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ESMAP
Energy Sector Management Assistance Program

Biomass Resource Mapping in Pakistan

PHASE 2 IMPLEMENTATION PLAN

March 2015

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

IMPLEMENTATION PLAN

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Implementing agency:

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

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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 plan 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). Therefore 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. It 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. This is fulfilled 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.

With regard to biomass resource mapping, the Food and Agriculture Organization of the United Nations (FAO) carried out a study and produced a scoping report in October 2014[2]. The report outlines the baseline country information, data requirements and availability, and recommendations on suitable methodological approaches for biomass mapping for electricity generation in Pakistan. This report will be used as one of the key references by the consulting Consortium in developing a Biomass Atlas for Pakistan.

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

[2] *Sustainable biomass production and biomass mapping for electricity in Pakistan (Scoping Phase). FAO, October 2014.*

2. OBJECTIVES OF THE PROJECT

The overall objective of this assignment 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. The specific objective is to support renewable energy mapping and geospatial planning for biomass resources in Pakistan.

3. OBJECTIVES AND CONTENT OF THE IMPLEMENTATION PLAN

The objectives of this task are to refine and finalize the work schedule that has been initially submitted in the proposal stage and to determine the budget for Phase 2. The Implementation Plan includes the identification of associated deliverables to be submitted for endorsement by client(s).

It takes into consideration feedback received and data obtained from the stakeholders during the Inception Meetings and also from National University of Sciences and Technology (NUST), Islamabad, Pakistan. It outlines key elements in the biomass mapping: its extent, limitations and delivery.

3.1 Priority regions

As agreed with WB/AEDB during the Inception Mission, the priority regions of biomass resource mapping are two provinces: Punjab and Sindh. The biomass atlas will be developed in detail for these two provinces. Provinces of KPK and Baluchistan will also be covered but in less detail.

3.2 Biomass resources to be included in the Biomass Atlas

(1) Crop residues

The feedstock supply potential for the Biomass Atlas will be based on two main information sources: land use classification and field surveys. The role of the land use classification is to provide a spatially explicit and complete coverage of Pakistan, including identification of crops cultivated during the Rabi and Kharif cropping seasons[3]. The role of the field survey is to provide information that allows conversion of the land use information into feedstock supply information. This further determines the total yield of each crop species, the share of different types of harvest residues of the yield, and the utilization patterns of the harvest residues.

Land use and land cover classification

The assumption at the project preparation stage was that no existing land use classification at the crop species level is available for the project; the project proposal included a remote sensing based

[3] There are two cropping seasons in Pakistan: Rabi and Kharif. Rabi season starts in October-December and ends with harvesting in April-May, while Kharif season starts in April and harvest takes place between October and December. Wheat, maize (Spring), gram, tobacco, barley, mustard, sunflower, soybean, pulses (Mung beans) are "Rabi" crops while rice, cotton, sugarcane, maize (Autumn), chickpea, jowar (shorghum), millet are "Kharif" crops.

land use classification component. However, during the Inception Mission, it was established that there is in fact an existing process that produces the land use classification with the level of details required in this project. The process is called "Crop Situation and Forecast" and is being accomplished by SUPARCO. Furthermore, for the Punjab and Sindh provinces, there is another land cover classification, "The Pakistan Land Cover Mapping Initiative" that could provide information of the land cover for the project on other than agricultural land. A request has been made to access these datasets from SUPARCO, but since the approval is not confirmed yet, two alternative work plans regarding the land use classification are hereby presented.

Option 1: If SUPARCO grants access to their existing land use classification datasets, no classification will be performed for the project. Instead, the effort will focus on the GIS modelling and dissemination activities, as specified below in the corresponding sub-chapters.

Option 2: If the access to the SUPARCO land cover classification datasets is not granted for the project, the land cover and land use classification will be executed as specified in the project proposal by the project Consortium based on satellite images. In this case access to recent high-resolution SPOT-5 images will be sought from SUPARCO for the Punjab and Sindh provinces while the rest of the land area will be mapped based on Landsat 8 images.

Field survey

A network of universities and research institutes led by NUST will conduct the field survey for crop production. PITCO will be responsible for monitoring and validating the said survey. It will be performed as a person-to-person interview by the survey team with the farmers using smartphones as survey tool. They will be using phone applications that can record their responses, indicate the location of the interview, and attach photographs of the survey results. The priority sub-regions for the survey are Punjab and Sindh provinces, but the provinces of KPK and Baluchistan will also be covered to a lesser extent.

For this project, feedstock supply potential estimation will utilize the methodology presented in the background paper "Sustainable biomass production and biomass mapping for electricity in Pakistan (Scoping Phase)" as prepared by FAO. This methodology will guide the survey data collection and will be followed to a certain degree based on the extent of the data coverage after the survey stage.

The survey will target the following "per hectare" factors for each region and crop species:

- Crop production level
- Residue-to-crop ratio
- Amount of crop residues that should be left in the field
- Amount of crop residues used for other purposes
- Accessibility to the harvest residues related to farm activities such as harvesting method and types of available machinery
- Current market prices for the harvest residues

In case of Option 2 for the land use classification, the survey observations will be also used as the field reference data for the satellite image classification. In this case, part of the survey locations will be pre-allocated to specific locations based on the initial analysis of satellite images. Hence smartphone application will be used as a tool to navigate to the assigned field location. In case of

Option 1 for the land use classification, the field survey locations will be *stratified* only on the Tehsil level agricultural production statistic to have sufficient cover of the different cropping systems. The located field observations will be used as validation dataset for the existing land use and land cover classifications.

(2) Livestock residue

PITCO will conduct the livestock residue and municipal solid waste survey. For the livestock residue only sites with large number of cattle (minimum 1000 heads), producing enough manure to be viable for power generation, will be surveyed.

The factors the survey will target are the following:

- The headcount / Livestock units (LU)/ Tropical livestock units (TLU);
- Kg of manure produced daily per head/LU/TLU;
- Number of months spent in pasture and the timing of the pasture feeding months.
- Existing use for the manure

Based on the initial Consultant's knowledge, the following dairy farms have a population over 1000 heads:

- Nishat Dairy Pvt Ltd,
- Sapphire Dairies Pvt Ltd,
- Dairyland (Pvt) Ltd Karachi,
- Dada Dairies Ltd.,
- Maksons Dairies,
- J.K Dairies,
- Everfresh,
- Sharief Dairy Farm,
- Prema,
- Premier Dairies Pvt. Ltd.

The relevant data for the abovementioned farms will be collected from the Pakistan Dairy Association and used to estimate the electricity generation potential from manure and its application for captive use or sale to the national grid.

(3) Municipal Solid Waste (MSW)

PITCO will conduct the survey on MSW for municipalities in major cities with centralized waste collection systems in place. Only sites with a potential capacity of at least 1 MW will be included.

A questionnaire will be sent out to the waste management companies of the cities listed below. It will seek information regarding the number of landfills and dumping sites in the city, daily waste generation, collection and its disposal to the dumping site, existing use of MSW (in waste to energy projects, etc.), and waste characteristics (such as organic/inorganic fraction of waste, heating value and others).

PITCO will visit municipalities/waste management companies (such as Lahore Waste Management Company, District Municipal Corporations, Capital Development Authority, etc.) of the following major cities to ensure that all the available information/data sought in the questionnaire is provided by the respective municipality/waste management company.

Sr.	City	Province	Population
1	Karachi	Sindh	21,142,625
2	Lahore	Punjab	9,718,745
3	Faisalabad	Punjab	6,047,446
4	Hyderabad	Sindh	3,429,471
5	Peshawar	Khyber Pakhtunkhwa	3,307,798
6	Rawalpindi	Punjab	3,039,550
7	Gujranwala	Punjab	2,799,766
8	Islamabad	Islamabad Capital Territory	1,740,000
9	Sialkot	Punjab	1,733,252
10	Multan	Punjab	1,606,481
11	Bahawalpur	Punjab	1,315,067
12	Larkana	Sindh	970,283
13	Quetta	Balochistan	896,090

(4) Forest harvesting and wood processing residues

Pakistan's forest cover is low and is still decreasing. Wood is imported from other countries to meet the demand of existing industries. Based on preliminary information collected from major biomass suppliers, there is no excess availability of forest harvesting and wood processing residues. All available residues are used up by small-scale brick-kilns, by other small industries or by domestic consumers.

However, PITCO will survey major wood processing companies to assess the validity of the assumption that there is no surplus availability of residues from wood processing plants.

(5) Secondary crop residues

PITCO will survey the industrial sites currently utilizing biomass based feedstock for energy production and producing secondary crop residues as part of their industrial processing chain. The type and amount of secondary crop residue produced will be mapped together with the amount that is actually used and the energy conversion technology. For the industrial sites using biomass, the type and amount of biomass used and the energy conversion technology in use will also be mapped.

PITCO will interact with Industrial associations such as All Pakistan Cement Manufacturers Association (APCMA), Pakistan Sugar Mills Association (PSMA), All Pakistan Textile Mills Association (APTMA), Renewable and Alternative Energy Association of Pakistan (REAP) for collection of biomass generation/consumption data for various industries. Furthermore, detailed questionnaires will be sent to major industries (both producers and consumers of biomass) for collection of relevant data. PITCO will visit major industries in each industrial sector for verification of data collected through questionnaires.

The questionnaires will be used to collect data and information that will include but will not be limited to:

- Biomass residue generation
- Excess quantity available (current market price for feedstock and transport cost if applicable)
- Availability period (months)
- Biomass residue consumption
- Type of technology used for biomass-based power generation.

At least five industrial units belonging to each industrial sector (where applicable) will be visited by PITCO to verify the biomass production and/or consumption data. Moreover, there are at least 16 biomass based power plants across various industries, other than those in the sugar and textile sector. PITCO will also visit these biomass based power plants for mapping purpose.

3.3 Key obstacles and constraints to biomass use for energy generation

(1) Technological Constraints

Biomass power generation projects involve various technologies/equipment for biomass collection, feedstock preparation and power generation. These technologies are not yet mainstream in Pakistan. As a result, there are difficulties in getting spare parts and qualified service for maintenance and rectification of problems in key components. This can lead to significant reduction in the plant availability, resulting in substantial financial losses for power plants owners.

Moreover, there is a risk that the technology provider may change the design during the detailed design phase, which can occur when the technology provider chooses to save on expenses or finds better solutions. Since there is lack of availability of local Owner's Engineers having precise know-how of plant design, the local project developers have to rely on foreign expertise to act as Owner's Engineer. This option is not only costly, but also, due to security conditions of Pakistan, it can be difficult to convince a reputable Consultant Engineer to come to Pakistan.

Operation of a biomass based power plant is much more complicated than gas/HFO based power plants which are commonly used in Pakistan. So far, the only source of skilled manpower for biomass based power plants are sugar mills. Therefore, project developers face the obstacle of not finding skilled manpower needed for reliable plant operation.

Biomass based power plants will have to include expensive flue gas treatment technologies to meet the National Environmental Quality Standards (NEQs). Any breakdown of the flue gas cleaning system (which might cause emission of particulates beyond the environmental limits) can severely affect the nearby population. Similarly, failure in the wastewater treatment systems can cause pollution of nearby canals.

(2) Physical and Geographical Constraints

To be operational throughout the year, biomass based power plants are designed to utilize a variety of biomass feedstock. Changes in yield for different biomass types can occur due to weather conditions and farmer's crop plantation choice. This may result in high fluctuations in fuel availability

and price. Getting a reliable supply of biomass fuel at competitive price is the single most important barrier for biomass based power generation projects.

Biomass power plants are located close to biomass fuel source supply to ensure reliable fuel supply and reduce fuel transportation costs. These sites are usually away from urban centers. As a result, the availability of the national grid and access roads is limited. Although 'Renewable Energy Policy 2006' poses the cost of power dispatch infrastructure on the power purchaser, the practical reality is that the power purchaser of Pakistan is often unable to fulfill this responsibility. Therefore, the cost of infrastructure has usually to be borne by the project developer which is a significant obstacle for the implementation of biomass power generation projects.

(3) Legal obstacles

There is no one-stop-shop for biomass based power generation projects in Pakistan. As a result, there is a possibility that permits and licenses required by the different relevant government authorities will not be obtained or if obtained, can only be implemented at a greater cost than what has been originally projected.

There is no upfront tariff for biomass based power plants. Given the fact that the feasibility study for biomass based power generation shows a very volatile biomass fuel availability and costing component, the project developers are always facing a risk that their assumptions may not be accepted by the National Electric Power Regulatory Authority (NEPRA).

Circular debt in the Pakistan power sector is the single biggest institutional problem which has plagued the country since 2006. Whilst various government measures have been implemented over the years to reduce the level of debt, these measures have failed to alleviate the problem in the long run. This problem still persists and is a major impediment to investment in power sector assets. The prevalence of the circular debt shakes the confidence of project sponsors in making long term investments in Pakistan's power sector. Given the fact that biomass based power projects are more capital intensive then conventional Natural Gas/HFO power plants, arranging a financial consortium in the presence of circular debt is a major obstacle.

(4) Other factors affecting the feedstock availability and power generation potential

Other factors that will be included in the Biomass Atlas Modelling stage as GIS layers affecting the Biomass Atlas creation are:

(i) High resolution digital elevation model (DEM);
(ii) Nation-wide road dataset at highest existing detail level, vector dataset;
(iii) Natural water body network and irrigation channel network, vector dataset;
(iv) Power Transmission system infrastructure, vector dataset;
(v) Urban area delineations, vector or raster dataset (already part of (i) for Punjab and Sindh);
(vi) Security area delineations, vector dataset;
(vii) Protective and conservation area delineations, vector dataset.

These will also address the physical and geographical constraints identified above.

These datasets have been requested from SUPARCO.

3.4. Biomass Atlas Modelling

(1) Primary biomass energy potential map

The primary biomass energy potential map covers the primary crop residues and wood harvesting residues. The biomass resource potential at the production site will be estimated by combining the land use classification and the field survey results as spatial mapping unit estimates. The methodology presented above will be used bearing in mind that the accessibility constraints are not taken into account at this stage. The minimum spatial mapping unit is determined by the grid cell size of the land use classification which is expected to be 5m x 5m in the case of utilizing the existing classification data. However, for the final biomass resource potential map land use segments are used. The segments are formed by merging neighboring grid cells if they are of the same land use class. For each segment, the resulting vector dataset contains the energy potential and the crop residue which is estimated based on Kharif and the Rabi crop seasons.

The wood harvesting residue information will be included in this dataset for the regions where such potential is identified, if any.

The degraded/fallow land will be included as its own layer for this map. In case of Option 1 for the land use classification, the geographic coverage of this land cover class will match the coverage of "The Pakistan Land Cover Mapping Initiative" available for the project at the time of creating this map. For option 2 some of the field survey effort will be dedicated to gather field observations matching the "Range Lands - Natural Shrubs and Herbs" land cover class used in the Pakistan Land Cover Mapping Initiative, but mostly the classification for this type will be in this case based on gathering reference data from online very-high resolution imagery.

The hypothetical primary biomass energy potential of this class will be evaluated based on literature survey of the possible feedstock species for this type of land. Hypothetical in the sense that for other feedstock resources the potential will be based on the surveyed, existing production, while in this case the evaluation will be on the possible potential, should these areas be utilised for feedstock production.

(2) Secondary biomass energy potential map

For these feedstock types, the energy potential map will be a point vector dataset pinpointing the location of the facility related to the feedstock production, the type of the feedstock available for energy production at the location as well as its energy potential.

(3) Resource sink energy potential map

Whereas the resource source energy potential maps show the distribution of resource potential at the source of its production, the resource sink energy raster map shows the likelihood of suitability of the location for energy production. The raster grid cell size for the resource sink energy potential map will be considerably larger than the source map. The working assumption at this stage is 1km x 1km. For each grid cell the feedstock availability will be modelled per feedstock type, transport

distance categories and cropping season. After that, the site suitability for a power plant investment will be derived by adding to the feedstock availability estimates the other factors affecting the site suitability such as proximity to the existing grid, water availability and other existing power plants as competing sinks for the resources.

The resource sink or site suitability maps will be produced for a set of energy production technologies having different biomass feedstock requirement profiles. The following biomass-based power generation technologies can be considered in the map:

- Biomass-fired steam boiler and turbine systems;
- Biomass gasifier and gas engine/turbine systems;
- Biogas digester and gas engine/turbine systems.

Besides the GIS datasets for both types of maps, specific cartographic outputs will be delivered according to the specifications in the document "WORLD MAP SPECIFICATIONS September, 2006". However, in contrast to the other renewable energy resources like sun and wind, the biomass based power generation is rather dynamic from the mapping aspect. For example when new biomass based power generation capacity is built, it will change the site suitability in its vicinity, as it will drain resources from the region. Similarly, changes in the crop species cultivation patterns will change the feedstock availability. Therefore, further deliverables in addition to the static data sets and maps are proposed. The actual content of these additional deliverables will depend on the land use classification options. In case of Option 1 in which the modelling can be based on an already existing land use classification, the modelling process can go deeper into the geospatial planning aspect, which is excluded from the present scope of work (Phase 1-3) but included in Phase 4. In case of Option 2 for the land use classification, the proposed content of the project and the deliverables is scoped according the original technical proposal and TOR.

For Option 2, in which much of the project effort will go to the land use classification itself, the "dynamic deliverable" will be developed as the background processing tool for the creation of the atlas maps based on the primary data sources.

For Option 1, a geospatial planning tool can be additionally developed allowing publishing of a dynamic atlas on the web. Using the planning tool the users can delineate an analysis area, change the parameters of the site suitability model, like the accessibility coefficient determining the feasibility of primary harvest residue collection (e.g. in cases when the project developers aim to set up their own supply chain for the feedstocks), and add new power plants to the analysis data set with information about their location and feedstock use level. The planning tool would thus allow online updating of the atlases for user-defined areas.

4. Matrix of Project Activities and Responsibilities

Project Activities	Implementation Arrangement based on the Inception Mission	Responsible Party
Phase 2 – Ground-based data collection and analysis; creation of draft biomass resource maps		
2.1 Prepare for remote data collection		
Gather available land cover and use classifications or alternatively satellite images	PITCO will facilitate the coordination with SUPARCO on how to get access to the following: (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.	PITCO possibly supported by SUPARCO

	(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. Option 1: If SUPARCO grants access to their existing land use classification datasets, no classification will be performed for the project. Instead, the effort will focus on the GIS modelling and dissemination activities, as specified below in the corresponding sub-chapters. Option 2: If the access to the SUPARCO land cover classification datasets is not granted for the project, the land cover and land use classification will be executed as specified in the project proposal by the project Consortium based on satellite images. In this case the land area will be mapped based on Landsat 8 images.	
Preparation for on-site data collection	In preparation for the ground-truth verification, the smartphone inventory system will be configured by SIMOSOL with the support of their technology provider, MHG Systems, based on the geography and the language of the smartphone. Software menus will also be translated to various local dialects in Pakistan whenever necessary. Training materials will also be prepared by SIMOSOL for capacity building of local counterparts for the delivery of Phase 2 data collection and other required components. This will include navigation of the smartphone menus and the processes taking place when used. Instructions will also be given on how they are used in the field. Based on NUST proposal for field survey, 60 smartphones will be used. The specification will be approved by SIMOSOL based on what is most suitable in the market at the time	SIMOSOL supported by MHG Systems for Smartphone Inventory System NUST for local acquisition of the phones PITCO for installation of Biomass Manager Mobile software

	of acquisition. Acquisition of smartphones will be NUST's responsibility. However, installation of Biomass Manager Mobile software[4] will be the responsibility of PITCO.	
Image analysis of the time series for field work allocation	These images will be processed and analyzed by SIMOSOL and VTT through the following algorithms: • Radiometric calibration of the image time series, • Cloud masking of the image time series, • Cluster analysis across the image time series. The process will produce images broken down to biomass clusters. The clusters will be divided into two parts: clusters for field inventory and clusters to be processed using software technology. From the first part, a detailed field inventory plan will be created to get sample observations on the ground for each different type of biomass cluster. The remaining clusters will be analyzed using sources of very-high resolution satellite images online thus reducing the field inventory cost. The scope of work will be dependent on the available data provided by SUPARCO. In case the existing land use classifications are accessible, this step will be replaced by allocation of field work based on the existing classification. Consortium partners SIMOSOL and VTT will be responsible for this activity but the scope of work will depend on the available satellite images.	SIMOSOL and VTT
2.2 PREPARE AND CONDUCT ON-SITE DATA COLLECTION		
Conduct training workshop on data collection using MHG Biomass Manager and other required components	Training will be conducted by FA/SIMOSOL. In order to fast track the trainer's training workshop, training coordinators and focal persons of PITCO, NUST and other participating universities and institutions will participate in the Trainer's Training Workshop. In the case where some local counterparts will not be able to attend, NUST will be responsible in training them in the use of software under the supervision of the	FA/SIMOSOL for Trainer's Training PITCO/NUST for Field Surveyor Training

[4] http://www.mhgsystems.com/services/mhg-mobile/, related: http://www.mhgsystems.com/services/mhg-biomass-manager/

	Consortium. NUST or the training coordinators and focal persons that attended the trainer's training workshop will train the field personnel using classroom-type training workshops and field sample inventory trainings for them to be familiarized with the features of the smartphone navigation, data entry, and data transfer. 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.	
Conduct GIS data acquisition of other driving components	This will depend on the available data provided by SUPARCO. If found insufficient or inadequate, the Consortium will conduct exhaustive data acquisition from other relevant agencies of GoP and/or provincial administration, This will be the responsibility of PITCO. Hereunder are some data sets subject for review and verification: • Geography • Transport infrastructure network • Water supply network • Security areas • Protective and Conservation areas • Urban areas • Power T&D system infrastructure	PITCO
Conduct field data collection from Industry / MSW	The industry / MSW surveys will be the responsibility of PITCO since it has strong connections 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. PITCO will identify all the possible industries/municipalities that can provide necessary	PITCO

	data.	
Conduct field data collection crop residue using MHG Biomass Manager Mobile Software	NUST will be in charge of the overall conduct and coordination of the crop residue field survey in collaboration with UAP and other institutions. The field surveys will be carried out across the country by several universities and institutes that are part of NUST network. This activity will be under the supervision of PITCO and the Consortium partners.	NUST and network for field survey PITCO/Consortium for supervision
2.3 DATA ANALYSIS AND MAPPING	The activity will be performed by Simosol with the support of VTT for the land use classification, if executed. The process of interpretation and creation of the biomass map will be as follows: • Generalize point field observations to area samples • Conduct land use classification based on the satellite images and field inventory • Prepare baseline biomass resource atlas - Model seasonal biomass production levels based on land use classification and productivity level estimates - Agriculture: productivity levels and cultivation seasons • Model potential energy conversion technologies for different feedstocks • Conduct potential energy use modelling No land use classification is needed if the existing SUPARCO classifications are available. If executed, the land use classification will utilize the VTT Probability Method. The modelling steps are described above in chapter 3. This will be the responsibility of SIMOSOL. Energy conversion chain modelling will be conducted by FA, PITCO and Simosol.	SIMOSOL and VTT for land use classification FA/PITCO for energy conversion technology modelling SIMOSOL for GIS modelling
2.4 STAKEHOLDER VALIDATION WORKSHOP	The Consultants will organize a one-day multi-stakeholder workshop for validation of the collected data and initial biomass resource maps. The topics of this multi-stakeholder	The Consortium

	workshop will include the following: • Presentation of the Biomass Atlas developed for Pakistan including the methodology applied; • Presentation of the use and the benefits of having an up-to-date Biomass Atlas Map; • Presentation of the key limitations of the maps and suggestions for further improvements; • Presentation of the next steps including introduction of Phase 4 and Phase 5. Based on stakeholder feedback in the Workshop, Implementation Plan for Phase 3 will be revised accordingly. Any drastic changes that will affect the timelines and budget will be consulted and coordinated with WBG and the Client and changes will be subject to their approval.	
PHASE 3 – PRODUCTION OF VALIDATED BIOMASS RESOURCE ATLAS		
3.1 FINAL ANALYSIS AND MAPPING	The activities will include the following: • Conduct simulation and final analysis based on stakeholder feedback • Revise Biomass Atlas • Prepare outline of key biomass resource assessment outcomes, methodologies applied and recommendations on additional analysis prior to biomass energy investments SIMOSOL will be responsible for this activity.	SIMOSOL
3.2 PRODUCTION OF FINAL BIOMASS ATLAS AND ASSOCIATED DATASETS	For this task the main activities of the Consortium will be the following: • Prepare final Biomass Atlas and datasets in digital form suitable for future application, operation and energy planning by the Client	SIMOSOL

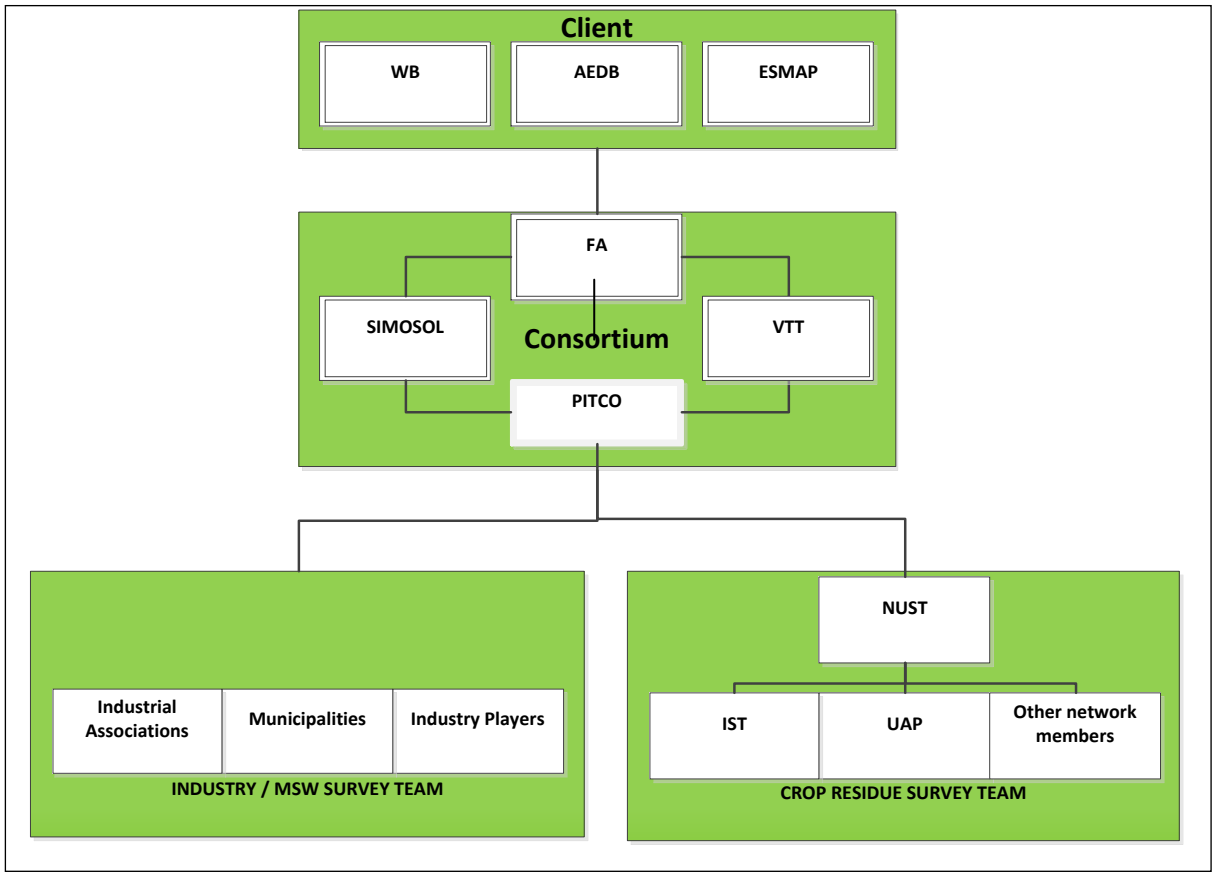
	• Produce final Biomass Atlas that can be categorized according to biomass feedstock type, availability, regional disaggregation • Produce final Biomass Atlas images suitable for publication / cartographic quality In case the existing SUPARCO land use classifications are available, and no land use classification needs to be executed within the project, the saved effort is moved here, and in addition to the static Biomass Atlas raster datasets and cartographic images, an online geospatial planning tool is developed for dynamic updating of the Atlas, as detailed in chapter 3. SIMOSOL will be responsible for this activity.	
3.3 DISSEMINATION WORKSHOP AND TRAINING	The Consortium will organize a one-day multi-stakeholder dissemination workshop for the presentation of the final Biomass Atlas. The Consortium will also conduct a two-day training of relevant local counterparts in using the digital outputs and mapping methodology of the Biomass Atlas. Given its close collaboration with SUPARCO, IST would be involved in this training activity, especially in the capacity building on GIS technology, Biomass Atlas utilization and updating.	The Consortium for conducting the 2nd multi-stakeholder workshop IST may support training on use of Biomass Atlas

5. Monitoring and Evaluation

The International Consortium partners led by FA will have overall monitoring and evaluation (M & E) supervision of the conduct of the whole project. FA will be in charge of the overall co-ordination while local partner PITCO will be directly responsible for the monitoring, evaluation and validation of the field survey data and activities.

In the initial phase, PITCO will review the field survey plan prepared by NUST. PITCO will assist the NUST staff in the setting up and use of 'Biomass Manager Mobile' software on smartphones. PITCO will review the consolidated field survey data, collected by NUST as per the Data Validation Protocol. PITCO will verify the field survey data through comparison with other studies and telephone calls to surveyed farmers. Based on an extensive review of data, PITCO will prepare a detailed M&E Report on the activities carried out by NUST. The organizational chart below shows the overall M&E management.

Figure 1: M&E Management



NUST will deploy monitoring and evaluation teams, headed by an experienced M&E Officer (focal person) to carry out the M&E activities over a period of three months. NUST will prepare and submit to the consortium an M&E plan for approval before the field survey is carried out. The members of the M&E team will be hired, trained by NUST and will be involved at all stages of the survey. Detailed monitoring and evaluation strategy proposed by NUST is provided in **Annex 5**.

6. Revised Work Schedule

No	ACTIVITY	Date Covered: (DD/MM/YY)	Lead	Support		Nov -14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug -15	Sep -15	Oct-15	Nov -15	Dec-15
1	**Phase I**																		
2	Contract Signing	09/11/14																	
3	**Project Inception**																		
4	Inception meeting	01/11 - 26/11/14	FA	Simosol, PITCO															
5	Compile Inception Report	27/11 - 04/12/14	FA	Simosol, PITCO															
6	Deliver Inception Report to the WB and the Client	05/12/14	FA																
7	Data Source Identification	19/11 - 31/12/14	PITCO	FA, Simosol															
8	Team Building	01/11 - 26/11/14	FA	Simosol, PITCO															
9	Implementation planning	27/11/14 - 02/03/15	FA	Simosol, PITCO															
10	Submission of Implementation Plan (IP)	03/03/15	FA	Simosol, PITCO, LSC															
11	**Phase II**																		
11	WB reviews and approves IP and budget for Phase II	09/03/15	WB																
12	WB and FA sign Contract Amendment	12/03/15	WB	FA															
13	FA signs contract with NUST	18/03/15	FA, NUST	Simosol, PITCO															
14	**Prepare for remote data collection**																		
15	Gather available land cover and land use classifications	01/11/14 - 27/02/15	PITCO	Simosol, LSC															
16	Prepare for field data collection	15/01 - 31/03/15	Simosol, FA	PITCO, LSC															
17	Image analysis of the time series[5]	01/03 - 30/04/15	Simosol	VTT															

[5] *Only applicable if activity 15 "Gather available land cover and land use classification" fails to secure access to the available data on land cover and land use classifications*

No	ACTIVITY	Date Covered: (DD/MM/YY)	Lead	Support		Nov -14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug -15	Sep -15	Oct-15	Nov -15	Dec-15
18	**Conduct training and on-site data collection**																		
19	Prepare for training workshop on data collection	10/03 - 20/03/15	Consortium	LSC															
20	Conduct training workshop on data collection (Trainer's Training, Field Surveyor Training)	07/04 - 9/04/15	Consortium	LSC															
21	Conduct GIS data acquisition of other driving components	13/04 - 30/06/15	PITCO																
22	Conduct field data collection of industry residues / MSW	13/04 - 31/08/15	PITCO																
23	Conduct field data collection of crop residues	13/04 - 31/08/15	NUST, PITCO	LSC															
24	Data analysis and mapping	02/03 - 30/09/15	Simosol, VTT	FA, PITCO															
25	Submission of comprehensive database necessary for biomass resource mapping, including raw data files	30/09/15	Simosol	FA, PITCO															
26	Submission of draft Biomass Atlas	30/09/15	Simosol	FA, PITCO															
27	Stakeholder validation workshop	01/10 - 15/10/15	Consortium	LSC															
28	Revise implementation Plan for Phase 3 based on feedback from the workshop	16/10 - 30/10/15	FA	Simosol, PITCO															
29	**Phase III**																		
30	Final analysis and mapping	16/10 - 06/11/15	Simosol, VTT	FA, PITCO															
31	Production of final Biomass Atlas and associated GIS files/datasets	02/11 - 16/11/15	Simosol	FA, PITCO															
32	Prepare for dissemination workshop and training	16/10 - 16/11/15	Consortium	LSC															
33	Execute workshop and training	18/11 - 21/11/15	Consortium																
34	Submission of Final Biomass Atlas and database	15/12/15	Consortium																

LEGEND:	LSC	- Local Sub-Contractors	▲	- Milestone	★	- Deliverables		- Home Work		- Field Work

7. Budget and Financing of Phase 2

Breakdown of budget for Phase 2 is shown in the table below. M&E Strategy and the detailed narrative of the proposed field survey to be conducted by NUST are found in **Annex 5** and **6** respectively.

Company	Activities	Total Amount (USD)	Breakdown
Consortium	Conduct 3-Day Trainers' Training Workshop	23,179	See **Annex 1**
PITCO	Conduct Industrial Survey	101,121	See **Annex 2**
PITCO	Conduct M&E of NUST Field Survey	36,800	See **Annex 3**
NUST	Conduct Field Survey	256,263	See **Annex 4**
	Sub-total	417,363	
FA	Financial Transaction Cost (2%)	8,347	
	Total budget for Phase 2	425,710	

8. Reallocation of Reimbursable Expenses of Phase 1

It is proposed that the budget for smartphones amounting to USD 3,000 in Phase 1 is reallocated to the payment of the venue and cost directly related to the holding of the Inception Meetings in the three venues. The original Reimbursable Expenses budgeted was only for one venue at USD 1,500. The two additional venues and related costs amounted to around USD 3,000. The smartphones for field survey is included in the Phase 2 budget for field surveys to be carried out by NUST. We would like to confirm that levels of effort from different experts were properly allocated in Phase I. Hence, in this regard, there is no need to make any revisions or reallocations in the budget at this point in time.