การวิเคราะห์ปัจจัยที่ส่งผลต่อการตั้งโรงไฟฟ้าพลังงานแกลบให้ประสบผลสำเร็จในเชิงพาณิชย์

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THE CRITICAL SUCCESS FACTOR ANALYSIS OF THE COMMERCIAL RICE HUSK BIOMASS POWER PLANT IN THAILAND

Mr. Pakadech Tabprayoon

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Engineering Program in Engineering Management

The Regional Centre for Manufacturing Systems Engineering

Faculty of Engineering

Chulalongkorn University

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Thesis Title	THE CRITICAL SUCCESS FACTOR ANALYSIS OF THE COMMERCIAL RICE HUSK BIOMASS POWER PLANT IN THAILAND
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Field of Study	Engineering Management
Thesis Advisor	Assistant Professor Paveena Chaovalitwongse

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ภคเดช ทับประยูร : การวิเคราะห์ปัจจัยที่ส่งผลต่อการตั้งโรงไฟฟ้าพลังงานแกลบให้ประสบผลสำเร็จในเชิงพาณิชย์ (THE CRITICAL SUCCESS FACTOR ANALYSIS OF THE COMMERCIAL RICE HUSK BIOMASS POWER PLANT IN THAILAND) อาจารย์ที่ปรึกษา : ผศ.ดร. ปวีณา เชาวลิตวงศ์, 147 หน้า

การวิจัยนี้มีจุดประสงค์เพื่อระบุถึงปัจจัยสำคัญที่มีผลต่อความสำเร็จของอุตสาหกรรมโรงไฟฟ้าพลังงานชีวมวลที่ใช้แกลบเป็นเชื้อเพลิงภายในในประเทศไทย รวมไปถึงการนำเสนอกลยุทธ์ในการดำเนินการที่เกี่ยวข้อง ทั้งนี้ขอบเขตของการวิจัยครอบคลุมถึงโรงไฟฟ้าพลังงานชีวมวลที่ใช้แกลบเป็นเชื้อเพลิงในทุกๆภาคส่วนของประเทศ รวมไปถึงการศึกษาถึงเชื้อทางเลือกอื่นๆนอกเหนือไปจากแกลบ

ขั้นตอนแรกของการวิจัยเริ่มจาก การรวบรวมข้อมูลจากแหล่งต่างๆ ที่เชื่อถือได้ ดังเช่น วารสารการศึกษา, ฐานข้อมูลขององค์กรรัฐบาลที่เกี่ยวข้อง, งานสัมมนา รวมไปถึงข้อมูลจากการสัมภาษณ์ผู้เชี่ยวชาญในสาขาที่เกี่ยวข้อง

ลำดับต่อมาจึงได้ดำเนินการวิเคราะห์ข้อมูล ทั้งในเชิงรูปแบบของอุตสาหกรรม, สถานการณ์โดยรวม รวมไปถึงบทวิเคราะห์ทางเทคนิค เริ่มจากการวิเคราะห์ข้อมูลในเชิงรูปแบบของอุตสาหกรรม โดยอ้างอิงจาก Porter's 5 force analysis ซึ่งประกอบไปด้วยการวิเคราะห์ถึง อำนาจต่อรองของผู้ผลิต, อำนาจต่อรองของผู้บริโภค, ความเสี่ยงจากการถูกแทนที่, ความเสี่ยงจากผู้แข่งขันรายใหม่ และการแข่งขันภายในตลาด
หลังจากนั้นจึงได้ทำการวิเคราะห์ข้อมูล ทั้งในเชิง สถานการณ์โดยรวมโดยอ้างอิงจาก SWOT Analysis ซึ่งประกอบไปด้วย การวิเคราะห์ถึงจุดแข็ง, จุดอ่อน รวมไปถึงโอกาสทั้งในเชิงบวกและลบ นอกจากนี้งานวิจัยฉบับนี้ยังรวมไปถึง การวิเคราะห์ในเชิงเทคนิค เพื่อให้ได้มาถึง เชื้อเพลิงทางเลือก และ เทคโนโลยีที่เหมาะสม

ผลจากการศึกษารวมไปถึงการให้คำแนะนำ และตรวจสอบจากผู้เชี่ยวชาญ สามารถสรุปได้ว่า ปัจจัยสำคัญที่ส่งผลต่อความสำเร็จของอุตสาหกรรมโรงไฟฟ้าชีวมวลที่ใช้แกลบเป็นเชื้อเพลิงในประเทศไทย ได้แก่ สถานที่, ฤดูกาล, วัตถุดิบ, การสนับสนุนจากรัฐบาลและ องค์กรภายนอก, เทคโนโลยี, ทรัพยากรบุคคล, การตลาด, การพัฒนาสินค้า และการสนับสนุนด้านการเงิน นอกจากนี้ในการวิจัยนี้ยังรวมไปถึงการนำเสนอกลยุทธ์ในการดำเนินการเพื่อบรรลุถึงปัจจัยทั้งหมดดังที่ได้นำเสนอไปข้างต้น

ผลของการศึกษาฉบับนี้ถือเป็นการแนะแนว แนวทางเพื่อเพิ่มศักยภาพของอุตสาหกรรม ซึ่งการดำเนินการตามแนวทางดังกล่าวจะสามารถเพิ่มโอกาสความสำเร็จได้ไม่มากก็น้อย นอกจากนี้ยังมีการนำเสนอแนวทางสำหรับการศึกษาถึงรายละเอียดในอนาคต รวมไปถึงการวิจัยในแนวทางเดียวกันที่เกี่ยวข้อง

ภาควิชา ศูนย์ระดับภูมิภาคทางวิศวกรรมระบบการผลิต ลายมือชื่อนิสิต.....................
สาขาวิชา การจัดการทางวิศวกรรม ลายมือชื่ออาจารย์ที่ปรึกษา.....................
ปีการศึกษา 2550

MAJOR ENGINEERING MANAGEMENT
KEY WORD: CRITICAL SUCCESS FACTOR / BIOMASS / POWER PLANT

PAKADECH TABPRAYOON: THE CRITICAL SUCCESS FACTOR ANALYSIS OF THE COMMERCIAL RICE HUSK BIOMASS POWER PLANT IN THAILAND. THESIS ADVISOR: ASST. PROF. PAVEENA CHAOVALOTWONGSE, 147 pp.

The objective of this thesis is to identify the critical success factors of a commercial rice husk biomass power plant in Thailand as well as to provide the relevant recommendations and strategies to achieve each of the factors. The scope of the research covers the power plant within the entire region of Thailand with a rice husk as a primary fuel together with the research on the alternative secondary fuel.

At the very first stage the data collection has been undertaken from various trustful sources named as academic journal, research report and information provided from the governmental department, academic seminar and expert interview.

Afterward with all gathered data, the stage of the analysis involved, industry analysis, situation analysis and technical analysis were then carried out. Starting with the industry analysis via the aid of Porter's 5 forces analysis to investigate for each of the force effecting the industry of rice husk power plant include a bargaining of a suppliers, bargaining of a customer, threat of a new entrants, threat of substitutes and the intensity of the existing competitors. Second by the situation analysis via the aid of SWOT analysis, include strength, weakness, opportunity and threat. Then lastly the technical analysis was then carried out to investigate for the most suitable alternative raw material and technology.

From the result of the study based on all the analysis carried out as well as the suggestion and validation from all the relevant experts, the critical success factors of the commercial rice husk biomass power plant in Thailand could be formulated to be a location, seasonality, raw material, governmental and external support, technology, human resource, marketing, product development and financial support together with the recommendations and strategies to be employed to achieve each individual.

This thesis is providing the guideline to increase the potential of the industry where the conformity to the factors provided could ensure the higher possibility of the success. Moreover the study could also be used as a guideline for the relevant deeply research as well as a research in the field of the critical success factor study.

The Regional Centre for Manufacturing Systems Engineering

Field of study Engineering Management	Student's signature............................
Academic year 2007	Advisor signature....Paveena C....

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Most of all the thankful goes to my parents who always providing all the support in all the way it could possibly be, without their encouragement and believe, my educational programme would never be accomplished.

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CHAPTER I

INTRODUCTION

1.1 Background of the research

Despite the recovery period from the economic crisis in the year of 1997 the consumption of the electricity of the country as a whole has been increasing unstoppably. As refer to the prediction from the Energy policy and Planning office, Ministry of Energy, Thailand, based on the moderate economic recovery (MER) with the growth rate of economic of four to five percents per year, by the end of the fiscal year 2011 the demand for the electrical consumption would be increased by approximately 88% comparing to the prediction fiscal year of 2001, as illustrating in table 1.1 where

- LER stand for low economic recovery
- MER stand for moderate economic recovery
- RER stand for Rapid economic recovery

Fiscal Year		Peak Demand (MW)				Energy (GWh)			
		ACTUAL	LER	MER	RER	ACTUAL	LER	MER	RER
2541	1998		14,180	14,180	14,180		92,134	92,134	92,134
2542	1999	13,712	14,287	14,449	14,972	90,414	91,834	93,178	96,904
2543	2000	14,918	14,762	15,254	16,037	96,781	94,570	97,858	103,709
2544	2001	16,126	15,398	16,214	17,286	103,165	98,108	103,685	111,475
2545	2002		16,150	17,308	18,678		102,108	103,685	121,457
2546	2003		16,892	18,339	20,042		106,947	117,341	129,080
2547	2004		17,764	19,611	21,597		111,736	124,532	138,647
2548	2005		18,588	20,818	23,223		116,980	132,228	149,439
2549	2006		19,467	22,168	24,958		122,796	141,300	161,378
2550	2007		20,575	23,728	26,590		129,738	151,322	174,490
2551	2008		21,861	25,450	29,021		137,996	162,438	188,005
2552	2009		23,286	27,232	31,090		146,979	173,532	200,949
2553	2010		24,671	28,912	33,132		156,032	184,213	214,215
2554	2011		25,951	30,587	35,216		164,381	194,930	227,993

Table 1.1: Electricity consumption forecasting

(Source: Energy policy and Planning office, Ministry of Energy, Thailand)

According to the growth in the consumption rate, ever since the year 1989 the government has announced the policy for the private sector to be involved in the electricity generation business, especially the small size biomass power plant.
At the moment several type of the biomass power plant are available with various alternative to be chosen. This thesis is aimed to focus on a biomass power plant with a primary source of fuel of a rice husk as refer to the issue of the availability of the fuel.

As illustrated in table 1.2 from the Office of Agricultural Economics among all the major rice harvester countries, Thailand is ranked at the sixth from the top where approximately 20 to 30 million tons of rice have been produced in the year of 2004.

Country	Harvest Area (1000 Rai)			Production (1000 tons)		
	2002	2003	2004	2002	2003	2004
China	178180	167376	183875	176342	162304	186730
India	252563	275000	265625	108900	130400	124400
Indonesia	72007	71773	73454	51490	52079	53100
Bangladesh	67319	67650	68750	37593	39090	37910
Viet Nam	46902	46558	46250	34447	34519	35500
Thailand	63284	60335	63709	26523	26057	27038
Myanmar	38750	41563	37500	22780	24640	23000

Table 1.2: Major Rice exporter country (Source: Office of agricultural economics)

Approximately twenty-three percents of the total weight of the rice being processed would be resulted in form of the husk; therefore in the case of Thailand 4.6 to 6.9 million of tons of husk would be available to be utilized.

In order to review the basic concept of the rice husk biomass power plant, illustrating in figure 1.1 is the overall flow chart of the process indicating the major stages and relevant descriptions, where the rice husk is identified as an input raw material together with the electricity with the identification of the output of the process.

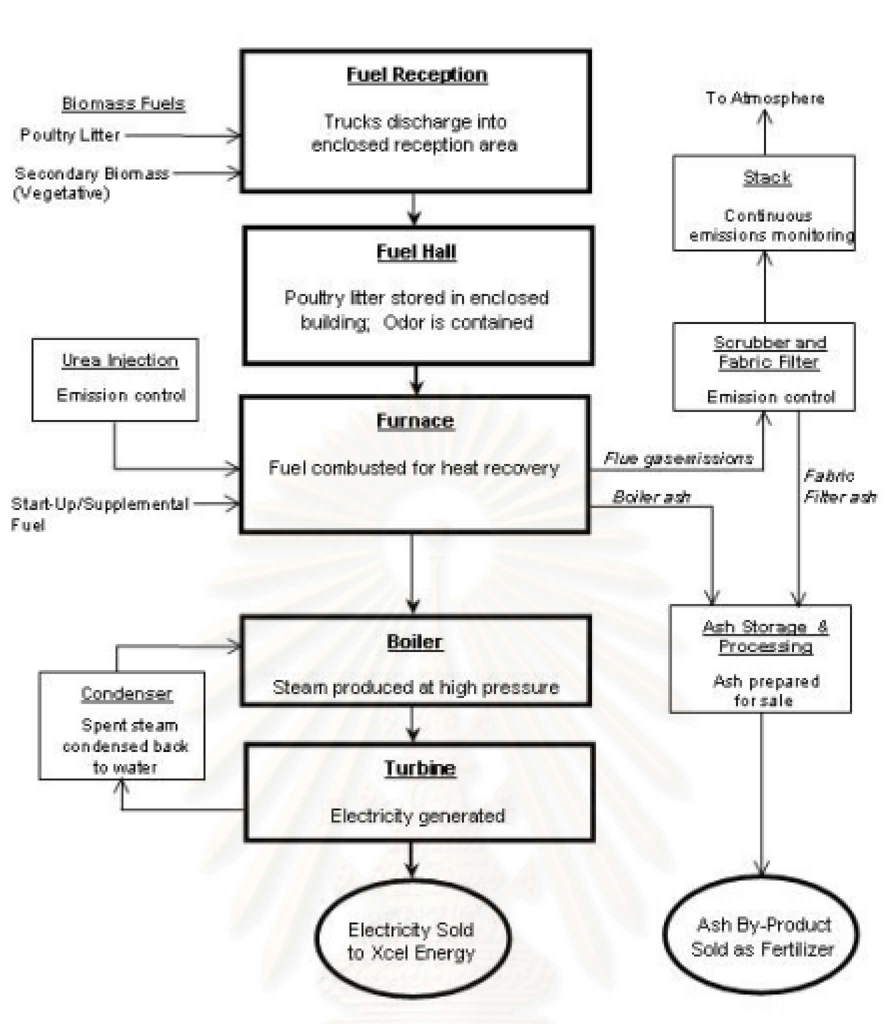

Figure 1.1: Flow chart of biomass power plant (Source: Fibrominn homepage)

Basically from the engineering perspective, the structure of the plant could be divided into 3 major categories:

- Furnace

At this stage the fuel would be burned up to generate the heat.

- **Boiler**

In here the heat transferred from the previous stage would be use to generate the steam.

- **Turbine**

The basic functionality at this phase is to use the steam to drive the turbine and generate the electricity.

For the issue of the appropriateness for the investment, of all the small size power plant operating under the period of inspection by the Energy policy and Planning office, Ministry of Energy, Thailand in the year of 2004, approximately 20% has been defined as a rice husk biomass power plant with a capacity of 282 MW in total. With the proportion of the availability of 4.6 to 6.9 million tons of rice husks as previously stated the capacity of only 282 MW is seems to be too little. The opportunity for the new investor is still available.

However referring to the information provided from the Ministry of Energy in the year of 2006 six projects out of twenty or equivalent to 30% of renewable energy project being granted from the Ministry of Energy, have requested for a termination of the projects.

1.2 Statement of the problem

As stated in the section of the background with the excess availability of the fuel together with all the positive situation for the rice husk power plant such as the supportive action from the government as well as the crisis on the need to search for a replacement type of fuel, the enquiry is why still quite a number of the plants existed were unable to be survived.

Therefore for the benefit of both commercial and further academic study the statement of the problem for this thesis is set up in order to conduct the analysis for the critical success factors of the commercial rice husk biomass power plant.

1.3 Objective

To carry out the research and analysis for the critical success factors of the commercial rice husk biomass power plant in Thailand.

1.4 Expected benefit

As a result, the thesis is expected to yield a benefit in several heading as categorized below

- To identify the suitability of the rice husk biomass power plant industry in Thailand as well as clarifying the critical success factors of the commercial rice husk biomass power plant in Thailand for the further utilization of both

  - Academic reference
  - Commercial reference
- To gain the understanding of the strengths, weaknesses, opportunities and threats existing in the industry of rice husk biomass power plant in Thailand
- To gain the present understanding of the market as well as the forth coming future trend of rice husk biomass power plant in Thailand
- To provide the guideline for the survival and competitive characteristic of the industry of rice husk biomass power plant in Thailand

1.5 Scope of the research

The scope of this study is confined to carry out the research and analysis to identify the critical success factors of an industry of the electricity generation plant with the rice husk as a primary fuel together with the research on the alternative secondary fuel within the entire region of Thailand.

First of all, for the preparation of the basic concept of the industry, the research on the general information of the rice husk power plant industry in Thailand would be carried out. Then the external and internal factors analysis would be taken place for the purpose of the identification of the major problems presently occurring. Finally the critical success factors would be analyzed and identified.

1.6 Research methodology

The study is planed to be conducted partly as a strategic management study where several theories are suitable to be employed such as SWOT analysis, Porter's value chain analysis, Porter's 5 force competitor analysis, Comprehensive Survey and Etc. As well as the research and analysis in detail of the operational level including all the essential factors such as

- Raw material analysis
- Demand / Supply factors
- Technical evaluation
- Economic analysis

And etc.

1.7 Research procedure

The sequence of the study would be carried out as illustrating below

1. Study the related literatures include,

- Academic journal
- Relevant thesis and dissertation

2. Collect the relevant information from both related documents and experts include,

- Academic journal
- Research report and information provided from the governmental department
- Academic seminar
- Expert interview

3. Define the support methodology for the analysis include,

- Porter's 5 forces
- SWOT analysis

4. Analyze the information

The analysis is categorized into 3 main aspects of

- Industry analysis
- Situation analysis
- Technical analysis

5. Identify the problems and critical success factors

Based on the result of SWOT analysis, Porter's 5 forces analysis as well as a technology analysis, the potential success factors for the industry of rice husk power plant in Thailand would be identified.

6. Validation of the formulated critical success factors

At this stage, the potential success factors for the industry of rice husk power plant in Thailand would be identified and validated by the group of the expert in the industry in order to evaluate for the critical success factors as well as a relevant recommendation.

7. Conclusion
8. Thesis written up

1.8 Thesis organization

Ch-1: Introduction

Ch-2: Related theory and literature review

2.1 Literature review

2.2 Related theory

2.2.1 Porter's 5 forces

2.2.2 SWOT analysis

Ch-3: Researching model

3.1 Evaluation constraints

3.2 Analytical model

3.2.1 Industry analysis

3.2.2 Situation analysis

3.2.3 Technical analysis

3.3 Data collection

Ch-4: Industry analysis

4.1 Porter's 5 forces analysis

4.1.1 Bargaining power of suppliers

4.1.2 Bargaining power of customers

4.1.3 Threats of new entrants

4.1.4 Threat of substitutes

4.1.5 Competitive rivalry between existing players

4.2 Industry analysis summary

Ch-5: Situation analysis

5.1 SWOT analysis

5.1.1 Strengths

5.1.2 Weaknesses

5.1.3 Opportunities

5.1.4 Threats

5.2 Situation analysis summary

Ch-6: Technical analysis

6.1 Alternative fuel analysis

6.2 Technology analysis

6.3 Technical analysis summary

Ch-7: Critical success factor formulation and recommendation

7.1 Information from the analysis

7.2 Formulation of a potential critical success factors

7.3 Selection of critical success factors

7.4 The critical success factor and recommendation

Ch-8: Conclusion and recommendation

CHAPTER II
LITERATURE REVIEW AND RELATED THEORY

2.1 Literature review

As a result of a survey, several of the feasibility studies have been previously carried out and totally suitable to be utilized as guidance for the organization of the research in such field. As refer to P. Jiramahakun (2001) the feasibility study has been carried out based on the airline business industry of AEROTHAI in order to establish an airline of Thailand, In order for the objective to be achieved; the author divided the study into 3 main aspects, marketing, engineering and financial. Which for the marketing section the research was carried out via the aid of SWOT analysis for the evaluation of the critical success factors and followed by the identification of location analysis, the market situation, market segmentation, the target market and the marketing mixed respectively. Followed by the identification of the fleet planning, aircraft specification and cost calculation to complete engineering feasibility study. For the financial aspect the research was including the source of fund, initial investment, estimated cost, cash flow and sensitivity analysis.

Another useful guidance is the work of K. Kobkanjanakorn (1999) which the dissertation is based on a polyester filament yarn plant with an aim to conduct a decision analysis in both aspect of engineering and economic for the manufacturing of the polyester filament yarn for a mosquito nets industry. Through out the research, the scope of the study were divided into 3 majors phase, engineering, management and finance in order to evaluate for the production cost, investment cost to support the decision making stage.

Another dissertation that has been surveyed is the project pre-feasibility study of the project investing in the refined products pipeline in the northern region of Thailand. Through out the thesis the study was divided into 3 major aspects, marketing, technical and economic including all the evaluation for the suitable province, appropriate size of the depot together with the evaluation of net present value, internal rate of return, benefit / cost ratio and pay back period as a criteria for the economic analysis (T. Auttaprecha, 1999)

To ensure the comprehensiveness of the research, the survey also including the financial based feasibility of K. Rukachantarakul (1998) which concerned the factor effecting the investment of the oil company to invest for the oil storage tanks for the customer as well as a feasibility study of the project, conservatively the financial study is based on the least values of the factors from the past records.

For the background of the study on the topic of the business critical success factor analysis the survey has included the study of the analysis in the industry of the textile and jewelry of T. Rungcharoenpattanakit (2002) and N. Tovikkai (2000) respectively.

For the background of the biomass power plant several academic article have also been studied to ensure the comprehensiveness of the term and technical aspect of the field. As the example of the successful actual operating biomass power plant existing at the moment such as CHINART BIOMASS POWER PLANT, the article provide the general information of the biomass power plant with primary source of fuel of a rice husk, the details is including the physical size and location, capacity, initial investment, fuel consumption, process and the environmental concentration also the issue of the crisis in the availability and the price of the rice husk has also been pointed out (Engineering today, 2006), DARN-CHARNG AND PHU-KEAW POWER PLANT, The article provide the general information of the biomass power plant with the waste from the sugar factory as a primary source of fuel including all aspects of the size for both physically and in term of the capacity, process and relevant technology together with the concentration on the environmental issue (ELECTRICITY AND INDUSTRY, 2006), BIOMASS POWER PLANT AT PICHIT PROVINCE THAILAND, The article mentioned about the current market situation and the number of the biomass power plant feed by a rice husk in both aspect of the size and the location together with the utilization of the ash as a result of the suspension-fired boiler technology which enable the characteristic of the ash to be controllable (A. Parntewan, 2006) and MITPHON POWER PLANT AND SPP PROJECT, The article provide the general information of the biomass power plant with primary source of fuel of a rice husk the details is including the physical size and location, capacity, initial investment, fuel consumption, process and the environmental concentration (The energy efficiency, 2001)

The survey has also included the general information and characteristic of some specific type of fuel and their availability as in BIOMASS, RENEWABLE FUEL, The article stated the definition of the biomass together with the benefit and the support from the government as a project of SPP-Biomass (Small Power Producer) (LAB.TODAY, 2002), ALTERNATIVE SOURCE OF ENERGY, The article contained the summary of the availability of the source of fuel for the biomass power plant together with the relevant characteristic and the demand in several areas not just only for the electricity generator. The article also provided the relevant technology and the support from the government for both electricity and heat generation (B. Mardmai, 2005) and BIOMASS ENERGY OUTLOOK; the article contained the information of the biomass utilization in the USA together with the ratio of the utilization in term of the power generation. The author also mention about the characteristics of various alternative source of fuel together with the relevant technology (W. Mungvititkul, 2006).

Future more the environmental issue has also been studied as in EFFECT OF THE BIOMASS TECHNOLOGY TO THE ENVIRONMENT, the article concern of the effect of the biomass technology to the environment, the author has divided the effect into 3 levels which are local, regional and global (The energy efficiency, 2001).

Several technical aspects such as an alternative technology has also been studied as in BIOMASS WITH THE CO-GENERATOR OF HEAT AND ELECTRICITY, This article provides the alternative technology for biomass power plant technology including both only electricity generator and co-generator of heat and electricity (The energy efficiency, 2001).

Governmental support has also been included in the survey such as a program of SPP (Small Power Plant Project) as in SPP PROJECT, The author has mentioned about the condition of jointing SPP (Small power plant project) together with the related information such as a the number of plant jointed or percentage of electricity generated (The energy efficiency, 2001) and SMALL POWER PLANT PROJECT(SPP), The article provide all the relevant information of the SPP project including the background, condition, amount of fund, procedure of application, regulation, duration and all other related issues (The energy efficiency, 2001)

2.2 Related theory

2.2.1 Porter's Five Force Analysis

The model of Porter, five force analysis is considered as a business analysis tool which by definition is defined as a tool for analyzing an organization industry structure (H. Onsman, 2004). In this framework Porter has identified 5 particular forces shaping every industry and market with the consistence as following

1. Bargaining power of suppliers
2. Bargaining power of customers
3. Threats of new entrants
4. Threat of substitutes
5. Competitive rivalry between existing player

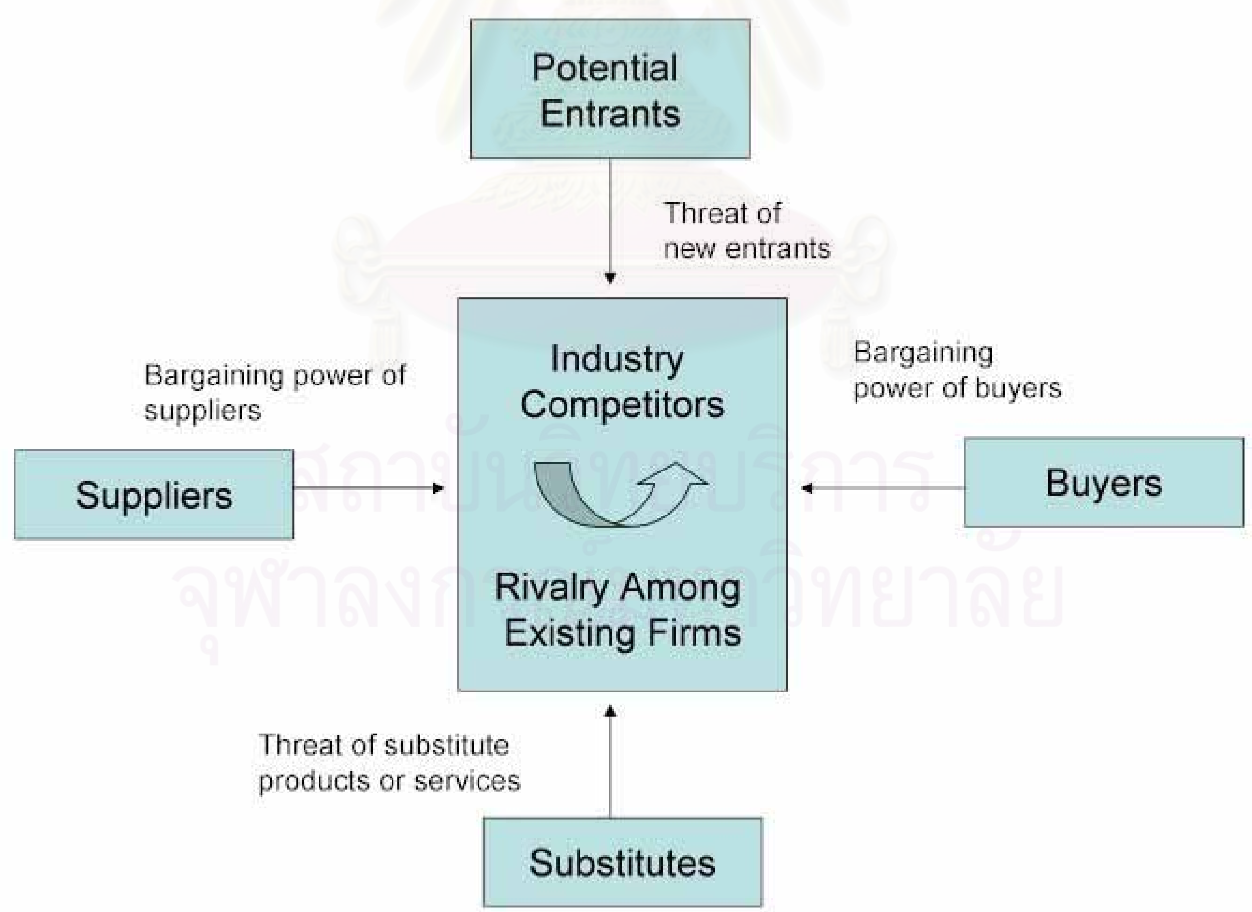

Figure 2.1: Porter's Five Force Model

Threats of new entrants

For most of the cases the new entrants to the industry is bringing an additional capacity together with the desire to gain the market share and often substantial resources. Assume the market with no incremental in demand, the new comer would bring up the intensity of the rivalry, the additional capacity would lead to the result of the less sale revenue and loss in return for the entire players in the industry. Oftenly with the keen to gain a large market share and an in-handed substantial resource, sometime the new entrant could affect the existed market by raising the standard of competition to be more effective.

The significance of the threats of the new entrant is generally depended on the barriers presenting and the expected reaction of the existing competitors where the entry barrier is obstacle which create the difficulty for the new player to enter. Normally if the barriers are significant and a sharp retaliation from the existed player is expected, any posing of serious threats would obviously be avoided. Summarized below some of the possible barriers for the new entrant

1. Economic of scale

   By definition the economic of scale is referring to the quantity of the production under the given period of time which resulting in the reduction of the cost per unit. The scale of economic could be identified in several aspects such as production, research, marketing and service. Generally the new entrant may be forced to accept the disadvantage in cost or to come in a large scale which would be at risk of a significant retaliation from the host.

2. Product differentiation

   Also called brand identification, dealing with the obstacle of the customer's brand loyalty with the belief in the uniqueness of the exiting product. At the forefront among all others factors, considered as having a priority are the promotion in the advertisement, customer service and the difference in the product. Significant resources and effort may be required over a long period of time for the factor of the loyalty to be overcome.

3. Switching costs

The costs of switching are defined as a one-time cost incurring with an initial purchasing from a different suppliers which could be the cost of retaining the workforce or procurement of the new equipment.

4. Capital requirement

In order to penetrate the existed barriers, in some cases a large financial resource may need to be invested, not only in the tangible facilities but also including an upfront advertising, R&D, customer credit or inventory. So as to remain their competitive status a large existing organization may have a huge capital in-hand which would limit the pool of likely entrants.

5. Cost disadvantage independent of size

Despite of the issue of the size or economic of scale, some player may have some certain cost advantage for their own as a result of the experience from the time spent in the industry such as proprietary technology, access to a better raw material sources, governmental subsidy or favorable location which would effect the limitation of the new entrants.

6. Access to a distribution channel

Sometime the issue could be significant especially in the industry of nondurable consumed product with the intensity in the rivalry resulting in the more tied up of the distribution channel where sometime the new entrants may be forced to develop their own channels.

7. Government policy

Directly or indirectly the governments policies are strongly affect the new entrants. Generally the governmental organization are capable of limiting or even exclude the entrant via several aspect such as enforcing the regulation of the licensing , limits on access to a raw material, tax incentive or permit requirement. Indirectly the government could play the role by enforcing the safety regulation or the pollution standard.

Bargaining power of suppliers

A powerful suppliers is, if desired, can significantly threat the whole supply chain by squeezing the profitability out via either the raise of price or reduction in the quality of goods / service. The significance of the suppliers is generally depended on their contribution to the industry and the characteristics of each particular market.

A suppliers would be powerful if

- They are a concentrated cluster
- There are only few dominated companies
- The required product are having a uniqueness
- There is existed a switching cost
- They are capable of posing the threat of forward integration
- They customers are not considered significant
- The products / services produced are irreplaceable

Bargaining power of customers

Likewise the customers are capable of forcing down the price. While the supplier is seeking to maximize the profit and forcing down the quality of goods to proximate the accepted level, the customer is expected for the other way around. Accordingly the practice is to balance both of the factors to the negotiable level.

A customers would be powerful if

- They are a concentrated cluster
- There's procurement in a large volume
- The products purchased are standard
- The products purchased are replaceable
- The product represents the significant fraction of the total cost
- The they earn low profit
- The product contribute insignificantly to the quality of the end goods
- They are capable of posing the threat of backward integration

Threat of substitutes

Substitutes are those with the capability to perform a similar function to the initial product with the threat of the replacement and effecting to both reductions in the profitability and viability of the industry, with the degree of the threat depended on how well they can serve under the same functionality of the replaced product.

Generally there is a relationship between the threat of the substitutes and the cost of switching together with the price and quality of the product, mean that the threat tend to be significant when the switching cost is considered to be low with an equal or relatively higher quality of the replacement. For most of the cases the host may differentiate themselves by offering a better deal on both the price and quality. Oftenly the industry could be easily penetrated while the intensity of the rivalry is focusing on the price reduction or performance improvement.

Competitive rivalry between existing players

Via the aid of the tactic such as price competition, advertising promotion or product introduction, all the existing players in the industry are striving to retain and improve their position. The competition is stimulated when the pressure could be felt from the competitor or the opportunities for the improvement could be identified. Like the effort to penetrate of the new entrant the rivalry among the existed player is focusing to promote their product differentiation such as price, quality or customer service. Referring to the frame work of Porter, the rivalry is related to the presence of the factors as illustrated below

- Equality in size of the competitors
- Slowness of the market growth
- The lack of product differentiation or switching cost
- High fixed cost
- Additional capacity available only with a large increment.
- High exit barrier
- Low product differentiation

2.2.2 The SWOT analysis

SWOT is an acronym for a company's strengths, weaknesses, opportunities and threats. The framework is referred to the analysis of the positive and negative factors for both aspect of internally via the analysis of the industry's strength (S), weakness (W) and externally via the environmental opportunities (O), threat (T) analysis. This analysis is aim to provided a critical view of the industry's internal capabilities and external environments with the usefulness of evaluating the fulfillment for the basic mission .As well as to uncover the strengths and opportunities that could be maximized, the weaknesses that could possibly be corrected and threats that could be avoid. Matching the industry internal factor with the external environmental is the practice enable management to formulate the strategy to achieve the goal.

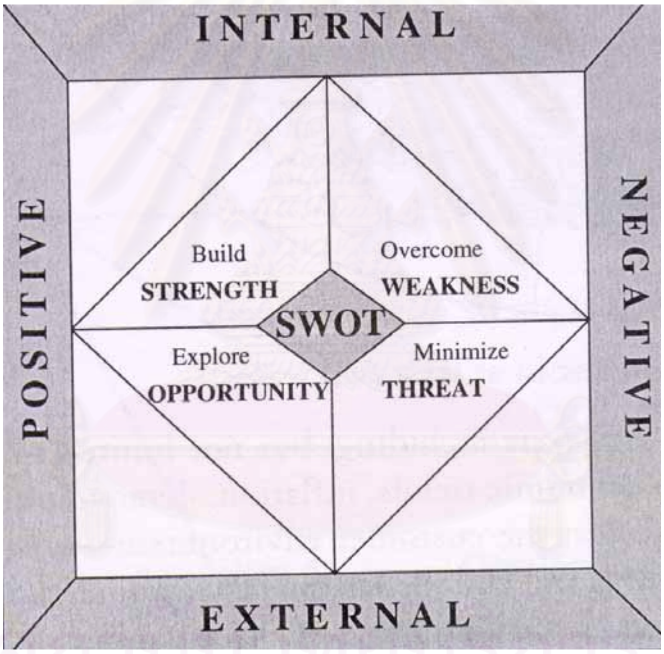

Figure 2.2: SWOT Analysis

Strength

Defined as a resources or capabilities within the firm which providing the competitive advantage in providing the customer's desired expectation, for instance the supreme quality or service.

Warwick Manufacturing Group (2006) has identified some checklist for the SWOT analysis under the category f strength as illustrated on the next page.

- What are the firm distinctive competencies and how well do these translate into competitive advantage?
- Is it acknowledged as market leader?
- How resilient is the firm to competitive pressure?
- How is it perceived by customer?
- How innovative are the product?
- Is the technology proprietary/home grown?
- Are the financial resources adequate?
- Does the firm have well conceived area/functional/SBU strategies?
- Is there a cost advantage; economic of scale?
- Is there a quality advantage?
- Are the management skill proven in this area?
- Other?

Weakness

Weaknesses are a limitation providing an obstacle to the competition and create a difficulty in meeting the customer expectation, such as a bad reputation

Warwick Manufacturing Group (2006) has identified some checklist for the SWOT analysis under the category of weakness as illustrated below

- Is there no unique or distinctive competencies or competitive advantages
- Does the firm have no clear strategic direction?
- Is the competitive position deteriorating?
- Is the firm vulnerable to new competition?
- Does the firm have the poor image or reputation in the eye of the customer?
- Are the marketing skills below average?
- Is the firm falling behind in R&D?
- Is the product range too narrow or too broad?
- Does the competition have access to the same technology?
- Is there insufficient finance to fund new strategies, R&D etc.?
- Are facilities obsolete?
- Is management poor / inexperienced?
- Other?

Opportunity

Opportunity is defined as a favorable situation from the external environment, for example a consumption incremental tendency, or governmental supporting regulation.

Warwick Manufacturing Group (2006) has identified some checklist for the SWOT analysis under the category f opportunity as illustrated below

- Is there potential for market growth?
- Is there potential to serve new customer groups, markets or market segments with existing products?
- Can new / enhanced products be launched?
- Is there potential for diversification?
- Is there potential for vertical integration?
- Is there complacency/lack of capability amongst competitors?
- Other?

Threat

The other way around of the opportunity, threat is defined as an unfavorable situation, for instance a slow market growth or incremental in the bargaining power of the buyer.

Warwick Manufacturing Group (2006) has identified some checklist for the SWOT analysis under the category f threat as illustrated below

- Is the market growth slowing?
- What is the likelihood of new competitors entering the market or growth in competitive pressure?
- Is there a growth in substitutes?
- Is the firm vulnerable to recession?
- Is the government likely to take unfavorable action (policy, regulation or new legislation)?
- Is the power of customers & suppliers growing?
- Are the customer taste changing; due to social/demographic changes?
- Others?

CHAPTER III

RESEARCHING MODEL

This chapter is the presentation of the researching model includes the introduction to the justification constraints for the formulation of a critical success factors. Second by the analytical model with the introduction to relevant employed tools of an industry analysis, situation analysis and technical analysis and follow by the data collection describing the obtained data and their relevant source for instance, academic journal, research report and information provided from the governmental department, academic seminar and expert interview.

As mentioned in the section of the statement of the problem despite the excess availability of the fuel together with all the positive situation for the rice husk power plant such as the supportive action from the government as well as the crisis on the need to search for a replacement type of fuel, still there is an evidence that quite a number of the plants existed were unable to be survived. Therefore for the benefit of both commercial and further academic study the statement of the problem for this thesis is set up in order to conduct the analysis for the critical success factors of the commercial rice husk biomass power plant.

From the research and analysis, the result is expected to extend the critical success factors for the industry of a commercial rice husk power plant in Thailand as well as to provide a recommendations and strategies to achieve each individual, for the benefit of all the relevant parties as being both academic and commercial references in the aspect of providing a guidance for the survival and competitive factors for the industry of a rice husk power plant in Thailand.

3.1 Evaluation constraint

In order to formulate a critical success factor, several constraints could be used to justify each of the proposed factors, accordingly to ensure the comprehensiveness of the study, the evaluation constraints are firstly needed to be identified.

As for generally business practice, before any investment decision could be finalized, what crucially needs to be ensured is the feasibility of the project. As refer to the framework of J. Juntaro and S. Thongpresert (1993), the feasibility of any regular project could be categorized into 3 categorizes of

- Marketing
- Financial
- Technical

As refer to the recommendation from the experts in the industry, the relevant constraints under each of the categories could be identified as

3.1.1 Marketing, generally marketing is the strive among the product or service provider to satisfy the target, either or both individual or group of customer. For both of the aspect the essentiality is to provide the most customer satisfaction product under the acceptable quality and price as well as to gain a market share to ensure the competitiveness. Accordingly the constraints to justify the critical success factors under the category of a marketing could be identified to be as following

- Market share
- Customer satisfaction
- Competitiveness
- Quality

3.1.2 Financial, another aspect considered to be crucial for the justification of the critical success factor is financial which could be identified as a foundation for any business in general. Accordingly in order to ensure the financial health of the business, the constraints for the evaluation of the financial aspect could be identified as

- Profit margin
- Initial expense

- Annual expense

3.1.3 Technical, as a matter of fact rice husk power plant is defined as a technology-intensive industry where the damage of the failure to operate could be as high as 600,000 to 700,000 baths per day, accordingly in order to ensure the consistency of the system another introduced constraint for the justification of a critical success factors is

- Reliability

Referring to the recommendation from the relevant experts, the contribution of each individual constraint is all considered to be vital toward the success of the industry of a rice husk power plant in Thailand and therefore identified as equally significant.

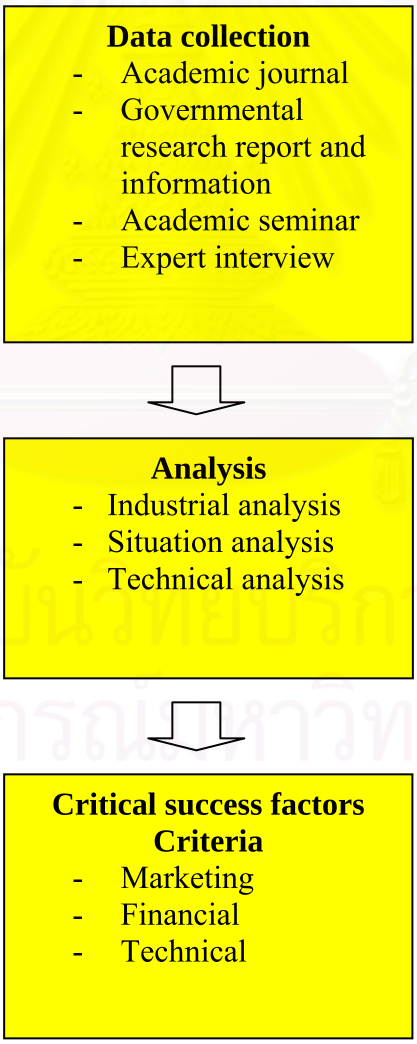

Figure 3.1: Researching model

3.2 Analytical model

This section is the presentation of the analytical model for the researching through out the thesis together with the relevant employed tools including an industry analysis, situation analysis and technical analysis

3.2.1 Industry analysis

As illustrated in figure 3.2, power producer is not the only consumer of a paddy husk, there are quite a number of yet unidentified consumer industries, more over the product of the power plant are not only considered to be an electricity but also an ash and the steam. The supplying system is no longer considered as a chain but rather a network with more than one possible path of the flow with the division of 3 levels ranging from the first level of a raw material producer, second by a product manufacturer with the competition both in term of a raw material consumption and electricity production, and lastly with three categories of the customers. Therefore the analyzing tool is needed to be capable of investigating all the factors affecting the industry.

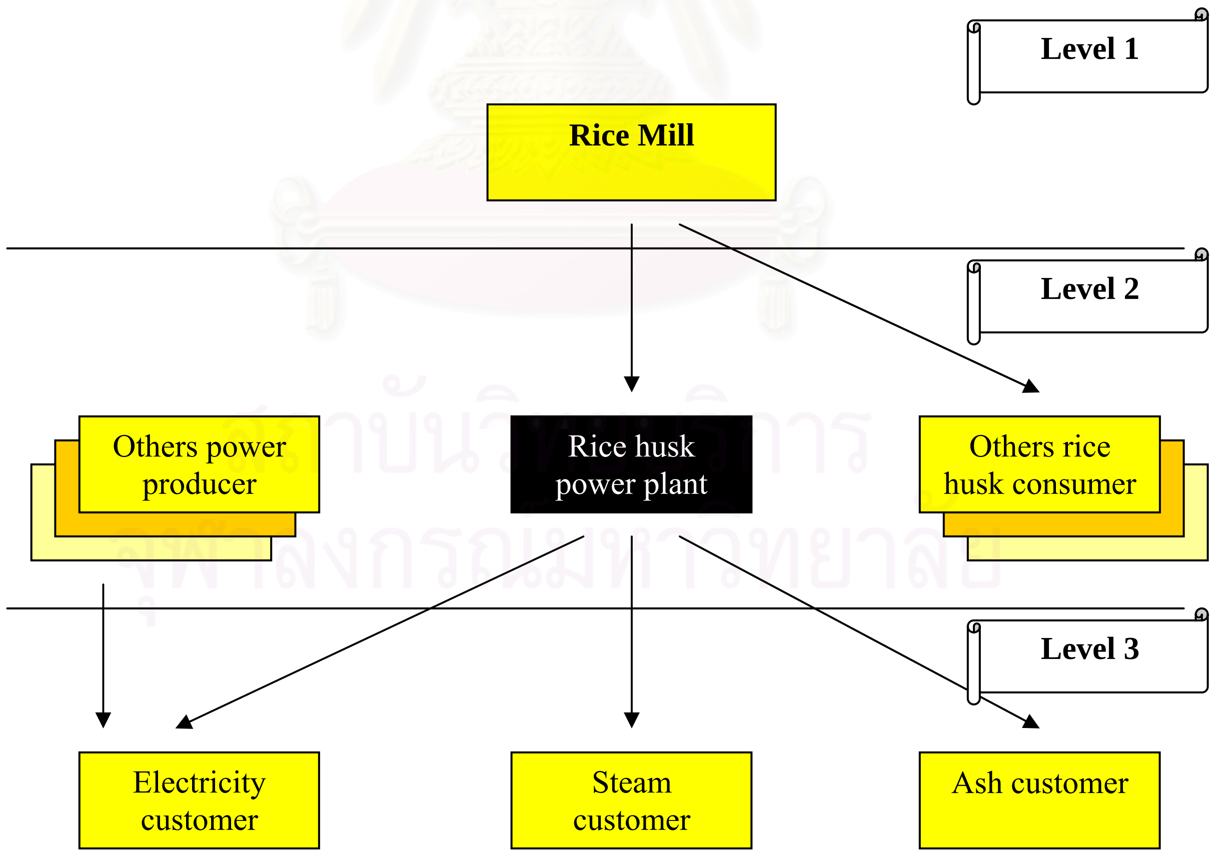

Figure 3.2: Rice husk power plant supply network

Via the aid of Porter's 5 force model, the structure of the industry could be 360 degrees analyzed to investigate for the forces exerted on the industry of the rice husk power plant in order to obtain the overview of the industry structure as well as to investigate each of the forces to identify the outstanding factors with a potential of being a critical success factors to satisfy the constraints of

- **Market share,** via the aid of the analysis of the rivalry among the existing competitors of Porter's 5 forces model
- **Customer satisfaction,** via the aid of the analysis of the bargaining power of the customer of Porter's 5 forces model
- **Competitiveness**, via the aid of the analysis of the rivalry among the existing competitors of Porter's 5 forces model
- **Initial expense,** via the aid of the analysis of the threat of a new entrant of Porter's 5 forces model

The analysis would be the combination of the review of the relevant information as well as the critical analysis of each of the forces exerted with some customization in the portion of the rivalry between the existed competitors, threats of the substitutes and the new entrant. With the emphasize on the raw material rather than the end product.

As illustrated in the figure 3.3, traditionally the approach is emphasized on the end of the customer products or services, however as refer to the uniqueness in the characteristic of the industry of the biomass power plant as long as the trading regulation could be conformed to, there is no evidence of the electricity trading obstruction existed. The rivalry is rather taken place on the other end of the effort to obtain the limited raw material, defined as a paddy husk.

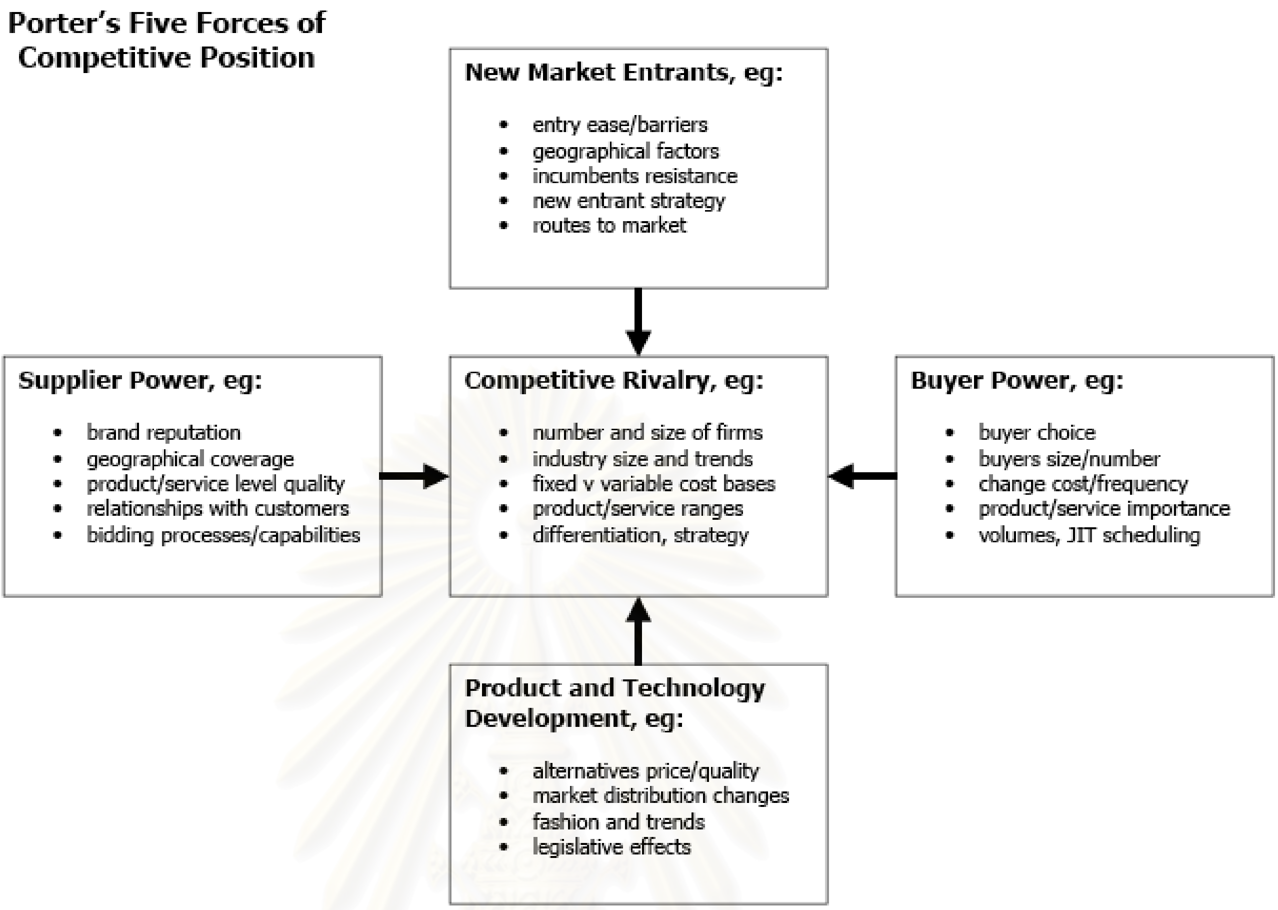

Figure 3.3: Porter's 5 forces analysis

3.2.2 Situation analysis

In order to investigate for the current industry situation, the analysis has been broken down into two equivalent sections of external environmental analysis and industry's internal capabilities analysis. Accordingly the employed analytical tool is needed to be competent to examine both of the aspects.

So as to carry out the investigation, the SWOT analysis is planned to be employed as refer to the expert the SWOT is "a tools designed to be employed in the preliminary stages of decision-making and as a precursor to strategic planning in various kinds of application" (Johnson at al., 1989). With the inspection of the possible positive and negative factors for both internal and external aspects together with the reviewing of the relevant information, the analysis is expected to yield the result of the big picture of the over all industry present situations, the understanding of all the positive and negative factors concerned as well as to extend the information to formulate the critical success factors based on the presence of some certain strength, opportunities and the factors to overcome some particular weaknesses and threats to satisfy the justification constraints of

- **Profit margin**

  Via the aid of external environmental analysis and industry's internal capabilities analysis the expectation is to investigate for the internal capabilities and external environmental factors affecting the value of the profit margin.

- **Annual expense**

  Based on the external environmental analysis and industry's internal capabilities analysis, the expectation is to carry out the investigation for the factors affecting the value of the annual expense.

3.2.3 Technical analysis

Apart from the strategic management analysis mentioned in order to get into a more operational level, the technical analysis partly as an evaluation for the most appropriateness are also incorporated in the research including

- Technology evaluation
- Alternative raw material evaluation

For a technical aspect the result is expected to support the formulation of a critical success factor, in term of the strategic recommendation for the most appropriate alternative fuel and core machines to satisfy the justification constraints of

- Technical reliability
- Product quality

3.3 Data collection

Commonly in order to obtain the information for the purpose of being an input for the analysis, the gathered data should concern all the possible relevant source of information in both aspects of primary and secondary. In this study, the data has been gathered from various trustful sources named as, academic journal, research report and information provided from the governmental department, academic seminar and expert interview. With the kindness of all the mentioned supporter, all the provided information would be used as a raw material for the analysis.

3.3.1 Academic journal

Frequently the valuable information could be found from the academic journal, contained in this research is partly information gathered from the academic journal named as

- **Engineering today journal**

  This journal provides an informative background of the biomass power plant, the article provide the general information of the actual operated biomass power plant with primary source of fuel of a rice husk. The details is including the physical size and location, capacity, initial investment, fuel consumption, process and the environmental concentration also the issue of the crisis in the availability and the price of the rice husk has also been pointed out. Thus, the information could be used as a reference for industry analysis activity and the overview for the section of the technical analysis.

- **ELECTRICITY AND INDUSTRY journal**

  The journal provide the general information of the biomass power plant with the waste from the sugar factory as a primary source of fuel including all aspects of the size for both physically and in term of the capacity, process and relevant technology which could be used as an overview for the section of the technical analysis.

- **LAB.TODAY journal**

The journal stated the definition of the biomass together with the benefit and the support from the government as a project of SPP-Biomass (Small Power Producer) which could be used as an input data for the analysis of the industry and situation.

- **Industrial technology review journal**

The journal contains the summary of the availability of the source of fuel for the biomass power plant together with the relevant characteristic and the demand in several areas not just only for the electricity generator. The article also provided the relevant technology and the support from the government for both electricity and heat generation as well as the example of another success actual operated biomass power plant. Thus, the information could be used as a preference for technical and situation analysis activity.

- **The energy efficiency journal.**

The journal provides the information of a governmental support, environmental issue as well as another successful actual operate biomass power plant which could be used as an input for the section of the situation and technical analysis.

3.3.2 Research report and information provided from the governmental department

For the more delicate information where the preciseness is required the research also include the data gathered directly from the governmental department named as

- **Electricity Generating Authority of Thailand (EGAT)**
- **Metropolitan Electricity Authority (MEA)**
- **Provincial Electricity Authority (PEA)**

From all the sources above, with the information of the electricity consumption and the regulation to trade the electricity, the information could be used as an input for the analysis of the industry and technical aspect.

- **Energy policy and planning office (EPPO), Ministry of Energy,** with the information of the regulation for the small power producer (SPP) the information could be used in the section of the industry analysis.

- **Department of alternative Energy Development and Efficiency (DEDE), Ministry of Energy,** with the gathered information of the available alternative fuel price, availability, consumption and number of the power plant all over the country, steam consumer industry and the governmental support, the information could be used as an input for the section of the industry, situation and technical analysis.

- **Office of agricultural economics, ministry of Agriculture and Cooperatives,** with the gathered information of the biomass plant harvested to be used as an input for the alternative fuel section of a technical analysis

3.3.3 Expert interview

In order to get the inside information and overall picture of the industry, the interviewing with the human expert has also been conducted to gather the relevant information. The list of the expert are presenting as

- **Director& Senior consulting engineer of the sustainable energy consulting company.**
- **Managing director of the biomass power plant turn-key contractor company.**
- **Senior project engineer the biomass power plant turn-key contractor company.**

From all above sources, the information gathered are the specification of the rice husk biomass mass power plant, engineering data, capital requirement as well as the consumption of the fuel for the analysis of the core machine and alternative fuel.

- **Division manager of the rice husk power plant division of the rice mill**, the gathered information of the production process, customers and sale of each of the products and competition among the existed player could be used as an input for analysis in the section of the technical, situation and industry analysis.

- **Senior engineer of the Department of alternative Energy Development and Efficiency (DEDE), Ministry of Energy**, with the gathered information of the available alternative fuel price, availability, consumption and number of the power plant all over the country, steam consumer industry and the governmental support, the information could be used as an input for the section of the industry, situation and technical analysis.

- **Staffs of EGAT, PEA and MEA,** the gathered information are the policy and regulation of the electricity trading, the electricity consumption and trend which is useful for the section of the situation and industry analysis.

3.3.4 Academic seminar

Lastly in order to keep up to date to the latest information, a seminar is also the other approach for the information gathered. For this research most of the seminars attained are under the topic of the renewable energy, with the essential gathered information of a CDM program, it could be used as an input for the section of the situation analysis.

CHAPTER IV

INDUSTRY ANALYSIS

In this chapter the industry analysis would be carried out via the aid of the Porter's 5 forces to investigate for the forces exerted on the industry of the rice husk power plant in order to extend the gathered information for the formulation of the critical success factors. The analysis would be the combination of the review of the relevant information as well as the critical analysis of each of the forces exerted.

4.1 Porter's 5 forces analysis

The model of Porter, five force analysis is considered as a business analysis tool which by definition is defined as a tool for analyzing an organization industry structure (H. Onsman, 2004). In this framework Porter has identified 5 particular forces shaping every industry and market with the consistence as following

1. Bargaining power of suppliers

   The research and study under the category of this force is aimed to be conducted to investigate for the general issue which enhancing the bargaining power of the suppliers of a rice husk. The study concern all the relevant aspect named as the overall availability of the fuel with the relevant information such as a distribution all over the country, current price as well as their relevant tendency. The research also include the consumer of the fuel, comprehensively include both within and out of the industry of the power generation.

2. Bargaining power of customers

   In order to investigate for the bargaining power of the customer the research and study is aimed to be comprehensively included all the related product from the industry of a rice husk power generation of an electricity, steam and ash. The study would concern all the information of the current demand in both aspects of the quantity and forth coming tendency as well as the relevant major customer of the industry.

3. Threats of new entrants

For the investigation for the threats of the new entrants, the study is aimed to explore all the relevant factor which could be considered as a barrier for a new entrant such as a capital requirement with their cost break down, availability and cost of a raw material together with their relevant effect to the value of IRR, net present value and simple pay back time of the project.

4. Competitive rivalry between existing player

The research and study under the category of this force is aimed for the rivalry among the existed competitors on the end of the strive for a raw material, where the rivalry concern all the relevant aspects of the existing competitors named as a capacity, location, employed fuel, type of business, original business and progress of the project.

5. Threat of substitutes

The study of a threat of substitutes concerns the possibility of being substituted of the rice husk power plant by both aspects of the player within and out of the industry of power generation.

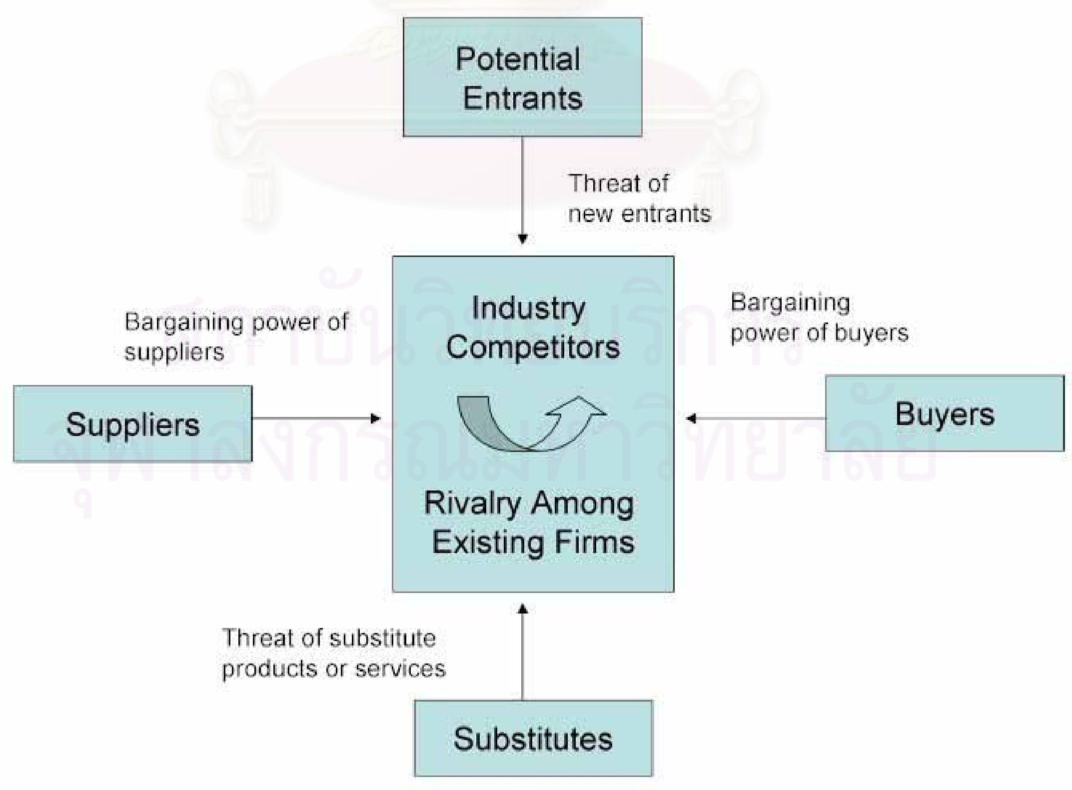

Figure 4.1: Porter's Five Force Model

4.1.1 Bargaining power of supplier

As for general manufacturing industry with no exceptional for the power generation business, the requirement for the raw materials is at the forefront of the most critical issues.

Particularly for the industry of the rice husk power generation as is self-expressed the majority of the raw material is considered to be a rice husk. For the purpose of the assessment of the feasibility of the industry the availability of the raw material is the first issue to be concerned, as of the latest research from the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, Thailand of all the regions is having the total capacity of the paddy of around 36 million tons per year. And result in the total amount of the husk of approximately 8 millions tons per year, as refer to the ratio of the percentage of the husk from the total harvested weight of the paddy from the research of the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, of exact 0.226. Illustrating in figure 4.2 is the map demonstrate the distribution of the capacity of the rice husk through out the entire region of the kingdom of Thailand where the distribution as illustrated in the lower right corner of the figure is ranging as following

1. 0 to 20,000 Tons per year
2. 20,000 to 75,000 Tons per year
3. 75,000 to 95,000 Tons per year
4. 95,000 to 200,000 Tons per year
5. 200,000 to 450,00 Tons per year

As being seen the concentration of the capacity are not equally distributed and the highest concentration is located at the middle and northeast region of the country with average available capacity per each province of 95,000 to 200,000 tons per years.

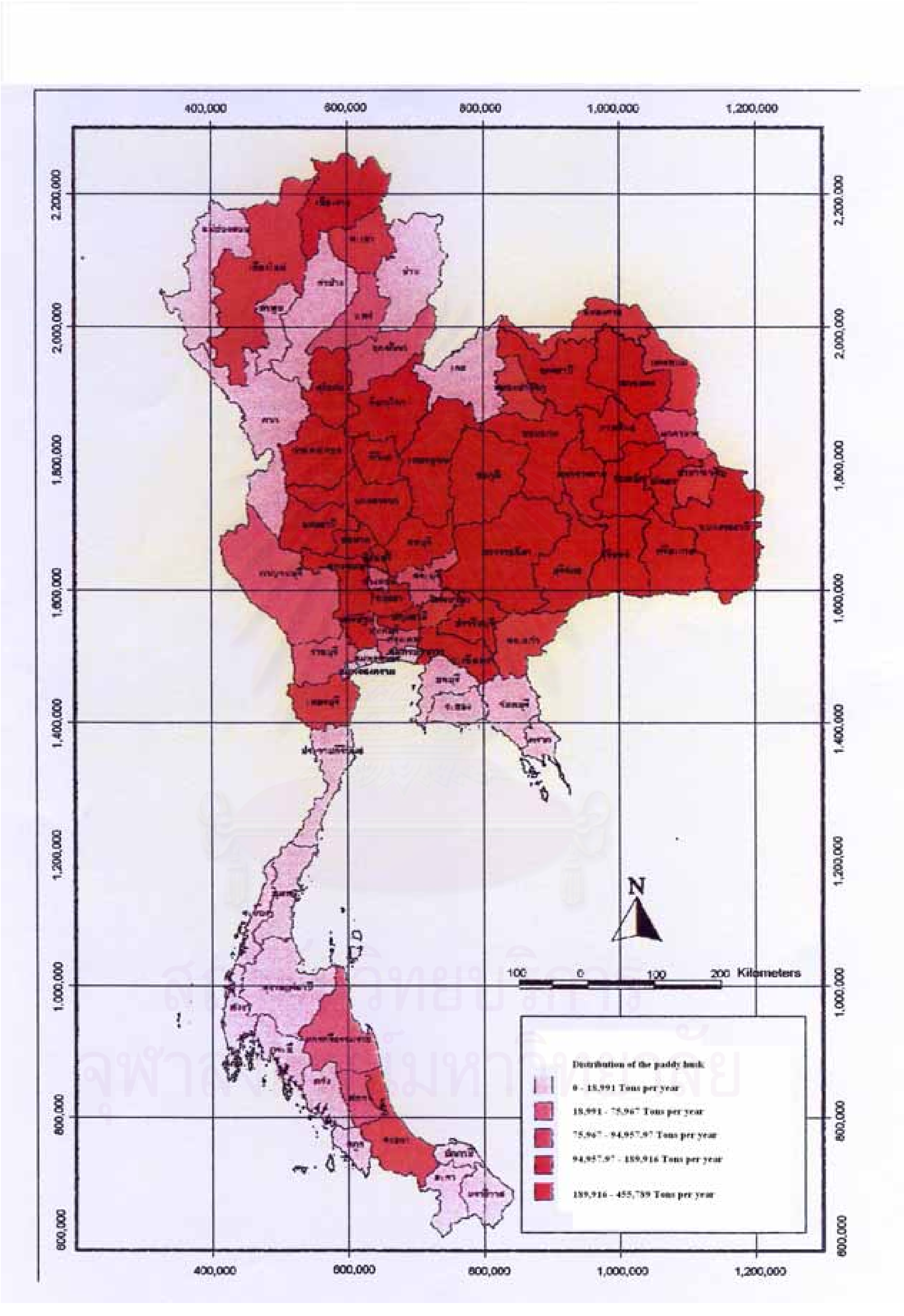

Figure 4.2: Distribution of rice husk (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

Second to the availability, the issue of the price and tendency is also needed to be concentrated on. As refer to the latest research from the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, illustrating below is the alternative energy raw materials prices under the category of rice. As illustrated in table 4.1 ever since the first period of the research in the year of 2001 to 2002, the average price of the paddy husk was 500 baths per ton and has been almost doubly increase with the factor of 80% in only a year time and remained ever since. As a result in the year of 2005, the average price per ton of the paddy husk was remained at 950 baths.

Rice	Annual Price (Bath / Kg.)				
	2001	2002	2003	2004	2005
Straw	0.81	0.81	1	1	1
Paddy Husk	0.5	0.5	0.9	0.95	0.95
Core Straw		2	2	2	2

Table 4.1: Alternative Energy Raw Material Prices under the category of rice (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

As a matter of fact regardless for the plenty of the paddy husk, a power generation is not the only industry of a kind that such a raw material is being consumed. As refer to the study from the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, the majority of the consumer of the paddy husk could be categorized into 3 main categories as the industry, agricultural and household.

1. Industry consumer

The majority of the industries that consume the paddy are considered to be as providing below with their potential sub-categories.

- Natural seed product industry, with potential sub-categories of a rice mill, cassava rhizome and other related products such as a bean cake
- Steamed product industry, with potential sub-categories of a bread, noodle manufacturer.
- Sweet product industry, with potential sub-categories of the manufacturer of a candy, chocolate and coffee in both form of a bar and powder.

- Cooking element product industry, with potential sub-categories of the manufacturer of consuming water, ice down to the industry of the cooking seasoning such as a soy sauce, fish sauce or bean cake source.
- Earth product for construction industry, with potential sub-categories of the manufacturer of decoration and construction brick.
- Cement product industry, with potential sub-categories of a manufacturer of construction cement.
- Power generation plant

2. Agricultural consumer

Generally in the country side for all the region of the country, paddy husk has been mainly utilized as a fertilizer and some minor agricultural aspect.

3. Household consumer

This category of consumption is considered to be taken place mostly in the country side located away from the grid of the EGAT and others source where some conservative source of energy still is a necessity.

Providing in table 4.2 is each of the mentioned categories of consumers together with their average consumption per year and the percentage from the overall availability. As illustrated the majority of the consumption is belong to the categories of the Agricultural consumption, the industry of Natural seed product and power generation.

Consumer	Annual average Consumption	Percentage
1. Industry consumer		
Natural seed product industry	1,958,450 Tons	33.55%
Steamed product industry	4,007 Tons	0.069%
Sweet product industry	2,400 Tons	0.041%
Cooking element product industry	166 Tons	0.0028%
Earth product for construction industry	358,159 Tons	6.1%
Cement product industry	2,088 Tons	0.036%
Power generation plant	1,189,000 Tons	20.37%
2. Agricultural consumer	2,300,000 Tons	39.39%
3. Household consumer	23,680 Tons	0.41%
Total	5,837,950 Tons	100%

Table 4.2: Major Rice husk consumer (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

As of the year of the research from the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, in 2005 the totality of the power plant in the industry of the power generation for both partially and fully feed by a rice husk is only 8 for all over the country. The balance of the demand and supply of the market was almost approaching equilibrium where only the surplus of approximately 2.5 million tons or 41% of the supply was still available. For now at the year of 2007 regardless for any other factors but the barely incremental availability of the rice husk and enlargement in the number of the rice husk power plant from 8 to 36 over a 2 years time, with regard to the technical information from the expert in the field of the biomass power plant technology and the technical data of the existed biomass power plant in the year of 2005 from the research of the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy for 1 Megawatt of the capacity under the general 330 days working condition, the requirement for the rice husk is averaged to be 17,968.91 tons per year. As illustrated in the table 4.3

Power plant	Fuel type	Capacity (MW)	Annual husk consumption (ton)	Average (Tons/MW)
PRG Granary Co., Ltd.	Paddy husk	9.24	162,000	17532.47
Bio-Mass Power Co.,Ltd.	Paddy husk	6	110,000	18333.33
Roi Et Green Co., Ltd.	Paddy husk	9.9	175,000	17676.77
Bua Sommhay Co., Ltd.	Paddy husk	6	110,000	18333.33
Total				71875.9
Average				17968.9

Table 4.3: Average rice husk consumption (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

According to the totality of the enlargement of 135.06 Megawatt capacity all over the country as of the research in the year of 2007 the consumption of the rice husk only in the field of the electricity generation for purely rice husk feed power plant is expected to be increase by 2,426880.98 tons. Obvious the situation is now considered to be before long approaching the stage of over-demanded, noted that the information is yet not included the partially rice husk feed power plant.

To sum up with no future consideration, corresponding to the information from the expert of a senior engineer from the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, there is an existing evidence of the strong bargaining power of the supplier in the industry of the rice husk power generation with the derivation of the factors as illustrated in figure 4.3.

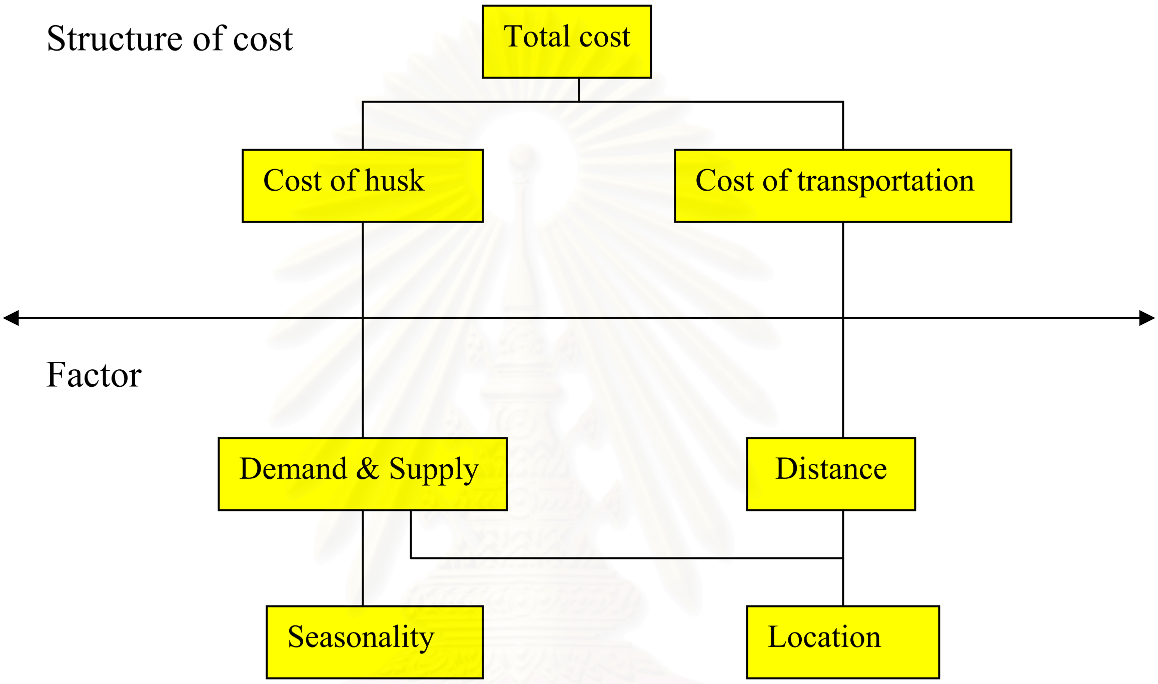

Figure 4.3: Element of paddy husk cost

As illustrated the majority of the factors affecting the value of the rice husk and the bargaining power of the suppliers could be precisely divided into two categories of the value of the rice husk itself and the value incurred from the cost of the transportation which each of the factors are manipulated respectively by the issue of the demand & supply and the distance away from the source. For the factor of the distance the significance of the cost does not concern only on the exact distance away from the source but also the geographic of the location since the transportation cost may varied upon both of factors for example at the same distance the transportation cost in the northern part of the country may be sometime significantly more expensive than those in the other parts as refer to the physical obstacle of the hill and mountain. For the root of the demand and supply the factor of the location is still having an affect since distribution of the raw material sources are not equal among each region therefore the balance of demand and supply may be varied upon the location of the plant. Other critical factor is the issue of the seasonality since naturally rice is not harvestable through out the year therefore the situation of over and under demand could possibly respectively take place out of and within the harvesting season.

4.1.2 Bargaining power of customer

In order to continue the study on the bargaining power of the customer, the identification of all the products from the power plant are needed to be firstly carried out. The majority of the products could be divided into 3 categories of the electricity, steam and ash with the relevant group of customer of both locally and internationally, in both private and governmental section.

Ever since the announcement of the government for the invitation for the private sector to be involved in the business of the power generation in the year of 1992 up to now Thailand as a country is becoming at the forefront of the country with the most renewable energy promotion in southeast Asia, by far the achievement is the establishment of the Electricity Generating Company (EGCO) together with the regulation and the agreement for the purchase of the power from SPP (Small power producer), IPP (Independent power producer) and VSPP (Very small power producer). With the accepted number of 7 IPP and 53 SPP projects and the capacity of 5,944 and 2,259 MW respectively, as of the research on the year of 2004 EGAT’s investment burden of 300,000 millions is expected to be reduced. Up to now as of the latest research, the totality of the biomass power plant in the country could be counted up to 113 plants. In order for each to fulfill the purpose of the foundation of the plant, the main product of the rice husk power plant is certainly electricity. As for general trading business first factor to be considered is the demand of the product. Illustrated in table 4.4 is the latest statistical data of the electricity consumption categorized into each sectors from the fiscal year of 2002 to 2006, as being seen the result illustrate the incremental trend of the consumption of the whole country in all the sectors.

UNIT : GWH

DATE	RESIDENTIAL	BUSINESS	INDUSTRY	AGRICULTURE	OTHERS	EGAT DIRECT CUSTOMER	TOTAL
2002	22,145.15	23,763.15	44,805.66	192.03	6,557.86	1,943.26	99,407.11
2003	23,329.53	25,336.85	48,293.79	227.88	7,070.52	1,949.26	106,207.83
2004	24,538.33	28,687.23	50,810.54	245.40	7,916.17	2,127.99	114,325.66
2005	25,514.09	30,163.82	53,894.12	249.52	8,406.63	2,409.19	120,637.37
2006	26,914.91	31,702.35	56,994.75	240.24	8,897.76	2,487.23	127,237.24

Table 4.4: Electricity consumption of the whole country
(Source; EPPO)

UNIT : GWH

DATE	HYDRO	FUEL OIL	LIGNITE	NATURAL GAS	DIESEL	GEO THERMAL	NON CONVENTIONAL	IMPORTED	DEDP	SPP	IPP	TOTAL
2002	7,366.94	1969.39	16651.86	35,251.60	150.98	1.44	0.31	2,812.18	31.71	12,548.25	34,469.23	111,253.87
2003	7,207.76	2434.28	16856.16	31,694.4	75.30	1.61	0.24	2,473.41	32.29	13,299.82	44,332.77	118,408.03
2004	5,896.29	5,467.67	17993.55	30,901.10	232.95	1.26	0.87	3,377.85	25.50	13,440.60	50,172.86	127,510.51
2005	5,671.18	7640.00	18334.5	33,064.85	176.85	1.45	0.81	4,371.89	17.40	13,546.61	51,972.65	134,798.2
2006	7,950.05	7808.44	18027.68	33,962.67	76.92	1.72	0.85	5,151.85	44.79	13,530.95	55,362.65	141,918.57

Table 4.5: Power generation by type (Source: EPPO)

For the issue concerning the supply of the electricity, the study considering only the projects of SPP since the capacity of no more than 90 MW is more appropriate for the project of rice husk biomass power plant in term of the availability of the fuel. Even though from the grand total the percentage of the SPP project seems to be small in the number but obviously there is an evidence of the incremental tendency and a significant opportunity for the expansion as illustrated in table 4.5.

In order for the private sector to sell the power to the system several issues may needed to be considered as provided in the regulation for the investors. The first major issue is the promotion to joint since after the beginning of the year 2007 the government has announce the policy to adjust the capacity of VSPP project from no more than 1 MW to be 10 MW with only firm contract which affecting the power plant under the category of rice husk fuel with 0.3 bath adder for each unit produced and resulting in approximate incremental percentage of 8 for the revenue from the trade of the electricity. For those exceeding the capacity of 10 MW there is no further option but to still remain with SPP with the alternative to go for firm or non-firm contract, illustrated in figure 4.4 is the pricing mechanism. For the firm contract the trader could get benefit from both Capacity payment (CP) and Energy payment (EP) for each single unit traded while for non-firm only EP would be received but the factor indicated this significant difference is the risking issue since there is a certain achievement level of the agreed capacity which the power plant under the firm contract needed to deliver or else the penalty would be enforced.

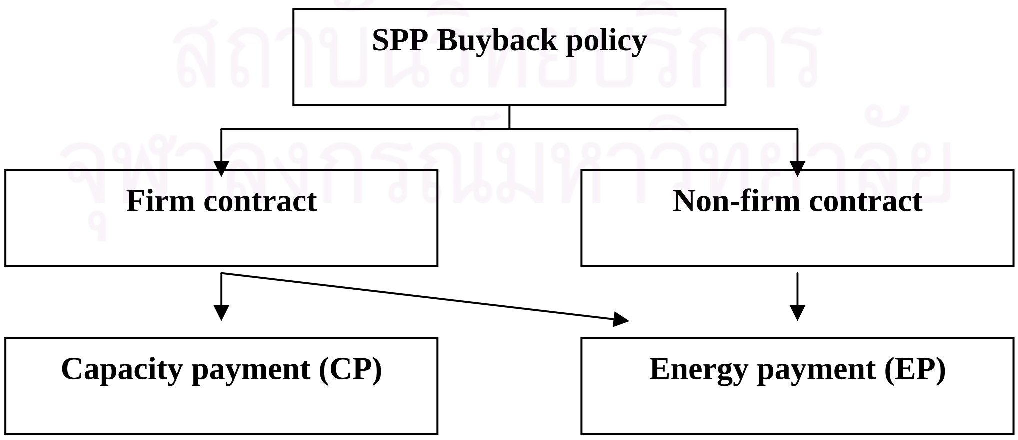

Figure 4.4: SPP buyback policy (Source: C. Yonhpanchert, 2004)

Another essential issue needed to be concerned is location of the plant, basically the location is 100% owner decision as long as the responsibility for the expense of the connection system from the plant to the grit of the MEA (Metropolitan Electricity Authority) or PEA (Provincial Electricity Authority) are willing to be held. As a matter of fact great distance come huge invoice therefore the general practices is to locate the plant in close proximity to the grit.

Generally for the product of steam, the utilization is concentrated in the section of private manufacturing industry. As refer to the latest research from the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, under the scope of the industries with the appropriateness for the employment of the steam from the biomass power plant as a main form of heat energy, 8 industries has been finalized with the totality of the heat energy consumption of 10,490 Ktoe as listed in the table 4.6 with their relevant heat consumption and their relevant biomass fuel.

Industry	Annual heat consumption (Ktoe)	Biomass
Can and other preserved food product	130.9	Maize cob Wood chip
Vegetable and meat oil product	290.1	Fiber Shell
Natural seed product	686	Paddy husk
Sugar mill	7,801.70	Bagasse
Wood product	105	Wood chip
Paper product	824.4	Wood chip
Earth product for construction	251.6	Paddy husk Wood chip
Cement product	322.3	Wood chip

Table 4.6: Major heat consumer industry (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

Regardless for any other factor one issue considered as being a major obstacle of the trading of the steam is the distance since unlike others form of energy, steam is tended to have a significant energy lost during the transmission. Therefore the proximity of the location of the provider and the consumer is crucially momentous.

Another considered main product of the rice husk power plant is an ash, in general cases a profit from the trading of the ash could contribute a vital role to the overall revenue of the industry.

For ash trading aspect, several industries could be considered as a potential customer in this commercial area as following

1. Steel industry

   In this industry the utilization of the ash has played the role in the process of the manufacturing of high quality plate and roll steel with their properties of low thermal conductivity, high melting temperature and low density, ash would be used as a thermal insulator. Generally the usage is to cover the top of the steel with the ash to prevent the rapid temperature drop of the steel. The ratio of the usage of the ash per steel produced is approximately 0.0005 to 0.0007% from the total weight of steel produced.

2. Cement industry

   Generally in the process of producing the concrete, the ration of the cement: sand: stone: water: air could approximately identify to be 11%: 26%: 41%: 6 %: 6%. The functionality of the cement is to form and bond all other element together nevertheless the usage of the cement is replaceable with an ash with the allowance of 50% from totality which the introduction of an ash is resulting in the reduction of the cost of 25% with all maintained physical properties of the concrete.

3. Heat resistance brick

   As refer to outstanding property of low thermal conductivity and high melting temperature, ash has also been used as an element of heat resistance brick for the usage of the combustion chamber.

4. Lightweight structure material

   The examples of the product are heat and electricity insulator board.

5. Silicon chip industry

   As refer to the high percentage of the silica of 92% in the rice husk ash after the process of purification the result of pure silica could be utilize in the industry of semiconductor and computer.

The area of consideration is the steel industry that has been firstly mentioned since it is the most potential consumer of the rice husk ash. As refer to the global demand of the steel from IISI (International Iron and Steel Institute) as illustrated in the table 4.7 with the percentage of the ash required for manufacturing a steel of 0.0005 to 0.0007 from the total weight of the steel produces the demand of the rice husk ash could be predicted to be approximately 600,000 to 900,000 tons for the year of 2008. Although the tendency of demand may seem significant but the major obstacle is the issue of the middle trader since most of the potential husk consumer are located internationally and by far none of the direct contact between local producer and the end user has yet been established therefore the bargaining power is still in hand of the trader.

REGIONS	2006	2007	2008	% 05/06	% 06/07	% 07/08
EU-27	184.7	187.4	191.0	11.2	1.5	1.9
Other Europe	28.0	29.8	31.7	14.9	6.5	6.4
C.I.S.	48.4	51.3	54.4	12.9	6.1	6.0
N.A.F.T.A.	154.9	150.1	156.6	11.1	-3.1	4.3
Central and South America	36.0	38.2	40.5	11.7	6.1	6.0
Africa	21.6	23.1	24.9	9.7	6.9	7.8
Middle East	36.8	40.2	43.6	10.3	9.1	8.4
Asia	602.8	658.5	708.0	6.1	9.2	7.5
WORLD	**1,113.2**	**1,178.6**	**1,250.5**	**8.5**	**5.9**	**6.1**

Table 4.7: Global demand of the steel (Source; International Iron and Steel Institute)

To sum up, from the research for all the categories of the product the evidences of the bargaining power of the customer is existing, corresponding to the suggestion from the expert of a division manager of the rice husk power plant division of a rice mill industry which mentioned for both electricity and ash the critical issues are the same since regardless for the significant growing tendency of the consumption still the immediate consumptions are under the control of only a few distributors who hold a serious high bargaining power according to the lower number of player in the market. In case of the steam as explained earlier due to the energy loss on the transmission process, the trade could only be made between the immediate customers where the physical proximity is required therefore generally only a few customers could be supplied at a time and reflecting in the result of the bargaining power from the customer.

4.1.3 The threats of new entrants

Unlike the others businesses the rivalry of the rice husk power plant industry is not intense on the side of the finished product but rather on the side of the raw material which now approaching the stage of the crisis especially in the region of the middle and northeast of the country. As mentioned, ever since the announcement of the government for the invitation for the private sector to be involved in the business of the power generation in the year of 1992 up to now the number of the rice husk biomass power plant projects jointed the grogram of SPP as of the latest survey on sep 2006, are already 36 country wide. Anyhow the richness in number presenting nothing close to the reflection of the new arrival of the industry since several more were unable to enter as refer to the barriers that would be illustrated further in this section. In case of the rice husk electricity generation industry several issues could be considered as threats for the new player entering the market.

First of all is the issue of the economic of scale, like all others business with more capacity of the product under a given period of time reflecting in the reduction in the production cost of each individual unit. But unlike the others, the scale of this specific business in term of the maximum output in megawatt is not defined by the customer demand alone but also an availability of the raw material which somehow even more influenced. Accordingly the capacity of the power plant is generally subjected to the long term ability and prediction to obtain the rice husk under the acceptable prices for both power plant and the husk provider. But generally unless the requirement of the raw material consumption could be served the scale of the rice husk power plant is limited to the maximum size of below 10MW since referring to the governmental regulation the power plant with the size of 10MW and above would require an agreement from the public opinion which the civilians are legally allow to repudiate the project within their own district.

Second with the issue of the raw material, several factors are considered to be important but of all, a couple which defined as a fatality in case of the absence are the availability and the cost to obtain of the raw material which for further discussion this lead to the issue of the favorable access to a raw material. In order to fulfill the massive consumption of the rice husk, generally the investor of the power plant is expected to have their own source of supply like a rice mill, or at least capable of arranging a relationship with the external source of supply which in this case the contract are needed to be arranged with an unambiguous specification of the agreement for the period of time and price of sale.

For the second stage even though the issue of availability of the raw material would has already been handled but unavoidable with or without the contract the price of sale of the rice husk have to reflect the reality in the market which as illustrated in table 4.8 with the unstoppable tendency of increment. For the case of owner own source, the financial analysis has to take into account the loss of the opportunity for the whole supply chain in case the price of sale is controlled regardless for the reality in the market, since anyway the gain of the power plant is the loss for the rice husk supplying business.

Rice	Annual Price (Bath / Kg.)				
	2001	2002	2003	2004	2005
Straw	0.81	0.81	1	1	1
Paddy Husk	0.5	0.5	0.9	0.95	0.95
Core Straw		2	2	2	2

Table 4.8: Alternative Energy Raw Material Prices under the category of rice (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

In order to demonstrate the effect of fluctuation of the price of rice husk on the overall financial health of the business, a brief summary of the financial sensitivity analysis for various prices of rice husk of the rice husk power plant with the cogeneration system with the specification and assumption as illustrated below has been carried out

- 9.9 MW capacity with 8 MW sale contract to EGAT
- 2.7 baths per MW contract sale
- 55 tons boiler
- 1.87 tons per hour of ash

- 1,000 baths per tons profit from ash
- 20 tons per hour of sale steam
- 350 bath per hour of steam price
- 535 million baths of initial investment
- 7.5% interest rate

As a result in the value of IRR (Internal Rate of Return), NPV (Net Present Value) and Simple pay back time have been varied as the price of rice husk has change. As illustrated in table 4.9 the incremental tendency of the price of rice husk resulting in the extension of the value of the pay back time and reduction in the value of IRR and NPV at the same time.

	at 500 bpt	at 600 bpt	at 700 bpt	at 800 bpt	at 900 bpt	at 1000 bpt
Simple Payback Time (yrs)	3.04	3.20	3.38	3.57	3.79	4.04
NPV (Million baths)	1,244.53	1,188.65	1,047.61	949.15	850.69	752.23
IRR	32.2%	31.1%	28.8%	27.0%	25.2%	23.5%

Table 4.9: Result of the variation of paddy husk

As a nature of the technology intensive business like all the others, rice husk biomass power plant is considered to be at the high-end of the medium amount capital requirement project. Generally the initial requirement is averaged to be 40 to 60 million baths per 1 MW of output capacity depend on the scale and expected quality. Generally the majority of the capital requirement could be categorized into three of the core machines, the asset of plant building, land, and utilities and the others such as a fee for a feasibility study.

In normal case the majority goes to the cost of core machines which generally is 76 percents where the others are 16 and 1 respectively plus other for vat of 7%. For most of the case the capital of investment is a merge from the loan from commercial bank and the owner equity which the ratio may vary from case to case. Illustrated in the table 4.10, 4.11 and 4.12 are the example of the actual percentage of the cost breakdown of rice husk power plant project in Thailand with the specification as in one analyzed in the financial analysis.

Item	Price percentage (%)
Fuel conveying system	1.461495
Combustion system	5.237025
Post combustion chamber	1.177316
Combustion system accessories	1.364687
Steam boiler	12.82868
Steam boiler accessories	1.217913
Feed water system	1.217913
Steam distribution	0.487165
Dust separator, Flue gas system	4.140903
Deashing system	1.217913
Ash storage silo	0.487165
Turbine generator	23.95228
Water cooled condenser	1.561427
Cooling power pump set	1.055524
Cooling tower	1.705078
Water DEMIN plant	0.893136
Plant balance equipment	0.730748
Control system	3.897321
Middle voltage transformer and Grid isolation	3.085379
Erection-Mechanical	1.217913
Erection-Electrical	0.933733
Spare parts	0.487165
General plant engineer	1.217913
Power plant building; foundation	4.222097
TMS Telemetry to PEA branch	0.162388
Transports	0.324777
Total	**76.28505**

Table 4.10: Percentage of cost of the core machine

Item	Price percentage (%)
Warehouse	6.995191
Master office	0.468428
Master scales	0.234214
Ash packing building	0.499656
fuel filling truck	0.936856
Road	0.858785
Water pond digging	1.561427
Piping from pond	0.234214
Feasibility and banker arrangement	0.936856
Land	0.780713
Husk yard	1.249141
Fuel transporting truck	0.780713
Fork lift	0.296671
Office equipment	0.156143
Total	**15.98901**

Table 4.11: Percentage of cost of the asset of plant building, land, and utilities

Item	Price percentage (%)
Project analysis	0.231091
Land deposit	0.031229
Machine deposit	0.922803
Total	**1.185123**

Table 4.12: Percentage of cost incurred from the other

To sum up, with more of the new entrants in the industry of the power generation the affect would be taken place but as mentioned not in the end of the consumer of the electricity but rather the rivalry at the other end of the material consumption, as refer to Porter's five forces model as well as the suggestion from the expert of

- Director& Senior consulting engineer of the sustainable energy consulting company.
- Managing director of the biomass power plant turn-key contractor company.

- Senior project engineer the biomass power plant turn-key contractor company.

The barriers for the new entrants could be summarized into 3 categories as illustrated below

1. Capital requirement
2. Economic of scale
3. Favorable access to raw material

4.1.4 Intensity of rivalry among existing competitors

As mentioned ever since the announcement of the government for the invitation for the private sector to be involved in the business of the power generation in the year of 1992 up to now as of the latest information from EGAT the number of the biomass power plant for both feeding fully and partly with a rice husk of all regions in the country have been magnified up to 36 projects.

Research summary

Of all 36 projects gathered, the information could be summarized that

Fuel use

- 18 projects or 50% are a 100% rice husk feed power plant
- 18 projects or 50% are rice husk partially feed power plant where the alternative on the type of fuel are named as a bagasse, wood bark, cassava rhizome or corn cob

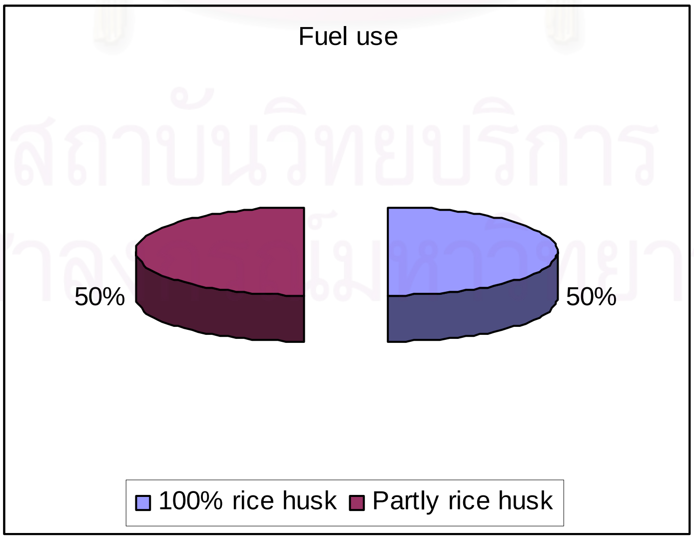

Figure 4.5: Fuel use (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

Capacity

- 12 projects or 33% have the capacity of more than 10 MW
- 2 projects or 6% have the capacity of precisely 10 MW
- 22 projects or 61% have the capacity of below 10 MW

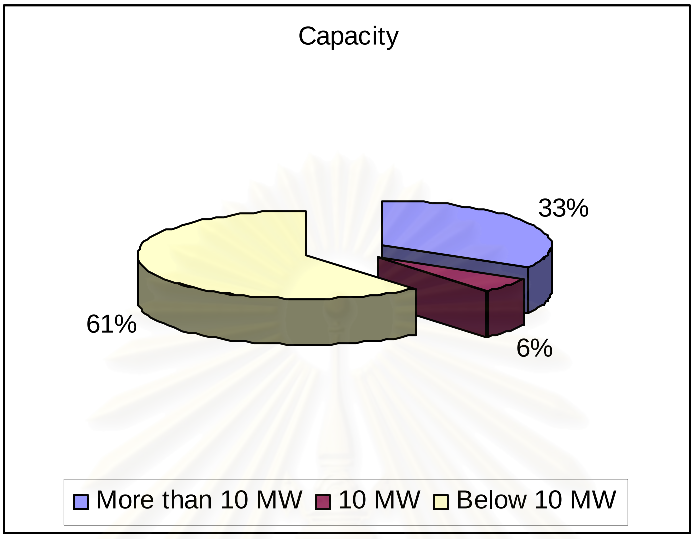

Figure 4.6: Capacity (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

Type of business

- 2 projects or 6% is in the industry of a Rice mill
- 34 projects or 94% are in the industry of cogeneration system power plant

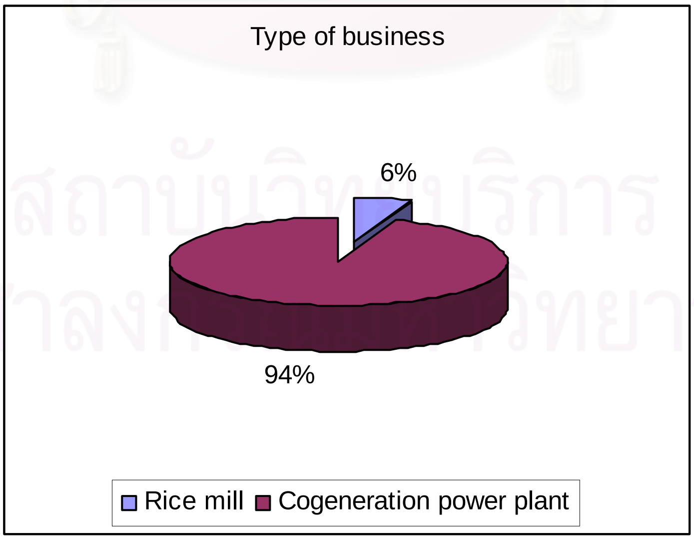

Figure 4.7: Type of business (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

Of all the projects defined themselves in the industry of cogeneration system power plant their parents business could be categorized as below

- Mainly power plant industry of 13 plants, 36 %
- Sugar mill of 3 plants, 8 %
- Rice mill of 20 plants, 56 %

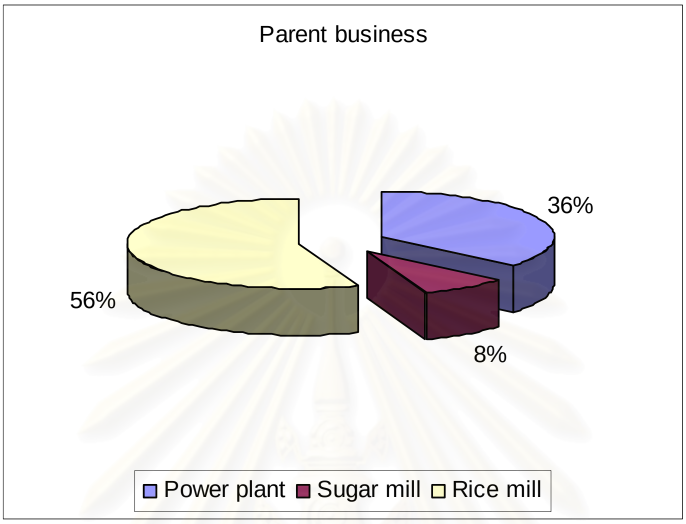

Figure 4.8: Parent business (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

Progress of the project

- 24 projects or 67% have already signed the contract with EGAT, MEA or PEA.
- 12 projects or 33%, the contract has not yet been signed.

Figure 4.9: Progress of the project (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

Location

- 7 projects or 19% are located in the north region
- 8 projects or 22% are located in the middle region
- 17 projects or 48% are located in the northeast region
- 4 projects or 11% are located in the east region

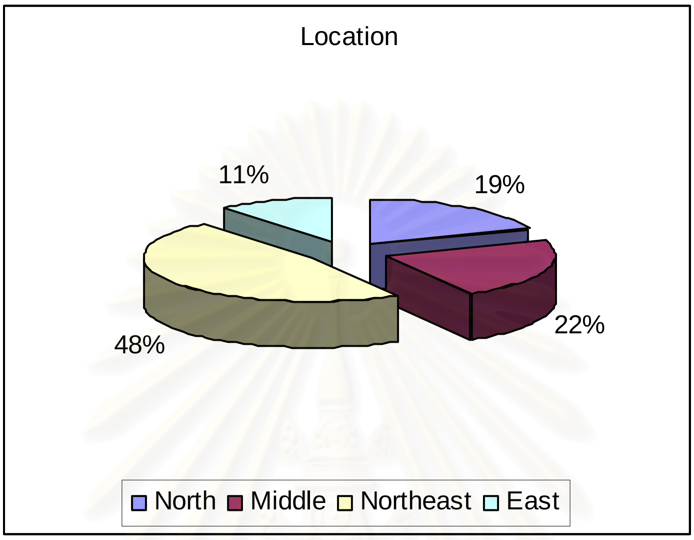

Figure 4.10: Location (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

To sum up referring to the raising tendency of the electricity consumption of the country as well as the suggestion from the expert of the staff from EGAT, PEA and MEA, the product of the electricity under the current situation is 100% sellable. Therefore on this side the competition between each producer could be defined as none. As mentioned earlier the rivalry among the existing competitors in this specific industry is intense on the end of the obtaining of the raw material. Referring to the expert of division manager of the rice husk power plant division of the rice mill and senior engineer of the Department of alternative Energy Development and Efficiency (DEDE), Ministry of Energy, in order for each individual to survive their own availability of the raw material is needed to be ensured, as illustrated in figure 4.8 for most of the power plant projects regardless for the type of fuel, the investors are the person who have the access to the control over the require raw material in form of the parent business such as a rice mill or sugar mill. As a matter of fact those who aren't, have to one way or another establish a relationship with the source in order to survive which the location is another critical issue as illustrated in figure 4.10 northeast region is where the rivalry is most intense therefore the consideration for other location may required.

4.1.5 The threats of the substitutes

As mentioned for the industry of the rice husk power producer the competition between each producer for the trading of the electricity could be defined as none while on the other hand the intensity of the rivalry is on the aspect of obtaining the raw material. Therefore under the current situation the threat of the substitutes is considered as being the other way around which concern the issue of being substituted by others consumer of the raw material. As previously summarized apart form the consumption within the industry of the electricity also there are quite a number of other industry which rice husk is being consumed as illustrated in table 4.13.

Consumer	Annual average Consumption	Percentage
1. Industry consumer		
Natural seed product industry	1,958,450 Tons	33.55%
Steamed product industry	4,007 Tons	0.069%
Sweet product industry	2,400 Tons	0.041%
Cooking element product industry	166 Tons	0.0028%
Earth product for construction industry	358,159 Tons	6.1%
Cement product industry	2,088 Tons	0.036%
Power generation plant	1,189,000 Tons	20.37%
2. Agricultural consumer	2,300,000 Tons	39.39%
3. Household consumer	23,680 Tons	0.41%
Total	5,837,950 Tons	100%

Table 4.13: Major Rice husk consumer (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

To sum up apart from the industry of the rise husk power generation, the threat of substitute on the end of the raw material consumption could be defined as minimal which is corresponding to the information from the expert of a senior engineer from the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, since the market situation of the other consumers has been steady for quite a while with a barely incremental in the consumption. On the other hand the threat is rather considered to be a substitution by the other consumers within the own industry of power generation since the level of competition is considered to be relatively high.

4.2 Industry analysis summary

As refer to result of the analysis of the porter's five force model as well as the suggestion from the relevant experts, there is an existing evidence of the strong bargaining power of the supplier in the industry of the rice husk power generation with the route of the bargaining power from the seasonality of the harvesting seasonality of rice as well as the location of the plant.

There are also the evidences of the bargaining power of the customer under the categories of the product of an electricity and ash as refer to the issue of the monopolization of the middle men.

For the barrier of a new entrant from the study of a threat for the new arrival, it could be summarized into 3 categories of a capital requirement, economic of scale and a favorable access to raw material.

For the rivalry among the existing competitor, it could be summarized that there is an intensity of the rivalry on the end of the strive for a raw material where the access to a source of raw material is considered to be most crucial issue.

From the study, the threat for the substitute on the end of the raw material could be defined as minimal but rather considered to be a substitute by the other within the industry of power generation.

Accordingly under the current situation the industry could be described as intense on the end of rivalry for the raw material for both within the power generation industry and external consumer. So far the survivors are those who own the source of fuel or at least having a relatively well connection. For those of the new coming this is also the fatal factor to be concerned with the elements of both seasonality and location which strongly affecting the value of both IRR and pay back period of the project, together with the factor of the economic of scale and capital requirement with the majority of the cost from a core machines. On the side of the finish product, a trading of steam is considered to be crucial as another source of revenue , as well as the electricity referring to the growing tendency of the national consumption the expansion of the market is still having a long way to go but on the other hand there is an evidence of the monopolization since after all the government organization is the only major immediate customer together with an ash trading with only few middle men despite the growing demand tendency from the industry of a steel manufacturer.

Accordingly from the result of the industry analysis as well as the suggestion from the relevant experts, several factors could be identified as having a potential to be a critical success factors starting with the factor of an access to a source of raw material and monopolization of the middle men of the product of electricity and ash which strongly influence the constraints of a market share and competitiveness.

Second by the constraint of customer satisfaction, this is strongly affected by the factor of the conformity to the power trading regulation. The other is a bargain of the core machines since it is the majority of the cost and relevant to the constraint of an initial expense.

As well as a capability to trade the steam which is strongly affects the constraint of a profit margin.

CHAPTER V
SITUATION ANALYSIS

Contained in this chapter is the investigation for the current industry situation, carried out via the aid of the SWOT analysis with the expectation to yield the result of the big picture of the over all industry present situations, the understanding of all the positive and negative factors concerned as well as to extend the information to formulate the critical success factors based on the presence of some certain strength, opportunities and the factors to overcome some particular weaknesses and threats.

Sequentially the positive and negative of the industry internal capabilities would be presented via the aid of strength (S) and weaknesses (W) and seconded by the introduction of the positive, opportunities (O) and negative, threats (T) of the external environmental factors affecting the industry.

5.1 SWOT Analysis

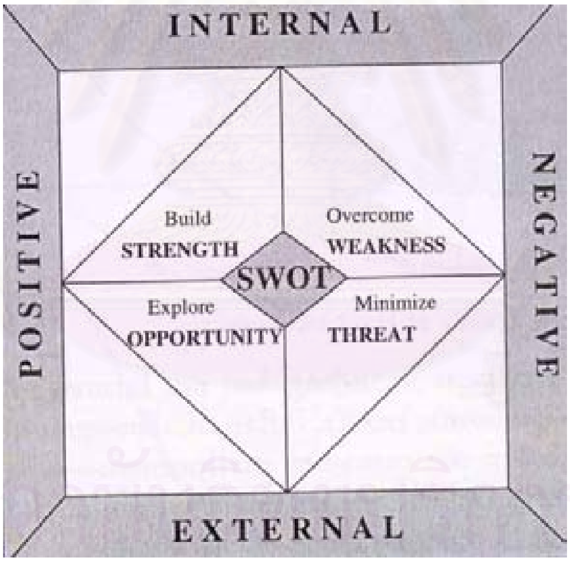

Figure 5.1: SWOT Analysis

Based on the information gathered from various trustful sources, presenting in this chapter is the SWOT analysis, sequentially as

- Strengths (S)
- Weaknesses (W)
- Opportunities (O)
- Threats (T)

5.1.1 Strength of the rice husk power generation industry

As a result of the analysis as well as the suggestion from the relevant experts the consistence of the strengths of the industry of the rice husk power generation could be identified as being an excellence supportive business and durable investment, having variety of technology and secondary type of fuel, low operating cost and having no requirement for a marketing effort.

Excellent supportive business

Truly the main product of the industry is the electricity which is by far the most universal form of the consumed energy, generally for most of the cases the product of the electricity is circulated back to support the consumption of the plant of the parent businesses themselves. As refer to the result of the industry analysis as illustrated in the figure 5.2, 64% of all the power plants are the diversification from such a business as a rice mill or sugar mill, for most of the cases the location are having a proximity with one certain activity of the trading of the electricity.

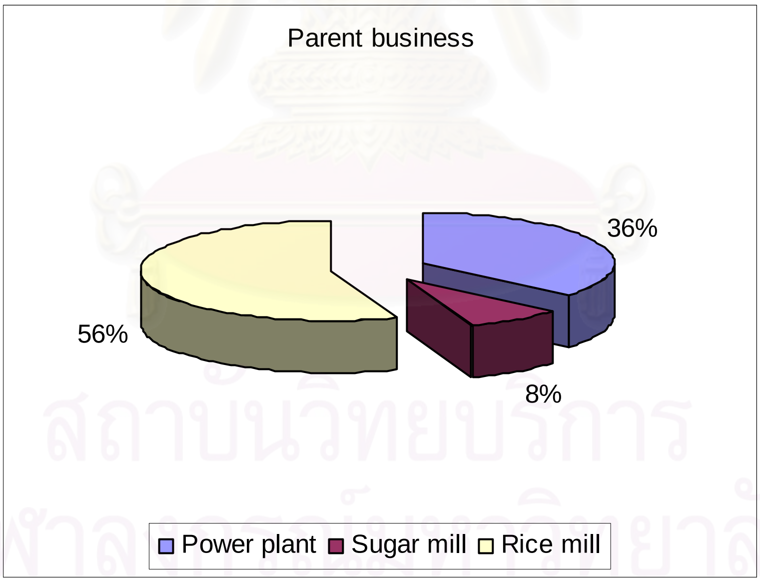

Figure 5.2: Parent business (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

Apart from the product of the electricity the other considered as a supporting product is the steam since in some cases it could be transmitted to be utilized especially in the industry of ingestion product. As refer to the research from the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, under the scope of the industries with the appropriateness for the employment of the steam from the biomass power plant as a main form of heat energy, 8 industries has been finalized in table 5.1. As illustrated for two out of the first three consumers, the steam is transmitted back to be utilized within the industries, defined as a rice mill and sugar mill whose as mentioned are having the majority among the investor of the biomass power plant industry.

Industry	Annual heat consumption (Ktoe)
Can and other preserved food product	130.9
Vegetable and meat oil product	290.1
Natural seed product	686
Sugar mill	7,801.70
Wood product	105
Paper product	824.4
Earth product for construction	251.6
Cement product	**322.3**

Table 5.1: Major heat consumer industry (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

According to the information from the expert of the division manager of the rice husk power plant division of the rice mill industry, this trading reflecting the efficiency of the whole supply chain and defined as the strength since the parent business could be benefited from the difference of the lower power purchasing price per unit comparing to those purchased from the other source.

Variety of alternative on the secondary type of fuel

As refer to the research as well as the suggestion from the expert from the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, an alternative on the secondary fuel is also considered as strength for the industry of a rice husk biomass power plant in Thailand. As illustrated in the figure 5.3 about a half of the rice husk power plant researched in the year of 2005 were defined as a partial rice husk power plant with the secondary fuel named as a bagasse, wood bark, cassava rhizome or corn cob. According to the research mentioned, the biomass defined as having a potential to be utilized as a fuel for the power plant could be summarized as listed in table 5.2.

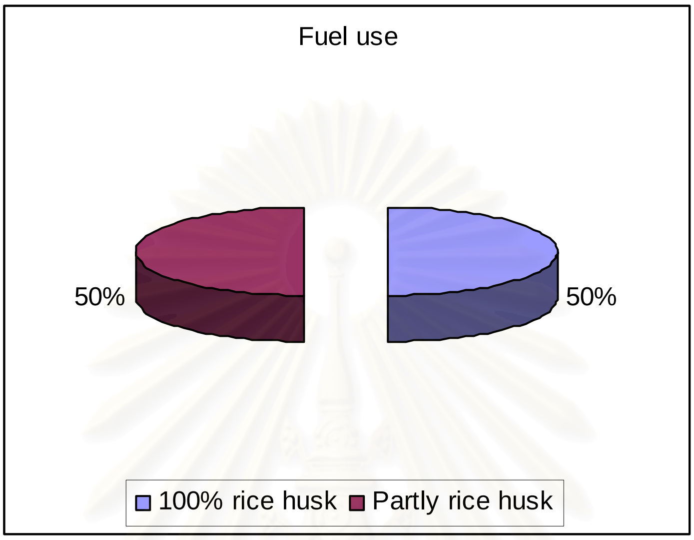

Figure 5.3: Fuel use (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

Plant	Relevant biomass
Sugar cane	- Trashier (Leaf) - Bagasse - Top
Rice	- Husk - Straw
Oil palm	- Empty bunches - Fiber - Shell - Frond - Male bunches
Soybean	- Stalk - Leaf

	- Shell
Cassava	- Top / Trashier - Stalk - Root
Maize	- Cob - Stalk - Top - Leaf - Skin
Pineapple	- Stump
Coconut	- Husk - Shell - Empty bunch - Frond
Wood	- Charcoal - Fuel wood - Frond - Leaf - Husk - Seed

Table 5.2: Potential biomass (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy

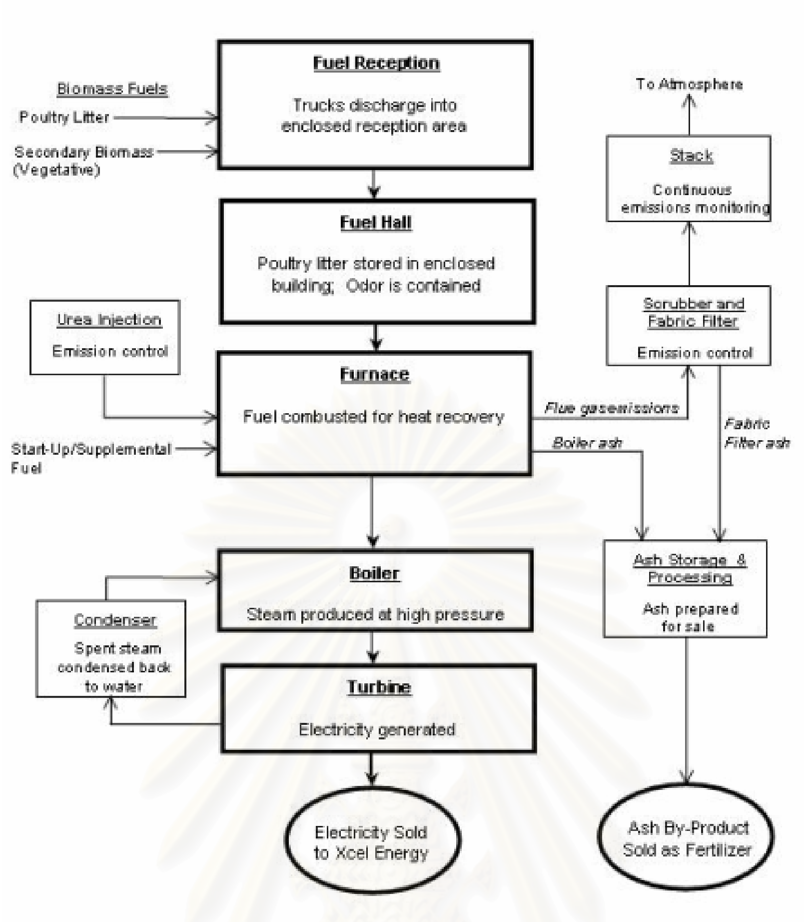

Figure 5.4: Flow chart of biomass power plant (Source: Fibrominn homepage)

Variety of alternative on the core machine

Generally the formation of the rice husk power plant is consisted of three major parts of fuel combustion, water boiler and an electricity generation section of turbine as illustrated in figure 5.4**.** Referring to the information from the expert of a director& senior consulting engineer of the sustainable energy consulting company, for both aspects with the broad selection of the suppliers of the core machine for both national and international together with a variety of the contractor available to be employed, the owners is having plenty of alternative to be chosen to fit the budget and expected quality.

Low operating cost

In term of the biomass power plant, generally the majority of the annual operating cost could be broken down into the elements of Raw material, water, chemical, maintenance and man power. Following is the characteristic of each individual element with the example based on the financial analysis of the actual operated rice husk power plant with the specification and assumption as illustrated below

- 9.9 MW capacity with 8 MW sale contract to EGAT
- 2.7 baths per MW contract sale
- 55 tons boiler
- 1.87 tons per hour of ash
- 1,000 baths per tons profit from ash
- 20 tons per hour of sale steam
- 350 bath per hour of steam price
- 535 million baths of initial investment
- 7.5% interest rate

For the element of the cost of water consumption, chemical consumption and man power the assumption could be made with general increment of 1 percent per year through out the life cycle of the project plus some extra cost of training and skill staff employment for a couple of the very first period for the element of manpower employment.

Illustrated in the figure 5.5 is the distribution of the annual cost incurred from the element of the water consumption over the 25 year-period of the project life time. As illustrated the cost has started with the value of annually 4.08 million baths and settles at the value of 5.18 million baths in the year of 25 with the annual incremental percentage of 1 percent, As well as in the case of the cost incurred from the chemical consumption and man power with the incremental rate of one percent the cost of chemical consumption as increased from 3.3 to 4.19 millions bath over 25 year of project and 10 to 13.83 million baths in the case of man power, as respectively illustrated in the figure 5.6 and 5.7

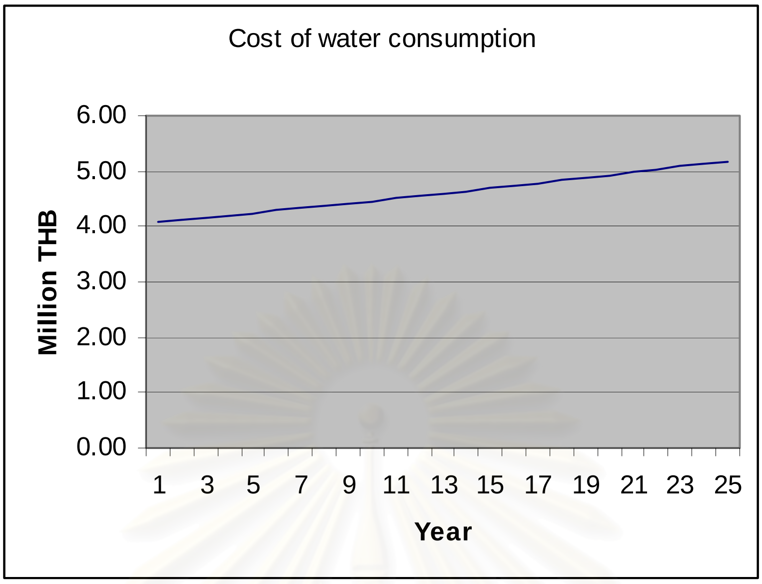

Figure 5.5: Cost incurred from the consumption of the water

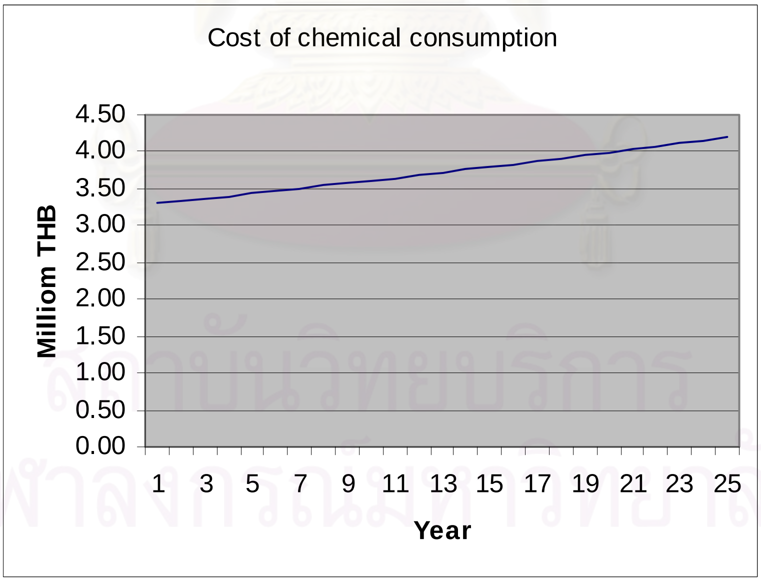

Figure 5.6: Cost incurred from the consumption of the chemical

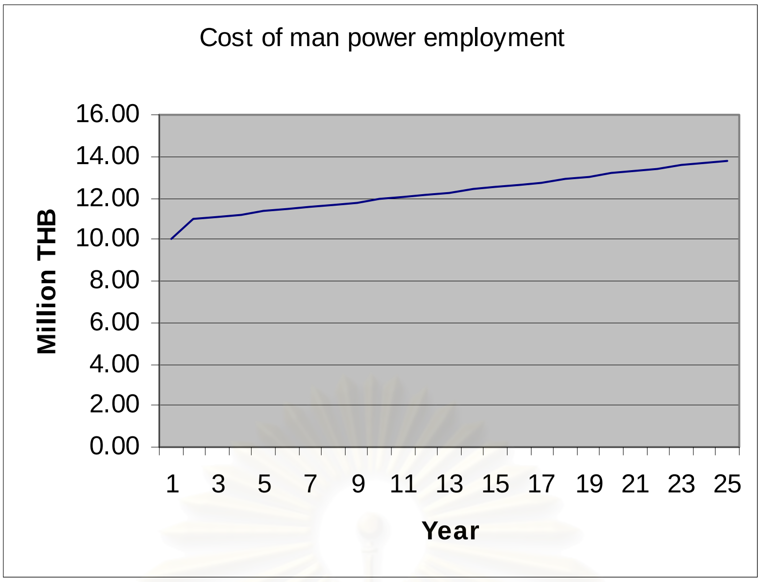

Figure 5.7: Cost incurred from the employment of the man power

For the category of maintenance, generally through out the life cycle of the project the requirement is to perform a major maintenance every 5 year-time, while during the period the minor maintenance activities are also annually require. Illustrated in the figure 5.8 is the distribution of the annual cost incurred from the element of the maintenance over the 25 year-period of the project life time, as illustrated the cost is having a peak at every 5 years with the step of the increment like a pattern of the ladder with the large step up and remained beyond the year of 20 from 5.78 to 11.58 million baths.

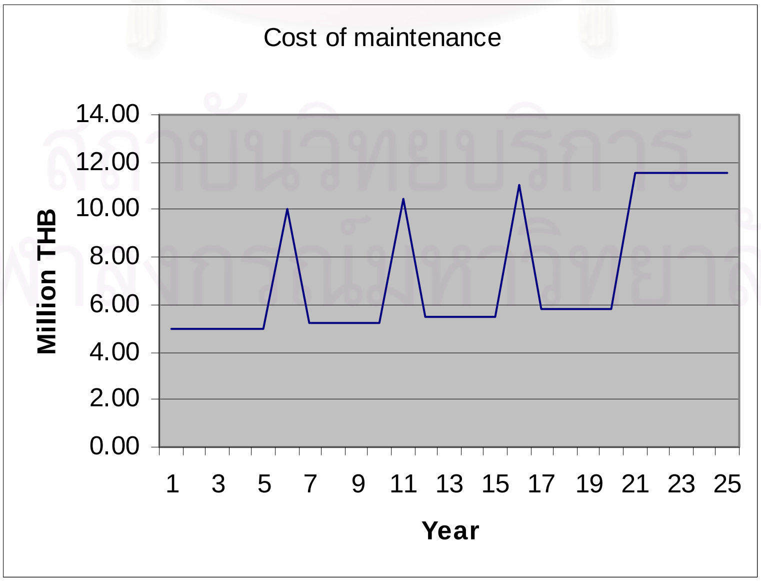

Figure 5.8: Cost incurred from the maintenance

As in general industry, whether under or over gaining price the majority of the cost of the rice husk power plant come from the cost of the raw material of the paddy husk which as illustrated in the table 5.3, the price has been doubly increase over a period of 3 years and significantly affecting the annual cost of the project.

Rice	Annual Price (Bath / Kg.)				
	2001	2002	2003	2004	2005
Straw	0.81	0.81	1	1	1
Paddy Husk	0.5	0.5	0.9	0.95	0.95
Core Straw		2	2	2	2

Table 5.3: Alternative Energy Raw Material Prices under the category of rice (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

Illustrated in figure 5.9 are the costs incurred from the raw material consumption over the project life period of 25 years, under the various price of the paddy husk ranging from the price per ton of 500 to 1,000 baths.

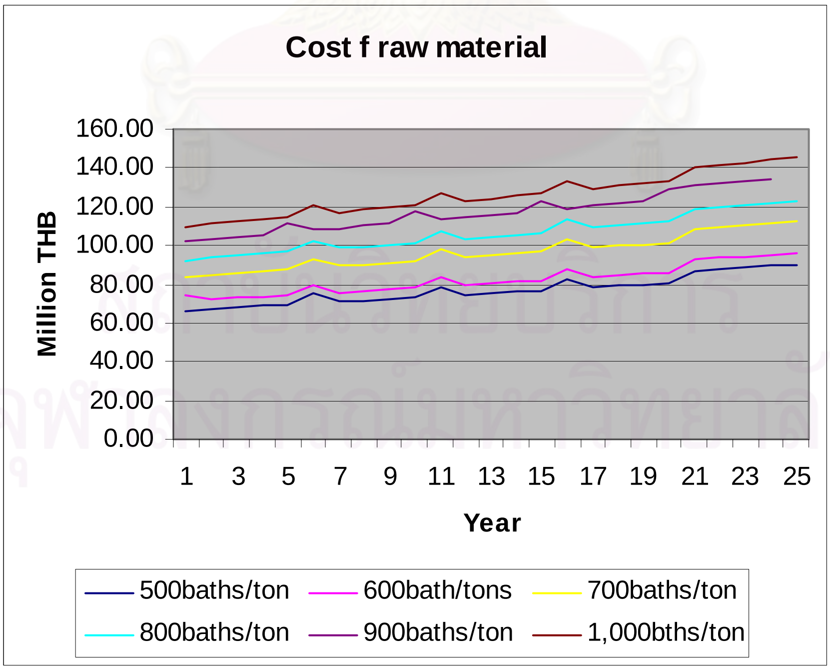

Figure 5.9: Cost incurred from the raw material

Referring to the expert of a senior project engineer the biomass power plant turn-key contractor company, regardless for the initial investment and depreciation, with all the cost combined the totality is considered to be relatively low comparing to the annual turnover as illustrated in the table 5.4. For the worst case at the price of paddy husk of 1,000 baths per ton the percentage of the expense per revenue is still expected to be around fifty percents.

Paddy husk (Baths/ton)	Total (Million baths) / 25 years		%
	Annual expense	Turnover	
500	1,926.03	6,044.28	0.318653338
600	2,060.93	6,044.28	0.34097196
700	2,418.13	6,044.28	0.400069156
800	2,664.19	6,044.28	0.44077872
900	2,910.24	6,044.28	0.481486629
1,000	3,156.30	6,044.28	0.522196192

Table 5.4: Percentage of an annual expense from the revenue

No requirement for the marketing effort for the main product of electricity

Ever since the announcement of the government for the invitation for the private sector to be involved in the business of the power generation in the year of 1992 as of the research in 2004, 53 SPP projects have already been accepted and precisely most of the biomass power plant is categorized under the category of the small power producer or SPP. As illustrated in table 5.5 ever since the first period in the year of 2002 to the latest study in the year of 2006, the share of the power produced from the project of SPP is seem to be relatively insignificant and illustrating a significant opportunity of the growth. Referring to the policy from EGAT, PEA and MEA any private organization who could be aligned with the regulation would be permitted to trade the power generated to the grid of the system.

Year	Power generated (GWH)		%
	SPP	Total	
2002	12,548.25	111,253.87	0.112789
2003	13,299.82	118,408.03	0.112322
2004	13,440.60	127,510.51	0.105408
2005	13,546.61	134,798.20	0.100495
2006	13,530.95	141,918.57	0.095343

Table 5.5: power generated from SPP project (Source: EPPO)

5.1.2 Weakness of the rice husk power generation industry

As refer to the result of the analysis as well as the suggestion form the relevant experts the weaknesses of the industry of the rice husk power plant is the result of the factors named as, high initial investment, technology intensive& requirement for expertise and the issue of the massive water consumption.

High initial investment

As refer to the information from the expert of a managing director of the biomass power plant turn-key contractor company, the initial investment of the industry of a rice husk power plant is considered to be high and considered to be a weakness of the industry. In contrast with the other type of business under the same category of the industry such as a rice mill or rice bran extraction plant, the required investment for the rice husk power plant per 1 MW of capacity is approximately 40 to 60 million baths which sum up to be 400 to 600 million for the general size of 10 MW while it take only approximately 100 million bath for a rice mill with the capacity of 1,000 tons or 70 tons capacity of rice bran oil extraction plant.

Future more even though Thailand is in the forefront position among Southeast Asian members in the promotion of the renewable energy principally biomass but still there is the difficulty in obtaining the financial support as refer to the unfamiliar of the financial institute to the renewable energy project.

Technology intensive and requirement for expertise

Unlike the other type of business under the same category of the industry such as a rice mill or rice bran oil extraction plant**,** as refer to the expert of a director& senior consulting engineer of the sustainable energy consulting company, the operator of the power generation machines ranging from the operation of the fuel combustion system down to the power generation section of the turbine are particularly delicate and needed to be closely supervised, and therefore the expertise is crucially required. As a general practice apart from providing machines and integrated competency system, the turn-key contractor is also responsible for providing the day to day operational training and minor maintenance for the investor selected crew. There are quite a number of evidence of the failure of the power plant which are a result of the failure in either or both the machine itself or the incompetence of the operators which the cost of shutting down could be relatively significant, for instance as refer to the financial analysis of the rice husk power plant with the specification as illustrated below the lost in the revenue of the machine breakdown could be up to 600,000 to 700,000 baths per day.

- 9.9 MW capacity with 8 MW sale contract to EGAT
- 2.7 baths per MW contract sale
- 55 tons boiler
- 1.87 tons per hour of ash
- 1,000 baths per tons profit from ash
- 20 tons per hour of sale steam
- 350 bath per hour of steam price
- 535 million baths of initial investment
- 7.5% interest rate

Water consumption

Like all others steam utilization business, as refer to the expert of senior project engineer of the biomass power plant turn-key contractor company and division manager of the rice husk power plant division of the rice mill, one particular factor considered as a weakness for the industry of the rice husk power generation is the massive consumption of the water, for instance as refer to technical data with the specification as illustrated below the daily circulation of the water is required to be up to 1,100 cubic meters or 363,000 cubic meters per year accordingly the proximity to the source such as a river may be required.

- 9.9 MW capacity with 8 MW sale contract to EGAT
- 2.7 baths per MW contract sale
- 55 tons boiler
- 1.87 tons per hour of ash
- 1,000 baths per tons profit from ash
- 20 tons per hour of sale steam
- 350 bath per hour of steam price
- 535 million baths of initial investment
- 7.5% interest rate

5.1.3 Opportunities of the rice husk power generation industry

According to the analysis as well as the suggestion form the relevant experts, the factors considered as an opportunities for the industry of rice husk power plant could be identified as, Governmental support, Clean Development Mechanism (CDM), Growing demand tendency.

Governmental support

As refer to the expert of senior engineer of the Department of alternative Energy Development and Efficiency (DEDE), Ministry of Energy, governmental support is considered as the major opportunities of the industry of a rice husk power plant in Thailand. Ever since the announcement of the invitation in the year of 1992 various pilot strategies to promote the generation of the power from biomass have been developed some have been and some are expected to be implemented as listed below

- Promotion for the generation and synchronization of the electricity to the national grid of 300MW from the project of SPP with an aim to reduce the energy consumption of 157 ktoe/year.
- Promotion of demonstrating the best practice in the medium scale power generating business using a biomass fuel such as a rice husk, cassava root etc. with an aim to provide the education for the public in the certain area of this environmental friendly technology and their relevant benefit of the reduction in power consumption of 25 ktoe/year or equivalent to 37.5 of the electricity and consequently reduce the consumption of an oil by 26.25 million litre/year.
- Founding the information service centre aim for promoting the power generation from the biomass.
- Creating the consciousness of utilizing biomass as a power plant fuel.

Up to now, apart from verifying and authorizing the competent private sector to trade the power under the certain agreed capacity and providing the comprehension and knowledge for the investor and relevant parties, some certain tangible aspect of the support from the government could be classified into 3 categories

1. Renewable Portfolio Standard

- Implementation of the legal enforcement for the new power plant to have at least 5% of the capacity to be produced from the renewable energy.

2. Feed-in Tariff

- Establishment of an attractive buy-back energy price to attract the investor such as

1. IRR of more than 11%
2. Having a pay back period of within 7 years

3. Others

- Referring to the crisis in the oil price the Board of Investment (BOI) will provide the maximum incentive for project engaging to the production of alternative or manufacturer of the equipment that utilizes the alternative energy. Including duty-free imports of machinery and 8 years corporate income tax exemption with no cap for the following activities

1. Manufacturer of energy saving equipment or equipment utilizing alternative energy
2. Manufacture of solar cell
3. Energy saving company, that provide consulting services regarding energy conservation equipment installation

- Ministry of Energy (MoE) has agreed in principle to a proposal of 2 to 3 years corporate income tax exemption for the factories proved successful in the issue of energy saving and which have installed energy-efficient equipment.
- Subsidy in renewable energy investment by providing a soft loan for the first 50 millions baths of the initial investment with no more than 4% interest rate and bound to the pay back period of within 7 years.

Apart from those mentioned the buy-back adder has also been established for the power plant under the category of VSPP or under 10 MW as illustrated in the table 5.6

Fuel / Technology	Adder (Baths/KW-Hr)
Biomass	0.3
Biogas	0.3
Small hydro-power generation (50 - 200 KW)	0.4

Small hydro-power generation (< 50 KW)	0.8
Garbage	2.5
Wind	2.5
Solar	8

Table 5.6: Adder for the power plant under the category of VSPP (Source: PEA)

Growing demand tendency

According to the expert of a senior engineer of the Department of alternative Energy Development and Efficiency (DEDE), Ministry of Energy, a tendency of an incremental in demand is another factor considered as an opportunity for the industry of a rice husk power plant. Figure 5.10 is the illustration of the tendency of the electricity consumption as of the whole country. Ever since the first period of the research in the year of 2002, the consumption in all the section were unstoppably amplified, as a result the total demand has increased from 99,407.1 GWH by approximately 28 percents to be 127,237.24 GWH in the year of 2006 with no sign of any forthcoming declining tendency.

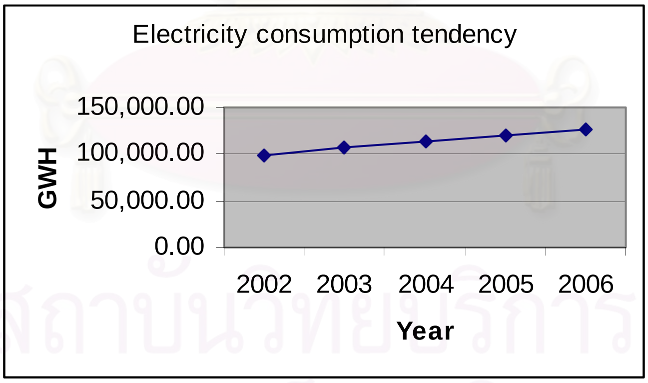

Figure 5.10: Electricity consumption of the whole country (Source; EPPO)

Apart from the electricity, another product considered as being an opportunity from the growing tendency of the demand is the ash. As refer to the growing tendency of the demand from the world wide manufacture of steel as illustrated in the figure 5.11. According to the information gathered from International Iron and Steel Institute as illustrated from year to year the demand has been continuously increased from the year of 2006 to 2008 with the rate of 5.6 and 6.1 percents per year respectively and resulting in the total amount of steel produced of 1.2505 billion tons and reflecting in the demand of the ash of approximately 600,000 to 900,000 tons in the year of 2008.

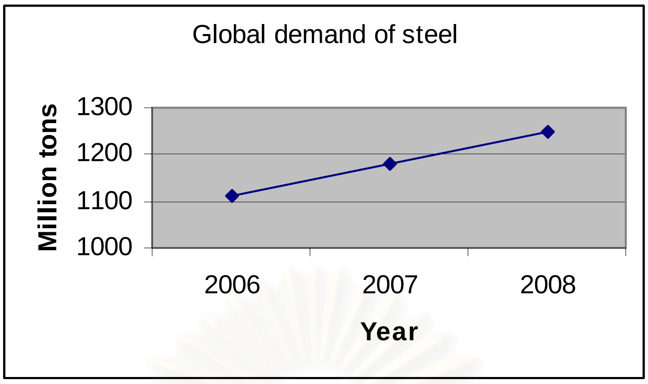

Figure 5.11: Global demand of the steel (Source; International Iron and Steel Institute)

Clean Development Mechanism (CDM)

Referring to expert of Director& Senior consulting engineer of the sustainable energy consulting company, another factors considered as an opportunity for the industry of a rice husk power plant in Thailand is a Clean Development Mechanism. As refer to the crisis of the global warming issue, under the initiation of UN, the Kyoto protocol has been established as an international agreement to take control over the GHG or Greenhouse gas emissions binding the industrialized country to the certain agreed reduction target with the goal to achieve the level of GHG emission to be at the same level as of the year of 1990 within 2012. The protocol has been enforced since the year of 2005 and would require a global action with a three folds aims as following

1. To contribute to the critical goal of the climate change of UN convention by control the GHG to be under the certain level which is unharmed to the atmosphere
2. To assist the developed country to the achieve the goal of the GHG emission reduction
3. To assist the developing country to achieve the sustainable development

. As a result the provisions of the three mechanisms have been developed to allow the reduction with the lowest costs as illustrating

1. **Clean development mechanism (CDM)** allow the developed country to bind GHG reduction target to the project in the developing country
2. **Joint implementation (JT)** allow the developing country to joint in the project of GHG reduction
3. **Emission trading (ET)**

As refer to the established regulation, the project would be registered as a CDM activity after the follow conditions have been satisfied

1. Must be a voluntary involvement by all the participated parties.
2. The project must be real and lead to the measurable GHG emission reduction that are transferable to the developed country partner in form of the CERs (Certified Emission Reductions)
3. Must be "additional" reduction; mean that there would be no occurrence in the absence of the project activities.

So basically CDM is the mechanism developed for the trading of the GHG emissioned reduction credits between the developed and developing country with the stimulation from the differentiation of the self-investing cost of the developed country and the trading with the developing one to achieved the certain agreed level of the protocol with the benefit to both of the parties as described on the next page.

Developed country

- To achieve the goal of the GHG emission according to the Kyoto protocol.

Developing country

- Reduction in the level of GHG emission
- A sustainable development
- Revenue from the trade
- Investment initiation

As refer to the technical information from Kyoto protocol, a Greenhouse gas could be identified as illustrated in the table 5.7 which the disposal of the rice husk biomass power plant is identified as a carbon dioxide.

Greenhouse gas	Global warming potential
Carbon dioxide	1

Methane	21
Nitrous oxide	310
Hydro fluorocarbons	140 – 11,700
Per fluorocarbons	6,500 – 9,200
Sulfur hexafluoride	23,900

Table 5.7: Greenhouse gas

As refer to Kyoto protocol, fifteen industries have been identified as having a potential to joint the program of GHG emission reduction as illustrated below which the rice husk power plant is considered to be under the first category of the power industry.

1. Energy industry
2. Energy distribution
3. Energy demand
4. Manufacturing industry
5. Chemical industry
6. Construction
7. Transport
8. Mining / Mineral production
9. Metal production
10. Fugitive emission from fuels
11. Fugitive emission from production and consumption of halocarbons and SF6
12. Solvents use
13. Waste handling and disposal
14. Afforestation and reforestation
15. Agriculture

As mentioned the main disposal of the rice husk power plant is the carbon dioxide with referring to the market price the CERS credit is ranging from 4 to 10 US$ per ton of Carbon dioxide and could be up to 8 to 15 in the forthcoming future depend on the issue as illustrated below.

- Risk, business health, technology and policy of the based country
- Type of business such as biomass, biogas or landfill

- Demand & supply

Illustrated in table 5.8 is the analysis of the revenue from the CDM program for the various sizes of the rice husk power plant based on the working hour of 7,920 per year and CERs of 332 baths per ton of carbon dioxide. As illustrated with maximum of 21 years interval, reveue from CDM program could be counted up to approximately 300 million baths for the power plant with the size of 12 MW.

7,920 Working hour

322 Bath/tCO_2 CERs price

Capacity (MW)	3	6	9	12
Electricity generated (MWh/yr)	23,760	47,520	71,280	95,040
CERs (tCO_2/yr)	11,800	23,760	35,640	47,520
Revenue (Bath/yr)	3,825,360	7,650,720	11,476,000	15,301,440
Revenue (Bath/7yr)	26,777,520	53,555,040	80,332,560	107,110,080
Revenue (Bath/21yr)	80,332,560	160,665,120	240,997,680	321,330,240

Table 5.8: Revenue from CDM program

5.1.4 Threat of the rice husk power generation industry

According to the analysis as well as the suggestion form the relevant experts, the result of the factors considered as a threat to the rice husk power plant industry could be defined as a tendency f price and availability of rice husk, Unawareness of the significance of the rice husk, Funding policy.

Tendency of price and availability of rice husk

As illustrated in the table 5.9 ever since the doubly incremental in the year of 2003, the price of rice husk has been remained at approximately 950 baths per ton with no sign of reversal and identifying as a threat of the rice husk biomass power plant.

Rice	Annual Price (Bath / Kg.)				
	2001	2002	2003	2004	2005
Straw	0.81	0.81	1	1	1
Paddy Husk	0.5	0.5	0.9	0.95	0.95
Core Straw		2	2	2	2

Table 5.9: Alternative Energy Raw Material Prices under the category of rice (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

Further more, from the research from the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, as of the year of 2005 after all the consumption from all the relevant industry have been taken into account the surplus of supply of the paddy husk was approximated to be around 2.5 million tons or 41% from the totality. According to the hardly incremental in the harvesting of rice, the supply of the rice husk could be presumed to be the same, with the totality of the enlargement of 135.06 Megawatt capacity all over the country as of the research in the year of 2007 the requirement of the rice husk only in the field of the electricity generation from purely rice husk feed power plant is expected to be increase by 2.4 million tons therefore the situation is defined as approaching the state of over demand and considered as another threat as refer to the expert of a director& senior consulting engineer of the sustainable energy consulting company.

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Unawareness of the significance of the rice husk

As refer to the research from the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy in the year of 2005, 2.3 million tons from the totality or 39.39 % as illustrated in table 5.10 has been consumed under the category of the agriculture as a fertilizer, covering the soil and plantation of various kinds of mushroom where the other less wasteful material is still available. Accordingly this is also defined as another threat for the industry of a rice husk power plant as refer to the expert of a director& senior consulting engineer of the sustainable energy consulting company.

Consumer	Annual average Consumption	Percentage
1. Industry consumer		
Natural seed product industry	1,958,450 Tons	33.55%
Steamed product industry	4,007 Tons	0.069%
Sweet product industry	2,400 Tons	0.041%
Cooking element product industry	166 Tons	0.0028%
Earth product for construction industry	358,159 Tons	6.1%
Cement product industry	2,088 Tons	0.036%
Power generation plant	1,189,000 Tons	20.37%
2. Agricultural consumer	2,300,000 Tons	39.39%
3. Household consumer	23,680 Tons	0.41%

Total	5,837,950 Tons	100%

Table 5.10: Major Rice husk consumer (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

Funding policy

Another obstacle considered as a threat for the industry of a rice husk power plant is the funding policy as refer to the information from the expert of a managing director of the biomass power plant turn-key contractor company**.** Among all the Southeast Asia members Thailand is in the forefront in the promotion of the utilization of the renewable fuel but still there is the difficulty in obtaining the financial support since the financial institutes are not familiars with the renewable projects financing. Oftenly the projects are considered as risky referring to the issues of the lack of confidence in the technology and the difficulty in providing the fuel further more the scheme of the financing existed is considered to be time consumption process with a long requirement of the application and approval which somehow is not appropriated for the projects in this field.

5.2 Situation analysis summary

To sum up as refer to the result of the situation analysis as well as the suggestion from all the relevant experts, there do exist the evidence of both positive and negative factors influencing the industry. Via the aid of the information gathered, the formulation of the critical success factors are enabled later on based on the presence of some certain strength, opportunities and the factors to overcome some particular weaknesses and threats.

The situation of the industry of the rice husk power generation is positively influenced by the presence of both the internal capabilities (Strengths) named as, being an excellence supportive business and durable investment, having variety of technology and secondary type of fuel, low operating cost, having no requirement for a marketing effort and the presence of the external environmental factors (Opportunities) of governmental support, Clean Development Mechanism (CDM), and growing demand tendency.

Concurrently the industry of rice husk power generation is suffering from the presence of the weaknesses named as high initial investment, Technology intensive& requirement for expertise, the issue of the massive water consumption and the threat of a tendency of price and availability of rice husk, Unawareness of the significance of the rice husk, Funding policy.

Accordingly based on the result of the analysis together with the recommendation from the relevant experts, the factors that could be summarized to have an effect to the value of the profit margin and annual expense are

- The characteristic of having a low operating cost
- No requirement for a marketing effort
- Governmental support
- Technology intensive and expertise required
- Clean Development Mechanism (CDM)
- Growing demand tendency
- Water consumption
- Tendency of price and availability of rice husk

CHAPTER VI
TECHNICAL ANALYSIS

To ensure the comprehensiveness, in order to scope down to a more operational level, in this section the analysis would be carried out to evaluate the technical aspect of the rice husk power plant with the objective to gain and extend the result of the suitability for the stage of the critical success factor formulation. The analysis include

- Alternative fuel analysis
- Technology analysis

6.1 Alternative fuel analysis

Apart from a primary fuel for the power plant of a paddy husk, in Thailand others kind of a biomass are still available to be utilized, some have already been defined as a valuable commercial biomass fuel as refer to the reproduction processes in the industry where it has been long ago utilized as a fuel in stead of the commercial kind in order to save the cost of trashing such as a rice husk itself from the rice mill industry or bagasse from the industry of sugar mill. Nevertheless referring to the issue of non-recognition or yet not being fully utilized as a fuel, still there are some others effective biomass available to be used named as sugar cane trashier (Leaf) and top, cassava rhizome and rice straw. As illustrated in table 6.1

Plant	Relevant biomass
Sugar cane	- Trashier (Leaf) - Bagasse - Top
Rice	- Husk - Straw
Oil palm	- Empty bunches - Fiber - Shell - Frond - Male bunches
Soybean	- Stalk

	- Leaf - Shell
Cassava	- Top / Trashier - Stalk - Root
Maize	- Cob - Stalk - Top - Leaf - Skin
Pineapple	- Stump
Coconut	- Husk - Shell - Empty bunch - Frond
Wood	- Charcoal - Fuel wood - Frond - Leaf - Husk - Seed

Table 6.1: Potential biomass (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy

Unfortunately not the whole 100% of biomass produced is able to be utilized, along the supplying process there are the occurrence of some loss. Based on the information gathered from the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, the remaining is the totals weight after all the loss factors have been deducted as illustrated in table 6.2 with their relevant description.

6.1.1 Potential biomass in Thailand

As illustrated in table 6.3, apart from the paddy husk the potential study of biomass in Thailand could be categorized into 20 categories.

1. Biomass from rice straw

Based on the information gathered from the Department of Agricultural Extension, Ministry of Agriculture in the harvesting year of 2002 / 2003, Thailand of all regions was having a capacity of rice harvested of approximately 36.51 million tons and resulting in the totality of 43.44 million tons of rice straw. After the consumption in the section of agricultural and the loss factors of 50% has been taken into account, the remaining could be identified to be 12.35 million tons which is able to produce the heat energy of 170,375 TERA, joule or equivalent to 4,034 Ktoe or 1,080 MW of electricity at the efficiency of 20%.

2. Biomass from maize stalk, top and leap

Based on the information gathered from the Department of Agricultural Extension, Ministry of Agriculture in the harvesting year of 2002 / 2003, Thailand of all regions was having a capacity of maize harvested of approximately 5.29 million tons and resulting in the totality of 4.72 million tons of maize stalk, top and leaps. After the consumption in the section of agricultural and the loss factors of 40% has been taken into account, the remaining could be identified to be 2.43 million tons which is able to produce the heat energy of 38,932 TERA, joule or equivalent to 922 Ktoe or 247 MW of electricity at the efficiency of 20%.

3. Biomass from a maize cob

Based on the information gathered from the Department of Agricultural Extension, Ministry of Agriculture in the harvesting year of 2002 / 2003, Thailand of all regions was having a capacity of maize harvested of approximately 5.29 million tons and resulting in the totality of 1.00 million tons of maize cob. After the consumption in the section of agricultural and the loss factors of 10% has been taken into account, the remaining could be identified to be 0.45 million tons which is able to produce the heat energy of 7,586 TERA, joule or equivalent to 180 Ktoe or 48 MW of electricity at the efficiency of 20%.

Biomass	**Remaining factor, %**	**Description**
Rice straw	90	Loss due to the milling process and transportation
Rice husk	50	Approximately 10-15 cm. at the lower sections are unable to be used
Sugar cane top and leap	70	Loss due to the harvesting process and transportation
Bagasse	100	Expect fully utilization since all produced at the mill
Maize stalk, top and leap	60	Slope plantation and expected a loss due to the harvesting process.
Maize cob	90	Loss due to the village level separation processes
Cassava rhizome	80	Loss due to the harvesting process and lack of plantation area
Cassava stalk	80	Loss due to the harvesting process and lack of plantation area
Pineapple	90	Loss due to the harvesting process
Soybean stalk, leap and shell	70	Loss due to the harvesting process
Oil palm shell	100	Expect fully utilization since all produced at the extraction plant
Oil palm empty bunch	90	Loss due to the separation processes

Oil palm fiber	100	Expect fully utilization since all produced at the extraction plant
Oil palm frond and male bunches	100	No others wasting expected since all collected would be well piled
Coconut shell	80	Loss due to the storage and transportation processes
Coconut husk	100	No loss expected
Coconut empty bunch and frond	100	No others wasting expected since all collected would be well piled
Charcoal	90	Loss due to the fragile property
Fuel wood	100	Expect fully utilization since all produced at the factory
Wood chip	90	Some loss expected especially a small pieces
Saw dust	80	Loss due to the manufacturing and transportation processes

Table 6.2: Remaining factors of biomasses (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

4. Biomass from sugar cane top and leap

Based on the information gathered from the Department of Agricultural Extension, Ministry of Agriculture in the harvesting year of 2002 / 2003, Thailand of all regions was having a capacity of sugar cane harvested of approximately 75.61 million tons and resulting in the totality of 15.42 million tons of sugar cane top and leap. After the consumption in the section of agricultural and the loss factors of 30% has been taken into account, the remaining could be identified to be 7.99 million tons which is able to produce the heat energy of 129,018 TERA, joule or equivalent to 3,055 Ktoe or 818 MW of electricity at the efficiency of 20%.

5. Biomass from bagasse

Based on the information gathered from the Department of Agricultural Extension, Ministry of Agriculture in the harvesting year of 2002 / 2003, Thailand of all regions was having a capacity of sugar cane harvested of approximately 75.61 million tons and resulting in the totality of 22.91 million tons of bagasse. However with a great requirement for energy of a sugar mill industry, of all the bagasse produced, are bounded to be utilized within the industry as for both purposes of heat and electricity generation.

6. Biomass from pineapple

Based on the information gathered from the Department of Agricultural Extension, Ministry of Agriculture in the harvesting year of 2002 / 2003, Thailand of all regions was having a capacity of pineapple harvested of approximately 3.56 million tons and resulting in the totality of 2.09 million tons of related biomass. After the consumption in the section of agricultural and the loss factors of 10% has been taken into account, the remaining could be identified to be 0.24 million tons which is able to produce the heat energy of 3,802 TERA, joule or equivalent to 90 Ktoe or 24 MW of electricity at the efficiency of 20%.

7. Biomass from cassava stalk

Based on the information gathered from the Department of Agricultural Extension, Ministry of Agriculture in the harvesting year of 2002 / 2003, Thailand of all regions was having a capacity of cassava harvested of approximately 20.81 million tons and resulting in the totality of 2.52 million tons of cassava stalk. After the consumption in the section of agricultural and the loss factors of 20% has been taken into account, the remaining could be identified to be 0.81 million tons which is able to produce the heat energy of 12,658 TERA, joule or equivalent to 300 Ktoe or 80 MW of electricity at the efficiency of 20%.

8. Biomass from cassava rhizome

Based on the information gathered from the Department of Agricultural Extension, Ministry of Agriculture in the harvesting year of 2002 / 2003, Thailand of all regions was having a capacity of cassava harvested of approximately 20.81 million tons and resulting in the totality of 1.89 million tons of cassava rhizome. After the consumption in the section of agricultural and the loss factors of 20% has been taken into account, the remaining could be identified to be 1.48 million tons which is able to produce the heat energy of 23,794 TERA, joule or equivalent to 563 Ktoe or 151 MW of electricity at the efficiency of 20%.

9. Biomass from soybean stalk, leap and shell

Based on the information gathered from the Department of Agricultural Extension, Ministry of Agriculture in the harvesting year of 2002 / 2003, Thailand of all regions was having a capacity of soybean harvested of approximately 0.223 million tons and resulting in the totality of 0.262 million tons of soybean stalk, leap and shell. After the consumption in the section of agricultural and the loss factors of 30% has been taken into account, the remaining could be identified to be 0.071 million tons which is able to produce the heat energy of 1,156 TERA, joule or equivalent to 27 Ktoe or 7 MW of electricity at the efficiency of 20%.

10. Biomass from coconut shell

Based on the information gathered from the Department of Agricultural Extension, Ministry of Agriculture in the harvesting year of 2002 / 2003, Thailand of all regions was having a capacity of coconut harvested of approximately 2.42 million tons and resulting in the totality of 0.6 million tons of coconut shell. After the consumption in the section of agricultural and the loss factors of 20% has been taken into account, the remaining could be identified to be 0.069 million tons which is able to produce the heat energy of 1,269 TERA, joule or equivalent to 30 Ktoe or 8 MW of electricity at the efficiency of 20%.

11. Biomass from coconut husk

Based on the information gathered from the Department of Agricultural Extension, Ministry of Agriculture in the harvesting year of 2002 / 2003, Thailand of all regions was having a capacity of coconut harvested of approximately 2.42 million tons and resulting in the totality of 1.36 million tons of coconut husk. After the consumption in the section of agricultural and the loss factors of 0% has been taken into account, the remaining could be identified to be 0.16 million tons which is able to produce the heat energy of 2,628 TERA, joule or equivalent to 62 Ktoe or 17 MW of electricity at the efficiency of 20%.

12. Biomass from coconut empty bunch and frond

Based on the information gathered from the Department of Agricultural Extension, Ministry of Agriculture in the harvesting year of 2002 / 2003, Thailand of all regions was having a capacity of coconut harvested of approximately 2.42 million tons and resulting in the totality of 1.36 million tons of coconut empty bunch and frond. After the consumption in the section of agricultural and the loss factors of 0% has been taken into account, the remaining could be identified to be 1.26 million tons which is able to produce the heat energy of 19,436 TERA, joule or equivalent to 460 Ktoe or 123 MW of electricity at the efficiency of 20%.

13. Biomass from oil palm frond and male bunches

Based on the information gathered from the Department of Agricultural Extension, Ministry of Agriculture in the harvesting year of 2002 / 2003, Thailand of all regions was having a capacity of oil palm harvested of approximately 3.98 million tons and resulting in the totality of 1.08 million tons of oil palm frond and male bunches. After the consumption in the section of agricultural and the loss factors of 0% has been taken into account, the remaining could be identified to be 0.02 million tons which is able to produce the heat energy of 300 TERA, joule or equivalent to 7 Ktoe or 2 MW of electricity at the efficiency of 20%.

14. Biomass from oil palm fiber

Based on the information gathered from the Department of Agricultural Extension, Ministry of Agriculture in the harvesting year of 2002 / 2003, Thailand of all regions was having a capacity of oil palm harvested of approximately 3.98 million tons and resulting in the totality of 0.59 million tons of oil palm fiber. After the consumption in the section of agricultural and the loss factors of 0% has been taken into account, the remaining could be identified to be 0.01 million tons which is able to produce the heat energy of 222 TERA, joule or equivalent to 5 Ktoe or 1 MW of electricity at the efficiency of 20%.

15. Biomass from oil palm shell

Based on the information gathered from the Department of Agricultural Extension, Ministry of Agriculture in the harvesting year of 2002 / 2003, Thailand of all regions was having a capacity of oil palm harvested of approximately 3.98 million tons and resulting in the totality of 0.513 million tons of oil palm shell. After the consumption in the section of agricultural and the loss factors of 0% has been taken into account, the remaining could be identified to be .017 million tons which is able to produce the heat energy of 303 TERA, joule or equivalent to 7 Ktoe or 2 MW of electricity at the efficiency of 20%.

16. Biomass from oil palm empty bunch

Based on the information gathered from the Department of Agricultural Extension, Ministry of Agriculture in the harvesting year of 2002 / 2003, Thailand of all regions was having a capacity of oil palm harvested of approximately 3.98 million tons and resulting in the totality of 0.86 million tons of palm empty bunch. After the consumption in the section of agricultural and the loss factors of 10% has been taken into account, the remaining could be identified to be 0.21 million tons which is able to produce the heat energy of 3,485 TERA, joule or equivalent to 83 Ktoe or 22 MW of electricity at the efficiency of 20%.

17. Biomass from charcoal

Based on the information gathered from the Department of Agricultural Extension, Ministry of Agriculture in the harvesting year of 2002 / 2003, Thailand of all regions was having a capacity of Para rubber and eucalyptus harvested of approximately 5.12 million tons and resulting in the totality of 1.52 million tons of charcoal. After the consumption in the section of agricultural and the loss factors of 10% has been taken into account, the remaining could be identified to be 0.3 million tons which is able to produce the heat energy of 9,188 TERA, joule or equivalent to 218 Ktoe or 58 MW of electricity at the efficiency of 20%.

18. Biomass from fuel wood

Based on the information gathered from the Department of Agricultural Extension, Ministry of Agriculture in the harvesting year of 2002 / 2003, Thailand of all regions was having a capacity of Para rubber and eucalyptus harvested of approximately 5.12 million tons and resulting in the totality of 1.27 million tons of fuel wood. After all the consumption in both section of agricultural and industry have been taken into account, the remaining could be identified as none which indicate the market situation of an over demand.

19. Biomass from wood chip

Same as those of a fuel wood with the demand and supply ratio of 1.13, the situation is also considered as over demand.

20. Biomass from saw dust

Based on the information gathered from the Department of Agricultural Extension, Ministry of Agriculture in the harvesting year of 2002 / 2003, Thailand of all regions was having a capacity of a saw dust from a Para rubber and eucalyptus of approximately 0.17 million tons. After the consumption in the section of agricultural and the loss factors of 20% has been taken into account, the remaining could be identified to be 0.094 million tons which is able to produce the heat energy of 1,558 TERA, joule or equivalent to 37 Ktoe or 10 MW of electricity at the efficiency of 20%

Plant	**Biomass**	**Yield (T/Yr)**	**Biomass Factor**	**Biomass (T/Yr)**	**Total consumption (Ton/ Yr)**	**Remain (Ton/Yr)**	**Remaining factor**	**Available (Ton/Yr)**	**Heating value (MJ/Kg)**	**Heat Energy**		**Electricity (MW)**
										(TERA, joule)	**Ktoe**	
Rice	Husk	36,507,164	0.226	8,250,619	5,942,635	2,307,984	90	2,307,984	14.54	30,202	715	192
	Straw		1.19	43,443,525	18,751,512	24,692,013	50	24,692013	13.8	170,375	4,034	**1,080**
Maize	stalk, top and leap	5,295,895	0.892	4,723,938	671,010	4,052,928	60	2,431,757	16.01	38,932	922	**247**
	Cob		0.189	1,000,924	498,582	502,342	90	452,108	16.78	7,586	180	48
Sugar cane	Sugar cane top and leap	75,610,632	0.204	15,424,569	4,012,136	11,412,433	70	7,988,703	16.15	129,018	3,055	**818**
	Bagasse		0.303	22,910,021	22,910,021	0	100	0	16.21	0	0	0
Pineapple		3,558,302	0.588	2,092,282	1,824,214	268,068	90	241,261	15.76	3,802	90	24
Cassava	Stalk	20,809,437	0.121	2,517,942	1,503,032	1,014,910	80	811,928	15.59	12,658	300	**80**
	Rhizome		0.091	1,893,659	47,446	1,846,213	80	1,476,970	16.11	23,794	563	**151**
Soy bean	Stalk, leap and shell	223,024	1.177	262,499	160,788	101,711	70	71,198	16.23	1,156	27	7

Oil palm	Frond and male bunches	3,978,285	0.272	1,082,094	1,063,408	18,686	100	18,686	16.3	300	7	2
	Fiber		0.149	592,74	579,877	12,887	100	12,887	17.25	222	5	1
	Shell		0.129	513,199	496,852	16,347	100	16,347	18.53	303	7	2
	Empty bunch		0.215	855,331	618,046	237,285	90	213,557	16.32	3,485	83	22
Coconut	Shell	2,415,714	0.247	596,681	509,829	86,852	80	69,482	18.26	1,269	30	8
	Husk		0.565	1,364,879	1,204,721	160,158	100	160,158	16.41	2,628	62	17
	Empty bunch and frond		0.563	1,360,047	100,935	1,29,652	100	1,259,652	15.43	19,436	460	123
Para rubber and eucalyptus	Charcoal	5,124,835	0.297	1,522,076	1,184,015	338,061	90	302,255	30.2	9,188	218	58
	Fuel wood		0.248	1,270,959	1,639,111	368,152	100	368,152	16.85	6,203	147	39
	Wood chip		0.101	517,608	594,147	76,539	90	68,885	17.3	1,192	28	8

	Saw dust		0.034	174,244	57,241	117,003	80	93,603	16.65	1,158	37	10
Total										**448,519**	**10,621**	**2,844**

Table 6.3: Biomass potential (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

Plant	**Biomass**	**Yield (T/Yr)**	**Biomass Factor**	**Biomass (T/Yr)**	**Total consumption (Ton/ Yr)**	**Remain (Ton/Yr)**	**Remaining factor**	**Available (Ton/Yr)**	**Heating value (MJ/Kg)**	**Heat Energy**		**Electricity (MW)**
										(TERA, joule)	**Ktoe**	
Rice	Straw	36,507,164	1.19	43,443,525	18,751,512	24,692,013	50	24,692013	13.8	170,375	4,034	**1,080**
Maize	stalk, top and leap	5,295,895	0.892	4,723,938	671,010	4,052,928	60	2,431,757	16.01	38,932	922	**247**
Sugar cane	Sugar cane top and leap	75,610,632	0.204	15,424,569	4,012,136	11,412,433	70	7,988,703	16.15	129,018	3,055	**818**
Cassava	Stalk	20,809,437	0.121	2,517,942	1,503,032	1,014,910	80	811,928	15.59	12,658	300	**80**
	Rhizome		0.091	1,893,659	47,446	1,846,213	80	1,476,970	16.11	23,794	563	**151**

Table 6.4: High potential biomasses (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

As illustrated in table 6.4, after all the alternative biomass have been evaluated, 5 outstanding types have been identified as illustrated below

- Rice straw
- Sugar cane top and leap
- Maize stalk, top and leap
- Cassava rhizome and stalk

Note that under the category of cassava, rhizome and stalk have been combined since as a matter of fact both of the biomasses are obtained from the same processes.

6.1.2 Regional evaluation

Generally most of the biomasses are bulky with the majority of the cost from the transportation; therefore for the most cost effective in this section the availability and potential of the major biomasses identified would be regional evaluated to identify the location and distribution of each as of the research on 2005 conducted by the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy

1. Rice straw

Based on the information gathered from the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, Thailand of all regions had a remaining rice straw after the consumption and all the loss factor have been deducted of 12.35 million tons which is able to produce the heat energy of 170,375 TERA, joule. With the top three regional potential combined the power is equivalent to 151,832 TERA, joule or 3,595 Ktoe or 963 MW of electricity at the efficiency of 20% with the top 3 regional potential as illustrated in table 6.5.

Region	Amount (Ton/yr)	Heat Energy		Electricity (MW)
		(TERA, joule)	Ktoe	
Northeastern	4,936,725	68,127	1,613	432
Northern	3,408,415	47,036	1,114	298
Central	2,657,195	36,669	868	233
Total	11,002,335	151,832	3,595	963

Table 6.5: Potential rice straw location (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

2. Sugar cane top and leap

Based on the information gathered from the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, Thailand of all regions had a remaining Sugar cane top and leap after the consumption and all the loss factor have been deducted of 7.99 million tons which is able to produce the heat energy of 129,018 TERA, joule. With the top three regional potential combined the power is equivalent to 124,774 TERA, joule or 2,955 Ktoe or 791 MW of electricity at the efficiency of 20% with the top 3 regional potential as illustrated in table 6.6.

Region	Amount (Ton/yr)	Heat Energy		Electricity (MW)
		(TERA, joule)	Ktoe	
Northeastern	3,510,180	56,689	1,342	359
Central	2,763,052	44,623	1,057	283
Northern	1,452,784	23,462	556	149
Total	7,726,016	124,774	2,955	791

Table 6.6: Potential Sugar cane top and leap location (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

3. Maize stalk, top and leap

Based on the information gathered from the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, Thailand of all regions had a remaining maize stalk, top and leap after the consumption and all the loss factor have been deducted of 2.43 million tons which is able to produce the heat energy of 38,932 TERA, joule. With the top three regional potential combined the power is equivalent to 38,562 TERA, joule or 914 Ktoe or 245 MW of electricity at the efficiency of 20% with the top 3 regional potential as illustrated in table 6.7.

Region	Amount (Ton/yr)	Heat Energy		Electricity (MW)
		(TERA, joule)	Ktoe	
Northern	1,713,879	27,439	650	174
Central	460,543	7,373	175	47
Northeastern	234,228	3,750	89	24
Total	2,408,650	38,562	914	245

Table 6.7: Potential Maize stalk, top and leap location (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

4. Cassava rhizome and stalk

Based on the information gathered from the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, Thailand of all regions had a remaining cassava rhizome and stalk after the consumption and all the loss factor have been deducted of 2.29 million tons which is able to produce the heat energy of 36,452 TERA, joule. With the top three regional potential combined the power is equivalent to 26,816 TERA, joule or 635 Ktoe or 170 MW of electricity at the efficiency of 20% with the top 3 regional potential as illustrated in table 6.8.

Region	Amount (Ton/yr)	Heat Energy		Electricity (MW)
		(TERA, joule)	Ktoe	
Northeastern	982,248	15,638	370	99
Northern	355,305	5,657	134	36
Central	346,193	5,521	131	35
Total	1,683,746	26,816	635	170

Table 6.8: Potential Cassava rhizome and stalk location (Source: Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy)

To sum up according to the result of the analysis apart from the primary fuel of paddy husk, still there are others secondary fuel available named as a rice straw, sugar cane top and leap, maize stalk, top and leap cassava rhizome and stalk with the combination of the total energy up to 8,874 Ktoe or 2,376 MW of electricity at the efficiency of 20%.

From the regional potential analysis, 3 regions identified as having a highest potential are northeastern, northern and middle with the respective heat energy of 3,414, 2,454, and 2,328 Ktoe.

6.2 Technology analysis

Unlike the others relevant industry such as a rice mill, biomass power generation is rather considered as technology intensive, two issues considered as crucial are the selection of the technology and the selection of the EPC contractor. Accordingly in order to provide the fully understanding of the system, contained in this section is the review of the whole production process and the evaluation for the best suitable technology.

6.2.1 Production processes

In order to review the basic concept of the rice husk biomass power plant, illustrating in figure 6.1 is the overall flow chart of the process indicating the major stages and relevant descriptions, where the rice husk is identified as an input raw material together with the electricity with the identification of the output of the process.

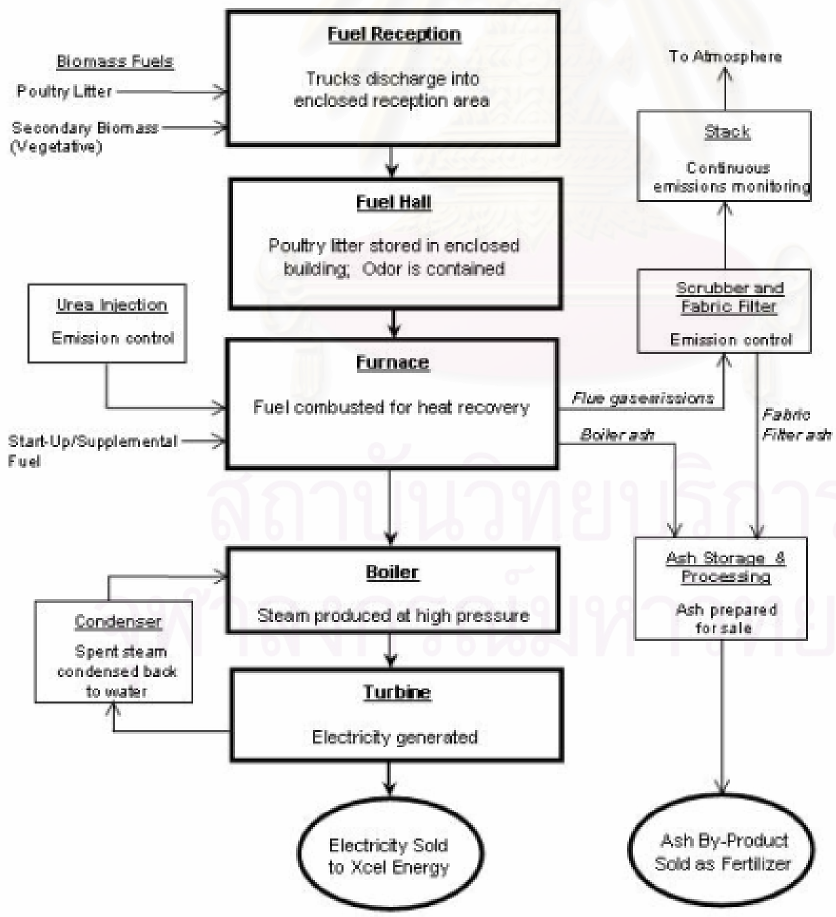

Figure 6.1: Flow chart of biomass power plant (Source: Fibrominn homepage)

Begin with **the fuel reception stage,** here is where the paddy husk gathered, generally from the proximate neighborhood, is received. Firstly the husk would be initially checked for the reception weight, moisture and contamination. Afterward the quality passed portion would be transferred by the wheel loader and conveying systems to the storage hall or field

Then at the stage of **the fuel hall**, here is where the husk is initially stacked up with a gap apart for 1-2 meters for the purpose of

- The preparation for first in-first out order due to the volatile matter of 56% of the total weight which is resulting in the reduction in the fuel quality as the time passes by.
- The moisture control
- The prevention of the fire disaster

Generally the fuel hall is specific to be closely seal or at least is a water and wind proved with the wheel loader and conveying system to convey husk to the fuel feed hopper to be transferred to the rice husk grinder to be grinded up and stored in the service silo waiting to be transferred to the chamber of a furnace.

At the stage of **the furnace**, in here the processes is started out with the process of pre-heating with the oil until the temperature reach 700-800c and the burning could be kept continue on only a husk. Afterward a husk together with a pre-heated air from the economizer would be mixed up and feed into the furnace through the burner. After being burned up, a high density bottom ash would be fallen underneath the furnace and pull out by the screw conveyer while the light one or fly ash would be circulated out with flue gas to the economizer for the process of heating up an initial feed in air and water, and being collected before the air is exhausted through the stack.

At the section of **the boiler** is where the water fed in would be boiled up generally to the temperature of 480c and 65 bars of pressure before being transferred to the turbine. From turbine a used steam would be transferred to be condensed at the condenser before being pumped through the water heater and Deaerator to be fed back to the boiler. For cooling water, for the condensing process after being used, the water would be transferred to be cooled down at the cooling tower which assumed to be a close system.

Lastly at the turbine, here is where the heat energy is transformed into an electrical energy by a steam turbine. At this stage a turbine would be driven by a steam to generate the electricity.

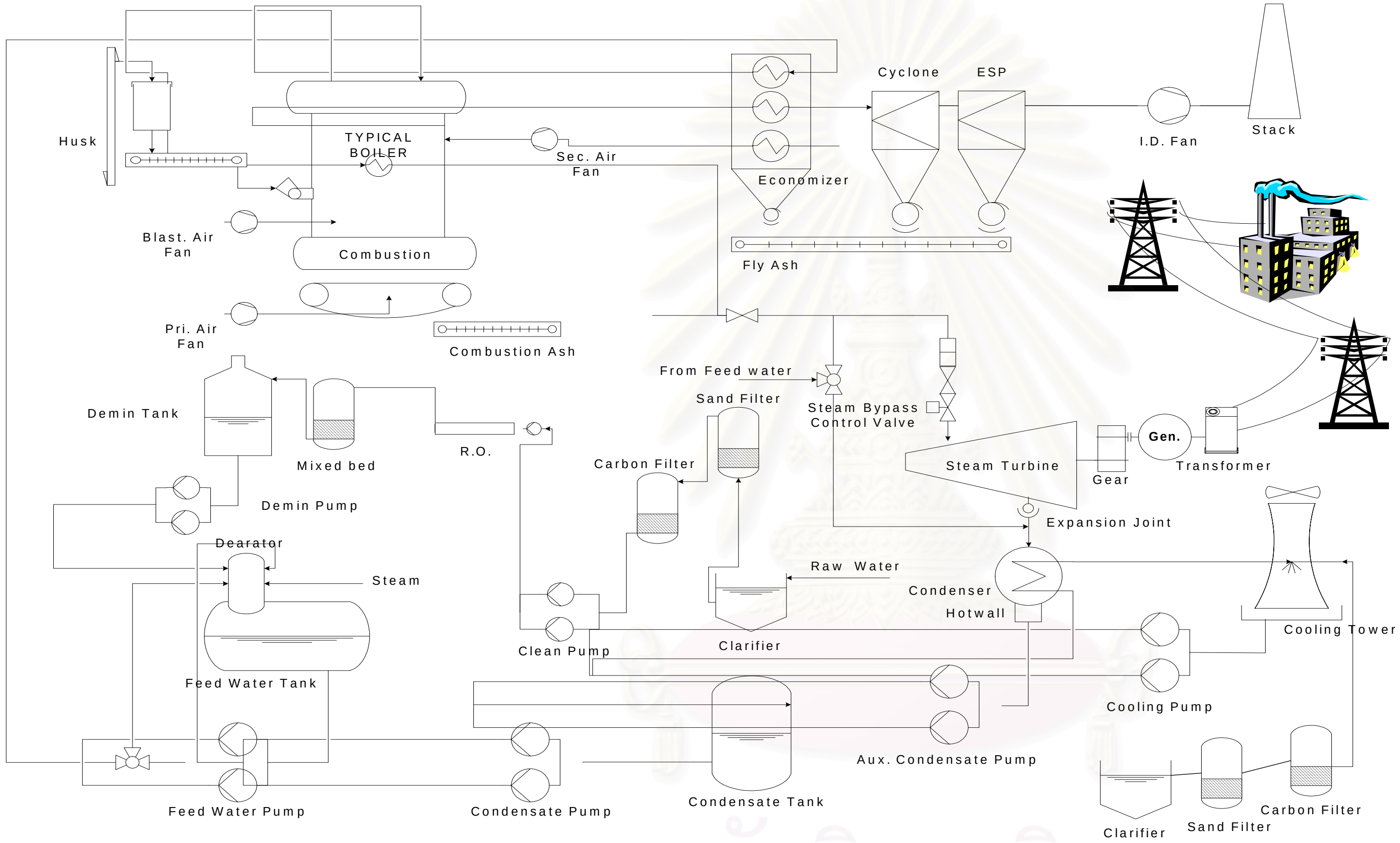

Figure 6.2: Rice husk power plant process

6.2.2 Technology evaluation

In general cases for the selection of the turbine the effect of the variation in the specification are considered to be minimal the importance is to evaluate for the best consistency, durability and term of warrantee within the settle budget. The weight of the significance is given to the section of the fuel combustion and boiler which is the determinator of the efficiency of the whole system since this very first stage is the generator and controller of the heating factor of the system.

Evaluation constraints

As a result from the interview with the expert, the constraint to evaluate for the most appropriate core machines could be identified as the following 9 issues.

1. A combustion furnace must be able to withstand the moisture, the design have to be able to be applied with a raw material with up to 50% moist with an effective ablaze system. Or in the other word the value of residue carbon of the bottom ash have to be control between 2 to 7% in order to keep them sellable.
2. The temperature of an output ash must be no more than 60c due to the appropriateness for the in-line packing, for the purpose of avoiding the extra cost incurred from a double handling where a cooling down machine may require.
3. A combustion furnace must be designed to have a nitrogen oxide (NOx) of no more than 200 mg/N.cu.M to make the plant able to joint the program of RPS of EGAT which providing a 0.15 baths per unit of electricity traded.
4. A combustion furnace must be designed to maximize the turbulence in order to ensure the inclusion of fuel and air which is strongly effect the efficiency of the burning process. Ideally the burning process is expected to be taken place in the air to enhance the 360 degrees interface between a fuel and the air. Therefore the specification is specified to have more than 50% of the burning process taken place in the air.
5. One factor concerned as a critical problem of using a paddy husk as a primary fuel is the erosion from SiO_2 in the fly ash therefore in order to eliminate the possibility, the percentage of fly ash is specified to be no more than 25.
6. A temperature of a hot gas in the area of the secondary nozzle is specified to be no more than 950c in order to prevent the problem of a fouling from the

vapor of the exhaust gas of Na_2O and K_2O. Together with the prevention of the chemical corrosion from chorine in case of the employment of maize element and eucalyptus with the specification of temperature of the super heat steam interacted with a super heat tube to be under 750c.

7. The selected boiler and heat exchanger section have to be easy for maintenance with a short time requirement.
8. The temperature of the water fed into the economizer is specified to be no less than 120c, and equivalent or having 30c tolerance to a saturated temperature in the drum for the outward water, for the purpose of fuel economic and the prevention of the stress at the internal wall of a drum.
9. Having an efficiency of no less than 87% or equivalent to 220kg/ton of steam consumption.

Alternative technology

Referring to the expert of a senior project engineer the biomass power plant turn-key contractor company**,** presenting in this section is the alternative of the currently available technology in Thailand which all the choice provided are designed with the features to satisfy all the mentioned 9 constraints

1. Traveling grate stoker combustion boiler.

The chamber has been designed to undertake the burning process along the horizontal moving grate with the variation of the thickness of the piles of fuel. Generally the speed of the grate is remained unchanged or considered barely for a single fuel burning process with only one value of moisture and particle size. Commonly the speed is directly depended on the load of the fuel.

In case of employing a high moist fuel, the burning process may not be fully undertaken therefore occasionally the load may need to be reduced to be suitable for the actual heat inside the chamber. In some cases there may be an additional fuel nozzle installed to enhance the process of burning to be taken place up in the air this may improve the efficiency of the design but still not to be very good since in case of a multi-fuel employment with a variation in the size, a large particle wouldn’t be able to be blown and resulting in a massive piles at the up steam section.

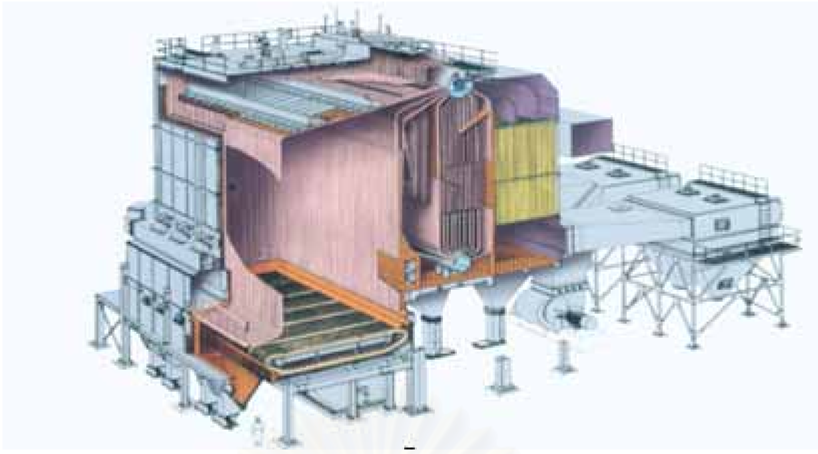

Figure 6.3: Traveling gate stoker combustion boiler

2. Stepping grate stoker combustion boiler.

For this technology the grate has been deigned with some slope lying degree where the ash after the burning process ash would be automatically slide down to the damper at the end of the grate due to its natural property of the husk of the reduction in volume and increment in the weight after transformed into a husk. Some issue considered as a major problem is the tube erosion from the fly ash since most of the stepping grate has been designed with only a single grate which resulting in the form of turbulence of only a single cyclone that make the fly ash unable to be controlled.

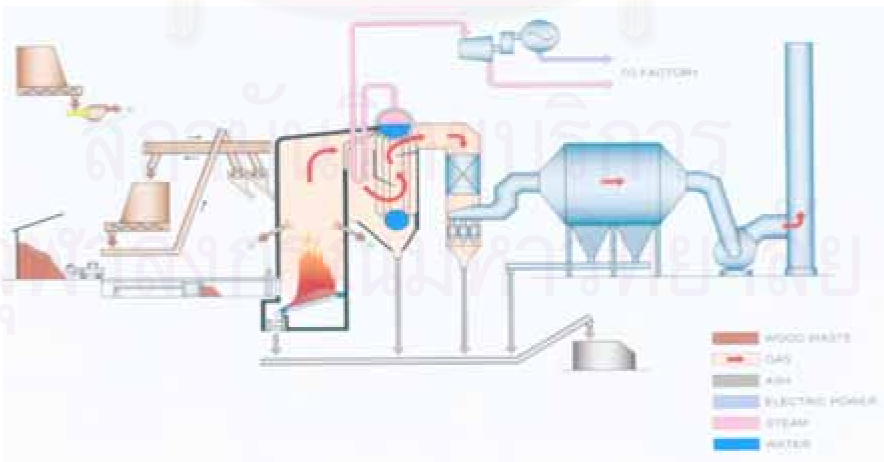

Figure 6.4: Stepping grate stoker combustion boiler

3. Bubbling fluidize bed combustion boiler.

This technology has been designed to utilize the heat conducting property of sand. The burning process has been design to be undertaken 60% above the bed and other 40% to be undertaken underneath. The major problem is occurring when more than one fuel is concurrently used, with a variation in the particle size the intensity of the primary fan have to be increased to prevent the collapsing of a sand bed accordingly the small particle would be blown up to the secondary nozzle area, resulting in the occurrence of more than 80% of a fly ash.

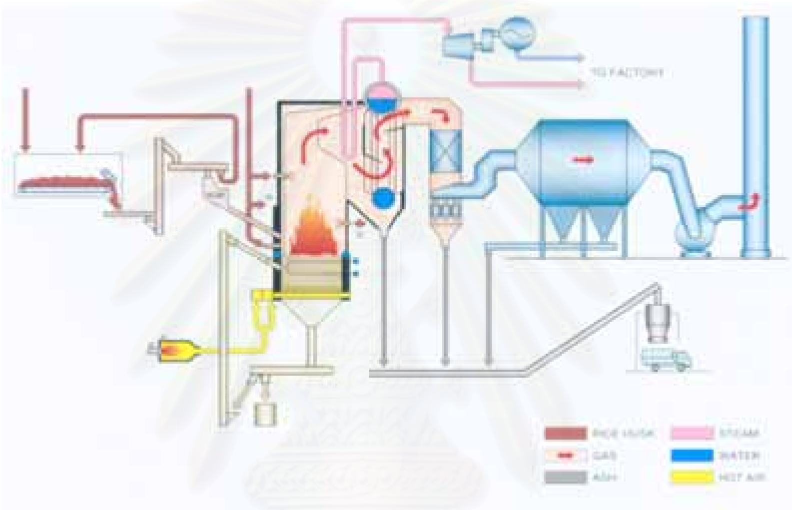

Figure 6.5: Bubbling fluidize bed combustion boiler

4. Stepping grate stoker combustion boiler with the functionality of a moving gate

Referring to the design specification, the burning process would be undertaken 60% up in the air and another 40% on the grate. The turbulence is control by the upward blowing from the primary fan while the secondary fan is responsible to create small multi-cyclones with the number equal to the divided lanes, 1 for primary and the others for secondary fuels. The cyclones would be blown in the same direction from the beginning section of the grate down to the end with the different intensities and speed depend on the type of the fuels in each lanes to ensure the efficiency of the burning process. With the separation of the multi-cyclones and a separated steam boiler, a fly ash is enabled to be controlled.

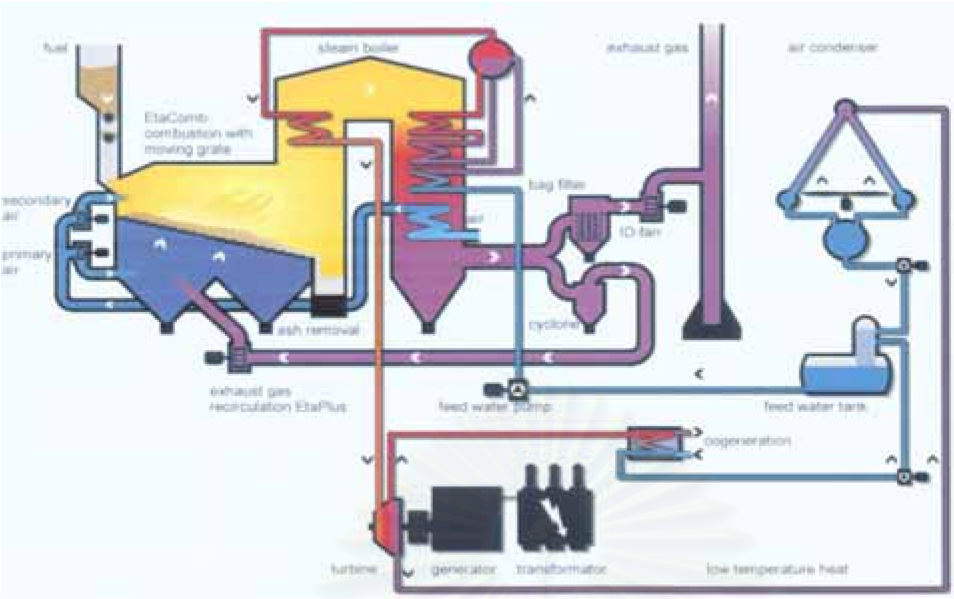

Figure 6.6: Stepping grate stoker combustion boiler with the functionality of a moving gate

After all the constraints previously provided together with all the positive and negative factors of the alternative technology have been analyzed as refer to the experts of a director& Senior consulting engineer of the sustainable energy consulting company and a managing director of the biomass power plant turn-key contractor company, all the provided alternative of technology is acceptable since each individual alternative are able to satisfy the standard evaluation constraints but ideally the features which the selected combustion technology are required to be capable of to ensure the highest efficiency of the system is as illustrated below

- Efficiency of the burning system
- Tube erosion due to an occurrence of a fly ash
- Multi-fuel utilization

As a result, the proposed technology is a design of a **stepping grate stoker combustion boiler with the functionality of a moving gate**. To sum up the design has overcome the problem identified with the feature of

1. With the separating lanes and cyclones, the inefficiency in the burning process of the technology of a traveling gate stoker combustion boiler would be overcome with 60% of the burning process undertaken up in the air.

2. With the reduction in size and increment in the number of the cyclones, the problem of the erosion due to the fly ash of bubbling fluidize bed combustion boiler and stepping grate stoker combustion boiler would be overcome. A fly ash in the proposed technology is expected to be no more than 20%.
3. With the controllable speed of each multi-cyclones and the lane separation, the weakness of the multi-fuel utilization in the technology of a traveling gate stoker combustion boiler, bubbling fluidize bed combustion boiler and stepping grate stoker combustion boiler would be overcome. Since in each lane a fuel would be separately burnt starting from the fuel injection down to the process of an ash packaging with no cross contamination.

For the selection of the boiler, a single drum type is evaluated to be an alternative due to the issue of an ease for maintenance since technically for a Bi-drum in case of the occurrence of a problem with any single tube, the others nearby may also need to be cut down, the maintenance process may consume time and the more welded spot is the more opportunity to be a weak point in case a high pressure is applied.

For the section of an economizer the design has been specified to have a wide range of an inlet/outlet water temperature to keep the economizer having the highest heat absorbsion quality and keeping the temperature inside to be closest to the saturated temperature drum with the allowance of 30-35c in order to reduce the stress inside the drum.

Note that even though the selected combustion technology of a stepping grate stoker combustion boiler with the functionality of a moving gate is proved to have less than 20% of a fly ash, still the occurrence of the tube erosion is still slightly possible accordingly the design of the convection part for instance a super heat tube, evaporator tube or economizer tube are specified to be easy to maintenance.

6.3 Technical analysis summary

To sum up for the issue of the alternative secondary fuels, from the research apart from the main fuel of a rice husk other type of fuels is still available and considered as having a potential named as a rice straw, sugar cane top and leap, maize stalk, top and leap cassava rhizome and stalk with the availability and distribution ranging from the region of northeastern, northern and central as summarized in the table 6.9.

Biomass (T/Yr) / Region	Rice straw	Sugar cane top and leap	Maize stalk, top and leap	Cassava rhizome and stalk	Total
Northeastern	4,936,725	3,510,180	234,228	982,248	9,663,381
Northern	3,408,415	1,452,784	1,713,879	355,305	6,930,383
Central	2,657,195	2,763,052	460,543	346,193	6,226,983
Total	11,002,335	7,726,016	2,408,650	1,683,746	22,820,747

Table 6.9: Summary of potential biomass

In conclusion the potential of the each of the biomass identified could be ranked respectively as

1. Rice straw
2. Sugar cane top ad leap
3. maize stalk, top and leap
4. Cassava rhizome and stalk

With the rank of a regional potential respectively as

1. Northeastern
2. Northern
3. Central

For the section of the evaluation for the most suitable technology to be employed to satisfy the constraints of a machine reliability and the quality of the product which mainly is the consistency of the output, as refer to the recommendation from the relevant experts, a technology of a stepping grate stoker combustion boiler with the functionality of a moving gate and a boiler with a single drum has been recommended due to the satisfaction in all the evaluation constraints from the expert together with the functionality to provide an outstanding feature to ensure the highest efficiency of

- An effective process with 60% of the burning process undertaken up ion the air.
- A reduction of the fly ash which is a cause of the erosion to be no more than 20%
- Enable the multi-fuel utility

CHAPTER VII
CRITICAL SUCCESS FORMULATION AND RECOMMENDATION

According to the result of SWOT analysis, Porter's 5 forces analysis as well as a technology analysis, the potential success factors for the industry of rice husk power plant in Thailand have been identified and validated by the group of the expert in the industry in order to evaluate for the critical success factors together with the relevant recommendation with the detail as presenting in the chapter.

7.1 Information from the analysis

7.1.1 Industry analysis

As refer to result for the analysis of the porter's five force model, under the current situation the industry could be described as intense on the end of rivalry for the raw material of both within the power generation industry and external consumer. So far the survivors are those who own the source of fuel or at least having a relatively well connection. For those of the new coming this is also the fatal factor to be concerned with the elements of both seasonality and location which strongly affecting the value of both IRR and pay back period of the project together with the factor of the economic of scale and capital requirement with the majority of the cost from a core machines. On the side of the finish product, a trading of steam is considered to be crucial as another source of revenue , as well as the electricity referring to the growing tendency of the national consumption the expansion of the market is still having a long way to go but on the other hand there is an evidence of the monopolization since after all the government organization is the only major immediate customer together with an ash trading with only few middle men despite the growing demand tendency from the industry of a steel manufacturer.

Accordingly from the result of the industry analysis as well as the suggestion from the relevant experts, several factors could be identified as having a potential to be a critical success factors starting with the factor of an access to a source of raw material and monopolization of the middle men of the product of electricity and ash which strongly influence the constraints of a market share and competitiveness.

Second by the constraint of customer satisfaction, this is strongly affected by the factor of the conformity to the power trading regulation. The other is a bargain of the core machines since it is the majority of the cost and relevant to the constraint of an initial expense.

As well as a capability to trade the steam which is strongly affects the constraint of a profit margin.

7.1.2 Situation analysis

As refer to the result of the situation analysis as well as the suggestion from all the relevant experts, there are the evidences of both positive and negative factors influencing the industry. Via the aid of the information gathered, the formulation of the critical success factors are enabled based on the presence of some certain strength, opportunities and the factors to overcome some particular weaknesses and threats.

The situation of the industry of the rice husk power generation is positively influenced by the presence of both the internal capabilities (Strengths) named as, being an excellence supportive business and durable investment, having variety of technology and secondary type of fuel, low operating cost, having no requirement for a marketing effort and the presence of the external environmental factors (Opportunities) of governmental support, Clean Development Mechanism (CDM), and growing demand tendency.

Concurrently the industry of rice husk power generation is suffering from the presence of the weaknesses named as high initial investment, technology intensive& requirement for expertise, the issue of the massive water consumption and the threat of a tendency of price and availability of rice husk, unawareness of the significance of the rice husk, funding policy.

Accordingly based on the result of the analysis together with the recommendation from the relevant experts, the potential factors that could be summarized to have an effect to the value of the profit margin and annual expense are

- The characteristic of having a low operating cost
- No requirement for a marketing effort

- Governmental support
- Technology intensive and expertise required
- Clean Development Mechanism (CDM)
- Growing demand tendency
- Water consumption
- Tendency of price and availability of rice husk

7.1.3 Technical analysis

For the issue of the alternative secondary fuels, from the research apart from the main fuel of a rice husk other type of fuels is still available and considered as having a potential named as a rice straw, sugar cane top and leap, maize stalk, top and leap cassava rhizome and stalk with the availability and distribution ranging from the region of northeastern, northern and central as summarized in the table 7.1.

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In conclusion the potential of the each of the biomass identified could be ranked respectively as

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With the rank of a regional potential respectively as

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For the section of the evaluation for the most suitable technology to be employed to satisfy the constraints of a machine reliability and the quality of the product which mainly is the consistency of the output, as refer to the recommendation from the relevant experts, a technology of a stepping grate stoker combustion boiler with the functionality of a moving gate and a boiler with a single drum has been chosen due to the satisfaction in all the evaluation constraints from the expert together with the functionality to provide an outstanding feature of

- An effective process with 60% of the burning process undertaken up in the air.
- A reduction of the fly ash which is a cause of the erosion to be no more than 20%
- Enable the multi-fuel utility

To sum up as refer to the analysis carried out as well as the recommendation from the group of the relevant expert, the factors concerned as fatal for the formulation of the critical success factors of the industry of a commercial rice husk power plant in Thailand could be summarized as

- Access to a source of raw material
- Monopolization of the middle men of the product of electricity and ash
- Conformity to the power trading regulation
- Bargain of the core machines
- Steam trading
- The characteristic of having a low operating cost
- The characteristic of having a high initial expense
- No requirement for a marketing effort
- Governmental support
- Clean Development Mechanism (CDM)
- Growing demand tendency
- Water consumption
- Tendency of price and availability of rice husk
- Technology intensive and expertise required
- Choice of technology of a stepping grate stoker combustion boiler with the functionality of a moving gate
- A boiler with a single drum

7.2 Formulation of a potential critical success factors

Base on the factors mentioned as well as a recommendation from the experts in the industry, a potential critical success factors could be formulated and categorized into the categories of a location, seasonality, raw material, governmental and external support, technology, human resource, marketing, product development and financial support

Location

Since the issue of the water consumption as well as a material in both aspect of the access to and a tendency of price and availability are all considered to be crucial for the industry of a rice husk power plant, a location is obviously considered to be one of the potential critical success factors with the requirement of the proximity to the source for both of the water and a fuel of a rice husk as well as another secondary fuel in some cases. As well as in case of the trading of the steam which as previously mentioned referring to the issue of the loss along the process of transmission the proximity to the customer is also required.

Seasonality

Apart form the critical success factor of a location, the other also being considered as having an influence to all the factor of water consumption and a material in both aspect of the access to and a tendency of price and availability is the factor of the seasonality of both water and the harvesting of a rice husk as well as the others type of secondary fuel.

Raw material

As refer to the result of the analysis, an issue of raw material both in term of an access to and a tendency of price and availability are all considered to be crucial. Accordingly another potential factor is considered to be an ownership of a source of raw material.

Governmental and external support

According to the result of the analysis, both factors of the governmental support as well as the profit margin from the protocol of a CDM (Clean Development

Mechanism) are contributing a vital role to the success of the industry of a commercial rice husk power plant.

Technology

By nature, a rice husk power plant is technology intensive with the characteristic of high initial investment, accordingly the return on the invest have to be ensure by the consistency of the technology selected in order to keep up to the tendency of the incremental in the demand.

Human resource

Referring to the analysis, the nature of a rice husk power plant is a technology intensive therefore there is a requirement for the expertise ranging from the foundation stage with the selection of a turn-key contractor down to the actual operation and maintenance team.

Marketing

From the research, there is an evidence of the monopolization of the middle men of the product of electricity and ash. For the product of an ash, there are only a few players playing a part of middle men and even worse with only one middle man between the end user and the producer of the governmental organization name as EGAT, MEA and PEA in case of the electricity and resulting in a significant bargaining power. Therefore another potential critical success factor for the issue of the monopolization of the middle men in the product of electricity and ash is considered to be marketing for both of the product.

Product development

Apart from the factors of marketing and distribution channel, another considered as critical for the issue of the monopolization of middle men of an ash trading is to investigate for the product value adding procedure in order to develop an ash from a current massive consumption in the industry of steel into a more valuable product.

Financial support

From the result of the analysis even though, a requirement for a financial support for a day to day operation is considered to be low nevertheless the expenditure of the initial investment with the majority from the core machines are considered to be high and require a financial support.

7.3 Selection of critical success factors

After all the potential critical success factors have been formulated based on the result from the situation, industry and technical analysis at this stage the proposed critical success factors would be summarized into the table, to weight each individual satisfaction against the criteria that has been previously identified of

1. Marketing
   - Market share
   - Customer satisfaction
   - Competitiveness
   - Quality
2. Financial
   - Profit margin
   - Initial expense
   - Annual expense
3. Technology
   - Reliability

In order to validate the proposed critical success factors, the result has been sent out to the group of the experts for their opinion as well as to score the satisfaction of the formulated critical success factor against each individual criterion ranging from the best of 100 down to 0 for worst with 50 as neutral neither having positive or negative impact as illustrated in the table 7.2, illustrated below is the list of the experts involved

- Director& Senior consulting engineer of the sustainable energy consulting company.
- Managing director of the biomass power plant turn-key contractor company.
- Senior project engineer the biomass power plant turn-key contractor company.
- Division manager of the rice husk power plant division of the rice mill
- Senior engineer of the Department of alternative Energy Development and Efficiency (DEDE), Ministry of Energy

- Staffs of EGAT, PEA and MEA

Criteria / Potential Factor	Market share	Customer satisfaction	Competitiveness	Quality	Profit margin	Initial expense	Annual expense	Reliability	Total
Maximum weight	100	100	100	100	100	100	100	100	800
Location									
Seasonality									
Raw material									
Governmental and external support									
Technology									
Human resource									
Marketing									
Product development									
Financial support									

Table 7.2: An evaluation form

Based on the result of the survey, the summary of the constraints satisfaction of each of the potential factors have been summarized in the table 7.3. As illustrated though each individual factor would has already been summarized and ranked but still the score of each of the factors are still close which make it unable to identify the critical factors by any simple method.

Criteria / Potential Factor	Market share	Customer satisfaction	Competitiveness	Quality	Profit margin	Initial expense	Annual expense	Reliability	Total
Maximum weight	600	600	600	600	600	600	600	600	4800
Location	485	390	480	300	490	280	475	310	**3210**
Seasonality	475	420	485	300	460	300	495	310	**3245**
Raw material	515	400	515	300	510	300	505	300	**3345**
Governmental and external support	310	310	350	300	450	430	310	300	**2760**
Technology	385	360	405	425	460	235	410	465	**3145**
Human resource	320	350	380	390	390	300	295	480	**2905**
Marketing	405	370	440	320	415	300	210	300	**2760**
Product development	460	410	445	340	445	300	160	300	**2860**
Financial support	310	300	310	300	300	480	300	300	**2600**

Table 7.3: A survey result

Accordingly for the purpose of the data analysis, the theory of ANOVA (Analysis of variance) is introduced to investigate if there's any evidence of the difference between each of the factor in order to identify the critical success factors. Referring to the definition from WMG (2006) ANOVA is "A test for difference in means of samples from different populations" with a hypothesis of

H_0: **No different between each of the factors**

$$\sigma_1^2 = \sigma_2^2 = \sigma_n^2 = 0$$

H_1: **There are different between each of the factors**

$$\sigma_1^2 \neq \sigma_2^2 \neq \sigma_n^2 \neq 0$$

Where

$$\hat{\sigma}^2 = \frac{\sum_{ij}(\bar{x}_j - \bar{x})^2}{n-1}$$

$$= \frac{Sum\ of\ \ Square}{Degree\ of\ \ Freedom}$$

$$= \frac{SS}{DF}$$, Mean Square (MS) in the ANOVA table

Variation	SS	DF	MS	F
Between types of catalyst	$\sum_{ij}(\bar{x}_j - \bar{x})^2$	$n-1$	$\frac{\sum_{ij}(\bar{x}_j - \bar{x})^2}{n-1}$	
Within types of catalyst	$\sum_{ij}(\bar{x}_{ij} - \bar{x}_j)^2$	$n(r-1)$	$\frac{\sum_{ij}(\bar{x}_{ij} - \bar{x}_j)^2}{n(r-1)}$	
Total	$\sum_{ij}(x_{ij} - \bar{x})^2$	$nr-1$		

As a result as illustrated in figure 7.1 with the tabulated value of the F-test at 95% confident interval of 0.267 the result could be summarized that at 95% confident level there is no evidence of any significant different between each of the factors. Accordingly as refer to the expert in the industry, each of the factors are defined as equally important and are all considered to be a critical success factor.

One-way ANOVA

```
Source  DF      SS     MS     F      P
Factor   8   83599  10450  1.29  0.267
Error   63  512050   8128
Total   71  595649

S = 90.15   R-Sq = 14.03%   R-Sq(adj) = 3.12%


Level                     N    Mean   StDev
Location                  8  401.25   92.53
Seasonality               8  405.63   87.60
Raw material              8  418.13  104.84
Governmental and external 8  345.00   60.94
Technology                8  393.13   72.95
Human resource            8  363.13   61.00
Marketing                 8  320.00  136.30
Product development       8  357.50  103.16
Financial support         8  325.00   62.79
```

```
                          Individual 95% CIs For Mean Based on
                          Pooled StDev
Level                     -------+---------+---------+---------+--
Location                               (----------*---------)
Seasonality                             (----------*---------)
Raw material                              (----------*---------)
Governmental and external     (---------*----------)
Technology                            (----------*---------)
Human resource                     (----------*---------)
Marketing                 (---------*----------)
Product development               (----------*---------)
Financial support          (---------*----------)
                          -------+---------+---------+---------+--
                               300       360       420       480

Pooled StDev = 90.15
```

Figure 7.1: A result of ANOVA

To sum up after the situation, industry and technology analysis together with the suggestion and validation process from the experts as well as the data analysis have been carried out, the critical success factors of the industry of rice husk biomass power pant in Thailand could be identified to be the factors of location, seasonality, raw material, governmental and external support, technology, human resource, marketing, product development and financial support.

7.4 The critical success factors and recommendation

After the situation, industry and technology analysis together with the weighting method, validation process and the data analysis have been carried out the critical success factors of the industry of rice husk biomass power pant in Thailand could be identified to be the factors as illustrating below together with the presentation of the relevant response recommendation from the expert later on in the chapter.

- Location
- Seasonality
- Raw material
- Governmental and external support
- Technology
- Human resource
- Marketing
- Product development

- Financial support.

Technology

As previously analyzed the factor of a technology is crucial as an indicator of the efficiency and reliability of the whole system, accordingly the chosen technology has to be able to satisfy all the technical constraints. Based on the result from the technical analysis as well as the recommendation from relevant expert, to ensure the reliability of the system, the recommendation for the critical factor of technology is a technology of a stepping grate stoker combustion boiler with the functionality of a moving gate and a boiler with a single drum has been chosen due to the satisfaction in all the evaluation constraints from the expert together with the functionality to provide an outstanding feature of

- An effective process with 60% of the burning process undertaken up ion the air.
- A reduction of the fly ash which is a cause of the erosion to be no more than 20%
- Enable the multi-fuel utility
- Easy for maintenance

With the detail of the technology as illustrated

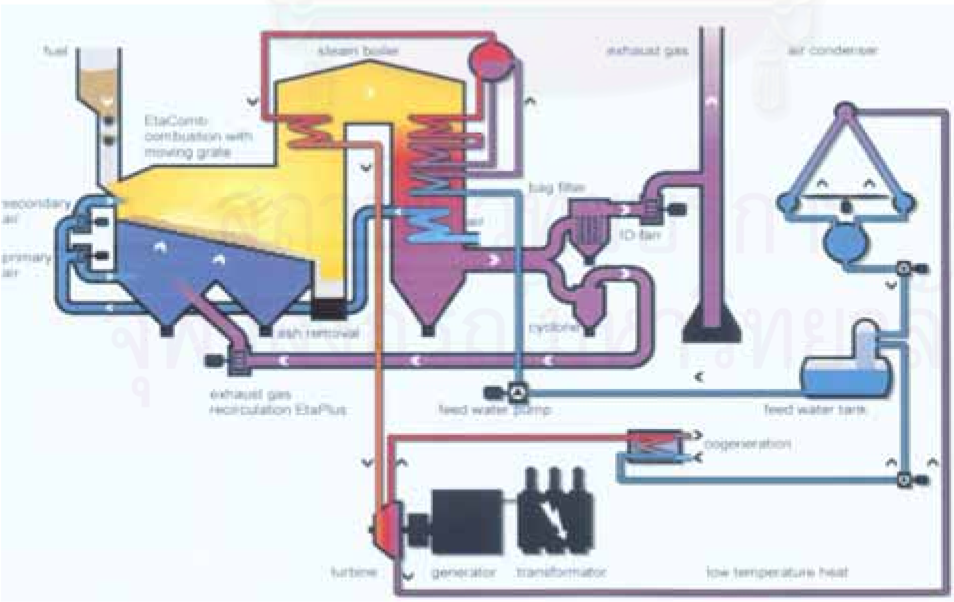

Figure 7.2: Stepping grate stoker combustion boiler with the functionality of a moving gate

The technology has been designed to undertake 60% up in the air and another 40% on the grate. The turbulence is control by the upward blowing from the primary fan while the secondary fan is responsible to create a small multi-cyclone with the number equal to the divided 3 lanes, 1 for primary and the other 2 for secondary fuels. The cyclones would be blown in the same direction from the beginning section of the grate down to the end with the different intensities and speed depend on the type of the fuels in each lanes to ensure the efficiency of the burning process. With the separation of the multi-cyclones and a separated steam boiler, a fly ash is enabled to be controlled.

Location

As refer to the expert in the industry, two issues considered as having the highest impact to the decision of the location are the access to both of the major input of the process of the water and raw fuel. Accordingly for the issue of the water the, the recommendation is to locate the plant with the proximity to the source such as a river as well as the grit of PEA or MEA in order to save the cost of the connecting system. For the issue of a fuel, referring to result of the fuel analysis for both primary of a rice husk and secondary of various kinds as illustrated in table 7.4, the suitability of the location is defined to be at the northeast region with the highest availability of the fuel of approximately 10 million tons per year.

Biomass (T/Yr) / Region	Rice straw	Sugar cane top and leap	Maize stalk, top and leap	Cassava rhizome and stalk	Total
Northeastern	4,936,725	3,510,180	234,228	982,248	9,663,381
Northern	3,408,415	1,452,784	1,713,879	355,305	6,930,383
Central	2,657,195	2,763,052	460,543	346,193	6,226,983

Table 7.4: Summary of potential location

Raw material

Considered to be crucial for both of the aspect of primary and secondary fuel, for a primary fuel of a rice husk referring to the result of the analysis as well as the expert in the industry, since the current situation is considered as approaching the stage of over demand, the recommendation is to gain the access to the raw material. Ideally the recommendation is the owner own source of material such as a rice mill, for those with no origination in the industry, the alternative of the joint venture investment with the owner of the source is recommended. The caution is the ensuring of the supply of the fuel by only signing the contract without any deeper bonding since referring to the past projects referring to the information provided from the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, oftenly the fuel suppliers are willing to scarify the penalty of breaking the contract for a better bargain.

For a secondary fuel same as those in primary, ideally the recommendation is the owner own source of material or establishing the joint venture investment. Referring to the result of a fuel analysis, the potential secondary fuels are as illustrate in table 7.5 with the degree of potentiality ranging from a rice straw, sugar cane top and leap, maize stalk, top ad leap, cassava rhizome and stalk respectively.

Biomass (T/Yr) / Region	Rice straw	Sugar cane top and leap	Maize stalk, top and leap	Cassava rhizome and stalk
Northeastern	4,936,725	3,510,180	234,228	982,248
Northern	3,408,415	1,452,784	1,713,879	355,305
Central	2,657,195	2,763,052	460,543	346,193
Total	11,002,335	7,726,016	2,408,650	1,683,746

Table 7.5: Summary of potential biomass

Seasonality

Generally in Thailand the harvesting season of rice is defined to be two as illustrated in figure 7.3 with the main season during October to January and from May to June of the second season. Accordingly the recommendation from the expert in the industry for this factor is the inventory and purchasing system with the mission to compensate the situation of over demand in the low season with the rice gather and stock during the high season.

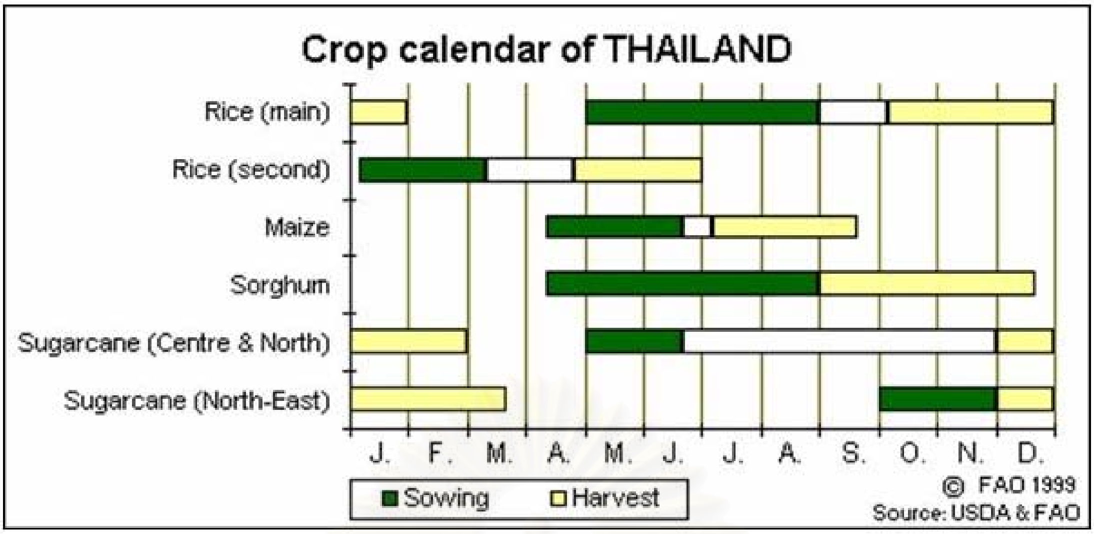

Figure 7.3: A crop calendar of Thailand (Source: United States department of agriculture (USDA))

Governmental and external support

Presently as illustrated in table 7.6, even though among Southeast Asia members Thailand is in the forefront in the promotion of the utilization of the renewable fuel, but still under the category of the rice husk power plant the promotion is still considered to be low as reflecting in the trading adder with the lowest value. Therefore the recommendation from the relevant expert for the related governmental organization is to increase the value of the trading adder in order to magnify the overall revenue of the industry.

Fuel / Technology	Adder (Baths/KW-Hr)
Biomass	0.3
Biogas	0.3
Small hydro-power generation (50 - 200 KW)	0.4
Small hydro-power generation (< 50 KW)	0.8
Garbage	2.5
Wind	2.5
Solar	8

Table 7.6: Adder for the power plant under the category of VSPP (Source: PEA)

Human resource

Based on the result of the analysis as well as the recommendation from the relevant expert, the industry of a rice husk power plant is defined as technology intensive, therefore the expertise is crucially require. For the beginning stage under the phase of the project development and the plant construction the recommendation is to employ the competent turn-key contractor as well as a consultant and project management team with actual operated reference to ensure the success.

For the stage of the actual plant operation the recommendation is to consider between along term investment of training the plant own staff or to employ the external O&M (Operation and maintenance) team.

Marketing

As refer to the result of the analysis the issue of the monopolization of the middle men for both products of electricity and ash are considered to be crucial since only a few are playing a part. Accordingly the recommendation from the expert in the industry is to do the marketing in order to supply the product directly to the customer.

In case of the product of the electricity, the possibility is considered to be low as refer the investment in the distribution channel but the initiative step could possibly be taken with the supply of the electricity to the other industry within the investor own group or to the neighbor factory as well as in case of the steam.

In case of the ash apart from the industry of a steel manufacturer which is considered to be a major customer with the expected significant consumption of approximately 600,000 to 900,000 tons for the year of 2008, still there are other potential customers as refer to the analysis name as

1. Cement industry
2. Heat resistance brick
3. Lightweight structure material
4. Silicon chip industry

Product development

With the same objective to deal with the issue of the monopolization of the middle men for both products of electricity and ash apart from doing the marketing in order to supply the product directly to the customer, the recommendation from the expert is to add the value to the product of an ash to shift from the massive usage as being a thermal insulator in the manufacturing process of the steel to be more valuable product by the product development process with the focus on the same industry as those for a marketing of

1. Heat resistance brick
2. Lightweight structure material
3. Silicon chip industry

One major constraint is the obstacle of the researching expense accordingly the study of the product development may require cooperation between the existed players.

Financial support

Referring to the expert in the industry, the factor is considered to be crucial for both investment and operation, as refer to the requirement of the high initial investment as well as the huge budget to cover the strategy of inventory management to deal with the factor of the seasonality.

The major obstacle for the financial support is the issue of the unfamiliarity of the financial provider to the project of a renewable energy accordingly the recommendation is for the government to provide the knowledge information for the better understanding of the industry as well as the subsidy of more soft interest loan for the project of a renewable energy apart from the exiting of the first 50 millions baths of the initial investment with no more than 4% interest rate and bound to the pay back period of within 7 years which financially could cover only 1 MW of the total capacity.

CHAPTER VIII
CONCLUSION AND RECOMMENDATION

This final chapter is the presentation of the thesis conclusion and the recommendation. It concludes the result of the research and the recommendation for the usage as well as the suggestion on the further study.

8.1 Thesis conclusion

Despite the recovery period from the economic crisis in the year of 1997 the consumption of the electricity of the country as a whole has been increasing unstoppably. According to the growth in the consumption rate, ever since the year 1989 the government has announced the policy for the private sector to be involved in the electricity generation business, especially the small size biomass power plant. At the moment several type of the biomass power plant are available with various alternative to be chosen. This thesis is aimed to focus on a biomass power plant with a primary source of fuel of a rice husk as refer to the issue of the availability of the fuel.

However referring to the information provided from the Ministry of Energy in the year of 2006, six projects out of twenty or equivalent to 30% of renewable energy project being granted from the Ministry of Energy, have requested for a termination of the projects. Therefore even with all the positive factors of the excess availability of the fuel together with all the positive situation for the rice husk power plant such as the supportive action from the government as well as the crisis on the need to search for a replacement type of fuel, this still indicate some yet not discovered potential factors that cause the failure neither or both within and outside the industry.

Hence, for the benefit of both commercial and further academic study the statement of the problem for this thesis is set up in order to conduct the analysis for the critical success factors of the commercial rice husk biomass power plant.

Throughout the research, the data has been gathered from various trustful sources named as, academic journal, research report and information provided from the governmental department, academic seminar and expert interview.

Via the assist of all the analysis named as an industry analysis, situation analysis, technical analysis as well as the validation process with the comment and recommendation from the group of the expert, the critical success factors have been formulated with all the relevant recommendation as

Location

Location is defined as the first critical success factor for the industry of a rice husk power plant in Thailand since the issue of the water and a material consumption in both aspect of the access to and a tendency of price and availability are all considered to be crucial. As well as in case of the trading of the steam which as previously mentioned, referring to the issue of the loss along the process of transmission the proximity to the customer is also required.

Accordingly the location is recommended to have a proximity to both source of raw materials and the customer of a product of the steam as well as the grit of PEA or MEA in order to save the cost of the connecting system. In case of fuel referring to the result of the research the location with the highest availability is ranked from the region of northeastern, northern down to the central region of the country.

Seasonality

Another critical success factor considered as having an influence to all the factor of water consumption and a material in both aspect of the access to and a tendency of price and availability is the factor of the seasonality of the harvesting of a rice husk as well as the others type of secondary fuel.

Accordingly the recommendation for this factor is the inventory and purchasing system with the mission to compensate the situation of over demand in the low season with the rice gather and stock during the high season.

Raw material

As refer to the result of the analysis, an issue of raw material both in term of an access to and a tendency of price and availability are all considered to be crucial. Accordingly another critical potential factor is considered to be an ownership of a source of raw material. Ideally the recommendation is the owner own source of material such as a rice mill, for those with no origination in the industry, the alternative of the joint venture investment with the owner of the source is recommended. In case of the alternative fuel as a result of the study it could be summarized that the highest potential alternative is ranking from a rice straw, sugar cane top and leap, maize stalk, top ad leap, cassava rhizome and stalk respectively.

Governmental and external support

Even though among Southeast Asia members Thailand is in the forefront in the promotion of the utilization of the renewable fuel, but still under the category of the rice husk power plant the promotion is still considered to be low as reflecting in the trading adder with the lowest value. Therefore the recommendation for the related governmental organization is to increase the value of the trading adder in order to magnify the overall revenue of the industry.

Technology

By nature, a rice husk power plant is technology intensive with the characteristic of high initial investment, accordingly the return on the invest have to be ensure by the consistency of the technology selected in order to keep up to the tendency of the incremental in the demand.

Based on the result from the technical analysis to ensure the reliability of the system, the recommendation for the critical factor of technology is a technology of a stepping grate stoker combustion boiler with the functionality of a moving gate and a boiler with a single drum.

Human resource

Referring to the analysis, the nature of a rice husk power plant is a technology intensive therefore there is a requirement for the expertise ranging from the foundation stage with the selection of a turn-key contractor down to the actual operation and maintenance team.

For the beginning stage under the phase of the project development and the plant construction the recommendation is to employ the competent turn-key contractor as well as a consultant and project management team with actual operated reference to ensure the success.

For the stage of the actual plant operation the recommendation is to consider between a long term investment of training the plant own staff or to employ the external O&M (Operation and maintenance) team.

Marketing

From the research, there is an evidence of the monopolization of the middle men of the product of electricity and ash. For the product of an ash, there are only a few players playing a part of middle men.

In case of the product of the electricity, the possibility is considered to be low as refer the investment in the distribution channel but the initiative step could possibly be taken with the supply of the electricity to the other industry within the investor own group or to the neighbor factory as well as in case of the steam.

In case of the ash apart from the industry of a steel manufacturer which is considered to be a major customer with the expected significant consumption of approximately 600,000 to 900,000 tons for the year of 2008, still there are other potential customers as refer to the analysis name as

1. Cement industry
2. Heat resistance brick
3. Lightweight structure material
4. Silicon chip industry

Product development

Considered as another effort to deal with the issue of the monopolization of the middle men for both products of electricity and ash, apart from doing the marketing in order to supply the product directly to the customer, the recommendation is to add the value to the product of an ash to shift from the massive usage as being a thermal insulator in the manufacturing process of the steel to be more valuable product with the focusing on the industry of

1. Heat resistance brick
2. Lightweight structure material
3. Silicon chip industry

Financial support

The factor is considered to be crucial for both investment and operation. A large amount of money is required to set up the plant plus that in order to achieve the strategy of an inventory management a large capital is also required.

The major obstacle for the financial support is the issue of the unfamiliarity of the financial provider to the project of a renewable energy accordingly the recommendation is for the government to provide the information for the better understanding of the industry. As well as the subsidy of more soft interest loan for the project of a renewable energy, apart from the exiting of the first 50 millions baths of the initial investment with no more than 4% interest rate and bound to the pay back period of within 7 years which financially could cover only 1 MW of the total capacity.

8.2 Thesis recommendation

At the end of the day, with the kind suggestion from all the relevant expert together with all the analysis of the structure of the industry, the current situation of the industry as well as the technical support, the obtained thesis is the overview of the industry of rice husk power generation in Thailand together with the critical success factor and their relevant recommendation to achieve. As mentioned the thesis is aimed to be used as a reference for both of the aspect of academic and commercial, the achievement of each of the factors do not concerned only the investor but rather require the support from all the relevant parties along the supply chain. However, this thesis is the study of the critical success factors of a rice husk power plant as a whole country where all the relevant result of the analysis is for all the plants within the industry, which from case to case some specific detail may change. Thus, for the further usage of the thesis either or both academic or commercial aspect the recommendations are as illustrated below.

- The thesis covers all the relevant aspect of the industry of a rice husk power generation as a whole, it could be used as a guideline where the conformity to the factors provided could ensure the higher possibility of the success. However the strategies could be varied from case to case, accordingly specific detail may be changed in the stage of implementation for the sake of maximizing the appropriateness.

- The thesis cover all the relevant aspect of the industry, thus the result is best appropriate as being a reference for the overview of the industry as well as being used as a guideline to achieve all the provided critical success factors in order to amplify the possibility of the success. For the purpose of the further research the recommendation is to carry out the study in detail for each of the factors.

- Even though this thesis concern only the industry of a rice husk power generation, but the methodology of the research could be used as a reference and is applicable to any study within the scope of the critical success factor.

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APPENDIX

Appendix A
Evaluation form

THE CRITICAL SUCCESS FACTOR ANALYSIS OF THE COMMERCIAL RICE HUSK BIOMASS POWER PLANT IN THAILAND

1. Information from the analysis

1.1 Industry analysis

As refer to result for the analysis of the porter's five force model, under the current situation the industry could be described as intense on the end of rivalry for the raw material of both within the power generation industry and external consumer. So far the survivors are those who own the source of fuel or at least having a relatively well connection. For those of the new coming this is also the fatal factor to be concerned with the elements of both seasonality and location which strongly affecting the value of both IRR and pay back period of the project together with the factor of the economic of scale and capital requirement with the majority of the cost from a core machines. On the side of the finish product, a trading of steam is considered to be crucial as another source of revenue , as well as the electricity referring to the growing tendency of the national consumption the expansion of the market is still having a long way to go but on the other hand there is an evidence of the monopolization since after all the government organization is the only major immediate customer together with an ash trading with only few middle men despite the growing demand tendency from the industry of a steel manufacturer.

Accordingly from the result of the industry analysis, several factors could be identified as having a potential to be a critical success factors starting with the factor of an access to a source of raw material and monopolization of the middle men of the product of electricity and ash which strongly influence the constraints of a market share and competitiveness.

Second by the constraint of customer satisfaction, this is strongly affected by the factor of the conformity to the power trading regulation. And bargain of the core machines since it is the majority of the cost and relevant to the constraint of an initial expense.

As well as a capability to trade the steam which is strongly affects the constraint of a profit margin.

1.2 Situation analysis

As refer to the result of the situation analysis, there do exist the evidence of both positive and negative factors influencing the industry. Via the aid of the information gathered, the formulation of the critical success factors are enabled based on the presence of some certain strength, opportunities and the factors to overcome some particular weaknesses and threats.

The situation of the industry of the rice husk power generation is positively influenced by the presence of both the internal capabilities (Strengths) named as, being an excellence supportive business and durable investment, having variety of technology and secondary type of fuel, low operating cost, having no requirement for a marketing effort and the presence of the external environmental factors (Opportunities) of governmental support, Clean Development Mechanism (CDM), and growing demand tendency.

Concurrently the industry of rice husk power generation is suffering from the presence of the weaknesses named as high initial investment, technology intensive& requirement for expertise, the issue of the massive water consumption and the threat of a tendency of price and availability of rice husk, unawareness of the significance of the rice husk, funding policy.

Accordingly the factors that could be summarized to have an effect to the value of the profit margin and annual expense are

- The characteristic of having a low operating cost
- No requirement for a marketing effort
- Governmental support
- Technology intensive and expertise required
- Clean Development Mechanism (CDM)
- Growing demand tendency
- Water consumption
- Tendency of price and availability of rice husk

1.3 Technical analysis

For the issue of the alternative secondary fuels, from the research apart from the main fuel of a rice husk other type of fuels is still available and considered as having a potential named as a rice straw, sugar cane top and leap, maize stalk, top and leap cassava rhizome and stalk with the availability and distribution ranging from the region of northeastern, northern and central as summarized in the table 7.1.

Biomass (T/Yr) / Region	Rice straw	Sugar cane top and leap	Maize stalk, top and leap	Cassava rhizome and stalk	Total
Northeastern	4,936,725	3,510,180	234,228	982,248	9,663,381
Northern	3,408,415	1,452,784	1,713,879	355,305	6,930,383
Central	2,657,195	2,763,052	460,543	346,193	6,226,983
Total	11,002,335	7,726,016	2,408,650	1,683,746	22,820,747

Summary of potential biomass

In conclusion the potential of the each of the biomass identified could be ranked respectively as

1. Rice straw
2. Sugar cane top ad leap
3. maize stalk, top and leap
4. Cassava rhizome and stalk

With the rank of a regional potential respectively as

1. Northeastern
2. Northern
3. Central

For the section of the evaluation for the most suitable technology to be employed to satisfy the constraints of a machine reliability and the quality of the product which mainly is the consistency of the output, a technology of a stepping grate stoker combustion boiler with the functionality of a moving gate and a boiler with a single drum has been chosen due to the satisfaction in all the evaluation constraints from the expert together with the functionality to provide an outstanding feature of

- An effective process with 60% of the burning process undertaken up in the air.
- A reduction of the fly ash which is a cause of the erosion to be no more than 20%
- Enable the multi-fuel utility

To sum up as refer to the analysis carried out the factors concerned as fatal for the formulation of the critical success factors of the industry of a commercial rice husk power plant in Thailand could be summarized as

- Access to a source of raw material
- Monopolization of the middle men of the product of electricity and ash
- Conformity to the power trading regulation
- Bargain of the core machines
- Steam trading
- The characteristic of having a low operating cost
- The characteristic of having a high initial expense
- No requirement for a marketing effort
- Governmental support
- Clean Development Mechanism (CDM)
- Growing demand tendency
- Water consumption
- Tendency of price and availability of rice husk
- Technology intensive and expertise required
- Choice of technology of a stepping grate stoker combustion boiler with the functionality of a moving gate
- A boiler with a single drum

2. Formulation of a potential critical success factors

Base on the factors mentioned, a potential critical success factors could be formulated and categorized into the categories of a location, seasonality, raw material, governmental and external support, technology, human resource, marketing, product development and financial support

Location

Since the issue of the water consumption as well as a material in both aspect of the access to and a tendency of price and availability are all considered to be crucial for the industry of a rice husk power plant, a location is obviously considered to be one of the potential critical success factors with the requirement of the proximity to the source for both of the water and a fuel of a rice husk as well as another secondary fuel in some cases. As well as in case of the trading of the steam which as previously mentioned referring to the issue of the loss along the process of transmission the proximity to the customer is also required.

Seasonality

Apart form the critical success factor of a location, the other also being considered as having an influence to all the factor of water consumption and a material in both aspect of the access to and a tendency of price and availability is the factor of the seasonality of both water and the harvesting of a rice husk as well as the others type of secondary fuel.

Raw material

As refer to the result of the analysis, an issue of raw material both in term of an access to and a tendency of price and availability are all considered to be crucial. Accordingly another critical potential factor is considered to be an ownership of a source of raw material.

Governmental and external support

According to the result of the analysis, both factors of the governmental support as well as the profit margin from the protocol of a CDM (Clean Development

Mechanism) are contributing a vital role to the success of the industry of a commercial rice husk power plant.

Technology

By nature, a rice husk power plant is technology intensive with the characteristic of high initial investment, accordingly the return on the invest have to be ensure by the consistency of the technology selected in order to keep up to the tendency of the incremental in the demand.

Human resource

Referring to the analysis, the nature of a rice husk power plant is a technology intensive therefore there is a requirement for the expertise ranging from the foundation stage with the selection of a turn-key contractor down to the actual operation and maintenance team.

Marketing

From the research, there is an evidence of the monopolization of the middle men of the product of electricity and ash. For the product of an ash, there are only a few players playing a part of middle men and even worse with only one middle man between the end user and the producer of the governmental organization name as EGAT, MEA and PEA in case of the electricity and resulting in a significant bargaining power. Therefore another potential critical success factor for the issue of the monopolization of the middle men in the product of electricity and ash is considered to be marketing for both of the product.

Product development

Apart from the factors of marketing and distribution channel, another considered as critical for the issue of the monopolization of middle men of an ash trading is to investigate for the product value adding procedure in order to develop an ash from a current massive consumption in the industry of steel into a more valuable product.

Financial support

From the result of the analysis even though, a requirement for a financial support for a day to day operation is considered to be low nevertheless the expenditure of the initial investment with the majority from the core machines are considered to be high and require a financial support.

3. Selection of critical success factors

After all the potential critical success factors have been formulated based on the result from the situation, industry and technical analysis at this stage the proposed critical success factors would be summarized into the table, to weight each individual satisfaction against the criteria that has been previously identified of

1. Marketing
    - Market share
    - Customer satisfaction
    - Competitiveness
    - Quality
2. Financial
    - Profit margin
    - Initial expense
    - Annual expense
3. Technology
    - Reliability

Ranging from the best of 100 down to 0 for worst with 50 as neutral neither having positive or negative impact

4. Evaluation form

Criteria / Potential Factor	Market share	Customer satisfaction	Competitiveness	Quality	Profit margin	Initial expense	Annual expense	Reliability	Total
Maximum weight	100	100	100	100	100	100	100	100	800
Location									
Seasonality									
Raw material									
Governmental and external support									
Technology									
Human resource									
Marketing									
Product development									
Financial support									

An evaluation form

Comment……………………………………………………………………………

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BIOGRAPHY

Mr. Pakadech Tabprayoon was born on 31 December 1982 in Bangkok. In the year of 2005 he obtained his bachelor degree with 2^{nd} class honor in manufacturing engineering from the University of Nottingham, and obtaining bachelor degree in industrial engineering from Thammasat University in 2006. After being granted he continued his study for the master degree in Engineering business management at regional Management at Regional Centre for Manufacturing System Engineering (RCMSE), Chulalongkorn University of Thailand and Warrick University, UK.