THE DEVELOPMENT OF A BUSINESS FRAMEWORK AND TECHNO-FINANCIAL MODEL FOR BIOMASS POWER PLANTS

IR. ABDUL MAULUD BIN ABDUL LATIF

UNIVERSITI TEKNOLOGI MALAYSIA

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IR. ABDUL MAULUD BIN ABDUL LATIF

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DEDICATION

In unreserved dedication to my beloved wife, children and family. It is their understanding, patience, undying love and continuous support that have made this dissertation possible.

I also dedicate this dissertation to my (Allahyarham) mother and father for their unremitting guidance and upbringing, cultured forever with the never ending quest for knowledge and success.

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ABSTRACTS

Renewable Energy (RE) was included in the 8th Malaysia Plan to ensure a sustainable energy growth for the country. An initial target of 600MW grid connected power plants, fuelled by RE sources, was set by the year 2005. However, their planting up have been sluggish. Only a few of the 62 approvals have taken off indicating, invariably, the need to revamp the 5th fuel policy for the forthcoming 9th Malaysia Plan (2006-2010). The objective of this Research Project is, therefore, to structure a business framework for the implementation of a technically feasible RE project and the construction of a Techno-Financial Model to determine its financial viability. The methodology of the research was, firstly, a research survey to identify the critical factors that ensure successful implementation of such a project and also the financial parameters that determine its viability. These data, from actual projects, were then used to design the business framework and the Techno-Financial Model. The business framework in the implementation of a biomass power project comprises the implementation, technical and financial structures. The implementation structure involves putting all the "players" and their linkages in place; the technical structure considers the technology to be employed; and the financial structure involves structuring the (financial) viability of the project. The research project delved in-depth the construction of a Techno (sic) - Financial Model (TFM) which amalgamates all the crucial "technical" and "financial" components inter-reacting iteratively to provide a cost-efficient investment. The TFM constructed also acts as a "negotiating" and "enabling" tool which was used successfully during negotiation of the electricity tariff with the Utilities and rising of funds with the Bankers. Analysis using the TFM on a Biomass Power Plant reveals that the electricity tariff of RMsen 17 per kWh yielding an Internal Rate of Return of 12.12% with a payback period of 7 years is not lucrative enough to attract RE Developers. The Research thus concluded that grid connected RE power generation in Malaysia is not a viable proposition, except in cogenerations for captive consumers. Therefore, these initiatives must be localised: localised feedstock; localised RE Technology; and localised distribution. It is recommended that the determination of RE generated electricity tariff by a Renewable Energy Development Board be based on a-case-by-case basis to ensure its viability and success.

ABSTRAK

Tenaga elektrik yang boleh diperbaharui (RE) telah dijadikan salah satu komponen dalam Rancangan Malaysia ke-8 untuk memastikan pertumbuhan tenaga yang berterusan. Selaras dengan pendekatan ini, sasaran awal bagi loji janakuasa elektrik yang menggunakan sumber tenaga yang diperbaharui sebanyak 600 MW bagi tahun 2005 telah ditetapkan. Walaubagaimanapun, proses perlaksanaan adalah agak lembab. Setakat ini, hanya beberapa projek, daripada 62 projek yang telah di luluskan, berjaya dilaksanakan. Ini menunjukkan bahawa 'Polisi Bahanapi' yang ke-lima perlu disusun semula sebelum diserap ke RMK9 yang akan datang (2006–2010). Tujuan kajiselidek ini adalah untuk menentukan rangka perniagaan yang boleh mempastikan kejayaan perlaksanaan dan daya maju kewangan projek biojisim. Kaedah pendekatan adalah dengan mendapatkan data kritikal daripada projek sebenar dan mengunakan data tersebut untuk merangka struktur perniagaan dan membuat Model Tekno-Kewangan (MTK). Rangka perniagaan untuk menjayakan perlaksanaan projek biojisim ini merangkumi struktur perlaksanaan, teknikal dan kewangan. Dalam struktur perlaksanaan, ia melibatkan "pemain" dan hubungkait mereka. Struktur teknikal melibatkan semua aspek teknologi yang akan digunapakai, manakala struktur kewangan pula melibatkan pengstrukturan aliran kewangan yang berdayamaju. Penyelidikan projek akan melibatkan pembinaan MTK. MTK ini akan menggabungkan kesemua komponen penting "teknikal" dan "kewangan" yang akan saling bertindakbalas untuk menyediakan satu pelaburan yang efektif dalam aspek kos. MTK ini juga haruslah bertindak sebagai alat "perundingan" dan "pembolehan" yang boleh digunakan dengan jayanya semasa proses perundingan tariff elektrik dengan pihak pembeli tenaga serta pihak bank dalam mendapatkan dana pinjaman. Kajian yang menggunakan MTK untuk loji janakuasa biojisim telah mendapati bahawa tarif tenaga elektrik sebanyak RM17 sen/kWh akan memberikan pulangan 12.12% dengan tempoh pembayaran semula 7 tahun. Hasil daripada kajian ini, pulangan sebegini tidak mencukupi untuk menarik minat para pemaju RE. Penyelidikan juga telah merumuskan bahawa penjanaankuasa elektrik RE adalah satu cadangan yang tidak berdayamaju kecuali penjanaankuasa elektrik "cogeneration" yang telah mempunyai pengguna yang tersediaada. Oleh yang demikian, initiatif-initiatif ini mestilah berbentuk tempatan iaitu bahanapi tempatan, teknologi RE tempatan dan juga pengagihan tempatan. Adalah dicadangkan supaya Lembaga Tenaga RE ditubuhkan bagi menentukan tarif tenaga elektrik RE yang berdasarkan kapada kes-kes tertentu bagi mempastikan ianya berdaya saing.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AGO	-	Australian Greenhouse Office
BNM	-	Bank Negara Malaysia
BOO	-	Build-Operate-Own
BOOT	-	Build-Operate-Own-Transfer
BPM	-	Bankruptcy Prediction Models
CDM	-	Clean Development Mechanism
CER	-	Certified Emission Reduction
CFC	-	Critical Financial Component
CH_4	-	methane
CO_2	-	carbon dioxide
CP	-	Condition Precedent
CTC	-	Critical Technical Component
DG	-	Distributed Generation(s)
CPO	-	crude palm oil
EB	-	Executive Board
EC	-	European Community
EFB	-	Empty Fruit Bunch
EGAT	-	Electricity Generating Authority of Thailand
EPCC	-	Engineering, Procurement, Construction and Commissioning
EPU	-	Economic Planning Unit (Prime Minister's Department)
ERU	-	Emissions Reductions Units
EU	-	European Union
EWS	-	Early Warning System
FFB	-	Fresh Fruit Bunch
FIM	-	Feed-In Model
FSA	-	Fuel Supply Agreement
GDP	-	Gross Domestic Product
GHG	-	green house gases
GIA	-	Government Investment Act

GIC	-	Government Investment Certificates
GWh	-	giga watt hour
Hc.	-	hectare
IBA	-	Islamic Banking Act
IFSB	-	Islamic Financial Services Board
IPP	-	Independent Power Producers
IRR	-	Internal Rate of Return
JAS	-	Jabatan Alam Sekitar (DOE)
JBEG	-	Jabatan Bekalan Elektrik dan Gas
JI	-	Joint Implementation
JSG	-	Joint and Several Guarantees
KATK	-	Kementerian Air, Tenaga dan Komunikasi
Kt	-	kilo tonne
kWh	-	kilo watt hour
LCO	-	Letter of Conditional Offer
LFG	-	Liquefied Fuel Gas
LLN	-	Lembaga Letrik Negara
LNG	-	Liquefied Natural Gas
Mj/kg	-	Mega Joules per kilogram
Mm^3	-	million cubic meter
MoF	-	Ministry of Finance
Mt	-	metric tonne
mmBTU	-	million British Thermal Unit
MTG	-	Microturbine generator
Mtoe	-	million tonnes oil equivalent
Mton	-	million tonnes
MW	-	mega watt
NFFO	-	Non-Fossil Fuel Obligation
NPL	-	Non Paying Loans
NSAC	-	National Syariah Advisory Council
O&M	-	Operation and Maintenance
OE	-	Operational Entity
OER	-	Oil Extraction Rate
OPP3	-	Outline Perspective Plan 3

PFC	-	Principal Financial Components
POME	-	Palm Oil Mill Effluent
PTM	-	Pusat Tenaga Malaysia
PV	-	photovoltaic
RE	-	Renewable Energy
REPPA	-	Renewable Energy Power Purchase Agreement
RET	-	Renewable Energy Technologies
RM	-	Ringgit Malaysia
RPS	-	Renewables Portfolio Standard
ROE	-	Return on Equity
SCORE	-	Special Committee On Renewable Energy
SESB	-	Sabah Electricity Sdn Bhd
SESCO	-	Sarawak Electricity State Corporation
SPV	-	Special Purpose Vehicle
SREP	-	Small Renewable Energy Programme
SWOT	-	Strength Weaknesses Opportunities and Threats
TEM	-	Techno-Economic Model
TFM	-	Techno-Financial Model©
TGC	-	Tradable Green Certificates
TNB	-	Tenaga Nasional Bhd
TNBG	-	TNB Generation Sdn Bhd
TNBT	-	TNB Transmission Sdn Bhd
UGR	-	Ultimate Generation Rate
UK	-	United Kingdom
UNFCCC	-	United Nation Framework Convention on Climatic Changes
USD	-	United States Dollar
WASP	-	Wein Automatic System Planning

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Preamble

Renewable Energy (RE) was included as the fifth fuel in the expanded four-fuel diversification policy of hydro-gas-coal-oil, and incorporated in the 8th Malaysia Plan: 2001-2005 (EPU, 2001). It will be a strategic complement of energy expansion in the future, to ensure competitiveness of the country's product into the borderless global market, well beyond the 2020 boundaries. It has been acknowledged as the insurance for sustainable growth of the power generation industry in the future, in the face of fast depleting (finite) fossil fuel reserves. The 1998 fuel crisis in the USA and the European Union countries is only a glimpse of the likely scenario that could develop in the next few decades when the supply of hydrocarbon (fossil) fuel fizzles out or reaches a level of "unaffordability". The current "price war" is an insight of the possible scenario for the future. Malaysia must also prepare for the time when she eventually becomes a net importer of fossil fuel. Nymex Crude as at August 12th, 2005, shot past the USD65 per barrel psychological level to USD66.56 per barrel, the highest recorded price, and more than double from a year and half earlier (USD27-30 per barrel in early 2004). Pump prices also surge upwards to double at USD2.50 a (US) gallon, and propane, a by-product of oil refinery and a common fuel, jumped 76% to USD1.79 per mmBTU during the same period. These have a knock-on effect on natural gas that rose to a 14 year high of USD8.10 (RM30.78) per mmBTU. All these price increases, although temporary due to unexpected increase in demand in anticipation of a colder winter in the west, and stronger than expected demand from China and India due to stocking up of oil reserve and improvement of their economy, will not settle down to its original, pre-price war

crisis, level of less than USD30 per barrel. This has a far reaching implication to the exports of most of the emerging economies such as Malaysia. These unpleasant scenarios would, therefore, hasten the need for the country to seek less (price) volatile alternative fuel and renewable energies to maintain global competitiveness.

Based on the Malaysian biomass power generation in the palm oil mill industry and the Kyoto Protocol which Malaysia has ratified, an initial target of 5% of the industry generating capacity, or 600-900MW equivalent by the year 2005 was set. This was based on the actual Maximum Demand recorded in May 5th 2005 of 12,493MW that forecasted the power demand in 2005 to be 13,913MW (Tenaga Nasional Berhad, Annual Report, 2005). Thus, the opportunities for renewable energy power generation in Malaysia are indeed promising.

1.2 Problem Statement

Despite the euphoria on the potentials of biomass feedstock for power generation, actual planting up has been sluggish. Only a few of the 62 approvals, such as the 2MW Landfill Gas Power Plant and a few Biomass Power Plants in Sabah and Semenanjung, have taken off (under construction) indicating, invariably, the need to revamp the 5th fuel policy for the forthcoming 9th Malaysia Plan (2006-2010). The primary reason for the sluggish planting up in Semenanjung Malaysia, it seems, was the (marginal) viability of the project at a low electricity tariff (RMsen 16.5 per kWh and RMsen 16.7 per kWh for landfill gas and biomass power respectively) purchased by the national utility board, namely, Tenaga Nasional Bhd (TNB). This, coupled with the heavy financial charges, consequence of the Asian Financial crisis of mid-97s, and sluggish global financial growth, resulted in higher imported capital equipments (due to higher foreign exchange rate), higher interest rates, and restrictive and stringent project loans further dampened the viability. This provides the backdrop and opportunity to research into a financial structure, albeit an

innovative and creative one, that could support the viability of the planting up (of the power plant), thus ensure success in implementing the Malaysian government's fifth-fuel policy.

1.3 Objectives

This research project dissertation entitled "The Development of A Business Framework and Techno-Financial Model for Biomass Power Plants" was proposed as a partial fulfilment for the Doctor of Engineering (Engineering Business Management) programme conducted at the Universiti Teknologi Malaysia.

The objectives of the Research Project will be the development of a "Business Solution" to improve planting up initiatives for biomass power plant projects in Malaysia. It will be two-fold as follows:

1. structuring of the Business Framework for the implementation of the Biomass Power Plant. The framework comprises the implementation, technical and financial structure. The complexities of the project are further exacerbated by the marginal viability of the project and complication due to the difficulties of the inconsistent quality and intermittency of supply of the mixed waste/feedstock. Thus the financial aspect requires in-depth treatment and this will be the basis for the construction of the Techno (sic) - Financial Model which is the core of the financial structure.

2. construction of a Techno -Financial Model to structure the long-term cashflow of the Biomass Power Plant to ensure its financial viability.

This “engineering business” approach is more “financial”, rather than “technical”, as that, so far, lacks proper research. The study will use the Landfill Gas Power Plant as an anchor project to test the Techno-Financial Model, as the project has been successfully commissioned in March 2004. This 2MW LFG Power Plant is Malaysia’s first LFG Power Plant and the first grid-connected Renewable Energy project (under the SREP programme). This project uses methane gas generated from decomposition of Municipal Solid Waste (MSW) disposed at the sanitary landfill site in Puchong, Selangor, as the feedstock. Thus, these Business Framework and Techno-Financial Model is the core of the Research Project.

1.4 Scope of Research Project

This Research Project will examine the issue from the perspective of business, technical and finance. These factors are indeed the critical component for success for these types of venture. The feasibility study (technical feasibility and financial viability studies) to develop such a project must integrate these factors in an interactive manner to become a properly structured Business Plan. In other words, the project must be properly “Financial Engineered” to achieve symbiosis for the business, technology and financial structures to make the project viable in the long-term. Based on the findings of these studies, this research will suggest measures that could be adopted to overcome these deficiencies in order to make these RE initiatives a success. As such, the scope of the Research Project would be as follows:

1. Identify key business components such as the Renewable Energy Power Purchase Agreement, Engineering Procurement Construction and Commissioning contract and Fuel Supply Agreement that becomes the implementation structure to ensure the long-term viability of the project.

2. Identify key technical variables that determine the technical structure of the project.

3. Identify key financial variables such as the Capital Cost and the Operating Cost that determine the financial structure of the project.

4. Construct the Techno-Financial Model as an integral component of the financial structure to dynamically link the key technical and financial variables.

The methodology of the Research Project would be by means of Literature Reviews. A Research Survey was also conducted involving two questionnaire surveys: secondary sources for the LFG power and Biomass Power would be from Britain, India and Thailand; and local sources would primarily be from the palm oil industry. Primary data was obtained from the LFG Power Plant project in Air Hitam and Genting Sanyen Power (IPP) co-generation plant in Ulu Langat, Selangor, Malaysia.

1.5 Limitations of the Research

The approach for this Research Project would be "business" rather than "technical" in nature as: firstly, there are already numerous researches conducted in the engineering aspects of biomass power generations; and secondly, the Engineering Doctorate is in Engineering Business Management. Thus, this Research Project would be more inclined towards the business and financial aspects in successfully implementing RE projects, in essence, its financial viability rather than technical feasibility.

Limitations to the study were due primarily to the following factors: Firstly, its infancy as there is inadequate information (secondary data) in the public domain to corroborate the study exhaustively. There are however, fragmented information

from both the oil palm industry and the power generation industry that could be used to create a wholesome model. Secondly, the main players in this industry are entrepreneurs (rather than corporate players). Therefore, there is a lack of documentation, and also a shroud of secrecy, to protect their commercial interest. Corporate players are not keen to participate due to the long gestation period that involves high risk and high hurdles. They are keen to acquire on-going projects even though if it involves premium payment due to the advantage of immediate recognition of income and guaranteed planting up. Lastly, renewable energy is "site specific; technology specific; and feedstock specific". That is to say, it is applicable only to certain countries, using certain technology due to the abundant availability of a particular source of renewable supply. For example, in the Scandinavian countries wind power generation is found in abundance due to the rather strong wind migration pattern from the North Pole region. This is also true for Malaysia which lacks this wind pattern, and therefore, wind energy is not promising.

Malaysia has, however, promising potentials in both solar and biomass energy development. Therefore, the only innovative way was to extract the relevant and applicable experiences from these countries, and amalgamate it with the Malaysian experience, and customize its implementation. Malaysia also has quite an extensive renewable energy power generation experience using mini-hydro power and palm oil biomass in the oil palm industry (PTM, 2001) for more than three decades, but the only snag was that these generations are not grid-connected and tends to be "inefficient" (complacency due to abundance of waste supply), and does not contribute to the national power generation mix.

1.6 Significance and Contribution of the Research

Fossil fuel is the prime mover of developing and industrialized countries. For Malaysia to achieve the Vision 2020's objective of being a fully industrialized nation by the year 2020, the country has to address seriously these initiatives. The significance of this Research Project therefore, evolves around three primary factors:

Firstly, due to economic reasons as fossil fuel is the prime mover of the economy. As supply of fossil fuels are fast depleting causing a drastic increase in fuel prices, and disadvantaging the third world and developing countries, making their produce in the borderless world less competitive, the “best” and perhaps the only alternative, for these predominantly agriculture countries are to develop their own RE technologies based particularly on biomass residues. This Research Project would contribute to a greater understanding of the Business Framework that could ensure the long-term financial viability of the project.

Secondly, due to strategic reasons countries which are dependent on the importation of fuels (import dependents countries) would expose themselves, both in terms of pricing and supply, to the global volatilities and eventually render themselves uncompetitive. The Economic Planning Unit (EPU) of the Prime Minister’s Department conducted a study (Longhi, 1998) on the RE potential in Malaysia and has concluded that RE feedstock, including biomass from wood residue and oil palm waste such as empty fruit bunch (EFB) and kernel shell constitute a significant fuel potential which remains mostly untapped. The estimate of biomass produced in the country, on an oil equivalent, amount to approximately RM10billion a year (produced annually). If properly utilised, this would save the country massive amounts of foreign exchange from the importation of fuels, such as coal and its associated invisible cost such as insurance and freight.

Thirdly, since renewable energies are power generation from an inexhaustible supply of feedstock such as solar, wind and biomass (from forest and agricultural waste) it has minimal impact on natural resources. Besides the generation of power to energize industries, the utilization of waste as feedstock also helps in its disposal which, if neglected, would have undesirable consequences to the environment. This Research Project would contribute not only towards reducing pollutions and green house gas emissions to the environment but adding economic values at the same time.

This Research Project is intended to contribute to the body of knowledge in these areas by constructing the Business Framework as a tool to ensure successful

implementation and Techno-Financial Model to ensure the long-term (financial viability) of the project.

1.7 Conclusion

This Research Project is about designing a “Business Solution” in the form of a Business Framework, integrating a Techno-Financial Model, as a tool, that would be able to ascertain the viability of a proposed project, given the technical and financial factors impinging at that point in time such as interest rates, feedstock cost and capital equipment cost of a particular technology. It is a crucial tool in structuring the long-term viability of the business and guiding the financial conduct at various levels and activities, in the operations of the business. It is also an important, and powerful instrument, in the negotiating process not only with the power off-takers to negotiate for a viable tariff, but also with government agencies to negotiate for investment incentives to enhance the project viability, and bankers (to further enhance the profitability) as it reduces the uncertainties and risk inherent in such a high risk venture. The lesser the risk inherent in a project the softer would be the loan that could enhance the expected return on investments. In addition, the Techno-Financial Model could also be used to determine the market position of the business using new technologies.

This Research Project could contribute to the vast body of knowledge, both in the industrial and academic world, by providing a platform that would enable decision makers (enabling technology) to make a more informed decision. This “knowledge is power” is, by far, heralded as the single most important attributes of Chief Executive Officers in the present k-economy era and beyond.

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