BIOMASS POWER DEVELOPMENT FOR THE PHILIPPINES

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ABSTRACT. The Philippines has abundant supplies of biomass resources, offering much potential for energy generation particularly from rice hulls and municipal solid waste. At present, the amount of usable power and other usable energy forms being produced from biomass is very small relative to the biomass resources available for this use. Biomass-to-energy projects, if developed and managed properly can create sustainable enterprises, protect the environment, and reduce poverty and improve the quality of life for the rural poor. An integrated project has been conducted to assess technological readiness, financing, capacity building, and Philippine national policy affecting biomass power development at selected sites. Key accomplishments include: (1) the creation of enabling policies and a favorable institutional environment for sustainable biomass resource use and development. (2) The development of a replicable training model to educate, build local capacity, create incentives, and structure the rural communities' own biomass projects. (3) The identification and selection of a rice mill that has established a strong collaboration and agreements with its community, local, regional, and national government and power distributors, technology suppliers, system developers, operators, local industries for maintenance and repair, transportation and other infrastructural activities, biomass fuel suppliers, and generators, and local and international research and development institutions, financiers, and others.

Keywords. Biomass Power Systems, Rice Hull, Rice Husk, Integrated Policy Development, Carbonized Rice Hull.

INTRODUCTION

Approximately 25% of the rural Philippine communities are without the necessary energy supplies in a useable form to sustain the power needs of the community appropriate to an improved standard of living. In order to develop and grow business, and meet industry and residential needs for income growth, the Philippines Government has recognized the need to

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accelerate the development of distributed power generation systems, and provide the tools and technologies for rural communities to make value added products from indigenous resources to generate self-sustaining income. Currently, the major source of energy for many of the communities is diesel, gasoline or kerosene engines. These fuel supplies are expensive and not always obtainable. In addition, these fuels are sources of pollutants causing environmental and atmospheric damage as well as local health problems. A more viable, plentiful, and environmentally sound approach is to use biomass residue as an alternative non-conventional fuel. A more sustainable environmental and economic approach would incorporate the use of the agricultural residue from the community in order to create new business opportunities while satisfying local ecological and power needs.

There are many forms of bio-resources, rice hull (husk), coconut shell, wood, sugar cane, animal manure, etc. Rice hull is considered one of the most abundant biomass resources in the Philippines. It is the major by-product of the rice milling industry. It constitutes 20% of paddy by weight. The estimated production of rice hull in the Philippines is about 2 million tons annually. This represents approximately 5 million BOE (billion of oil equivalent) in energy. It is largely unused, a poor source of animal feed, and often open-field burned causing hazards to the people and the environment.

The premise of the program is built upon the "pilot to pathways concept" developed by the National Renewable Energy Laboratory in the U.S.A. This concept is to look beyond the simple technical demonstration and to address the issues of capacity building, sustainable development, application, and financing. Such a comprehensive systems approach means in many cases not just how to replicate the use of the technology, but also how to make the communities self-sustaining so that these communities can generate an income to afford the continual development. Several attempts have been made through the years to stimulate bioenergy development both for rural electrification as well as regional scale power generation. Many of the larger scale, government sponsored programs did not accomplish intended objectives, partly due to the expense and limited availability of acceptable technologies, and partly as a result of a lack of coordination among proponents and users in developing and conducting these projects.

Successful implementation of biomass and bioenergy systems in community development requires strong collaboration among citizens of the target community, local, regional, national and international government, technology suppliers, system developers, operators, local industries for maintenance and repair, transportation and other infrastructural activities, biomass fuel suppliers and generators, and local international research and development institutions, financiers, and others.

The Council States of Government (CSG) supported Phase I of the Biomass Power System Development for the Philippines beginning in 1999. Phase I of the project was initiated with the goal of building in-country capability in biomass energy development,

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improving communication and coordination among Philippine government agencies, non-profit organizations, and other institutions in the area of biomass policy and project financing and analysis, and identifying potential demonstration sites for implementing biomass power systems as part of rural community development and life-style improvement.

The University of California at Davis (UCD) coordinated efforts with Global Green-Life Institute (GGI) and Preferred Energy Inc. (PEI) jointly implementing the project in consultation with and support from two other Philippines NGOs and five Philippines government agencies. A preliminary framework for an interagency coordinating body was established involving five Philippines government agencies along with local NGOs and development banks to collaborate in policy relating to biomass energy in rural development. Moving beyond this to the ultimate goal of commercial rural electrification embodies a number of remaining steps, which if properly supported, sequenced, conducted, and documented should prove successful in achieving that goal. The process and needs are not unique to this effort, but there are unique aspects in attempting to build biomass power systems as part of rural electrification.

Phase II continues to deepen and widen results from Phase I by helping Philippines government and community leaders and entrepreneurs to assess the value of biomass residue as an energy resource for rural economic development and to provide the structure for development of this resource to produce affordable energy for the communities. The specific project purpose is to pursue an integrated pathway to develop energy from agricultural residues, mainly rice hulls, to improve rural livelihoods. The pathway encompasses four directions simultaneously: technology, policy, social development, and financing. The project was initiated with the goal of creating a model for future projects to train, build capability, create incentives, and structure financial mechanism and policy making for the establishment of a viable demonstration site with appropriate biomass technology.

The Shell Foundation provides funding for Phase II. As part of Shell's Sustainable Energy Program, Phase II helps to underscore the objective of reducing the impact of fossil fuel use and overcoming poverty by increasing the access by low-income communities to modern energy services.

GGI, PEI, the Development Academy of the Philippines (DAP), and the Philippine Rural Reconstruction Movement (PRRM) cooperated to implement this project. A technical advisory group was instituted with representatives from UCD, U.S. Department of Energy, California Energy Commission, the National Renewable Energy Laboratory (NREL), the Philippines Rice Research Institute (PhilRice) and the Philippines Department of Science and Technology (DOST).

There are three major components to the project. The first component has the objective of creating an enabling policy and institutional environment for the promotion of a

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government-private-local communities partnership for sustainable biomass resource use and development. For this component, DAP heads the efforts to create a national Interagency Working Group (IWG) composed of representatives from the Department of Agriculture (DA), Department of Agrarian Reform (DAR), Department of Energy (DOE), Department of Environment and Natural Resources (DENR), and the Department of Interior and Local Government (DILG).

Current key results of the first component are:

- Reviewed energy and environmental legislation and administration
- Adopted sustainability indicators of Philippines Agenda 21, a policy directive for development
- Developed an integrated biomass policy paper
- Gathered resource inventory data on biomass and rice hull in particular
- Helped craft the Implementation of Rules and Regulations (IRR) of Ecological Solid Waste Management Act (ESWMA)

At the end of the project, there should be a well-defined strategic policy and institutional framework for agri-biomass development, promotion and implementation, and increased private sector participation.

The second component is to identify two villages (barangays), one on grid, one off grid, and to conduct a resource assessment to determine energy needs, viability of biomass supply options in comparison with other conventional fuels, and the social and technical readiness of the villagers to implement a biomass power system. The second component aims to develop and test an innovative, participatory, community-based approach for biomass (rice hull) energy resource assessment and planning towards influencing policy and practice that will ensure the integration of efficient and sustainable biomass energy resource use, sustainable agriculture development and poverty reduction.

Concurrently, the second component also facilitates the formulation of a Local Technical Working Group (LTWG) composed of relevant local government units and agencies and research institutions, such as Phil Rice, that will provide necessary technical and social support to the initiative.

PRRM leads the second component, and the current key results are:

- Selected two pilot rice-producing villages, Barangay Triala, an on-grid site, and Barangay Balbalungao, an off-grid site, both in the province of Nueva Ecija.
- Completed a "Participatory Biomass (Rice Hull) Resource Assessment" for the two selected sites.

- Completed two pre-feasibility studies at the village level. The first study proposes carbonized rice hull (CRH) production, rice stove manufacturing, and services offered by a flat bed dryer. The second study focuses entirely on producing, marketing, and distributing rice stoves.
- Coordinated multiple workshops and training courses, facilitated and provided from PhilRice, PRRM, DOST, etc., and local agencies/working groups. Training courses have been so popular that they are now being conducted beyond the two original selected areas.
- Training resulted in functional linkages between government, research institutes, and communities, and production and sales of Carbonized Rice Hull as fertilizer to Japan.

The third component is to work with one or more rural private enterprises that are economically, financially, and technologically ready to implement biomass power systems at a commercial scale. Specifically, PEI, who is leading this effort, helps the enterprise to develop a business concept that is acceptable to stakeholders, including cash flow analysis for prospective investments, ownership structures, model agreement outlines, performance requirements, financing mechanisms, and agreements with vendors. Also along with advice and technical support from the Technical Advisory Group, PEI helps to identify, review and evaluate various small-scale biomass energy technologies. This component is ultimately intended for commercializing small-distributed biomass energy systems by creating a market for rice hull gasifiers or steam boilers for small rural enterprises that previously did not have access to modern, alternative energy services.

Current key results are:

- Identified two viable rural enterprises that are economically, financially, technologically, and socially ready to bring on a biomass power system ranging from 1 to 2 MWe. One site identified is a rice mill that needs extra power and heat for its operation. It is foreseeable that during non-peak operation, additional power may be sold and distributed to the local power distributor and power company.
- The selected sites were also accepted to be part of the third phase of the EC-ASEAN cooperation programme (COGEN 3) and now qualified to seek funding for full-scale demonstration for a biomass power system. The pilot project is the implementation of proven technology on a full-scale basis in order to demonstrate its technical reliability, economic viability, and environmental friendliness. Support activities including assistance in the training of operators, and monitoring of the plants, and financing. PEI has been touring Europe and Asia to witness how various countries' rice hull biomass power system technology work and analyzing cost and technological appropriateness for the Philippines.

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In addition to the three major components, the project also reviews the various important financing schemes for private sector investments, government programs for renewable energy promotion and support, and soft loans managed by national banks and organizations.

Though there are a number of accomplishments in this project, there are also many challenges and lessons learned. The obstacles encountered are discussed later; unfortunately, these are all part of the developmental costs of any new projects and especially for small distributed biomass energy systems that have yet to reach a thriving commercial standard.

I. BIOMASS POLICY DEVELOPMENT & DATABASE – 1ST COMPONENT

A. Legislative Policy Development

Biomass, which constitutes a large fraction of agricultural production, needs to be recognized for its economic value. Moreover, because of the abundance of biomass waste, it has evolved into a serious waste problem in the countryside. The disposal through open burning has caused many health problems as well as severe concentrations of particulate pollution emissions. Even with these problems and potential, biomass has attracted little attention from the Philippine policy makers. It remains on the margins of policy formulation and strategic planning by most government agencies concerned with the rural sector. This neglect arises from confusion about its nature of being perceived as a waste instead of a resource in need of development. As a waste there are costs and environmental problems associated with disposal. As a resource it can be controlled by the community to provide energy and develop a source of revenue for the people. With no action, it will continue to be seen and treated as only a waste product with problems. There have been attempts in the past to use the resource in economic enterprises, however the limited successes and several failures among them have not engendered the momentum required to adequately exploit the resource potential.

No one agency oversees the flows of biomass in its entirety and, predictably, the management of the resource has not been subject to coordinated policy. If biomass is to contribute productively to rural development, then there must be a concerted effort by the concerned agencies to establish a coherent and comprehensive policy framework that recognizes the value of the resource and maps out paths by which people in the countryside may use it for creating self-sustaining enterprise.

In Phase I the concerned agencies along with the Philippine NGO's are being brought together to develop the policy framework and strategic action plan for advancing the productive uses of biomass. In Phase II, an Interagency Working Group (IWG) consists of five national government agencies, the Department of Agriculture (DA), the Department of

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Agrarian Reform (DAR), the Department of Energy (DOE), the Department of Environment and Natural Resources (DENR), and the Department of Local Government Units (DILG) is formed. The IWG mission is to formulate internal or national policies and programs to promote the full utilization of biomass as a resource.

With a history of training legislators on policy making and implementation, the Development Academy of the Philippines (DAP) leads the biomass policy and database development by first reviewing the country's energy and environmental legislation and administration and then abstracting the legal provisions that are relevant to biomass to effect new or current policies or programs. First, DAP/IWG work to incorporate provisions that advocate the use of biomass into the country's foremost policy on solid waste management. The law requires a framework that includes "waste to energy generation" and local governments as the sole responsible party in dealing with the solid waste management problem. Specifically, DAP helped craft the Implementation on Rules and Regulation of Ecological Solid Waste Management Act (ESWMA) to include agri-waste[1] as part of solid waste and to promote the use, conservation, and recovery of this resource.

With a clear mandate on agri-waste management, various government agencies now cannot ignore biomass residue and but have to perform certain tasks to control and manage them. For example, DENR is required to pursue improvement in disposal practices for solid wastes including sludge, undertake research on economic instruments in solid waste management, and have to study factors for success/failure of community-based waste management initiatives. The DA now leads in the improvement of composting technology and has to make such resources affordable for the villagers, assists the compost producers to ensure that the compost products conform to standards, and sets standards for organic fertilizers from compost. The DOE spearheads landfill extraction and utilization of biogas, and leads in production of usable forms of recovered resources, including fuels from solid waste. The Department of Science and Technology (DOST) needs to develop and apply new and improved methods of collecting and disposing of solid wastes and processing and recovering materials and energy from solid wastes. In addition, the Electric Power Industry Reform Act of 2001 declares the promotion of utilizing indigenous and renewable energy resources in power generation in order to reduce dependence on imported energy, and to assure socially and environmentally compatible energy sources and infrastructure. With the new legislative mandates, the national agencies are working closely with the local government

[1] The Implementing Rules and Regulations of RA No. 9003 defines solid waste as "all discarded household, commercial waste, non-hazardous institutional, port/harbor and industrial waste, street sweepings, construction debris, **agriculture waste**, and other non-hazardous/non-toxic solid waste." The term agricultural waste refers to "waste generated from planting or harvesting of crops, trimming or pruning of plants and wastes or run-off materials from farms or fields."

units and local communities in offering trainings and educational seminars on the various options in utilizing biomass resources.

B. Biomass Policy Paper

The IWG also decided to generate a biomass policy paper within the group on the productive use of biomass as a resource. The paper first describes how the lack of an integrated biomass policy impinges on the government's ability to see and fully utilize the value of this resource. It follows by elaborating on the effective use of biomass to help reduce poverty, promote sustainable development, protect the environment, increase gender equity, improve quality of life, and enhance the use of indigenous resources. These five themes are sustainability indicators adopted from the Philippines Agenda 21.

In addition, the paper also includes the total volume of biomass produced yearly, how they are being used, and a brief assessment of the biomass energy technologies in the Philippines. It follows by a description of each agency's efforts, programs and activity in the biomass area. The paper closes with an analysis of the issues, gaps, and challenges in the absence of an integrated policy and concludes the need for each government agency to formulate an integrated program and policy to promote the productive use of this resource and support ongoing and future projects of such.

C. Database Development

The biomass database is a comprehensive collection of information pertaining to the production and use of biomass in the Philippines, the list of biomass technologies available and the relevant business, academic, and non-government institutions that are involved in the productive use of biomass residues.

Specifically, the database includes: the allocation of various crops and animal biomass residues and their production quantity in the twelve regions of the Philippines from 1990 to 1999; the heat and power equivalent of biomass generated in year 1999; an estimated million barrels of biomass fuel oil equivalent (MMBFOE) resources from 2000 to 2009 including wood and municipal waste; the various regions utilizing or methods of disposing rice hull; rice hull-fueled energy (thermal and electric) projects and their location in the Philippines, and the project's proponent or owner; the various rice hull consumption methods by industrial or residential sector; rice hull energy savings potential; a few modern biomass technologies and its energy and environmental impacts.

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II. BARANGAYS SELECTION, RESOURCE ASSESSMENT, & FEASIBILITY STUDIES – 2ND COMPONENT

A. Site identification and selection

A main output of this project is to identify a few viable sites in the rural areas for the installation of biomass energy systems and associated infrastructure. PRRM, which has a almost 50 years of experience in working with the rural population in social, economic, environmental, and institutional development, worked with the local organizations and government agencies to select two barangays. Determining factors for site selection were location and production of the mill/villages, readiness and consistency of biofuels supply, transportation infrastructure, mill/village financial standing, access to local power plant or grid, willingness of local utility to purchase excess power, and the mill/village manageability of power plant operations. In addition, detailed assessments and feasibility studies will further dictate or indicate the community's ability and readiness for which specific biomass technology system to adopt and use.

On the basis of the above selection criteria, the two pilot sites were identified. Nueva Ecija (NE) is the top rice-producing province in the Philippines contributing 20% to the total national rice production. Agricultural production in the province covers almost 300,000 hectares, 86% of which is devoted to rice production. 46% of the total population of NE is rice farmers, which accounts for 87% of the province's entire labor force. In addition, these two sites are also selected as agrarian reform communities, which means there is a presence of a relatively strong partner people's organization (PO) in the village and the villagers have a high need for income generating/livelihood projects for the villagers.

B. Participatory Resource Assessment (PRA)

Once the sites were determined, PRRM arranged meetings and obtained support from relevant local government agencies, research institutes, and the private sector. A local working group was set up to interact and update all relevant parties including the barangays' Mayor offices on project progress, and technical and academic workshops were conducted to educate the villagers on various uses of rice hull/husks.

The objectives of the PRA are to determine the biomass resources available, how they address community needs, and to develop a feasibility study for planning the use of these resources. The PRA shows the methodology, communities and sampling procedures, data, and a brief conclusion of results assembled. Sitio Batac, i.e. barangay Balbalungao of Lupao has a 90% survey return rate, whereas, barangay Triala of Guimba, has 32%. The household population in Triala is 6 times of Batac.

The survey included a brief village profile, personal/family/farm characteristics and employment location, appliances owned, biomass production data, uses of rice straw/hull,

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potential use of electricity, technology options based on available local biomass, and the potential technology suppliers.

Triala is a lowland type of ecosystem with a total land area of 404 hectares, and has 85% or 344 hectares as farmlands that are irrigated by a brush dam and shallow tube wells. The remaining 15% or 60 hectares are residential lands. It has a total population of 1,901 where 48% or 914 are males and 52% or 987 are females. Based on the latest data gathered during the PRA process, the average household size is 5 with a total household population of 403.

Agriculture is the main source of income. Palay is the main crop with an average production of 130 cavans per hectare for the wet season and 80 cavans per hectare for the dry season. Statistical results from the PRA showed that only 18% of the respondent households are above the poverty threshold. There are three palay buying stations in Triala with a warehouse and solar dryer each. In addition, there is also a mobile rice mill in the area.

Tricycles, hand tractors, and public utility jeepneys are the main means of transportation in the area. Electric power service is provided by the Nueva Ecija Electric Cooperative II (NEECO II) to 98% or 394 of the total number of households. Pitcher pumps are the main sources of water for household consumption.

The main conclusion for barangay Triala was that it yields substantial volume of rice hull/straw. The rice straw was observed to have more uses in the farm as fertilizer. Though rice hull is not presently used as much and shows more promise as a source of energy, the volume produced is not enough for scaling to larger sizes. The villagers have a high level of organization for the development of livelihood projects and the communities certainly need other sources of income to boost their economic conditions.

Barangay Balbalungao is an upland-lowland type of ecosystem. It is composed of six sitios and our pilot site, Sitio Batac, is one of them. Based on the PRA data, Sitio Batac has a total household population of 51 with an average size of 6 members (8 households). Agriculture is the main source of income with palay as the main crop for the wet and dry seasons. Although Balbaluangao has a large area, production yield is relatively low due to the inadequacy of basic production elements like irrigation. In Sitito Batac, the yield is an average of 59 cavans of palay per hectare and only one cropping season; 100% of the farms are rainfed.

Statistical results showed that all the respondent households are below the poverty threshold. There is no significant agriculture-based commercial establishment in Balbalungao. In addition, there is also a mobile rice mill in the area.

The conclusion is similar to Triala that the amount of rice hull produced currently may not suffice for a biomass power plant. But since both selected sites focus on organic farming,

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there is opportunity to use rice hull as livelihood projects such as production of CRH as soil conditioner or fertilizer, rice stoves for home heating or cooking purposes, and services for a flat bed dryer to be added at the rice mill.

With the PRA results, PRRM arranged meetings, site visits, and training sessions with research institutions such as the International Rice Research Institute (IRRI), University of Philippines at Los Banos, the Foundation for a Sustainable Society, Phil Rice, and government agencies such as the Department of Science of Technology (DOST) on educational workshops on rich hull carbonization, rice hull stoves, rice hull-fueled gasifier for irrigation, and compost making using CRH and household and kitchen waste. During the trainings sessions, DOST introduced private enterprises engaged in biomass resource development to the farmers and now Sitio Batac is successfully producing and selling CRH to Japan and local areas as organic fertilizer for algae growth.

Educational programs have expanded into four other barangays in San Jose City –Santo Nino, Kita-Kita, Tayabo and Palenstina. In addition, PRRM provided this training model to its Partner PO in North Cotabato to educate more farmers in different areas. With this multi-stake partnership, PRRM was able to mobilize financial and technical resources from the Local Government Units (LGUs), PhilRice, and the Central Luzon State University. As a result, functional linkages with private enterprises, villagers, government and financial institutions are established with a focus on CRH and organic product exporters.

C. Preparation for PRA and lessons learned

Many rural biomass projects failed in the past because there was too little involvement, education and decision making from the local people from the very beginning. Therefore, to ensure full participation and acceptance from the local population, project managers worked very closely with the communities from the start and worked to answer questions and resolve differences.

To prepare for preliminary site assessments that included initial rice husk production, energy loads, husk collection and disposal mechanisms, and energy needs for surrounding communities, graduate students from UCD toured selected rural sites with PRRM organizers and surveyed local representatives to test the level of acceptance, readiness and willingness of the villagers in setting up a biomass project. The organizers and students also shared with the farmers the potential economic and environmental benefits of this project at the household and community levels.

Regular meetings with the farmers in the villages were conducted after the students' visit with more intense discussion of project objectives, implementation activities, expected outputs and schedule of events. Also included in the meetings was a review of basic concepts and information on biomass resources, applications, and technologies. This was done to update

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both the newcomers and the previous attendees to the meetings. The comments, perceptions, and issues raised by the villagers have led to the task of not only developing a primer attuned to local needs but also a campaign plan for the project and biomass technology information that included local talent as well. The village meetings thus became venues for the continuing information and education on biomass.

Batac, which is a sitio (sub-village) of Balbalungao, with 51 households has 90% respondents. Triala with almost 403 households, has 30% household respondents in the survey. From these figures, preparation for the pretest was determined. In line with the project objective of capability building and participatory process development, a training activity was launched for local enumerators from the villages themselves for the resource assessment. Five enumerators (3 women and 2 men) came from Batac, Balbalungao, the off-grid site, and ten (7 men and 3 women) from Triala, the on-grid site.

In the pre-testing, a trial survey of 35 respondents (10 for Batac and 25 for Triala) was made to assess if the respondents can easily and quickly understand the instrument and that the intended data requirements are obtained. Other factors like length of time of interview per respondent, and problems encountered during the interview were also discussed -- all these were done to aid the enumerator during the survey. Pre-survey results were reviewed to fine tune the instrument, remove redundant sections, reduce and simplify questions and to make final instructions and guidelines for the enumerators prior to start of the survey.

The use of villagers as enumerators for the PRA was intended to equip them in research and survey skills and to ensure that they participate in all the processes and activities in the project. Although there was a minimum level of literacy level required for enumerators, the training conducted for them in preparation for the resource assessment and their conduct of the pretest were intended as a screening process. When the results of the pretest revealed the inadequacy and unreliability of the responses generated, the project consultants who made the review recommended the hiring of enumerators who are college graduates, especially those whose courses were related to agriculture. From the batch of fifteen villagers trained as enumerators, only four were left to form the final team.

Teaming up the village enumerators with the college graduates proved beneficial to both parties. The village enumerators were able to introduce the graduates to the respondents, thereby making the interview process easier and non-threatening both for the enumerator and the respondent. The village enumerators also served as guides to facilitate locating the respondent. On many occasions, the village enumerators helped in selecting respondents who could substitute for the respondent listed when they turned out to be non-rice producers (either as leaseholders or owners)—an important criterion for respondents.

Although much groundwork was laid to encourage a high PRA response ratio, only 178 responses were received from both villages. Problems encountered during the survey included

unavailability of respondents (it being the peak of the harvest season), time consumed by enumerators per respondent, and tediousness in computing costs assigned for biomass resources. This was due to the fact that a baseline survey was, in effect, conducted for a number of reasons: 1) dearth of updated and accurate village level information on the project villages; 2) data generated was intended for use in the feasibility study and proposal development, and 3) to have some form of baseline to gauge the villagers' acceptance or rejection of any project that may turn out to be most viable and feasible in the project village.

D. Pre-Feasibility Studies

There have been two pre-feasibility studies conducted in the selected barangays. The first study proposed carbonized rice hull (CRH) production, rice stove manufacturing, and services offered by flat bed dryers. The second study focuses entirely on producing, marketing, and distributing rice stoves.

i. Center For Rice-Based Biomass Enterprises for Carbonized Rice Hull Production and Rice Stove Manufacturing

Incorporating the results and analysis from the PRA, The Organic Farmers Union Association in Triala proposed the first program. In addition to the already mentioned social, economic and environmental benefits in utilizing rice hulls, the study focuses heavily on the financial and project management side of the proposed project. Very detailed financial statements and sensitivity tests are included in the study. The estimated program cost for the first year was $65,000; the project duration is five years.

Today, the non-agricultural sector is the major contributor of the growth performance of the country. On the other, the agricultural sector, which is the traditional leading sector, failed to sustain its growth momentum due to the past macroeconomic and sectoral policies of the government that biased against farmers in favor of consumers; poor technology adoption owing to poor rural infrastructures; and prevalence of bad weather conditions. Rural poverty remained the major concern for development. To address such, the Center for Rice-Based Enterprises (CRBE) was formed to serve as avenue for poverty alleviation through livelihood and enterprise development.

Initially serving a population of 366 households (or 2201 persons) CRBE intends to expand its service coverage in Nueva Ecija. At the outset, CRBE shall implement two-program components namely: Carbonized Rice Hull Processing and Rice Hull Stove Manufacturing. All components require building, facilities, operating capital and human

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resources. The total funding requirement is P3,444,253.12[2] ($68,885 USD), which shall be funded mainly by grants, soft loans (long-term low-interest loans with little collateral risk), and the like.

The implementation scheme of the Carbonized Rice Hull (CRH) Processing and other livelihood components includes training of qualified participants with rice hull processing techniques through hands-on training and small-scale demonstration, which shall eventually graduate to commercial operation. On the other front, the rice hull stove manufacturing project shall also pursue an effective marketing program, which is focused on technology information drive aimed to spread improved local-specific technologies, both addressing productivity enhancement and environmental management. Both the DOST and PhilRice provide the CRH and rice stoves technology and training

The technical aspect does not pose any difficulty since machines and equipment necessary for carbonized rice hull (CRH) and rice hull fuelled stove (RHFS) are available and simple to operate. The supply of raw materials is abundant because the two pilot sites were considered major producers of rice and other crops as sources of biomass products.

The organizational aspect would be complemented by the existing coordination and management system of the PRRM. Labor supply is adequate since the location of the project is inside the service-community. Out-of-school Youth's (OSY's) and rural women would be likewise employed.

The total capital requirement of the project consists of operating capital and capital outlay. The amount of P1,776,950 ($35,539) is to be earmarked for the construction of the building and the acquisition of equipment and facilities while P1,667,303 ($33,346) would be allocated to the operating requirements. Funds of P3.4 M ($68,000) shall be sourced from internal or external funding agencies.

The financial viability for both the CRH and rice stoves production project was very encouraging because it passed the financial feasibility criteria. The summary of such findings is found below.

MEASURES	WORTH
Internal Rate of Return(IRR)	76%
Net Present Worth (NPW)	PhP3,689,781 ($73,395)
Benefit Cost Ratio (B/CR)	1.31
Payback Period (PP)	2.8 years

[2] The foreign exchange rate varies according to Philippines economy and political situation. For the purpose of the paper, the conversion rate of 50 p to $1 USD is being used; this is the average conversion rate in the last year.

Profitability Index (PI)	208%
Ave. Return on Investment (ROI)	78%
Net Benefit-Investment Ratio(N/K ratio)	2.24

The socio-economic impact of CRBE in terms of employment generation and the provision of markets for inputs and outputs of livelihood enterprises certainly make the difference in the lives of the target beneficiaries. With the expected improvement in the socio-economic condition of the target beneficiaries, agricultural and economic practices that are detrimental to the quality and sustainability of the environment shall be reduced if not totally eliminated.

III. INDUSTRIAL SITE, CORFARM GRAINS, INC. – 3RD COMPONENT

The third component, in contrast with the 2nd component, is to work with one or more rural private enterprises that are economically, financially, and technologically ready to bring on a biomass power system at a commercial scale. It is important to note that it is not the Shell Foundation's objective to help create wealth or fund a specific power project for rice mills owners but rather to reduce the impact of fossil fuel use and overcome poverty by increasing the access of low-income communities to modern energy services. These objectives lend support to renewable energy pilot projects that ultimately help reach a higher mission of commercializing small-distributed biomass energy systems by creating a market for rice hull gasifiers or steam boilers for small rural enterprises that previously did not have access to modern, alternative energy services.

The following is an executive summary of Corfarm's feasibility on establishing a rice husk-fired power plant in Pangasinan. Corfarm is not new in seeking to erect a biomass power plant, in fact, it has been in discussions and meetings with various biomass technologies suppliers and equipment vendors in Europe, USA, and Asia for over five years. Corfarm came close to achieving its goal several years ago but could not continue due to the inability of the equipment supplier to provide warranties that are part of the developmental realities for small distributed biomass energy system. Now Corfarm is again searching for equipment and has received some funding from the European Co-Generation 3 Programme (CoGen 3) to help cover some of the initial costs.

Corfarm is a corporation engaged in paddy procurement, rice milling and marketing. Its operations in Umingan, Pangasinan integrate 2 milling lines that each produce 127 cavans of milled white rice with 159 cavans of paddy input per hour. Running 15 milling hours per day, 20 days per month, total monthly production of the finished product equates to 76,200 cavans

of milled rice or roughly 914,400 cavans of rice milled in a year. That translates to approximately 45,720 metric tones (MT) of milled rice per year[3]. The remaining 10 days are used for upgrading and maintenance of the rice mill. The rice mill can operate 16 hours per day at full capacity for a maximum of 22 days. The milling plant was formerly owned by officials and employees of the power utility firm Manila Electric Company (MERALCO). It is now a corporation with a diversified shareholder base.

Aside from Pangasinan, most of CORFARM's source of paddy during the dry season comes from Isabela and Nueva Ecija and the Ilocos region during the wet season. Unlike other mills that depend solely on paddy inputs within their province, the strategic location of CORFARM allows it to source paddy all year round. Private traders, wholesalers and retailers from the neighboring towns and provinces provide up to 70% of the paddy procured by CORFARM. These paddy sources prefer CORFARM over other mills operating in the Luzon area because the mill has an established name that supplies most of the rice requirements of Luzon and Metro Manila's corporations and fast food chains. The remaining 30% of paddy is provided by smaller farmers in the surrounding Umingan area.

Recently however, CORFARM has cut its production tie-ups with farmer's cooperatives and instead relies on individual farmers for its supply of paddy; this because farmer's cooperatives wanted to link the production tie-up only to loans from the milling company. CORFARM does not encourage the practice.

CORFARM is the single, largest supplier of white rice in Luzon, the bulk of which is supplied to Metro Manila corporate consumers. Undoubtedly, it has one of the most organized distribution channels on the island, and this has made its production and supply operations very stable and reliable in the long-term. CORFARM however has shied away from the traditional wholesale and retail outlets based in the different public markets in Luzon. It perceives a great risk in the lack of collateral from these markets as well as in difficulties in collection activities.

Aside from CORFARM, there are existing rice mills in the nearby Dagupan area. However, these do not at all affect CORFARM's operations because these rice mills are at least 50 kilometers away from Umingan, and cater to smaller and medium-type markets.

On its research and development activities, CORFARM is trying to revive the Japonica rice variety it successfully market-tested some years back. It plans to either acquire a company that produces seedlings of this type or purchase new seedlings from Negros. In 1995, it was able to successfully propagate this type of rice. However, after the 3rd and 4th cropping season, the Japonica variety lost its purity due to cross-pollination from other local varieties.

[3] 1 cavan is approximately 1 50-kilogram sack of rice. 1000 kilograms is equivalent to 1 MT.

CORFARM plans to acquire new seedlings of the Japonica rice and have it planted upland, insulating the crop from local varieties. CORFARM is also considering production of other more exotic varieties.

Rice Husk Production

CORFARM does not keep account of the total rice husk production as a result of its milling operations although officials forecast a 20% crop to residue ratio. Thus, if CORFARM produces a total of 914,400 cavans of milled rice annually, rice husk[4] would account for 183,000 cavans per year. CORFARM dumps the rice husks on a landfill owned by the company near the mill. Once near maximum levels, the husks are simply burned. If need be, rice hull can also be imported mostly from San Jose City, Nueva Ecija.

As for by-product ash, current average price for good quality ash under one production contract is US$200/MT. Good quality ash has been qualified as that with a 5% or less carbon content.

Power Consumption and PANELCO III Sales to CORFARM

CORFARM obtains its power from the Pangasinan Electric Company (PANELCO) III. Average monthly power consumption of CORFARM is as follows:

Power Use (kWh/month)	***56,959***
Power Bill (P), Average Monthly	***260,183 ($5,203)***
Power Cost (P/kWh)	***4.5679 (($0.09)***
PANELCO III charges	***P15/kW/month ($0.30)***

A transmission substation of PANELCO III is located nearby to CORFARM. The lot was provided by the owners of the mill to the electric cooperative primarily to ensure reliability of power supply and to get first-hand information/knowledge on possible scheduled power interruptions.

PANELCO III schedules at least 2 power interruptions a month lasting 8 hours each. The mill is effectively shutdown on these days because each brownout influences mill operations.

[4] Rice husks weights are reported on a wet basis with a moisture content of between 12 to 14%.

CORFARM does not operate its mills for the remaining 2 hours of electricity provided by PANELCO III. To make up, CORFARM schedules additional hours during the days extending them to 12 hours. No other power development opportunities have appeared in the area, except for the installation of power transmission lines at the back of CORFARM's warehouse.

As a result of CORFARM's operations, it was reported that several socio-economic benefits/services were derived by the town and province such as infrastructure projects including setting up of a grocery and a rural bank. CORFARM also hires at least 70 to 80 local residents, mostly women to handle the manual cleaning of milled rice. These women work from 8am to 5pm, full time, 5 days a week. CORFARM also hires around 100 laborers from Umingan in addition to the mill operators especially during procurement season for the hauling of palay and rice.

PANELCO III was formally incorporated and registered with the National Electrification Administration (NEA) on May 20, 1979. It has been classified as an "extra large" rural electric cooperative (REC) and has been given an "A" rating based on its 1995 operations. It has a revenue collection efficiency of 98%[5] as of June 2000. Prior to the current rating, PANELCO III has been a consistent "B"-rated REC. In the past, PANELCO III was the recipient of NEA's Exemplary Payor Award. In 1998, its revenue growth was a healthy 29%. Some of PANELCO III's financial ratios are summarized in the table below:

Financial Ratio	***1995***	***199 6***	***1997***	***1998***	***1999***	***2000***
Return on Revenue	12%	6%	13%	9%	5%	5%
Return on Total Assets	10%	6%	12%	8%	4%	2%
Current Ratio	1.92	2.26	1.34	1.48	1.37	1.22
Acid-Test Ratio	1.89	2.23	1.02	1.18	1.05	1.2
Strict Liquidity Test Ratio	0.42	0.49	0.17	0.16	0.15	0.27
Debt Service Coverage	3.43	3.08	3.86	2.82	2.47	2.67

Source: NEA Loan Relationship Review Documents,
Year-ender Reports 2000 (as of June 2000 only; full year report not available)

PANELCO III maintains its current payment record with NPC and regularly avails itself of the Prompt Payment Discount.

[5] Collection efficiency for 1995 to 1999 were: 100%, 95%, 99%, 93%, and 99%, respectively.

In addition to the feasibility study, Corfarm and its partners toured many biomass power technology sites in Asia and Europe to assess the cost and appropriateness of the foreign technology in the Philippines. Furthermore, studies were also requested from European manufacturers of biomass equipment to submit technical and financial quotations for the turnkey supply of a power plant using rice husks as primary fuel. Five responses were obtained from the following main suppliers:

1. Vyncke of Belgium, which proposed a 700 kWe (net) power plant using a Vyncke boiler and a Nadrowsky (Germany) steam turbine. Vyncke has obtained a 10 percent grant from ABOS, a Belgian government agency. The Vyncke proposal is about US$1.10 Million or US$0.99 Million net of grants.
2. IMS Engineering of Malaysia, which proposed a 700 kWe (net) power plant using a UGM (Italy) boiler and a Nadrowsky (Germany) steam turbine. Their proposed equipment cost is US$1.02 Million.
3. Mets Philippines, Inc., which proposed an ERATIC (Spain) fire-tube boiler and a Nadrowsky (Germany) steam turbine. The total cost of the proposal is US$1.53 Million.
4. Standardkessel of Germany, which proposed a Standardkessel boiler and steam turbine. The total cost of the proposal is US$1.66 Million.
5. Konus-Kessel of Germany, which proposed a Konus-Kessel boiler and a multistage steam turbine. The total cost of the proposal is US$3.72 Million.

The latest findings show that using Vynke boiler and Nadrwosky tubine is a viable option for Corfarm's energy needs. The chart following provides the financial analysis.

Preliminary Financial Analysis

INTERNAL RATE OF RETURN	37.61%	**Using Vynke boiler &
NET PRESENT VALUE @ 20%	21,917 Thousand Pesos	Nadrowsky turbine
GENERATION COSTS, P/KWH	Based on total generation 1.6617 P/kWh	
@20% discount rate	Mill Requirements only 3.0346 P/kWh	

Sensitivity Analysis of IRR versus Equipment Cost & Power Price
(CASE: 1000 kW capacity, US$1002/kW installed eqpt cost, 15% EC grant)

IRR						Power price (P/kWh)
	3.00	3.50	4.00	4.50	5.00	5.50
(Pesos)						
40,000,000	18.9%	21.7%	24.5%	27.3%	30.1%	32.8%

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41,000,000	18.3%	21.1%	23.9%	26.6%	29.3%	32.0%
42,000,000	17.8%	20.6%	23.3%	26.0%	28.6%	31.2%
43,000,000	17.3%	20.0%	22.7%	25.3%	27.9%	30.5%
44,000,000	16.8%	19.5%	22.1%	24.7%	27.3%	29.8%
45,000,000	16.4%	19.0%	21.6%	24.1%	26.6%	29.1%
46,000,000	15.9%	18.5%	21.0%	23.6%	26.0%	28.5%
47,000,000	15.5%	18.0%	20.5%	23.0%	25.4%	27.9%
48,000,000	15.1%	17.6%	20.0%	22.5%	24.9%	27.3%

Equipment Cost

The second viable site for the implementation of a biomass power plant is La Suerte. La Suerte rice mill is located in Isabela province, which hosts the largest concentration of big rice mills in the Philippines. The rice mill produces 6 MT of rice per hour with a 24-hour operational capability. It is a highly automated system with a single person controlling the entire system. La Suarte has enough rice hull for a 1.2 MW power plant. The estimated additional investment is about 1.8 million (based on quotation from European suppliers). The self generation cost is estimated at P6/kWh. PEI is helping La Suerte in the feasibility study and preparation of an investment brief for an external investor on the project. At least one serious investor has been identified.

Both owners of Corfarm and La Suerte visited the Chia Meng rice mill in Vietnam to familiarize themselves with the biomass technology. Although foreign examples exist, local rice millers are hesitant to undertake the project with no existing local example. La Suerte management will only do the project with an external investor on the power component. Other than these two sites, PEI has also identified three more rice mills with the same capacity and interest as La Suerte.

IV. FISCAL INCENTIVES

The Executive Order 215 of 1987 first allowed private sector participation in power generation in the Philippines. However, the Build, Operate and Transfer (BOT) scheme (Republic Act 6957), introduced with the aim of encouraging private investment in infrastructure development to allow economic growth, has been one of the most important incentives for private investment in the energy sector. The BOT legislation was amended in 1994 (RA 7718) further decreasing restrictions on private and foreign investors. Further, the Omnibus Investment Code (Executive Order 226 of 1987) offers a number of incentives to projects, especially with concessions to renewable energy projects:

- Tax duty exemptions on imported capital equipment
- Tax credit on domestic capital equipment
- Income tax holiday for 6 years for biomass projects
- Additional deduction for labor costs, and
- Deduction of infrastructure expenses from taxable income.

The Renewable Energy Power Program (REPP) funded by the DOE and implemented by the Development Bank of the Philippines (DBP), the Land Bank of the Philippines and the Philippines National Bank, provides funding to Philippine nationals or entities for renewable power projects using commercial technologies. Total funds of P750 million have been made available from the Government Services Insurance and Social Security Systems.

The Window III of DBP financing is available for lower interest rates (between 12 and 16.5 % per year) for viable development projects which have difficulty obtaining financing from other sources because of a lack of equity, long project development phases, or high risk. This facility has been used to finance pilot project for the installation of solar home system in rural areas. It also provides support to viable new technologies.

The Philippines National Oil Company Energy Development Corporation administers the Decentralized Energy Systems project, aimed at commercializing decentralized or non-grid connected energy systems, by involving private sector manufactures and developers. Assistance is provided in the form of loans or loan guarantees, with some help available for project preparation and implementation. The project is also intended to facilitate cooperation and joint ventures between EU and Philippines companies.

Other sources of support include:

EC-ASEAN COGEN Program, which is an economic cooperation plan between the European Commission and ASEAN, to transfer European technologies and know-how in the field of heat and power generation from biomass residues to ASEAN countries. The program focuses in particular on wood and agro-industry wastes (in particular from the rice and sugar sectors). The program provides information to European and ASEAN actors. For example, a database containing information on European companies and organization specializing in biomass energy technologies has been developed (www.cogen3.net). Assistance is also provided for demonstration projects, up to 15% of total equipment cost, with a ceiling of 400,000 ECU per project.

European Community Investment Partners (ECIP) program is designed to help European companies establish joint ventures in developing or emerging countries. The scheme is administered by banks, including European and ASEAN banks, and provides assistance in the form of grants for the identification of partners and projects, interest free advances for establishing joint ventures, equity or equity loan funding for JV projects, interest

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free loans for technical training and management development, and grants for the preparation of BOT/ BOO or privatization schemes for infrastructure, utilities and environmental services, including energy projects.

Projects eligible for support under the **UNDP/World Bank Global Environment Facility's (GEF) Small Grants Program** in the Philippines include those using alternative sources of energy such as biomass. The program gives priority to small-scale projects which if replicated could have an impact on the global environment. In addition, a number of support packages are also available from USAID via Winrock International, REPSO-Philippines, and PEI.

Although the operators and their financial standing, equipment vendors, providers of debt, strategic and financial equity investors are all important factors influencing which types of financing mechanism to adopt, a closer look reveals the industry itself and technology and political risks are actually the drivers in the process of raising finance, reviewing concessions and licensing agreements, and dictating the terms that shape project structures.

CONCLUSIONS

The Philippines has abundant supplies of biomass resources, offering much potential for energy generation particularly from rice hulls. At present, the amount of electricity and other usable energy forms being produced from biomass is very small relative to the biomass resources available for this use. Biomass-to-energy projects, if developed and managed properly can create sustainable enterprises, protect the environment, and reduce poverty and improve the quality of life for the rural poor.

Developing successful biomass distributed power systems will depend on technological readiness, financing, capacity building for the end users and operators, and a uniform national policy that recognizes biomass as a resource and mandates the use as such. This project attempts to integrate these pathways through a process of research and education including data analysis and information synthesis along with pilot site studies to build capacities for local communities to actually implement biomass energy and/or power systems/projects. Such a comprehensive systems approach means in many case not just how to replicate the use of the technology, but also how to make the communities sustainable and self-sustaining.

Key accomplishments include: (1) the creation of enabling policies and a favorable institutional environment for sustainable biomass resource use and development. (2) The development of a replicable training model to educate, build local capacity, create incentives, and structure the rural communities' own biomass projects. The training model resulted in actual sales of CRH to Japan as fertilizer and provided additional income for the farmers and enterprises in Balbalungao. The trainings and educational workshops have been duplicated in four other regions in the Luzon province and are well received in those villages as well. (3)

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The identification and selection of a rice mill which is ready to bring on a biomass power plant and has established a strong collaboration and agreements with its community, local, regional, and national government and power distributors, technology suppliers, system developers, operators, local industries for maintenance and repair, transportation and other infrastructural activities, biomass fuel suppliers, and generators, and local and international research and development institutions, financiers, and others.

Although project development results are promising so far, there remain challenges to the creation of a market for distributed biomass power systems, principally in the lack of readily available and commercially viable distributed biomass power systems with adequate warranties to attract investment. Continued research and government funded mandates to use biomass residues may help to accelerate the technology to reach commercial scale and thus bring the prices down. However, in the mean time, we may need to also rethink our approach to include additional factors beyond just the power aspects, for example, integrating and treating the overall energy, sanitation, municipal development system as a whole may hold more promise.

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