Study for Biomass based Power Plants in Punjab

Feasibility Study for Biomass based Power Plants in Punjab

Description of Project Activity:

The project activity involved preparation of feasibility studies for 5 biomass based power plants in different areas of Punjab.

Methodology:

Among the 21 available sites, 5 sites were shortlisted on the basis of following factors:

1. Biomass availability (50%)
2. Grid connection availability (25%)
3. Water availability (12%)
4. Road access (8%)
5. Distance from the nearest city (5%)

Feasibility Study for Biomass based Power Plants in Punjab

Methodology:

- Biomass availability was calculated on the basis of field survey in all (36) districts of Punjab.
- In each district 200-300 farmers (selected on the basis of statistical sampling) were interviewed. The interview questionnaire included the following details:
  - *Cultivated land*
  - *Major crops*
  - *Yield of crops*
  - *Yield of biomass from each crop*
  - *Domestic consumption of biomass*
  - *Sale of biomass to different consumers (industrial, domestic, etc.)*
  - *Quantity of available biomass*
- On the basis of data gathered, biomass availability, consumption and collection efficiency was calculated in each district.

Feasibility Study for Biomass based Power Plants in Punjab

Site Specific Summary:

Site name and Address	Maize Straw (000 tons)	Sugarcane Trash (000 tons)	Rice Straw (000 tons)	Cotton Sticks (000 tons)	Power Potential (MW)
AARI Farm, Near Chak Jhumra, District Faisalabad	10.96	177.63	37.09		29.70
Mouza Rajowal, Tehsil Depalpur, District Okara	62.33	81.35	53.88		25.99
Chak No. 24/WB, Tehsil & District Vehari	20.66	51.59		98.61	22.48
Chak No. 81/M, Tehsil Jalalpur Pirwala, District Multan		55.74		95.27	19.87
Chak No. 41 Fateh, Tehsil Chishtian, District Bahawalnagar	8.62	30.11	13.62	52.25	13.76

Feasibility study of Biomass based Power Plant at Pioneer Cement Limited

Feasibility study of Biomass based Power Plant at Pioneer Cement Limited

Description of Project Activity:

The project activity involved the preparation of feasibility study for 35-50MW coal + biomass based power plant site at Pioneer Cement Limited. District Khushab in Punjab Province of Pakistan.

Methodology:

Biomass assessment was made by two methods.

1) Desktop Study
2) Field Survey

Feasibility study of Biomass based Power Plant at Pioneer Cement Limited (Cont.)

Desktop Study

- Assumption of average crop production for rice, sugarcane, wheat, maize and cotton on the basis of crop reports from Agriculture Department Government of Punjab for the years 2008 to 2012.
- Annual biomass residue production was determined using average crop production and RCRs
- As a conservative approach, annual availability of biomass residues (for PCL) was assumed to be 10% of the total biomass residue production.

Feasibility study of Biomass based Power Plant at Pioneer Cement Limited (Cont.)

Field Survey Visit

The **Sargodha, Khushab, Mandi Bahauddin, Hafizabad, Mianwali, Bhakkar** districts over a radius of 120 km were targeted to assess the supply of biomass residues. Field teams conducted interviews with the following:

- Farmers
- Rice Mills/ Rice Sheller
- Sugar Mills
- Local Biomass Suppliers
- Poultry Farms

Feasibility study of Biomass based Power Plant at Pioneer Cement Limited (Cont.)

Field Survey Visit

The interview questionnaire contained the following information

- Cultivated land
- Major crops
- Yield of crops
- Yield of biomass from each crop
- Domestic consumption of biomass
- Sale price of biomass (supplier specific, ex-field, ex-mill)
- Transportation cost of biomass
- Quantity of available biomass

On the basis of data gathered from field surveys, an assessment of biomass availability, consumption and price was performed for the proposed power plant.

Feasibility study of Biomass based Power Plant at Pioneer Cement Limited (Cont.)

Project Results:

- 50 MW plant based on 70% coal and 30% biomass.

Name of Crops	Residue-to-Crop Ratios	Annual Biomass Production (000 Tons)	Annual Biomass Availability (Tons)
Rice Husk	20%	104	10,417
Wheat Straw	100%	2,251	225,056
Corn Cob	22%	9	892
Cotton Sticks	425%	94	9,365

"Development of market based approach for utilization of biomass in industrial power generation" by GIZ

Development of market based approach for utilization of biomass in industrial power generation

Description and Methodology of Project Activity

The goal of this Report was to evaluate and demonstrate the availability of agricultural residues for energy generation in industries in eight regions of the Punjab province:

- Faisalabad
- Chiniot
- Jhang
- Nankana Sahib
- Okara
- Sahiwal
- Burewala.

More specifically, the focus was on the potential application for electricity generation and cogeneration of electricity and heat.

Development of market based approach for utilization of biomass in industrial power generation

Methodology:

The assessment of the crop residues availability was based on:

- Data retrieved through field surveys and interviews with farmers. The interview included the following information
  - Cultivated land
  - Major crops
  - Yield of crops
  - Yield of biomass from each crop
  - Domestic consumption of Biomass
  - Sale of biomass and sale price of biomass
- Statistical data obtained from the Agricultural Department of Punjab
- The total production of crops and crop residues in the assessed areas was calculated using information about the crop yields and residue-to-crop ratio from the surveys and the production area from the statistical data.

Development of market based approach for utilization of biomass in industrial power generation

Project Results:

- The report gives the overview of residues generation and patterns of their use in the assessed areas.
- The most abundant crop residue types suitable for electricity production are identified and the potentially available amounts evaluated.

"Promoting Sustainable Energy Production and Use from Biomass in Pakistan"

by

Global Environmental Facility (GEF)-UNIDO

Promoting Sustainable Energy Production and Use from Biomass in Pakistan

Description and Methodology:

- The study involved assessment of biomass potential for electricity and biogas generation in Pakistan.
- Project included preparation of pre-feasibility study for biomass gasification plants, for electricity and heat requirements for rural and industrial plants.
- Installation of 3 biomass gasification plants as a demo project.

Promoting Sustainable Energy Production and Use from Biomass in Pakistan (Cont.)

Methodology:

- Gives an overview of the biomass conversion technologies and biomass gasification for power and heat generation
- Gives an overview of biomass resource data of the country, estimation of power and heat generation and assumptions made therein to calculate the figures
- Elaborates the technical and financial parameters for SMEs
- Describes the village electrification part.

Promoting Sustainable Energy Production and Use from Biomass in Pakistan (Cont.)

Name of Crop	Crop Production (000 tons)	Residue Production (000 tons)	Residue Collection (000 tons)	Gas Production (000 Nm3)	Electricity Generation (000' MWh)
Wheat (Wheat Straw)	24,032.9	24,032.9	15,621.4	48,065,800	12,990,757
Rice (Rice Straw)	6,952.0	4,637.0	3,014.1	9,274,000	2,506,478
Maize (Corn Cob)	3,593.0	5,389.5	3,503.2	10,779,000	2,913,243
Cotton (Cotton Sticks)	11,819.0	50,230.8	32,650.0	100,462,000	27,151,757
Sunflower (Sunflower Cob)	420.5	841.0	546.7	1,681,948	454,581
Rice (Rice Straw)	6,952.0	6,952.0	4,518.8	13,904,000	3,757,838
Sugarcane (Bagasse)	46,923.3	9,865.6	6,412.6	19,731,228	5,332,764

Thank you!

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BIOMASS RESOURCE MAPPING – PAKISTAN [PHASES 1-3]

ASSESSMENT OF CURRENT MAPPING WORK AND STATUS OF BIOMASS DEVELOPMENT IN PAKISTAN

Dr. Jussi Rasinmäki & Qazi Sabir

FULL ADVANTAGE

SIMOSOL

VTT

PITCO

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Assessment of Current Mapping Work

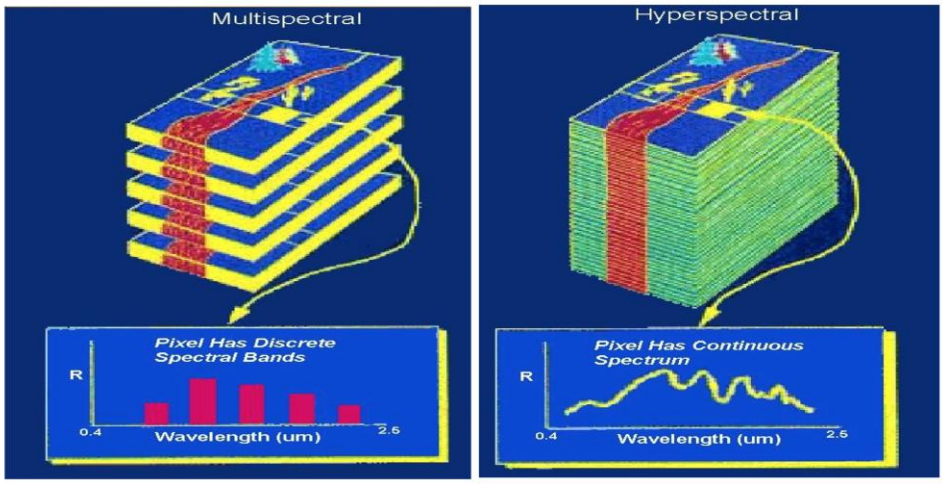
- Mapping Crop Type using Hyperspectral and Multispectral Datasets – SUPARCO
- Survey on the Availability of Biomass in Punjab Pakistan Resource Mapping Study – NUST
- Sustainable biomass production and biomass mapping for electricity in Pakistan – FAO

MAPPING CROP TYPE USING HYPERSPECTRAL AND MULTISPECTRAL DATASETS – SUPARCO

- Objective: Assessment of potential of Hyperspectral data for mapping crops and other land cover feature using Multispectral image as reference
- Study area: Larnaka
- Study material:
  - Hyperspectral data: Hyperion
  - Multispectral data: Landsat ETM+

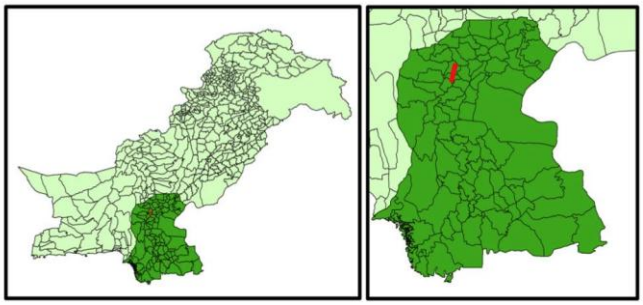
MAPPING CROP TYPE USING HYPERSPECTRAL AND MULTISPECTRAL DATASETS – SUPARCO

- Hyperspectral? Multispectral?



MAPPING CROP TYPE USING HYPERSPECTRAL AND MULTISPECTRAL DATASETS – SUPARCO

- Result: Better agricultural land classification results with hyperspectral data
- So why aren't we using that in the project?
  - Data availability



SURVEY ON THE AVAILABILITY OF BIOMASS IN PUNJAB PAKISTAN RESOURCE MAPPING STUDY – NUST

- Objectives
  - To identify the availability of different biomass in various agriculture areas/regions of Pakistan
  - To categorize the current and potential usage of biomass in each area depending on the neighborhood industry and residential consumer groups
  - To map crop type by integrating satellite data and ancillary data leading to develop recommendation for the installation of small power plants preferably using the technology of biomass gasification

SURVEY ON THE AVAILABILITY OF BIOMASS IN PUNJAB PAKISTAN RESOURCE MAPPING STUDY – NUST

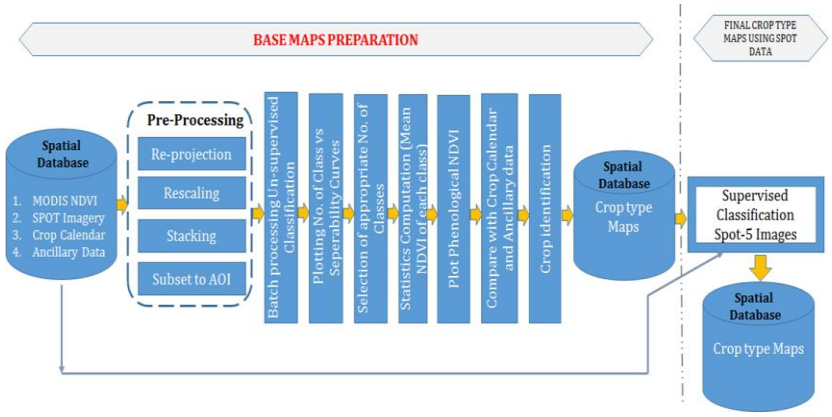
- Methodology
  - To obtain the biomass production figures and consumption patterns, following data collection tools were used:
    - Literature Survey
    - Data from the Government agencies
    - Field Surveys & Industry visits

SURVEY ON THE AVAILABILITY OF BIOMASS IN PUNJAB PAKISTAN RESOURCE MAPPING STUDY – NUST

- Methodology
  - Following activities were performed to conduct the survey
    - Identification of areas in Punjab region to conduct survey for biomass availability
    - Identification of crop cultivation pattern in each area in order to identify possible biomass types availability
    - Designing of questionnaire and data collection form

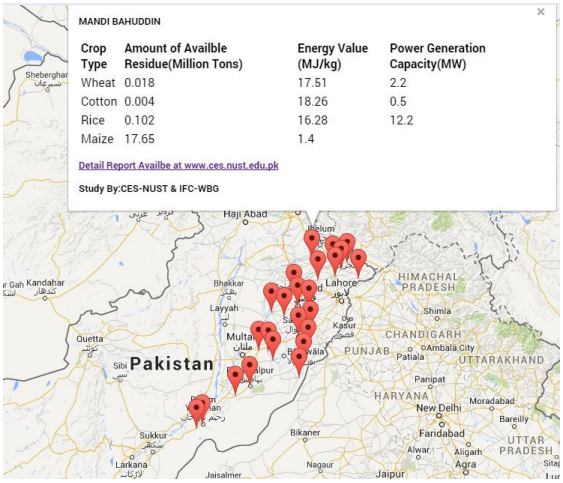
SURVEY ON THE AVAILABILITY OF BIOMASS IN PUNJAB PAKISTAN RESOURCE MAPPING STUDY – NUST

- Methodology



SURVEY ON THE AVAILABILITY OF BIOMASS IN PUNJAB PAKISTAN RESOURCE MAPPING STUDY – NUST

- Final Output



SUSTAINABLE BIOMASS PRODUCTION AND BIOMASS MAPPING FOR ELECTRICITY IN PAKISTAN - FAO

- The report on "Sustainable biomass production and biomass mapping for electricity in Pakistan (Scoping Phase)" contains:
  - Methodology for Biomass Resource Assessment and Mapping
  - Biomass Resource Assessment and Mapping in Pakistan
  - Bioenergy Policy Development
  - Overview of Relevant Research and Previous/Existing Activities

SUSTAINABLE BIOMASS PRODUCTION AND BIOMASS MAPPING FOR ELECTRICITY IN PAKISTAN - FAO

- Methodology for Biomass Resource Assessment and Mapping
  - Utilization of Biomass as energy (Heat / Electricity / Biofuels)
  - Biomass resource potential (Theoretical potential / Technical potential / Economic potential / Implementation potential)
  - Biomass resource assessment and Mapping (Crop Residues / Livestock Residues / Forest harvesting Residues / Wood Processing Residues / Municipal Solid Waste)

SUSTAINABLE BIOMASS PRODUCTION AND BIOMASS MAPPING FOR ELECTRICITY IN PAKISTAN - FAO

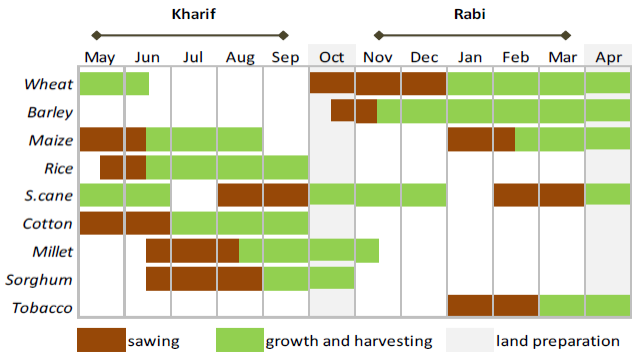
- Biomass Resource Assessment and Mapping in Pakistan

Crop	Residue type	Location of residue generation
Wheat	Straw	Spread in the field
Rice	Straw Husk	Spread in the field Processing plant
Maize	Stover Cob Husk	Spread in the field Collected (field, farm, processing facility) Field, collected (field, farm, processing facility)
Sorghum	Stalk	Spread in the field
Pear millet	Stover Cob	Spread in the field Collected (field, farm, processing facility)
Barley	Straw	Spread in the field
Cotton	Stalk	Spread in the field
Sugarbeet	Beet pulp	Sugar processing plant
Sugarcane	Bagasse	Sugar processing plant

Crop Residue Types Suitable for Electricity Production In Pakistan

SUSTAINABLE BIOMASS PRODUCTION AND BIOMASS MAPPING FOR ELECTRICITY IN PAKISTAN - FAO

- Biomass Resource Assessment and Mapping in Pakistan



Growing periods of the selected crops in Pakistan (Adapted from: Pakarab, 2014 and GIEW, 2014)

SUSTAINABLE BIOMASS PRODUCTION AND BIOMASS MAPPING FOR ELECTRICITY IN PAKISTAN - FAO

- Animal Residues
  - Cattle Manure
    - 7% of dairy farms have over 50 animals
    - "Landhi Cattle Colony" has world's biggest concentration of buffaloes/cattle at one place with numbers exceeding 250,000
  - Poultry Manure
    - 99% of households in Pakistan have less than 50 Birds
    - Only manure from commercial producers is vialble
- Forest harvesting residues and wood processing residues
  - 1.66% Annual rate of decline in forest cover
  - Reliable estimates of residues not present

Sustainable biomass production and biomass mapping for electricity in Pakistan - FAO

- Bioenergy Policy Development
  - Governmental bodies relevant for bioenergy sector development in Pakistan
    - Ministry of Water and Power
    - Ministry of National Food Security and Research
    - Ministry of Industries and Production
    - Ministry of Science and Technology
    - Cabinet Secretariat Ministry (Climate Change Division)

Status of Biomass Development in Pakistan

- Governing Policies
  - National Power Policy 2013
  - Medium Term Policy for Development of Alternative and Renewable energy (2011)
  - Framework for Power Cogeneration 2013 (Bagasse / Biomass)
- Relevant Studies
  - Biomass Potential Resource Assessment & Feedstock Preparation Report – GIZ
  - Promoting sustainable energy production and use from biomass in Pakistan to meet Energy Needs of SMEs and Rural Electrification – GEF-UNIDO

STATUS OF BIOMASS DEVELOPMENT IN PAKISTAN

- Biomass Power Generation Projects in Pakistan

Location	Plant Size (MW)	Expected lifetime (year)	Primary Fuel	Alternate Fuel
38-Km, Jhang-Muzzafargarh Road, Dargai Shah, District Jhang, Punjab	20.00	20	Bagasse	Firnace Oil(FO)
Opposite Al-Abbas Sugar Mills Limited in the town of Mirwah Gorchani, District Mirpurkhas, in the Province of Sindh	12.00	30	Bagasse/Rice Husk	Cotton Stalk/Wood Chips etc.
3.3-KM Jhang-Chinoiot Road, District Jhang, in the Province of Punjab	12.00	30	Cotton Stalk/Rice Husk	Cotton Stalk/Wood Chips etc.
Deh Jagsiyani, Taluka Matli, District Tando Muhammad Khan, Sindh	9.132 (3x3.044MW)	25	Biogas	Not Applicable (N/A)
Machi Goth, Tehsil Sadiqabad, District Rahim Yar Khan, in the Province of Punjab	26.35	30	Biogas	Biomass

List of biomass projects with electricity generation license (Source: NEPRA, 2014)

STATUS OF BIOMASS DEVELOPMENT IN PAKISTAN

- Biomass Power Generation Projects in Pakistan

Location	Plant Size (MW)	Expected lifetime (year)	Primary Fuel	Alternate Fuel
26-KM Chiniot-Jhang Road, Tehsil and District Chiniot in the Province of Punjab	62.40 (2x31.20MW)	30	Bagasse	Biomass
Janpur, Tehsil Liaquat Pur, District Rahimyar Khan in the Province of Punjab	30.00 (2*15MW)	30	Bagasse	Furnace Oil
Jetha Bhutta, Tehsil Khanpur, District Rahimyar Khan, in the Province of Punjab	30.00 (2*15MW)	30	Bagasse	Furnace Oil

List of biomass projects with electricity generation license (Source: NEPRA, 2014)

STATUS OF BIOMASS DEVELOPMENT IN PAKISTAN

- Other Key Biomass Power Generation Projects

1. **Pioneer Cement Biomass/Coal Fired Power Plant**
   Status: In-Pipeline
   Site: Khushab District of Punjab
   35-50MW Power Plant with 30/70 % Biomass/Coal Ratio based on detailed biomass Availability Analysis of 120km radius around the site

2. **Bulleh Shah Paper Mills Biomass based Power Generation**
   Status: Operational
   Site: Kasur, Punjab
   41 MW Steam Turbine powered by Multi Biomass Based Boilers
   Biomass Used: Corn stover, Wheat straw, Cotton stalk

STATUS OF BIOMASS DEVELOPMENT IN PAKISTAN

- Other Key Biomass Power Generation Projects

3. **DGKCC Municipal Solid Waste Project**
   Status: In-Pipeline
   Sites: Lahore & Multan
   Envisaged collective MSW processing capacity of 2600 tons of MSW per day (Lahore 2000 TPD, Multan 600 TPD)
   Methane capture for use in Power Generation

4. **LWMC Landfill Project, Lahore**
   Status: In-Pipeline
   Development of new Landfill in Lakhodair, Lahore.
   Methane recovered from landfill will be used for power generation.

STATUS OF BIOMASS DEVELOPMENT IN PAKISTAN

- Other Key Biomass Power Generation Projects

5. **Landhi Cattle Colony Waste to Energy Project**
   Status: In-Pipeline
   Site: Karachi
   IFC Funded project
   Will process 4200 TPD of cattle waste and 700 TPD of organic food waste to produce a total of 30MW electricity

Thank you!

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ESMAP
Energy Sector Management Assistance Program

BIOMASS RESOURCE MAPPING – PAKISTAN [PHASES 1-3]

Team Exercise: Biomass – Data Sources, Competing Uses and Conflicts

Dr. Jussi Rasinmäki and Dr. Ludovic Lacrosse

FULL ADVANTAGE

SIMOSOL

VTT

PITCO

CONDITIONS OF USE

This material has been developed for the purposes of the Phase 1 biomass mapping inception mission held on November 19th-26th, 2014 in Islamabad, Lahore and Karachi as part of the ESMAP-funded World Bank project on Renewable Energy Resource Mapping and Geospatial Planning: Pakistan.

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- Any use of the material must be given the appropriate reference: "World Bank Biomass Mapping Project for Pakistan: Phase 1-3".
- Users take full responsibility for any subsequent use or analysis based on this material

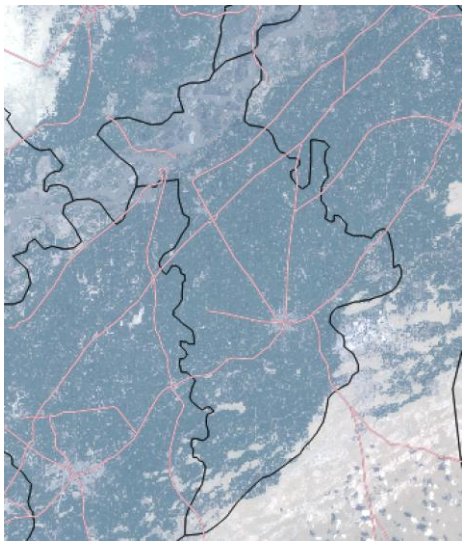
Biomass Mapping – Data Sources

- The goal is to move from knowing the situation at this level of detail:

Biomass Mapping – Data Sources (Cont.)

- To this level of detail:

  i.e. mapping the exact <u>location</u> of resources not at sub-district or district level, but at the resolution of 30 x 30 m and in relation to infrastructure



Biomass Mapping – Data Sources (Cont.)

- Ways of achieving that goal
  - Land use => satellite images combined with the field survey
  - Biomass processing by-products (secondary residues), existing industrial scale consumers of the by-products => Existing GIS-data, i.e. maps, for these?
  - Data needed to convert the raw resource data to investment potential data (road network, grid, etc.) => Existing GIS-data?

Biomass Mapping – Data Sources (Cont.)

- A very important aspect for the project end result quality: the level of coverage of the existing GIS data.

Red dotted line: road GIS data

Competing and conflicting uses of biomass residues

- Current use of the biomass residues by industry/utilities for power generation?
- Could there be a better use of this biomass residues? Technology shift?
- Current use of biomass residues for other purposes? (household, agriculture, building material, etc.)
- Food vs bioenergy?

The Floor Is Yours!

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BIOMASS RESOURCE MAPPING – PAKISTAN [PHASES 1-3]

BIOMASS RESOURCE MAPPING FOR PAKISTAN
IMPLEMENTATION METHODOLOGY AND PLAN

Dr. Ludovic Lacrosse (FA)
Dr. Tran Quang Cu (FA) and Dr. Jussi Rasinmäki (SIMOSOL)

FULL ADVANTAGE SIMOSOL VTT PITCO

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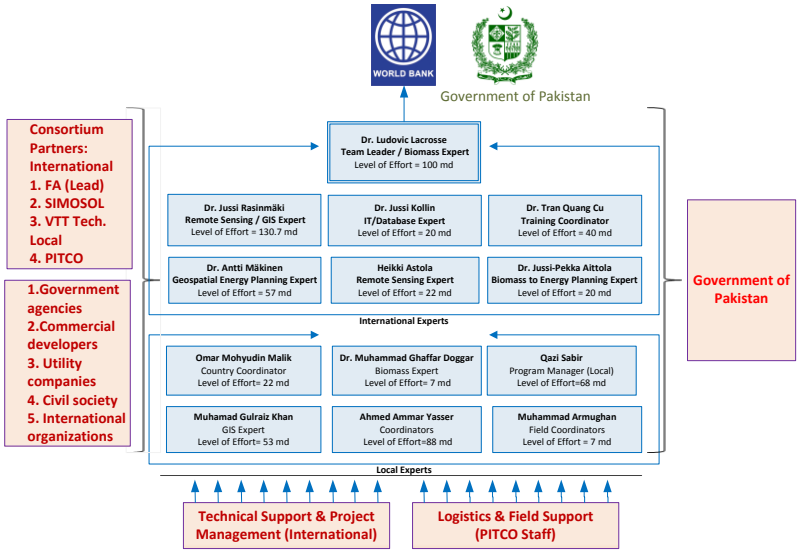
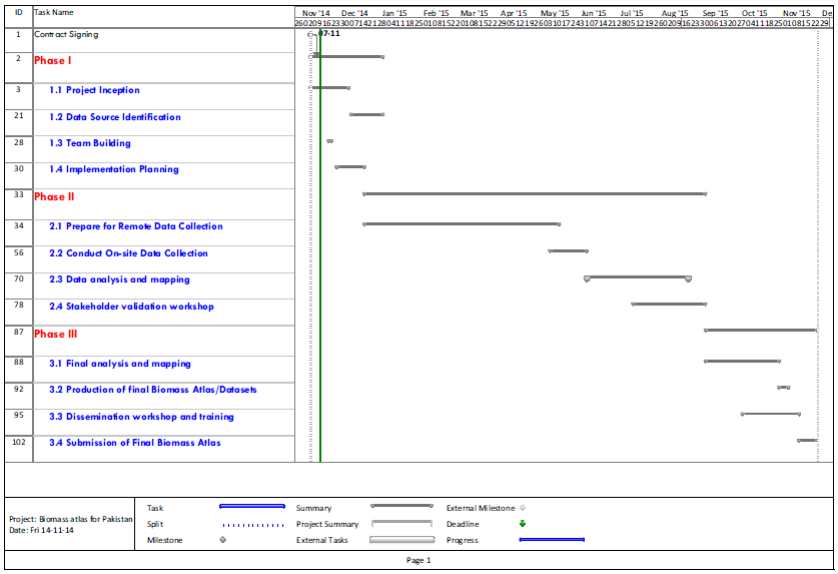
Organization of Project Implementation



Implementation Timeframe

- **Overall timeframe:** 7 Nov 2014 to 27 Nov 2015
- **Phase 1:** 7 Nov 2014 to 31 Dec 2014 (~ 8 weeks)
- **Phase 2:** 18 Dec 2014 to 2 Sep 2015 (~ 37 weeks)
- **Phase 3:** 3 Sep 2015 to 26 Nov 2015 (12 weeks)

Work Schedule



Milestones

No	Deliverables	Deadlines
	Phase 1	
1	Inception Report	5 Dec 2014
2	Implementation Plan including a Work Schedule	17 Dec 2014
	Phase 2	
1	A comprehensive database necessary for biomass resource mapping	9 Jul 2015

Milestones

No	Deliverables	Deadlines
Phase 2		
2	Draft biomass resource map(s)	20 Aug 2015
3	Stakeholder workshop for data validation	26 Aug 2015
Phase 3		
1	Biomass Atlas report including associated GIS files and datasets	4 Nov 2015
2	Dissemination workshop and training	10-12 Nov 2015

Biomass Resource Mapping

- **Two parallel lines:**
  - Satellite image analysis and field survey for land use mapping
  - Infrastructure & Secondary crop residue mapping from existing datasets

Satellite Image Analysis & Field Survey

- Steps:
  1. Image time series acquisition
  2. Image time series pre-processing; e.g. cloud masking
  3. Image analysis for field observation allocation
  4. Field survey:
     - Land use observations recorded from allocated sites
     - Information on total productivity, crop to residue ratio, own use, alternative use, and market prices
  5. Image analysis combining the image data and field observations for final land use classification

Infrastructure & Secondary Crop Residue Mapping

- Compilation of GIS datasets using official datasets for:
  - Processing sites producing secondary crop residues
  - Stable based feeding sites for cattle & poultry
  - Existing biomass based power plants
  - Geography
  - Transport infrastructure network
  - Water supply network
  - Security areas
  - Protective and Conservation areas
  - Urban areas
  - Power Transmission system infrastructure

GIS Modelling For Biomass Potential

- Compilation of GIS model
  - Combines the datasets described above
  - To produce Biomass Atlases for *sustainable technical potential* and *investment potential*
  - Using user-modifiable parameterisation

Capacity Building and Training Plan

- **Objective:** To build the capacity of local partners and relevant local agencies in biomass resource mapping methodology and in using the Biomass Atlas
- **Approach:** Training of Trainers
- **Methods:**
  - Multi-stakeholder workshops
  - Hands-on practical training
  - Q&A sessions through exchanges in emails and/or conference calls

Capacity Building and Training Plan (Cont.)

- **Expected Output:**
  - A training workshop on on-site data collection, validation and analysis (in May 2015, the duration of the training workshop will be defined by the end of Phase 1)
  - A one-day workshop on data validation (in Aug 2015)
  - A one-day workshop on information dissemination (in Nov 2015)
  - A two-day hands-on practical training on biomass resource mapping and in using Biomass Atlas (in Nov 2015)

Capacity Building and Training Plan (Cont.)

- **Training workshop on on-site data collection, validation and analysis**
  - ***Objectives:*** to train on on-site data collection, validation and analysis for biomass resource mapping
  - ***Duration:*** 1-2 days
  - ***No. of trainees:*** 15-20 persons
  - ***Type of trainees:*** Students and Engineers from key stakeholders
  - ***Main training materials:*** Smartphone inventory system

Capacity Building and Training Plan (Cont.)

- **One-day workshop on data validation**
  - ***Objectives:*** to present the data collected and the draft biomass resource map(s) for validation and verification
  - ***Duration:*** 1 day
  - ***No. of participants:*** 40-50 persons
  - ***Type of participants:*** Multi-stakeholders (who are involved in biomass sector)
  - ***Main workshop materials:*** Draft datasets and draft biomass resource map(s)

Capacity Building and Training Plan (Cont.)

- **One-day workshop on information dissemination**
  - ***Objectives:*** to present the project outputs and share experience with the relevant stakeholders
  - ***Duration:*** 1 day
  - ***No. of participants:*** 40-50 persons
  - ***Type of participants:*** Multi-stakeholders (who are involved in biomass sector)
  - ***Main workshop materials:*** outputs/deliverables of the project, final biomass atlas for Pakistan

Capacity Building and Training Plan (Cont.)

- **Two-day hands-on practical training on biomass resource mapping and in using Biomass Atlas**
  - ***Objectives:*** to train on biomass mapping methodology and how to use, modify and/or update the biomass atlas
  - ***Duration:*** 2 days
  - ***No. of trainees:*** 20-30 persons
  - ***Type of trainees:*** Multi-stakeholders (government officials, potential atlas users such as project developers/investors, consultants, etc.)
  - ***Main training materials:*** Final datasets and biomass atlas

Thank you!

Annex 5: Selected Photos of the Inception Mission

Inception Meeting in Islamabad
(21 November 2014)


21/11/2014 10:21


WORLD BANK GROUP
ESMAP
World Bank/AEDB Renewable Energy Mapping Project-Pakistan
Inception Meeting of Biomass Component of Project
November 21, 2014
Serena Hotel, Islamabad
SIMOSOL
VTT
PITCO
21/11/2014 10:22


ESMAP
PITCO
21/11/2014 10:51


ESMAP
PITCO
21/11/2014 10:51

Inception Meeting in Lahore
(24 November 2014)


WORLD BANK GROUP
ESMAP
24/11/2014 11:21


24/11/2014 12:25

Inception Meeting in Karachi
(26 November 2014)


WORLD BANK GROUP
ESMAP
26.11.2014 11:54


WORLD BANK GROUP
ESMAP
26.11.2014 12:32


26.11.2014 12:34


WORLD BANK GROUP
ESMAP
AEDB
World Bank/AEDB Renewable Energy Mapping Project-Pakistan
26.11.2014 13:25

Meeting with NUST
(22 November 2014)


22/11/2014 10:15


22/11/2014 13:53

Site Visit to Best Paper & Board Mills
(25 November 2014)

Meeting with IST/SUPARCO
(26 November 2014)


26.11.2014 13:39


AEDB
Energy & Extractives
Energy Sector Management Assistanc
World Bank/AEDB Renewable Energy Mapping Project-Pakista
PITC
26.11.2014 13:36

Annex 6: Stakeholder Feedback Form

World Bank/AEDB Renewable Energy Mapping Project

Phase 1 Inception Meeting: Biomass Resource Mapping

Date:

Venue:

Feedback Form

Dear Participant,

We highly value your participation in this Inception Meeting.

As you are among the key stakeholders of this project, we would wish to receive your feedback about this event and about the project itself.

Please kindly fill this form as we hope to establish some collaboration with you in the course of the implementation of this project.

Thanking you for your support,

The organisers

How relevant did you find the topics presented during this meeting?	*Not so relevant*	*Fairly relevant*	*Relevant*	*Very relevant*
How do you rate this meeting in general?	*Poor*	*Fair*	*Good*	*Excellent*
What is your current/past involvement in renewable resource mapping?				
What role could you play in the implementation of the project?				
Would you have some recommendation(s) in relation to the implementation plan of the project?				

***Contact details*:**	
Name, Title	
Organization/ company	
Address	
Email	
Telephone	
Website	

Annex 7: Summary of Feedback from the Stakeholders

November 21, 2014 Shamadan Combo I & II, Serena Hotel, Islamabad					
Participant Name	**Topic Relevance**	**Meeting Rating**	**Involvement in RE Resource Mapping**	**Role that could be played in Project**	**Recommendations**
Nayyar Iqbal	Relevant	Good	I have never been involved in such type of projects.	Since I belong to a distribution company (IESCO) hence the scope to play any role with regard to implementation of the project at present is very limited	Capacity building program may be conducted for the awareness of participants and implementation of the projects.
Nadeem Ahmed		Good	Not involved in resource mapping but involved in power system planning for Pakistan	Review & suggestions plan, methodology and reports	Already communicated in the meeting. Emphasis should be given on utilizing waste lands in green belts in major cities and municipal waste.
Dr. Munir Ahmed	Very relevant	Excellent	I'm working in renewable energy resources (biogas, biomass gasification, solar energy).	I may comment on methodology for useful outcome of this project	1. Wheat straw should not be used for energy generation because it is used as feed for animals 2. Rice husks, straw, corn stalk, cotton sticks (some part). 3. Competing uses of biomass must be found exactly during this study.
Mohammad Akmal	Very relevant	Excellent	Working on crop production and cropping system in the KP.	Can assist in the form subject to case relevant for crops and species. Student research for the data validation etc.	Crops classification based on higher biomass production per unit area time & costs etc.
Prof. Dr. Muhammad Afzal	Fairly relevant	Fair	Theoretically we are involved to teach the importance of renewable resource mapping but practically do not have any experience. We would like to be involved.	The university has the capacity and facility to collect the required data for the project if assigned.	I recommend that the current work of project be continued in order to benefit Pakistan in helping the production of energy.
Mir Ahmad Shah	Very relevant	Excellent	Renewable & Alternative Energy Association (REAP) is involved in	Being an Association REAP could play very productive	Awareness and affordable solutions are highly recommended.

			renewable resource mapping since 2009 & sincerely making efforts.	role to involve its members in the project.	
Dr. Ehsan Ali	Very relevant	Excellent	Biomass to Energy	I would like to be contributor for the project implementation.	It is extremely important to estimate the feedstock for power generation. It is project "on time".
Dr. Naveed Akhter	Fairly relevant	Fair	Producing biomass from different crops but not directly used for renewable resources.	After getting knowledge in this meeting scientists of my institution if provided trainings can add much in this project.	As mentioned by my colleagues that depleted soil organic matter must be taken into consideration before going further in the matter.
Inayatullah Khan		Good	Crop Sector	Could provide information on the available resources with respect to production in crop sector.	Pakistan has shortage in energy sector & surplus biomass must be utilized in energy sector.
Taskeen Akhtar	Very relevant	Excellent	Never been involved in this particular exercise, but working as GM biogas projects	I can give support in triple A cycle exercise and can provide technical assistance.	Initially potential areas may be selected to have a model.
Shahid Bokhari	Very relevant	Good	Working to develop a linkage between AEDB and Govt. of Baluchistan to develop Wind Masts for data collection.	- Available for any field research - Organization of workshops etc.	Capacity building of private sector is required because they will be key players at the end of the day.
Muhammad Jawad	Very relevant	Excellent	We had lot of informal discussions, but this was first formal meeting	We can provide 2.5m satellite imagery and contribute for GIS database development.	It should be done and to avoid humongous cost SUPARCO must be consulted
Muhammad Saeed	Relevant	Good	Not involved in RE mapping	Concluding results of this study will provide us up to date information on this RE technology.	GIZ REEE Project has conducted a study regarding biomass availability in Eight districts of Punjab that can be helpful in this regard.
Asif Farid	Very relevant	Excellent	Not directly but GIZ has conducted some regional studies which we already mentioned.	We would be happy to see the detailed report/output of this study; it would be very useful for Pakistan and our project to plan some activity.	
Engr. Khurram Durrani	Relevant	Excellent		Energy & Power Department Govt. of KPK will facilitate for feasibility studies & execution of the project in KPK.	Proper feasibility studies may kindly be carried out in KP. Special focus may kindly be given to KP province. E & P Dept. KP will facilitate any donor etc.

Mr. Farhan Manzoor Ahmed	Very relevant	Excellent	Involved in biomass power plant.	I don't find any role in this project of data collection/mapping. It will be possible to get involved afterwards (Biomass PP)	
M. Yassen	Relevant	Good	No	On the basis of my previous experience and learning to be obtained from this meeting up till last session, I will share lot of inputs.	Few other stakeholders may be invited in upcoming meeting like Power Producers i.e. sugar mills owners, Economic Coordination Committee (responsible for awarding of Tariff on use of any alternative energy resource).

November 24, 2014
Indus Hall, Avari Hotel, Lahore

Participant Name	Topic Relevance	Meeting Rating	Involvement in RE Resource Mapping	Role that could be played in Project	Recommendations
Wasif Azhar	Relevant	Excellent	Only related to Lahore based waste monitoring	Data collection (in fields)	More data should be included regarding cattle manure and municipal solid waste.
M. Imran	Fairly relevant	Excellent	Not much as the focus of the agenda and project is agriculture only		
Engineer Mohammad Haneef Memon	Relevant	Good	Not at this stage	By following the renewable energy policy-2013, given by GOP, all technical coordination	Real time data must be kept in, along with the satellite imaging and mapping which will result in the actual design data for power generation.
Malik Muhammad Mukhtar	Very relevant	Excellent	Sharing of information with practicality about biomass-energy plants in area under jurisdiction	Help & assist, share, knowledge, pros, cons of existing installed plants in Muridkay and Kamoky	a) We should exclude residual of wheat as it is being utilized for animal feed b) Residual of rice husk plus other fuels should be mixed. Efficiency of the plant and machinery is required to be improved. c) Data presented is debatable and it should be corrected/ altered. d) Regular capacity building of stakeholders, particularly DISCOS is recommended. e) Good efforts by team presenting data.

Shaukat Ali Gill	Very relevant	Excellent	The undersigned has very little knowledge for renewable resource mapping before this briefing.	Awareness to our industries lying under GEPCO can be created about Biomass products.	Studies should be done on large scale for small farmers in Punjab. Biomass of wheat and rice husk also should be eliminated to save life of cattle.
Dr. Anjum Munir	Very relevant	Excellent	I am involved in various renewable energy development and projects at my university at Punjab level, but mapping is not my research field/area	I can play role in design research development of appropriate technologies for power generation from Biomass.	It is really an excellent project. This was need of time. It would be nice if you add the appropriate locations for installation of power plants based on the availability of biomass and keeping in view of the transportation charges due to long distances from power plants.
Rana Faisal	Very relevant	Good	We at LWMC working actively on biogas and waste to energy projects.	Planning and technical evaluation	Latest waste related data can be shared if requested for GIS modelling.
M. Munir Anjum	Relevant	Good	Project management (complete scope) for renewable energy projects.	- Share our knowledge - Onsite arranging visits	Extract of previous studies is being utilized. This rather should be activity done anew. The scope should have included geothermal studies as well.
Mr Muhammad Ahmad	Relevant	Good	I worked in calculating in the solar potential available at our plant side to shift street lights on solar.	I am more interested in biomass gasification from cow dung to produce energy. Any relevant study is welcome.	I recommend that the data collection should be precise so that the atlas may be used for maximum.
Nazakat Hussain		Good	We are working on 62.4 MW bagasse based project. Previously, I had worked on 50 MW and 56.4 MW wind projects.	We are implementing our project in Jhang and can provide relevant area info.	Yes, you can utilize the data of PMD (Pakistan Meteorological Department) as well as LRMIS (Land Record Management Information System)
Muhammad Asghar Khan	Relevant	Excellent	First meeting but ready to co-operate in any manner keeping in scope.	MEPCO will be happy to buy the electricity on acceptable tariff approved by NEPRA,	Soft loans with flexible payback period may be given by World Bank/AEDB to project investors and proper trainings would be imparted.

Bilal Hussain	Very relevant	Good	Officially, I assist in execution of purchase agreements with incoming biomass power plants. Up till yet, I never involved in renewable resource mapping.	My organization owns national transmission grid and will be helpful in facilitating mapping project in respect of grid availability. Moreover, the tail project will comprise policy.	Most of the government organizations/government bodies dealing with biomass sector don't have a culture of efficient data collection and coordination. I recommend that right from the start such departments should be pushed for getting fruitful results. As a part of CPPA, which executes govt. power policy for purchasing renewable power, It is very crucial that CPPA has comprehensive participation in this process.
Mehmood Aslam	Very relevant	Excellent	Today's meeting and past some internet information on this topic.	I can collect information on biomass from field	You are already doing very well
Salis Usman	Very relevant	Good	Representing the purchaser CPPA with reference to development component.	CPPA would surely be available as the purchaser for all biomass (on grid projects) and thus can play an active role in implementation.	Active role of CPPA development team should be ensured as their presence will give lot of confidence to the IPPs.
November 26, 2014 Ambassador III (Hall), Marriott Hotel, Karachi					
Participant Name	**Topic Relevance**	**Meeting Rating**	**Involvement in RE Resource Mapping**	**Role that could be played in Project**	**Recommendations**
Arisha Haider	Relevant	Good	KE has been working in enhancing its Renewable Energy portfolio. KE has actively worked for a 22MW Biogas project which will utilize cattle manure from Landhi cattle colony. Currently we have initiated a 15MW (approximately) waste to energy project using the municipal solid waste.	KE would definitely be interested in working with this project it would help KE in installing renewable projects (within the vicinity of Karachi). We are open to discuss further on this subject.	
Sheikh Shakil Ahmed		Good	Not in the mapping but preparing RE Projects for Govt. of Sindh.	If training will be provided, can support to find exact ground development.	Field workshops and awareness programs and trainings, requirement for capacity building is highly appreciated.
Niaz Ali Sheikh	Very relevant	Good	I have been given assignment for development of Power Projects	Would assist the project team for co-ordination among	Yes, all the presentation of the meeting are required. Please email me to prepare

			(all types) in the province.	Government departments and the Growers/stakeholders.	detailed input recommendation on behalf of Government of Sindh.
Mohammad Sultan	Relevant	Good	Serving in Biogas, Solar and wind mills yet	As nominated in the project	Add local govt. and local Abadgars/landowners and interested local persons.
Sayed Waqas Qadri	Relevant	Good	Not involved	Field data collection as a student of research	
Engineer Kamran Soomro	Relevant	Good	Not directly involved in mapping, but have been closely involved in renewable resources like solar and biogas.	I have been involved in R&D and PARC is working in agriculture and water and while at SARC, PARC sector we can get data form cattle colony for biogas generation.	Yes I think if research program is involved like PARC it will be helpful to get exact data of agri crops, its potential in Sindh.
S. Ayaz Ahsen	Relevant	Good	Consultancy	Environmental consultant and field study	The overall project benefits depend on mainly GOP. The overall beneficiary of this project.
Sardar Abdul Nabi Thaheem	Very relevant	Excellent	I am heading energy sector in my department which is involved in policy making for the province in Renewable energy field and also involved in approval of energy projects.	P & D is a policy making and initiator of development projects in the province. Depending upon results of the study the projects could be launched in the province.	Field surveys should be conducted separately for Rabbi & Kharif for better quality data.
Waqar Azeem	Relevant	Good	As a power producer and electric utility provider	Provide transmission and distribution network on GIS	Also Map the type of technology suitable for a specific site and total MW generation form every individual site
Fatima Hafsa	Relevant	Good	WWF- Pakistan is a leading conservation organization and has installed 2500 biogas plants in Punjab +Sindh for domestic use. And has worked to develop this resource.	- Resource Surveying - Feasibility Analysis - EIA	There needs to be a section of ecological impacts of potential resource utilization to curtail overexploitation /conflict of the resources
Saadia Naeem	Relevant	Excellent	Involved in mapping of natural resources using Satellite remote sensing tools & technology	Capacity Building activities such as mapping land covers	To get better discrimination of species (crop, forest) high resolution data is a solution
Khalid Hayat Khan	Relevant	Good	Faran Sugar mill is planning to set up a Co-Gen project & working for alternative source of Fuel, other that bagasse, but so for	Currently Pakistan sugar industry is looking for some other fuels like biomass to use in boilers.	We need to gauge trash of sugar cane, which should be assessed more effectively & be used as biomass by sugar sector to make it more usable to run

			unable to have a scientific data of biomass		their boiler in off season.
Bilal Bawany	Relevant	Good	We try our best to map and monitor sugar cane crop quantity yield & variety for our sugar mill on our surrounding and reachable areas	We have our field agents and network in the interior of Sindh, if provided with proper training and resources we could help in accurately map and monitor biomass mapping throughout the year every year	My sugar mill produces energy during the 4 month crushing season, but I would like to produce and supply energy throughout the year, but biomass is not sufficient to support the entire year or is it? And is it supported by the Govt.?
Arjumand Zaidi			Not directly, but I teach in Remote sensing and GIS department of Institute of Space Technology	We may involve our students. Many of our students do not only have expertise in RS&GIS tools, but have experience in field data collection in Agri Sector Sindh. Also we may contribute in trainings.	Academic institutions should be involved in such projects. Also people from Agriculture and irrigation departments of Sindh and Punjab should have been involved.
Akhlaq Ullah	Fairly relevant	Good	Working for U.S based investor to establish first 12MW biomass based IPP in Sindh province since 22nd September, 2010. Project is held up by AEDB for not providing project agreement.	Non so supportive response given to first project	
Sardar Sarfaraz	Relevant	Good	From the dept. which has mapped the wind power potential	Not sure	Taking care of ecology preservation is to be ensured
Faisal Sadiq Abid	Relevant	Good	In past as for as energy sector is concerned our dept. introduced Plant species Jatropha which also called biodiesel plant	To support sharing data in respective forest residue and field cover.	1. Be careful for Eco-system/Ecological system 2. Public/private partnership 3. Use of new technology or to collect the data for biomass residue from relative dept. to save time and money
Syed Ghulam Mehdi Shah		Excellent	Nil	If valuable with much sincerity	Both provinces of the country Sindh & Punjab are abundantly rich in resources Biomass & Bio gas. To make plan for anything is simplest term. However, the plan should be executed with extreme care taking into account the mutual

					interests of the stakeholders involved.
Ibad Ur Rehman	Fairly relevant	Good	1. Authored Sustainable Energy finance study for IFC in Pakistan 2. Authored Captive power potentials study for IFC Mena Region		The outcome needs to have and indicative roadmap for private sector investors otherwise its utility will be very limited