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La Suerte Rice Mill Cogeneration Project: A PILOT Case for the Philippines

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ABSTRACT

The Philippines lags behind its brother ASEAN neighbors when it comes to the institutionalization of cogeneration policies and activities. The country is still in the process of developing a national cogeneration policy for inclusion into the overall Renewable Energy policy framework. For years, much of the installed cogeneration capacity is in industries where cogen systems are inherent in their operations, such as the sugar, pulp and paper, chemicals and coconut oil industries.

1995 figures account for 345MW of installed cogeneration capacity in 11 industrial sectors consisting of 63 firms. The sugar industry accounted for 57% of the total. It is quite interesting to note that none of the hundreds of rice mills in the country practice cogeneration.

Several barriers have been identified to the implementation of cogeneration in the country. These can be divided into 2 major issues: technical and economic.

During the celebration of the ASEAN Cogeneration Week in the Philippines in June 2003, a high ranking Department of Energy official admitted that the decision makers, the policy makers in the government themselves do not have the necessary information on the benefits of cogeneration systems. If ever there should be, industry owners have very limited expertise and skills in practicing small-scale cogeneration techniques.

The other technical problem faced by end-users is the often mismatching of equipment to the type and nature of their plant operations.

On the other side, to be economically viable, an industrial plant with a cogeneration facility should initially realize significant savings on electricity purchases through lower investments, operations and maintenance and fuel costs per kilowatt hour of produced electricity through cogeneration.

Beyond electricity cost considerations, investors and end-users are not attracted on the very high cost of financing cogeneration projects adding to it, the considerably long-term returns on capital investments. At some point in time, energy prices may dictate the viability of cogen plants.

Company owners are also divided whether to indeed "go" cogen or to compete with other investment opportunities and priorities of the plant. A classic case in the Philippines is the CORFARM Project which has always been part of the adjudication procedures of the EC-ASEAN COGEN Programme each time it launches its Call for Full Scale Demonstration Projects or FSDPs. CORFARM normally rates high in scores but somewhere along the way, the project always FAILS to materialize because of the indecisiveness of the plant owners to invest its resources on plant expansions rather than in cogeneration technologies, primarily because going cogen is just not in line with corporate objectives of industrial expansion.

Finally, and this is indeed a difficult barrier to hurdle: the non-existence of a successful cogeneration plant in the Philippines dampens the mood of potential projects. There is this inherent trait in us Filipinos that unless we see something working well within the country's system, investors, mostly industry owners will not dare take the risk into a new venture.

But just as there is but ONE (1) successful cogeneration venture in the country, then everything comes into place.

Several measures have been floated as possible means to overcome the barriers just presented. Among these are:

- *The imminent restructuring of the power industry and the privatization of the national power utility; and,*
- *The perceived state of the power industry in the next 5 years.*

  Power sector reform has opened opportunities for the development of cogeneration. Our development policy recognizes that adequate power supply is one of the pre-requisites for sustained economic growth. Power sector restructuring will open the industry to private investors. Thus the participation of the private sector in the country's power expansion program is urgent and lack of generation capacity may lead to widespread load shedding, particularly for industries.
- *Private-government sector collaboration is also seen as crucial to advance renewable energy development, and for that matter, cogeneration, in the Philippines. Enhanced non-fiscal and financial incentive packages including:*
  - *preferential utilization of RE for power generation;*
  - *10-year income tax holiday;*
  - *duty-free importation of machinery and equipment;*
  - *tax credit on domestic capital equipment; and,*
  - *special realty tax rates.*

The challenge really now is for cogeneration facilities to operate efficiently to produce electricity (and steam) at a cost that can compete in the open market through upgrade processes and equipment as well as purchase of modern yet proven technology.

The resurgence of interests for cogeneration projects in the Philippines showcases the need for a better and more efficient electricity system in energy-intensive industries. The La Suerte Rice Mill Cogeneration Project, once it gets on stream by 2004 will pave the way for succeeding projects in the coming years. We only need a single and successful cogeneration project, just one (1) and the country will definitely follow its other ASEAN neighbors in the implementation of a more reliable and stable supply of electric power to its thriving industrial sector.

1. INTRODUCTION

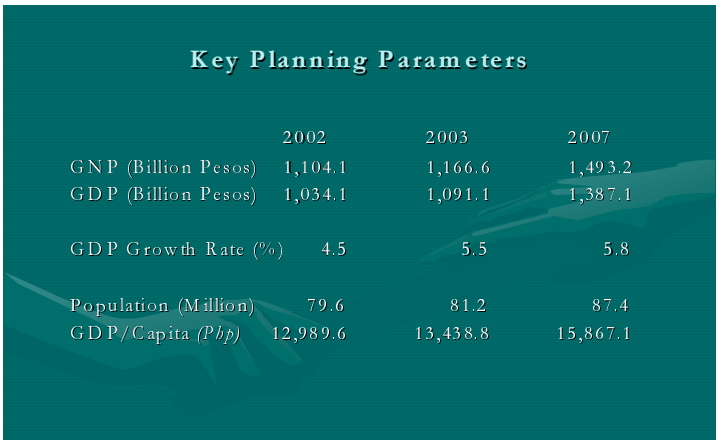
For the planning period up to the year 2012, the Philippines energy sector reinforces the macroeconomic goals of the current administration to promote balanced economic growth, a market-based energy industry and poverty alleviation.

These projections are based on continued economic recovery and robust expansion in investments and exports as the economy benefits from greater renewed confidence and sustained macro economic stability as well as measures to improve governance and the competitiveness of major industrial sectors, energy included.

Investment demand will be driven by continued strong growth in infrastructure developments in the power sector.

Year-end GDP in 2003 was expected to reach Php1.1 trillion (roughly US$200 billion) with a similarly optimistic growth rate posted at 5.6%.

Key planning parameters used in the last economic exercise by the Philippines' National Economic and Development Authority (NEDA) expects that the country will continue to register positive growth rates from last year onwards to 2007, posting a high of 5.8% by end-2007.



Source: Philippine Energy Plan, 2003-2012

Fig. 1 Key Planning Parameters

The performance during the last 5 years of the energy market complement's the government's policy to reduce dependence on conventional fuel as much as imported energy. Oil based facilities decreased by 15.2% from 1997 to 2001, owing to the retirement of oil-based power plants in the islands of Luzon and Visayas. Generation by hydro on the other hand increased by 4%, geothermal by 9.6% and natural gas, by a whopping 190%. The significant increase in generation from natural gas is due to the commissioning of the Malampaya Deep Water Gas-to-Power Project in October 16, 2001, with the initial delivery of gas to the Sta. Rita power plant off the coast of Tabangao, in Batangas province. Coal-fired generation also increased due to the commissioning of three (3) power plants with a combined capacity of 2,363MW covering the period 1998 to 2000.

1.1 Clean Fuels Available In The Country

Currently, the focus and current power sector policy and regulations of the Philippine government encourage indigenous energy production, particularly those with positive greenhouse gas impacts. Three (3) alternative and clean fuels available in the country are thus briefly described for this purpose:

1.1.1 Natural Gas

The natural gas industry in the Philippines is a very young sector, with its birth only a couple of years back. This significant development has necessitated the formulation of policies and the accompanying regulatory framework for the industry, to ensure competition as well as make the sector more attractive to downstream investments, in particular.

To effectively encourage private sector investments in the sector, the government has focused its sights on these measurable targets:

- the aggressive promotion of natural gas for both power and non power applications;
- the establishment of institutional and physical infrastructure;
- the construction of greenfield power plants or conversion of existing fossil-fired plans to gas-power;
- and the promotion of natural gas alternative fuel in the end-use sectors such as in buildings and residential establishments for cooking.

The gas supply will come mainly from the Malampaya field production, projected to yield up to 146 billion cubic feet (BCF) until 2007 and another 150 BCF starting 2008.

However, other gas fields (San Antonio, Libertad, Octon, San Martin and Sampaguita) are also envisioned to contribute to total gas production. For the planning horizon, 1.5 trillion cubic feet is expected to be generated by the gas producing fields.

1.1.2 Coal

Coal is the second major fuel source for power generation in the country and yet, is also the largest contributor of particulates, sulfur dioxide (SO_2) and carbon dioxide (CO_2) to the environment.

Compliance with the Clean Air Act (CAA) and the higher cost of mitigating equipment to abate the effects of coal emission remain to be the main challenge faced by the downstream coal industry. Thus, government has focused its policy and advocacy on the adoption of Clean Coal Technologies (CCTs) in coal-fed power plants while maintaining the competitiveness of local coal.

An incentive on the use of CCT in the power and industrial sectors will encourage the use of this technology, despite being highly capital-intensive.

1.1.3 Biomass

To promote the development of renewable energy technologies, the Philippine government will focus on meeting the needs for developing a clear, concise and coherent renewable energy program.

Major part of this effort will be:

- the promulgation of incentives for biomass projects such as income tax holidays, tax and duty-free importation of capital equipment and materials, and tax credits on local equipments;
- a soon-to-be-restructured power industry will strengthen, accommodate and will have preferential bias for renewable energy technologies and projects;
- a market mechanism will be established for renewable energy-based power plants.

Agenda for Legislation

Obviously, the country still has to put in place a final policy supporting the development and utilization of renewable energy. Thus, target policy actions for renewable energy include:

- a Renewable Energy Bill to be deliberated and hopefully, approved by Congress within the year;
- a green pricing mechanism to promote consumer choice of power supply;
- the allocation of a minimum amount of generation capacity from RE, similar to what other countries have implemented; and,
- the provision of financial and fiscal incentives to RE developers and implementers.

1.2 National Cogeneration Policy

The Philippines lags behind its brother ASEAN neighbors when it comes to the institutionalization of cogeneration policies and activities.

The country is still in the process of developing a national cogeneration policy for inclusion into the overall Renewable Energy policy framework.

For years, much of the installed cogeneration capacity is in industries where cogen systems are inherent in their operations, such as the sugar, pulp and paper, chemicals and coconut oil industries.

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1.2.1 Barriers to Implementation

Several barriers have been identified to the implementation of cogeneration in the country. These can be divided into 2 major issues: technical and economic.

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On the other side, to be economically viable, an industrial plant with a cogeneration facility should initially realize significant savings on electricity purchases through lower investments, operations and maintenance and fuel costs per kilowatt hour of produced electricity through cogeneration.

Beyond electricity cost considerations, investors and end-users are not attracted on the very high cost of financing cogeneration projects adding to it, the considerably long-term returns on capital investments. At some point in time, energy prices may dictate the viability of cogen plants.

Company owners are also divided whether to indeed "go" cogen or to compete with other investment opportunities and priorities of the plant. A classic case in the Philippines is the CORFARM Project which has always been part of the adjudication procedures of the EC-ASEAN COGEN Programme each time it launches its Call for Full Scale Demonstration Projects or FSDPs. CORFARM normally rates high in scores but somewhere along the way, the project always FAILS to materialize because of the indecisiveness of the plant owners to invest its resources on plant expansions rather than in cogeneration technologies, primarily because going cogen is just not in line with corporate objectives of industrial expansion.

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But just as there is but ONE (1) successful cogeneration venture in the country, then everything comes into place.

1.2.2 Measures to Remove Barriers

Several measures have been floated as possible means to overcome the barriers just presented. Among these are:

- the up and coming restructuring of the power industry and the privatization of the national power utility; and,
- the perceived state of the power industry in the next 5 years.

  Power sector reform has opened opportunities for the development of cogeneration. Our development policy recognizes that adequate power supply is one of the pre-requisites for sustained economic growth. Power sector restructuring will open the industry to private investors. Thus the participation of the private sector in the country's power expansion program is urgent and lack of generation capacity may lead to widespread load shedding, particularly for industries.

- Private-government sector collaboration is also seen as crucial to advance renewable energy development, and for that matter, cogeneration, in the Philippines. Enhanced non-fiscal and financial incentive packages including:
  - preferential utilization of RE for power generation;
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  - special realty tax rates.

The challenge really now is for cogeneration facilities to operate efficiently to produce electricity (and steam) at a cost that can compete in the open market through upgrade processes and equipment as well as purchase of modern yet proven technology.

2. THE LA SUERTE RICE MILL

The La Suerte (Spanish literal term for *"good luck"* Rice Mill is the only cogeneration project in the Philippines that was granted as one of the Full Scale Demonstration Projects (FSDPs) for the third phase of the EC-ASEAN Cogen3 Programme.

The La Suerte Rice Mill (LSRM) is located 600 kilometers north of the city of Metro Manila, along the national road in San Manuel, Isabela Province. It is about 85 kilometers from the nearest airport of the nearby province of Cagayan. From the airport, a land trip over mainly good roads will pass through several rice-producing towns with the trip taking at least 90 minutes during normal traffic and road conditions.

LSRM's business is built around the production of premium quality milled rice. One of its popular brands, "Sterling" has been known in the rice industry for its consistent quality. La Suerte's market knowledge and network are the keys to its continued sales growth and brand recognition.

While some researchers have pointed to the decline of the local rice industry, this is not reflected in the general prosperity and growth of rice millers in the Isabela province. The province hosts the largest and most modern rice mills in the country. Three (3) other rice mills are seriously considering the installation of similar cogeneration systems. These include: (i) Valiant Rice Mill; (ii) Cauayan Grains Inc.; and, (iii) Golden Season Rice Mill.

Corn is also a product of the province of Isabela. Many of the large rice mills in the area are involved in the corn industry. La Suerte has identified a seasonal market for corn-drying, which is about three (3) months of the year. There is a current lack of quality grain drying facilities in the province. Cauayan Grains Inc. is one of the largest corn milling companies in the Philippines. Like La Suerte, it is expanding and modernizing its operations. It has prioritized the installation of new silos and is closely monitoring the LSRM Cogeneration Project as in intends to replicate the same.

All of these rice mills use essentially the same milling equipment provided by a local agri-industrial company based in Manila. Further, the owners of these rice mills have blood relations and have a history of following the successful project implementation lead of any one of them, incidentally, through the services of Padiscor, the Manila-based agri-industrial firm.

The Pasig Agricultural Development and Industrial Supply Corporation or Padiscor, serves as a primary technical advisor of La Suerte, aside from supplying its major milling equipment. Padiscor is recognized in the country for its long experience and expertise in the rice milling industry as a manufacturer of equipment and a keen follower of trends in post-harvest technology and rice mill operations. The company is also a holder of a patent on a rice husk furnace which has been used primarily for grain dryers.

2.1 LSRM Operations

Demand for La Suerte quality rice continued to increase through the years. In 2003, it built two (2) 1,200 square meter warehouses. Thereafter, LSRM started the construction of a modern 6-metric tons per hour rice mill[1]. This mill has 2 parallel lines which can be independently operated. Each line can produce 3MT of rice per hour.

In July last year, LSRM completed the construction of another parallel line with a 3-ton per hour output. The new line builds upon the design of the 6-ton rice mill and includes enhancements that were learned from it. This mill was built for the purpose of allowing LSRM to operate continuously for 24 hours a day, six days a week during portions of the peak milling season.

There are three (3) seasons: peak, normal and lean, in the rice mill industry in the country. The mill is assumed to run at 6MT of rice output per hour capacity during most of this time. This operating level is 67 percent of its 9MT per hour capacity. This conservative mode of operation is consistent with the operating philosophy of LSRM. The same conservatism will continue to be reflected in the company's selection and sizing of equipment for the cogeneration system.

Thus with 3 milling lines, LSRM can operate any two lines at a time in 12-hour intervals. The milling equipment can therefore be "rested" and/or maintained or repaired if necessary, during its "off" interval. Only during a portion of the peak season will the mill operate at the full capacity of 9MT per hour using the three lines. The third milling line was inaugurated in October last year.

LSRM's operation is supported by a fleet of 35 units of tractor-trailers,[2] and 20-tonner and 10-tonner trucks. LSRM controls and optimizes the movement of its stocks from paddy sources to its product markets. The movement of stocks within the premises is handled by a fleet of forklifts and front-end loaders. This will soon be supplemented with the construction of the silos and related materials handling equipment.

2.2 Electrical Supply and Demand

LSRM, together with Green Harvest Rice Mill, a nearby smaller rice mill also owned by the same family, depend on various units of diesel generating sets for critical loads. The electric cooperative, Isabela Electric Cooperative II or ISELCO2, does not have good voltage stability, particularly in late afternoons and on to the evening. At this time of day, voltage dips to about 200 volts or less from a nominal voltage of 240.

Specific diesel gensets are assigned to each critical load. For example, to serve LSRM's two parallel milling lines, they alternate the use of two units of 750 kVA gensets on a daily basis. They use the grid supply for the dehusking stage, office and residential loads and security lighting.

2.3 Milling and Marketing Operations

LSRM currently operates 300 days a year, typically 12 to 14 hours a day, 6 days a week. However, milling hours dictated by market demand. Milling hours during the peak season may stretch to 16 hours a day. Lately, LSRM had to procure no less than 23,000 tons of paddy per season. The

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[1] Mr. Jeff Mestdagh of Vyncke Malaysia and Bangkok-based EC-ASEAN COGEN experts remarked that LSRM is the cleanest rice mill they have ever seen. LSRM management is conscious of the positive impact of clean work areas and well-designed tasks on labor productivity.

[2] Each of these can transport 800 bags of 50 kg. each for a total payload of 40MT. Current schedules show that at least 5 of these trucks are dispatched daily for wholesale buyers in Metro Manila. LSRM reconditions its own trucks indicating its competence in restoring/repairing equipment.

paddy are placed in bags, stored in the warehouse, and classified as to variety and quality. Majority of the supply comes from traders all over the rice-producing province and its neighboring regions as well. They also maintain landed farmers around the town of San Manuel by financing the production inputs. La Suerte only buys specific rice varieties of sufficient quality that meets its standard.

LSRM markets 90 percent of its rice mostly in Metro Manila. It directly supplies major rice wholesalers and caters to some institutional buyers in Metro Manila. Rice operation statistics showed that La Suerte sells an average of 15,000 tons of various graded rice per season. With the recent mill expansion, LSRM sees a continued growth and sharp increases in production and sales. As it expands, it faces several challenges that a cogeneration system is designed to address. These challenges are:

- Daily voltage fluctuation and frequent power outages in the San Manuel town. LSRM has so far handled this problem by operating several diesel generator sets to serve critical loads. However, diesel gensets require frequent maintenance and are more costly to operate.[3] Diesel gensets have also limited life span, necessitating constant sourcing of units to meet the mill requirements.[4]
- Increasing cost of grid electricity and diesel fuel.
- Rice husk disposal.
- Need to provide steam and electric power to a new higher-capacity grain dryer.

3. THE LA SUERTE RICE MILL COGENERATION PROJECT

La Suerte Rice Mill is now considering the implementation of a cogeneration project using its by-product rice husk as fuel. The project is expected to bring the following benefits:

- Improve the quality and reliability of electric power supply to the entire rice milling operation. Now the rice mill operates several diesel-fired gensets to meet its power requirements. The electric cooperative serving the area cannot maintain stable voltage and electric power service interruptions are frequent.
- Lower the cost of power and rice husk disposal cost.
- Meet the new demand for power and steam with the ongoing mill expansion.
- Potentially introduce a new revenue stream from the sale of rice husk ash.
- Potentially introduce another revenue stream from the sale of carbon credits. Specifically, the project will attempt to qualify for clean development mechanism (CDM) credits and/or bilateral initiatives at carbon credits.

LSRM's proposed project definitely meets the stated objectives of the government's policy on projects with positive greenhouse gas impacts. The project considers the implementation of a modern rice husk heat and power system with an electric power output of 1MW and process steam supply of 1.62 metric tons per hour (at 110 degrees Celsius). The power output will displace current onsite generation from diesel gensets and power purchases from the electric cooperative. The steam output will provide the requirements of a new grain dryer which is part of the proposed installation.

The rice milling industry has become more complex with the entry of significant amounts of imported rice into the country. LSRM is well prepared to meet the challenge head-on. It has a modern rice mill with the ability to process various grades of paddy into good quality rice. Thus, it can bring

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[3] Last year, fuel cost alone accounted for nearly Php5 million (close to US$100,000.00) With the new rice milling line, longer hours of operation, and operation of the large Cimbria grain dryer, the fuel consumption and cost will increase proportionately. This can be quite expensive without an alternative source of power.

[4] The rice millers in Isabela have become "experts" in sourcing diesel gensets. However, long term growth can only be attained with having a stable power supply at reasonable cost. This project addresses this need while providing a host of benefits.

in relatively cheap rice from countries such as Vietnam, "polish" this into higher quality rice and blend it with local varieties to arrive at a mix of texture, taste and body that the local market favors.

LSRM has been operating successfully under this new market. It has grown continuously as evidenced by the expansion and modernization of its milling operations. It operates year-round with an estimated 300 operating days. It has a 6-month peak period during the rainy season beginning June and a 4-month lean period during the dry season. Current operations vary from 14 hours daily during the peak months down to 12 hours daily during the lean months.

However, LSRM has been constructing a new line of rice polishing with a capacity of 3MT per hour. This adds 50 percent to the current effective milling capacity of 6MT per hour, bringing total milling capacity to 9MT per hour. With this expansion, LSRM will need additional energy supply. The total husk produced will also significantly increase, thereby worsening an already tedious husk disposal problem.

3.1 Waste Generation

LSRM estimates that 24 percent of the paddy input is composed of rice husk. The husk does not have commercial value in the province of Isabela, although it is used as an agricultural soil filler to increase air capacity. LSRM transports the rice husk to these relatively small users at no cost to them. The bulk of the rice husk output will need to be disposed of a major problem for large rice mills.

Given the 6MT per hour rice output and 300 operating days annually, the yearly rice output is 699,000 cavans (or 50 kilogram bags). Under this scenario, the annual husk available is 2.27MT per hour or a total of 12,918MT.

The energy requirement of LSRM consists mainly of electric power for driving the motors and process heat for the grain dryer. The estimated power requirement of the LSRM mill is about 60 kWh/ tones of paddy input. This estimate considers other power loads within the LSRM compound such as security lighting, two residences, the administration office, and the power load of the Suncue[5] grain dryer (104.1kW).

The boiler to be used, from Vyncke NV Belgium, is rated at a maximum of 3.2MT per hour rice husk input. The simultaneous operation of all three milling lines (at 9MT[6] rice output per hour) will produce enough rice husk to attain the full capacity of the boiler. However, actual operation envisions a 2.27MT per hour or about 71 percent of capacity. Vyncke has assured that the boiler will run well under this operating condition.

The internal waste generation is enough to support the operating schedule of the cogeneration system. However, there is some provision for greater output with the availability of more rice husk, either from additional internal capacity or by supplemental rice husk from nearby rice mills.

3.2 Selection of the Cogeneration Equipment

The key technical issue in the project is the selection of boiler supplier. While various technologies exist, the proponents, with the assistance of the EC-ASEAN COGEN3 Programme, focused more on the credibility and track record of the boiler manufacturer. Several manufacturers were contacted but only two responded to provide technical information. These were: Vyncke N.V. of Belgium through its regional office in Kuala Lumpur, Malaysia, and Alstom of France through their Philippine office in

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[5] This is a relatively small oil-fired grain dryer that is built into the design of the rice mill. It cannot be stopped even with the installation of the new Cimbria dryer.

[6] The calculation is as follows: 9MT/hr x 1.5MT paddy/MT rice x 24% rice husk/paddy = 3.24MT rice husk/ hour.

Manila. Alstom is more of a turbine supplier but because of their size, they have various arrangements with affiliate companies in the boiler side. Vyncke's proposal included a quotation for the steam turbine and ancillary systems by Jebsen & Jessen Process Engineering Sdn. Bhd, an authorized dealer of KKK steam turbines of Germany.

3.2.1 Vyncke N.V.

Vyncke is well known in ASEAN and has several references, including the Bang Heng Bee rice husk-fired cogeneration project in Malaysia. The Bang Heng Bee boiler is about the same size (10 versus 12MT steam per hour) as the one envisioned for the LSRM cogeneration project. The EC-ASEAN COGEN Phase II Programme supported this Malaysian project as an FSDP and it has been well in operation for 5 years with no technical problem. During a recent visit of COGEN3 Philippine country coordinators to the plant, the owners/managers disclosed their expansion plans and decision to add another boiler by Vyncke but at a much larger scale.

In the end, the proposal from Vyncke was seen by the LSRM management as more credible than that of Alstom. Likewise, the financial analysis prepared for the project showed the significant potential of ash sales to the project returns. This can only be surely realized using Vyncke's proven technology.

3.2.2 Boiler Steam Pressure

The boiler steam pressure is a major determinant of efficiency and power output of the cogeneration system. Generally, higher steam pressure is desirable because they enable greater energy extraction and higher efficiencies. However, high steam pressures may cost significantly more, may require more stringent water purity specifications, and may need much more qualified staff to operate and maintain.

The boiler steam pressure of 30 bar is similar for both Vyncke and Alstom. This pressure is appropriate for steam cycle systems of the size contemplated.

3.2.3 Selection of turbine supplier

Steam turbines transform available heat in the steam into kinetic energy and utilize steam velocity to induce torque upon a rotor. With the choice of Vyncke as boiler supplier, Jebsen & Jessen's proposal was found to be most advantageous given their previous experience of working together. Both companies are also based in Malaysia, which simplified communications, particularly during the design stages.

3.2.4 Basic system configuration of rice husk-fired power plant

The proposed system configuration/heat balance diagram as submitted By Jebsen & Jessen is shown below. Since J&J is the source of this diagram, it only shows the inclusions in J&J's scope of supply.

The typical "boiler" will fall within the scope of Vyncke N.V. while the grain dryer will be sourced from Padiscor. Note that the proposed grain dryer shall be connected to the process steam header in this diagram. The grain dryer is an integral part of the cogeneration system because it performs the function of a condenser in a typical steam cycle power plant.

Air-cooled condensers are also to be used to condense the steam not passing through the grain dryer. Air-cooled condensers can be made locally with engineering drawings supplied by Vyncke. The details of this arrangement are still being worked out by Vyncke and the LSRM management.

The major components are:

- Vyncke boiler system (Type JNO-HD-CLC) producing 12MT per hour of superheated steam at 30 bar and 300 degrees Celsius[7] and ancillary systems including the following:
  - Rice husk fuel system
  - Feed water system
  - Cooling system
  - Ash handling system
  - Pollution control equipment
- KKK steam turbine (Model AFA4-G4a), turbine auxiliary systems, and ancillary systems including the following:
  - Electric generator and auxiliary systems
  - Process steam header to provide steam for the Cimbria grain dryer
- Cimbria grain dryer, silos and related equipment

Raw water is taken from the river and is treated in the water treatment system. A simple water softening system is required to prevent scaling and corrosion within the boiler. Some chemicals are added to improve the quality of water before being fed into the boiler. The make-up water requirement of the boiler is estimated at 500 liters per hour. A cooling tower system was adjudged not to be ideal given the need to pump the volume of water required coming from the nearest river source. However, it is too far to access for a once-through cooling system. Thus, the project chose to adopt the air-cooled condensers, similar to those employed at the Bang Heng Bee project.

Rice husk is the only fuel used in the boiler. Compared with other solid fuels, rice husk has very high ash content and is quite abrasive. These qualities make it more challenging to design rice husk boilers. At maximum capacity, the boiler will need 3.2MT of rice husk per hour.

The boiler generates superheated steam at 30 bar and 300 degrees Celsius. During this process, ash is continuously evacuated from the boiler and stored. A programmable logic controller (PLC) provides fully automatic monitoring, process control, safety control and alarm feedback when necessary, for the boiler system.

The back pressure turbine converts the thermal energy available in the form of steam into mechanical energy (shaft power) and the generator converts the mechanical energy into electrical energy.

From the steam turbine, the steam goes to a process steam header where it may be taken to provide heat to the Cimbria grain dryer. Any remaining steam is condensed using air-cooled condensers and returned to the boiler, making it a closed system.

The current stock[8] diesel generator sets of LSRM may be used as start-up, stand by and reserve capacity. LSRM has an internal operating voltage of 240volts and receives power from the grid at 13.8kVA transformers. The power output of the cogeneration plant will replace all current diesel genset generation and normal purchases from the electric utility.

It should be noted that despite the country's imminent power sector restructuring as mandated under the Electric Power Industry Reform Act or EPIRA, which allows electric generating industries to sell excess power to the grid, no power export to the ISELCO2 (the electric cooperative which holds the franchise area where La Suerte is located) is contemplated given the cooperative's precarious financial

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[7] Although the steam turbine needs only 25 bar steam pressure, an allowance of 10 percent for boiler aging and an additional 2 bar for steam distribution system losses were made to assure consistent output for the life of the power plant.

[8] LSRM has a total of 8 diesel gensets onsite. The 2 largest gensets (of 2 x 750 kVA) are envisioned as start-up and reserve capacity. All others may be maintained for reserved capacity for their dedicated loads.

status. Based on information from the National Electrification Administration (NEA), ISELCO2 operated at a loss in 2001. It had a high systems loss of 19.8 percent and overall, its rating has gone from A to C. Months after a strong typhoon hit the entire region, ISELCO2 has not fully restored its power supply. This is expected to further exacerbate its financial difficulties.

The only power market for LSRM's excess capacity is Green Harvest Rice Mill, which is situated just 200 meters away from the former's premises. The year 2006 is the scheduled time for retail competition. It is therefore assumed that beginning 2006, LSRM can sell excess power to Green Harvest as allowed by law.

During the shutdown period, electricity is required for maintenance work, office activities and during start-up. During these periods, LSRM may use its diesel gensets to provide electric power.

3.2.5 Fuel Source

Unlike many rice husk-fired power projects proposed before[9], this LSRM cogeneration project will not have any problem with rice husk supply. The proposed Vyncke boiler will need 3.20MT of rice husk per hour at maximum capacity and about 2.16MT per hour at the design operating point for this project. This is about the current level of output of LSRM even without the third milling line.

The rice mill will shift to a 24-hour daily operation with the third line being switched on and the 2 milling lines running at any one time. Thus, the project can run 24 hours a day, 6 days a week, 300 days annually from its byproduct rice husk. Though highly unlikely, the rice husk from Green Harvest may be used when necessary.

3.2.6 Rice husk ash aspects

Since the first rice husk-fired cogeneration project supported by the EC-ASEAN COGEN Phase 3, the programme has been following the trends in worldwide rice husk ash market. Recent preliminary investigations by COGEN3 staff indicate that rice husk ash is being used in the steel, cement, fertilizer, refractories, poultry farms, brick-making, die casting, semi conductors, rubber and oil recycling industries. Geographically, there is a strong demand for rice husk ash in Japan, North America, Northern and Southern Europe, Korea, Taiwan, Australia and New Zealand. In Thailand, it is estimated that the domestic price per ton of rice husk ash is at 1,000 baht (about US$25.00) while the international price ranges from US$100 to US$250 per metric ton depending on its quality.

COGEN3 and Vyncke are willing to assist LSRM to identify potential marketing channels for selling rice husk ash in the future. Vyncke has informed LSRM of its own studies into the rice husk ash market and its willingness to share such information.

3.2.7 Fuel Requirements, Handling and Storage

The fuel specifications (expressed in wet basis) for the Vyncke boiler are as follows:

- Rice husks with nominal moisture content of 12 percent and maximum moisture content of 15 percent.
- Nominal lower heating value (LHV) of 3,200 kcal per kilogram with minimal LHV of 3,000 kcal per kilogram.
- Maximum husk dimensions: 30mm x 10mm x 10mm

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[9] This includes a 40-MW rice husk power plant in San Miguel, Bulacan (in the Central Luzon region) by Cypress Energy of the United States and a smaller 20-MW rice husk power plant by Phinfra-Zurn. Both will source their fuel from several rice mills in at least 2 nearby provinces.

- Granular distribution of husk: 95 percent coarse content (>1mm) by weight. 5 percent fines content (<1mm) by weight.
- Bulk density of husk: 115 kilograms per cubic meter.
- Ash content: 16 to 20 percent.
- Ash softening point: >1,100 degrees Celsius, 1,500 degrees Celsius nominal.

Since the rice husk will be internally generated, its handling and storage maybe adequately provided by current equipment and storage areas. In fact, the consumption of rice husk internally will reduce the internal requirement for husk storage.

An alternative way[10] to store the rice husk is open storage in conical shape to prevent the rain from soaking the husk. While rice husk soaked by rain would absorb large amounts of moisture, it has been observed that the rice husk which are stored openly in conical form do not absorb much moisture even after some rain. The storage would consist of a paved flooring on a compacted ground, a couple of bucket elevators to bring and pour the rice husk to the top of the cone, and a conveyor to transport the rice husk from the open storage to the husk silos.

The recommended rice husk handling procedure shall follow as stated:

- The unloaded husk shall be loaded to the bucket elevator, which in turn will bring and unload the husk to the top of the conical rice husk storage and to the conveyor belt.
- The rice husk shall then be transported from the open storage to the husk silos using a conveyor.

3.2.8 Environmental Aspects

The challenge for "clean energy" projects like this cogeneration project has always been to realize financial benefits from their positive environmental impacts. Economists can compute "positive externalities" but these are far removed from the day-to-day business realities and decisions that corporate managers face.

However, recent developments in the international and local fronts may soon make this dream a reality. There has been concerted effort to operationalize the mechanisms to allow clean energy projects to be paid actual cash for mitigating greenhouse gas (GHG) emissions.

The most immediate benefit from the project is the disposal of rice hush in an environmentally-acceptable manner.

3.2.9 Project Emissions

The cogeneration system's GHG emissions will be limited to nitrous oxide emission, which is calculated to be 198MT CO_2 equivalent yearly. Thus the project can reduce GHG emissions by 7,783 MT CO_2 equivalent annually.

4. STATUS OF THE PHILIPPINES' COMMITMENT TO THE KYOTO PROTOCOL AND RELATED ACTIVITIES

The Philippines has completed its GHG emission inventory, assessment of mitigation plan (via the ALGAS Project), vulnerability and adaptation assessment and the National Action Plan. Thus, the country actually meets the initial requirements for becoming a CDM host country. It has elaborated

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[10] Information provided by the COGEN3 Project Management Unit based at the Asian Institute of Technology in Bangkok, Thailand. It reflects the results of actual experiences of Thai rice mills.

its national development and energy plans that support sustainable development goals. Also, it is restructuring energy industries towards liberalization and privatization. This has been done for the downstream petroleum sector. The government is formulating its plan to privatize the state power utility and restructure the power market.

The Philippine constitution and other laws provide a framework that is consistent with the CDM. The national priorities focus on poverty alleviation, market-oriented economic policies and private sector-led development.

The Philippines has a variety of renewable energy projects that may qualify for CDM support. This proposed cogeneration project is one example of a potential CDM project. It will directly result in GHG mitigation and provide sustainable development opportunities for farmers and other industries in the area.

Some of the following salient elements have to be established to create an environment supportive for private enterprises:

- A stable and effectively administered rational system of laws and regulations is a decisive element in private sector participation. An inappropriate framework or poor administration will force the economically and socially efficient private enterprise to enter into informal activities outside the framework.
- The timely resolution of strategic issues will demonstrate government's seriousness and concern for private enterprise. These may include sensitive political issues of cooperation and support from groups most affected such as employees of the affected enterprise, the management, and the politicians ultimately responsible for the action taken.
- The availability of innovative and development-oriented financial institutions is crucial. Development finance institutions, commercial banks, merchant banks, or capital markets are not fully equipped to assist private investors in the energy sector.
- The government must set clear technical and financial standards, labor laws and environmental policies and standards.

Value of Carbon Credits

Although there is no formal mechanism that is fully operational, the Clean Development Mechanism (CDM) is shaping up to have a reasonable chance of being ratified. Current efforts have also been placed to simplify accreditation of "small-scale" projects (defined as those with 15 MW capacity and below).

Using the estimated GHG reduction (at 7,783 CO_2 equivalent) and a current value of carbon credits at a range of US$2 to US$5, the LSRM cogeneration plant stands to gain from US$15,566 to US$38,915.00 annually. However, the process of acquiring carbon credits is new and fraught with uncertainties. Since the project is looking at financing from the Development Bank of the Philippines (DBP), it may be helpful to discuss with the Bank as they are being supported by the World Bank as a potential future participant in this process.

5. SOCIAL DEVELOPMENT AND INVESTMENT BARRIER REMOVAL

The cogeneration project will provide several benefits to the community at large within the province.

5.1 Benefits to small farmers

As LSRM expands and modernizes its operations, it gives additional capacity for its paddy suppliers, composed mainly of families which have been doing business with the rice mill for several

decades. These are growing families and LSRM has grown in size together with them. LSRM notes the higher landholdings of their traditional paddy suppliers. This has been a result of their long-term partnership whereby LSRM provides critical financing of inputs and services during the planting and harvesting periods.

LSRM's continued growth provides a stable market for the produce of their traditional paddy suppliers. This has enabled their suppliers not only to increase landholdings but to provide education to their children and sustenance for their families.

The large capacity of the grain dryer will enable LSRM to buy higher volumes of wet paddy during the rainy season, thus ensuring a continuous market for the rice production of their paddy suppliers. LSRM can also afford to pay higher prices for the wet paddy as they will have an efficient way to remove the moisture. Finally, this steady ability to absorb the rice production will help reduce the need for farmers to source their immediate cash needs from the traditional loan sharks in the community.

5.2 Alternate livelihood

LSRM's vision for its employees is to liberate them from the drudgery of farm work and its attendant seasonal income. LSRM's mechanization requires new skills in operating high-technology equipment. The management has shown willingness to train people working for them and provide them with good working conditions, continuous source of income as their operations are year-round and relatively higher salaries and wages.

5.3 Barriers Removal

Biomass cogeneration is widely practiced in Thailand and Malaysia. This type of project has so far eluded the Philippines on account of several policy, institutional and investment barriers.

The actual implementation of the proposed cogeneration project will showcase the positive impacts and practicality of biomass cogeneration. This is not only a theoretical benefit but a real benefit given that at least three other rice mills in the province are seriously considering replicating this cogeneration once its operation is implemented successfully.

6. CONCLUSIONS

The rice husk-fed power plant is technically feasible to be implement for La Suerte that: (i) it produces electricity of 1 MW of electric capacity, and (ii) it provides steam for grain drying at 1.5 bar under the conditions prevailing in LSRM. A boiler with 12MT steam output per hour at 30 bar and 300 degrees Celsius is more than sufficient for this requirement.

The financial analysis prepared for the project shows a positive return with a pay-back by the 7^{th} year. This positive return is maintained under the worst case scenario.

The project is commercially viable and appropriate for the expansion and modernization of LSRM. It defines a scheme which is well within the technical and managerial capability of LSRM management and staff. Being a capital intensive project however, the implementation should be closely monitored. There should be adequate contractual definition of the various supplier responsibilities and their linkages among each other.

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