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Feasibility Study of Forestry Project in Sarawak State, Malaysia

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Abstract

This research paper investigates available options for implementing clean development mechanism (CDM) project in Sarawak state, Malaysia. To investigate economic feasibility, data was collected using survey and field research methods. Also, economic analysis was estimated using net present value (NPV), internal rate of return (IRR) and payback period (PBP) during the 30 years CDM: afforestation and reforestation periods. The result of economic analysis indicated that, the payback period was estimated at 9 years with 18 percent of internal rate of return (IRR). This study also highlighted that CDM biomass supply project have a lot of challenges due to the reduction and exclusion of bio-Solid Recovered Fuel (SRF), supply and demand scenario, and impact of restriction of illegal logging in Malaysia. This study results demonstrate the methodology and guideline for future CDM investment and projects.

Key Words: feasibility study, timber product, wood pellet, net present value, internal rate of return

Introduction

Domestic wood supply has been increased due to the maturity of domestic forest in S. Korea (Jung et al. 2010). However, there are also increased in imported timber due to lack of domestic wood supply in S. Korea timber supply chain (Kim 2012). Demand for imported wood was expected to increase steadily as it is expected to be 16.4% less self-sufficient as of Annual Report on Forest Landscape (Korea Forest Service 2017).

However, increased cost of timber product and restriction of export wood product from international timber market, the imported timber has faced a lot of challenges to supply wood product to domestic market (Woo and Seo 2002). To overcome these problems, some of the alternative options were considered to improve wood supply in S. Korea and CDM is the one of the attractive options considered carbon reduction and implementation of United Nations Framework Convention on Climate Change (UNFCCC) (Ui 2006; Kim 2018).

The average annual production volume (MAI : Mean Annual Increment) of tropical forest (Southeast Asia and South America) is approximately 20 and 35 m^3/ha/year and the total wood supply chain cost is much lower than Korea wood supply chain cost (Korea Forest Promotion Institute 2017). For these reasons, Korea government and forest industry are looking for opportunities to implement CDM projects in Southeast Asia and South America (Korea Forest Research Institute 2006; Shin 2014). Additionally, increased fuel cost and environmental concerns, forest bio-

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mass and bioenergy feedstock are widely used to produce bio-energy in worldwide.

Despite the efforts in using forest biomass, there are still barriers to intensify and commercialize use forest biomass in S. Korea. The wood biomass demand such as wood pellet has continued to increase since 2009 due to the government's policy to expand the supply of new renewable energy sources such as RPS (Renewable Energy Portfolio Standard) and RHO (Renewable Heat Obligation) (Korea Forest Service 2001; Korea Forest Service 2016). In fact, the current supply of wood pellet production (supply) is only 3.8% as of 2017 (Korea Forest Service 2017). Interest and investment in CDM projects are rapidly increased for implementation of CDM such as securing carbon emission rights and trade (Park 2008). The Korea government also set up various plan to complement the shortage of domestic wood supply.

This research paper presents an investigation being conducted to collate, analyses and implement a CDM project in Malaysia. To investigate economic feasibility, data was collected using survey and field research methods. Also, economic analysis was estimated using net present value (NPV), internal rate of return (IRR) and payback period (PBP) during the 30 years CDM: afforestation and reforestation periods. This study is going to demonstrate the methodology and guideline for future CDM investment and projects.

Materials and Methods

Study Area

Sarawak province is covered 38% (12.38 million ha) of Malaysia and industrial afforestation site is established in 211,748 ha (Table 1).

The total forest area in Sarawak, including secondary forest, was managed to be as large as 10 million ha. The land use information was shown in Table 2 and it is classified by forest type GIS data.

Research method

Research procedure

To conduct economic analysis, forest type was investigated using remote sensing (RS) and geographic information system (GIS) techniques, investment cost wood pellet plant was used to economic feasibility analysis and following input data were collected from local wood pellet business industry (Fig. 1).

- Investment cost for local wood pellet construction

Table 1. Malaysia land use and forest type

Site	Area		Dipterocarp	Wetland	Mangrove	Afforestation	Sum	%
	ha	%						
Malaysia Peninsula	13.18	40	4.17	0.25	0.10	0.39	4.91	37.3
Sabah	7.37	22	3.88	0.12	0.34	0.11	4.45	60.4
Sarawak*	12.38	38	7.89	0.54	0.08	0.89	9.37	75.7
Malaysia	32.93	100	15.94	0.91	0.52	1.36	18.73	57.8

Sources: FDPM Annual Report 2015, SFD Annual Report 2014&Mashor Ahmad 2014, FDS Annual Report 2013, Jason Hon &Shozo Shibata (2013).

Table 2. Information of Sarawak land use and forest type

Land use (*unit: ha*)	Forest	Wetlands	Mangrove	Non-forest	Gross area	%
Persistent Forest (PFE)	3,973,595	176,614	12,924	158,863	4,321,996	34.90
Total Protection Area (TPA)	405,724	70,749	10,535	30,189	517,197	4.18
National land	4,886,576	289,939	55,788	452,567	5,684,870	45.92
Farming industry	298,036	216,798	7,011	1,335,771	1,857,616	15.00
Total	9,563,931	754,100	86,258	1,977,390	12,381,679	100

- Price of pellet production volume ($/m^3)
- Net Present Value (NPV)
- Internal rate of return (IRR)

Field data collection

The height and diameter at breast height (DBH) data were collected by field measurement data collection. Total five sample plots were selected to collect height and DBH data in 3 to 7 age old sample sites. The field data collection was conducted by professional forest labors who worked in local forest company. The collected height and DBH data were used to input value to calculate the volume/ha and total volume in selected study area.

$$V = 0.25 \times \pi \times (\frac{D}{100})^2 \times h \times f \quad (1)$$

Where:
V (m^3) : Volume of Single Tree
D (m) : DBH of Standing Tree
h (m) : Tree Height of Standing Tree
f : Form Factor, 0.6

Economic feasibility analysis

Net Present Value (NPV): NPV is the difference between the present value of cash inflows and the present value of cash outflows over a period of time. NPV is used in capital budgeting to analyze the profitability of a projected investment or project (Kurt and Daniel 2003).

$$NPV = \sum_{t=1}^{T} \frac{C_t}{(1+r)} - C_0 \quad (2)$$

Where:

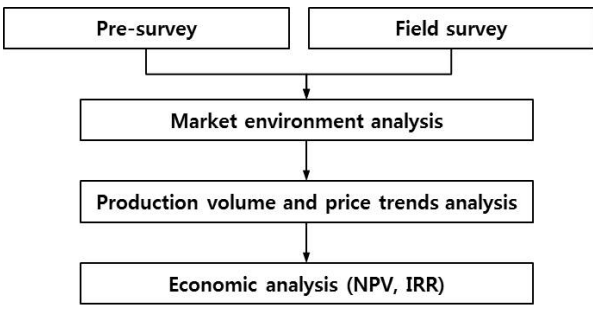

Fig. 1. Overall research procedure.

C_t = Net cash inflow during the period
r = Discount rate
T = umber of time period
Co = Total initial investment cost

Internal Rate of Return (IRR): IRR is a metric used in capital budgeting to estimate the profitability of potential investments. Internal rate of return is a discount rate that makes NPV of all cash flows from a particular project equal to zero (Kurt and Daniel 2003).

$$\sum_{t=0}^{n} \frac{B_t}{(1+i)^t} - \sum_{t=0}^{n} \frac{C_t}{(1+i)^t} = 0 \quad (3)$$

Where :
B_t = Net cash inflow during the period
C_t = Initial investment at the start of the project (the period n is usually given in years)
t = umber of time period
i = discount rate
n = project periods

Results and Discussion

Malaysia is the most stable country in politics, economy and society among the developing countries in Southeast Asia. Forest area is approximately 2.2 million ha and 68% land is covered with forest. The economic growth rate is 4%, and minimum wage is 800 to 920 Linggit in 2017. The 44% of the total land area is designated as permanent forest, and the estimated growth rate in afforestation area is 10-30 m^3/ha (Korea Forestry Promotion Institute 2017).

Field Survey

Climate and infrastructure

The average temperature of afforestation candidate sites were 27.3°. The humidity is 75% and annual precipitation is 2,796 mm. The average daytime under the sunshine is 5.5 hours and average wind speed is 3.6 m/s. The minimum distance from pellet plant to the export port (Bintullu) is 20 km and the furthest distance is 100 km. The average width of forest road is 6 m and 2 m in main and subsiding road respectively. The energy supply rate of Malaysia is one of the highest countries in Southeast Asia. For this study, af-

forestation area was classified using Google Earth image analysis using 2006, 2007, 2008, and 2015 image data.

Afforestation study field sites

The study area, afforestation plantation sites, was managed by Malaysia government. The most of planted species are consisted with *Eucalyptus pellita*. The annual harvesting area was around 14,000 ha/year. This afforestation sites owned public seed nursery to supply plantation trees. The targeted harvesting trees were less than 12 cm DBH and most of them were used for green pellet feedstock material. As a result of field study measurement, total number of measured trees were 819. The number of stems and volume were presented in Table 3.

The average height of three age old stands are 11m and rest of them are 13 m. In DBH, three age old stands were 11 cm and four age old stands DBH were 12 cm. As a result of field study survey, 67 m^3/ha, 96 m^3/ha, 117 m^3/ha, 131 m^3/ha, and 162 m^3/ha were estimated in age three, four, five, six, seven old stands respectively (Fig. 2).

Profitability analysis

Type of industrial afforestation business

Timber production business: Afforestation is planned 14,000 ha with rotation seven years during 60 years. For the

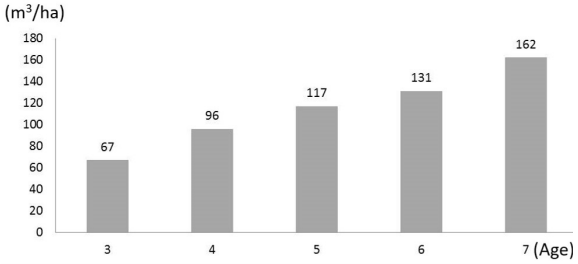

Fig. 2. The information of volume and age structure in Eucalyptus pellita afforestation sites.

Table 3. Field study measurement of sample plots

Plot no.	Category	Study site age class (years old)				
		3	4	5	6	7
1	Stem number (number)	36	34	32	34	30
	Volume (m^3)	3.0910	3.6489	4.4971	5.2290	5.7104
	Stem number (number/ha)	900	850	800	850	750
	Volume (m^3/ha)	77.27619	91.2225	112.4277	130.7261	142.7601
2	Stem number (number)	33	32	35	32	37
	Volume (m^3)	2.8139	3.1730	4.6914	5.0994	7.1919
	Stem number (number/ha)	825	800	875	800	925
	Volume (m^3/ha)	70.34699	79.3258	117.2853	127.484	179.7964
3	Stem number (number)	31	37	28	34	23
	Volume (m^3)	2.2982	4.2276	4.6919	5.2438	5.9735
	Stem number (number/ha)	775	925	700	850	575
	Volume (m^3/ha)	57.45572	105.6908	117.2963	131.0942	149.3376
4	Stem number (number)	34	30	32	35	34
	Volume (m^3)	2.5290	4.0566	4.7556	5.6636	6.5495
	Stem number (number/ha)	850	750	800	875	850
	Volume (m^3/ha)	63.22547	101.4157	118.8898	141.5897	163.7373
5	Stem number (number)	37	33	35	31	35
	Volume (m^3)	2.7073	4.1263	4.8099	5.0675	7.0600
	Stem number (number/ha)	925	825	875	775	875
	Volume (m^3/ha)	67.68192	103.1576	120.2471	126.6872	176.4994
Sum	Stem number (number)	171	166	162	166	159
	Volume (m^3)	13.4394	19.2324	23.4459	26.3033	32.4853
	Stem number (number/ha)	855	830	810	830	795
	Volume (m^3/ha)	67.1973	96.1625	117.2292	131.5162	162.4262

first seven years, it will be planted at 2,000 ha per year and annual growth rate is 70 m^3/ha/year. After first rotation year (7 years), available harvesting area is estimated at 2000 ha/year and production of timber volume was calculated at 140,000 m^3/year.

Wood pellet production industry: To produce pellet feedstock, the feedstock material was provided from afforestation residues or byproduct 200,000 ton of raw material was supplied to produce 100,000 ton of wood pellet.

After harvesting rotation age (seven years), the generated material was multiple than initial feedstock source (100,000 ton) then, 200,000 ton of pellet production was expected to produce pellet.

Wood pellet

Domestic wood pellet price forecast: According to the Forest Service statistics, it was expected to 175 USD per ton in 2014 and 120 USD/ton in 2015. Additionally, the cheap pellet imported from Vietnam leading price deceasing. As a result, the pellet price was decreased to 90 USD/ton in 2016 and current pellet price is increased to 120 USD/ton in 2017.

Wood pellet price Forecast: According to the 2030 new renewable energy policy in S.Korea, previous biomass policy was changed to strict to prohibit using industrial biomass waste such as Bio-SRF. Using domestic woody biomass is raised public awareness, the domestic wood pellet market is expected to various change in near future. In addition, high quality wood pellets are integrated RFID and traceability techniques which are available to monitoring wood supply chain.

Timber and wood pellet business profitability

General information of business profitability analysis in Malaysia is as shown in Table 4.

Profitability analysis

Total project investment cost for the first 7 years: The total project investment cost is 152 million USD including afforestation, harvesting, and construction cost. Afforestation cost is allocated in 28 million USD and product cost of pellet and harvesting is 93 million USD, and factory construction cost is estimated at 32 million USD. As indicated above, the harvesting and pellet production cost is consisted 60% of total cost. It is presented that the logistic cost of pellet production is most important cost factor in this project.

The result of profitability analysis: As a result of profitability analysis, the total investment cost of this project 153 million USD and total generated revenue from this project is estimated 131 million USD during 7 years. To invest this biomass project, 22 million USD was required. For this study, 10 million USD cash was invested from owners capital and 12 million USD was assumed to loan from borrowed capital. The interest rate of borrowed capital was assumed 6% and redemption was set to repayment in three years with a seven years grace period.

To estimate feasibility analysis, the study was assumed that the price index 4.5%, corporate tax rate 24%, discount rate 10%, wood price 100 USD/m^3, and pellet price 115 USD/ton. As a result of feasibility analysis, the project IRR was estimated at 18% during 30 years period and NPV was estimated 55,961,691 USD respectively. Also, the payback period was identified at 9 years.

Sensitivity analysis of NPV & IRR according to timber and wood pellet price: Sensitivity analysis was conducted to investigate impact of variables among the input variables such as discount rate, timber price, and pellet price. NPV was increased to 1.64 times when it discount rate was decreased from 10% to 7.5%. Also, NPV was increase to 2.72 times when discount rate decreased to 5.0%. Conversely, if discount rate was increased to 12.5%, NPV

Table 4. General information of business profitability analysis

Business overview	Project area	14,000 ha
	Project period	January 1, 2018 to December 31, 2048
Main Factor	Price index	4.5% (world Bank)
	currency	USD
	Corporate tax rate	24%
	Applied exchange rate	1,150 won=1 USD
	Discount rate	10%
	Timber price	100 USD/m^3
	Pellet price	115 USD/ton
	Factory capacity	200,000 ton/year (Initial 100,000 ton/year, after 7 years 200,000 ton/year)

was decrease to 0.6 times than 10% discount rate. Additionally, discount rate was increased to 15%, NPV was 0.34 times than 10% discount rate. Based on this assumption, NPV will be zero when discount rate increased to 21.9%. Also, if timber price is going down from 100 USD to 47.9 USD, the NPV was estimated zero. Timber price is decreased from 100 USD to 90 USD and 80 USD, IRR was decreased 1.6% and 3.3% respectively. Conversely, when timber price is increased from 100 USD to 110 USD and 120 USD, IRR was increased 1.5% and 3.1% respectively. Wood pellet price is going down from 115 USD to 87.6 USD, the NPV was estimated zero. Wood pellet price is decreased from 115 USD to 100 USD, IRR was decreased 6%. Conversely, when wood pellet price is increased from 115 USD to 130 USD, IRR was increased 7.1%.

Conclusion

This study analyzed Malaysia's economic and afforestation environment, environment for afforestation candidate, growth analysis through pre-investigation and field investigation, and then used the values to analyze the project profitability. The location of afforestation candidates were very efficiency when it considered transportation logistic costs from factory to export ports. Also, the infrastructure around afforestation area is not only enough to support afforestation project but also, the energy demand of pellet plant was satisfied by energy supply from infrastructure facilities.

The afforestation project has seven years rotation plan and to plant 14,000 ha of *Eucalyptus pellita* to produce 280,000 m^3/year of timber product after 7 years. During initial project periods (one to seven year), wood pellet plants can produce 100,000 tons of pellets and 7 year later, predicted pellet production was estimated 200,000 tons.

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