Kingdom of Cambodia

Survey on Rice Husk Power Generation Project in Cambodia (Small and Medium-Sized Enterprise Partnership Promotion Survey)

Final Report (Summary)

May 2013

Japan International Cooperation Agency (JICA)

EJ Business Partners Co., Ltd.
Eight-Japan Engineering Consultants Inc.

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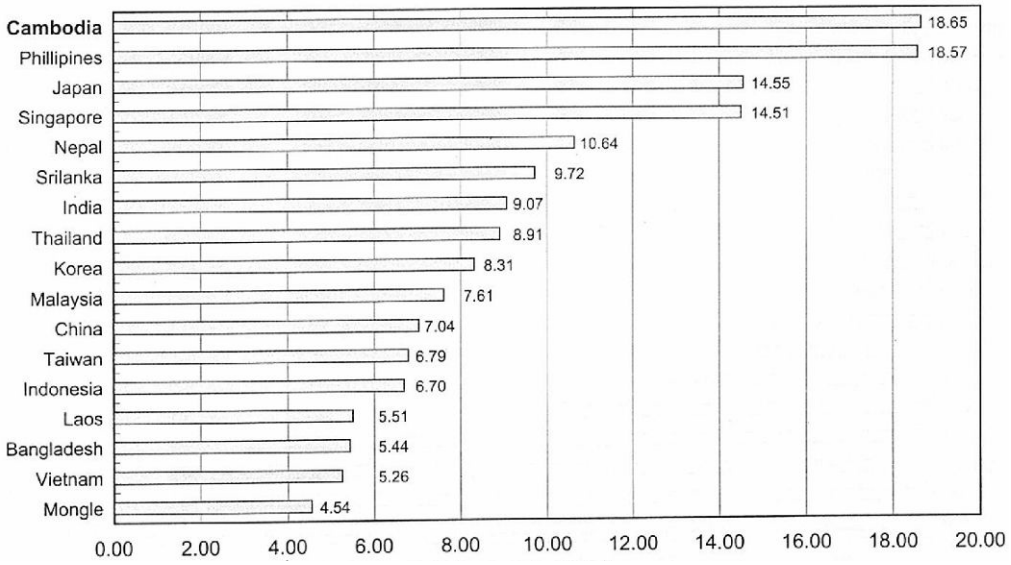
1. Project Background and Purpose

1.1 Project Background

Agriculture makes up 32.8% of Cambodia's GDP of approximately 13.2 billion US dollars. Roughly 80% of Cambodia's 14 million people make their living as farmers in the country's agricultural regions. Additionally, 97% of Cambodia's total agricultural land is devoted to rice production, and therefore rice-related industries form an important element in domestic economic development. At the same time, the Cambodian government is striving to activate rice-related industries throughout the country under a national policy of increased rice production and export promotion. However, much of the unhulled rice produced in Cambodia is not milled there, but rather sent directly from domestic farmers to the neighboring countries of Thailand and Vietnam. This situation is an obstructive factor in the execution of the government's policy. Moreover, rice millers in Cambodia must grapple with high power costs that place a serious drag on their businesses. Consequently they continue to have difficulty demonstrating any advantage when procuring unhulled rice in competition with Thailand and Vietnam.

The use of energy from rice husks is looked to as a possible means of alleviating the power cost burden on millers. Among biomass resources, rice husks in particular have the characteristics of uniform qualities and shape that make them highly valuable for use as an energy fuel. However, because introducing and maintaining rice husk power plants requires considerable labor and cost, there are many rice millers who will struggle to adopt the technology on their own. Accordingly, overcoming these problems and promoting the use of rice husk power plants present important challenges for Cambodia.

Figure 1: Electricity tariffs in Cambodia and neighboring countries (US cents/kWh)

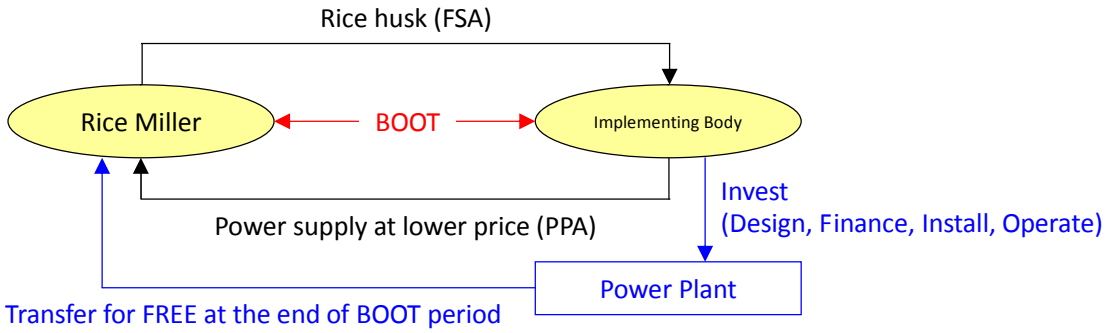


Source: Ministry of Industry, Mining and Energy

1.2 Project Purpose

The purpose of this project is to use the BOOT (Build-Own-Operate-Transfer) method to introduce power-generating equipment that uses rice husks discharged from milling plants as fuel in milling business of Cambodia. The project's implementing body, EJ Business Partners Co., Ltd. (hereafter, the Implementing Body) will handle planning, funding, design/construction, and operation of rice husk power plants on behalf of a local rice miller. The Implementing Body will transfer all ownership rights and privileges associated with the rice husk power plants to a targeted rice miller without charge following completion of the BOOT period. Furthermore, in addition to the BOOT contract, the Implementing Body will enter into separate fuel supply agreement (FSA) and power purchase agreement (PPA) with the targeted rice miller. The basic plan of action for the project will be as follows: The targeted rice miller will supply a fixed amount of rice husks discharged from its milling plant to the Implementing Body at a set price, in exchange for which the Implementing Body will supply power generated from the supplied rice husks to the targeted rice miller at a price that is below the current power price.

Figure 2: The project concept



The basic objective of the project is to make a contribution toward increased domestic rice production and promotion of rice exports and the vitalization of domestic rice millers. This will be achieved by reducing the operational costs of milling plants and thus raising the competitiveness in the procurement of unhulled rice from local farmers with a supply of power that is less expensive than the current power supply to local rice millers. In addition, using the BOOT method will produce benefits for the targeted rice miller. Among them will be the ability to introduce a power plant that uses in-house supplies of rice husks as fuel without the need to outlay expenditure to cover plant introduction, employment of specialized personnel, or maintenance or for time- and labor-consuming operations.

1.3 Project Implementation Strategy

The power-generation technology to be used in the project will be the boiler-turbine generator (BTG) method. It is a technology that has already been applied in numerous rice-husk power generation projects in other countries and can operate continuously. As for the scale of power generation, the project will set the amount generated at 1,000 kW or more per project case (based on consideration of investment efficiency), and the targeted milling plant that produce more than 100 tons of milled rice per day. In general, the amount of rice husks generated in the milling process is about 22% of the amount of milled rice. If it is considered that the amount of rice husks needed to generate 1,000 kWh is 1.8 tons/hour, a milling plant that produces at least 100 tons of milled rice per day should be able to supply approximately 50% of the rice husks it needs to operate a 1,000 kW power plant continuously for 24 hours a day.

Figure 3: The project process (conceptual image)

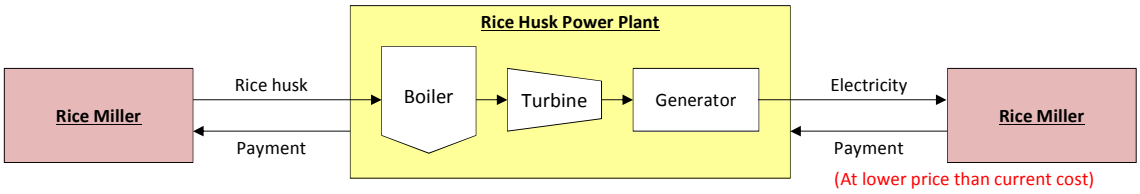
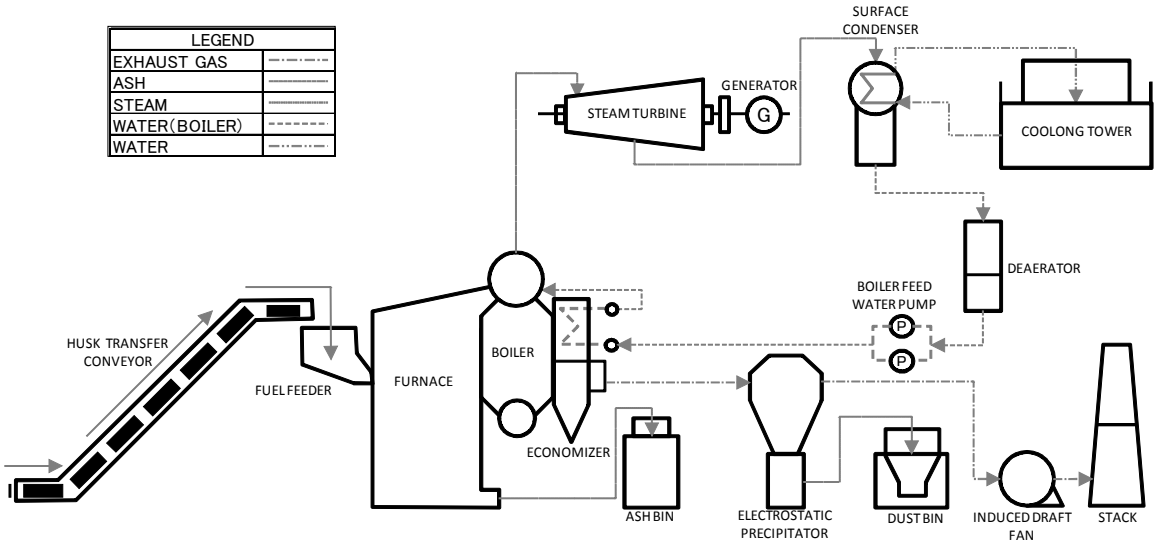


Figure 4: The power generation process using standard BTG



2. Survey Outline

2.1 Survey Outline

Name	Survey on Rice Husk Power Generation in Cambodia
Ordering party	Japan International Cooperation Agency
Accepting party	Consortium for the Survey on Rice Husk Power Generation in Cambodia ・EJ Business Partners Co., Ltd. (representative) ・Eight-Japan Engineering Consultants Inc. (constituent member)
Work period	September 13, 2012 – May 27, 2013

2.2 Survey Implementation Strategy

In undertakings involving biomass power generation such as this project, stable procurement of fuel is an important factor. Thus, for this survey, the basic plan of action was to implement a flexible fuel procurement plan that corresponds to actual generated amounts of rice husks. The survey also investigated the environment surrounding Cambodia's rice-milling businesses in order to evaluate the management risk of the targeted plant that will be charged with fuel supply. Moreover, given the need to fully consider the risk of lower power sales prices for the project (i.e., the risk that public power costs in the target regions could fall as a result of the government's policy to develop large-scale power sources and expand the power grid), the survey also studied and arranged data that give a general picture of Cambodia's power sector as well as future development plans.

Figure 5: Survey outline

Survey item	Description
Local business environment	System of tax breaks for investment, tax system, accounting systems, power-related legal system, environment-related legal system, rice-milling business environment, power business environment, etc.
Project business model	Identification of client, differentiation from competing companies, introduced technologies, project site selection
Formulation of project plan	Project schedule, basic power plant plan, fuel procurement plan, power sales plan, incinerated rice husk ash disposal

	plan, operation and maintenance plan, startup cost estimates, funding plan, depreciation plan, loan repayment plan, forecasted financial statements for the project period, project feasibility evaluation
Project risks	Identification of major project risks, assessment of impact when risks occur
Environmental and social consideration	Scoping, proposed countermeasures and strategies

3. Survey Results

3.1 Local Business Environment

3.1.1 System of Tax Breaks for Investment

Figure 6: Summary of survey results on the system of tax breaks for investment (applicable conditions for the project)

Item	Description
Prohibition of investment activity	N/A
Negative list for application of investment tax breaks	N/A
Exemption from corporation tax	May be applicable (0% during project period)
Period of exemption from corporate tax	Minimum of 5 years (depending on time of occurrence of profit)
Exemption from import duties	May be applicable (0%)
Restriction on foreign investment	N/A (no land ownership)
Investment guarantees	Applicable (freedom of overseas remittance, prohibition of price controls, etc.)
Period for acquisition of investment license	Minimum of 31 business days from application *Need to fully consider risk of delay
Investment license application fee	Approx. 1,800 USD

3.1.2 Tax System

Figure 7: Summary of survey results on the tax system (applicable conditions for the project)

Item	Description
Corporative income tax	Annual rate of 20%
Withholding tax	—
Interest payments (expatriate)	14%
Repatriation of dividends (expatriate)	14%
Service charge payments (expatriate)	14%
Value-added tax	10%
Registration tax (at time of corporate registration)	300 USD
Real estate tax (on real estate valued at 25,000	Annual rate of 0.1%

USD or more, excepting farmland)	
Import duties (equipment, facilities, etc.)	15%

3.1.3 Power-related Legal System

Figure 8: Summary of survey results on the power-related legal system (applicable conditions for the project)

Item	Description
Class of power business license	Power Generation
Annual license fee	0.000425 USD/kWh (based on electricity generated)
Power plant performance	Based on general requirements and special requirements of power technical standards established by the Electricity Law
Period of acquisition of power business license	Total of 15 months (MIME = 12 months + EAC = 3 months)
Application fee for power business license	150 USD

MIME: Ministry of Industry, Mining and Energy

EAC: Electricity Authority of Cambodia

3.1.4 Environment-related Legal System

Figure 9: Summary of survey results on the environment-related legal system (applicable conditions for the project)

Item	Description
Obligation to conduct environmental impact assessment	None
Environmental standards	・ Based on plant effluent quality standard ・ Based on management standards for solid waste (rice husk ash) ・ Based on plant exhaust release standards and plant noise standards

3.1.5 Rice-milling Business Environment

Figure 10: Summary of survey results on the rice-milling business environment

Item	Description
Trends concerning rice-milling	・ In total, there are 15,499 rice-milling businesses existing in Cambodia (as of November 2012).

businesses	・ The number of medium and large rice millers (operating expense of 50,000 USD or more) is 145. Thus, almost all rice millers in Cambodia are small. ・ The Cambodian government announced a policy to increase rice production and promote rice exports in 2010. Since then, the number of large rice millers newly entering the business has been increasing. (The number of businesses taking advantage of new tax breaks for investment was zero in 2010, 2 in 2011, 6 in 2012.)
Use of rice husks	・ Currently, domestic rice millers in Cambodia can dispose of rice husks by using them as fuel in in-house rice husk power plants, selling them to other consumers (brick factories, salt factories, etc.), etc. ・ In Cambodia, it is common to see power plants that gasify rice husks (Indian technology, manufactured in Cambodia) installed in medium and large milling plants. At the present time, approximately 80% of medium and large milling plants have such power plants. ・ Rice millers that have already installed rice husk gasification power plants can cover their fuel needs with rice husks that are produced at their own milling plants. This can help them reduce their power costs significantly. ・ However, it was confirmed that the rice husk gasification power plants that are now commonly used present some environmental impact problems in terms of managing rice husk ash and cleaning water.

Rice husk gasification power plant (reacting furnace)

Rice husk gasification power plant (gas engine)

Ash from a rice husk gasification furnace

Drainage water treatment equipment of a rice husk gasification power plant

3.1.6 Power Business Environment

Figure 11: Summary of survey results on the power business environment

Item	Description
Summary of the power sector	・ In outlying regions, mainly small-scale generation and distribution businesses provide power using low-efficiency small-scale generators. Power prices are high as a result (suburbs of Phnom Penh = 0.15 – 0.21 USD/kWh; Kampong Thom Province and Kampong Cham Province = as high as 1.00 USD/kWh). ・ Large-scale power sources and regional grids are being planned or under development planning for 2020 at the

	latest. These facilities should help resolve power shortages and high power prices in Cambodia.
Trends concerning rice husk power businesses	・ At existing rice milling plants, rice husk gasification power plants that are based on Indian rice husk gasification technology are commonly used for in-house power generation. A Cambodian company called SME is well known domestically as an existing supplier of these plants. ・ As for rice husk power businesses seeking to sell power to the public grid, SOMA has begin building a 1.5-MW rice husk power plant (Indian gasification technology and GE gas generator) in Kampong Cham Province. ・ The Angkor rice husk power plant (2,000 kW) is a large-scale rice husk business that is bringing in steam power generation technologies utilizing direct firing of rice husks. The entire amount of generated power is supplied to an adjacent Angkor milling plant. In addition, sales of incinerated rice husk ash as soil improvement material and cement material are being studied.

View of the Angkor rice husk power plant

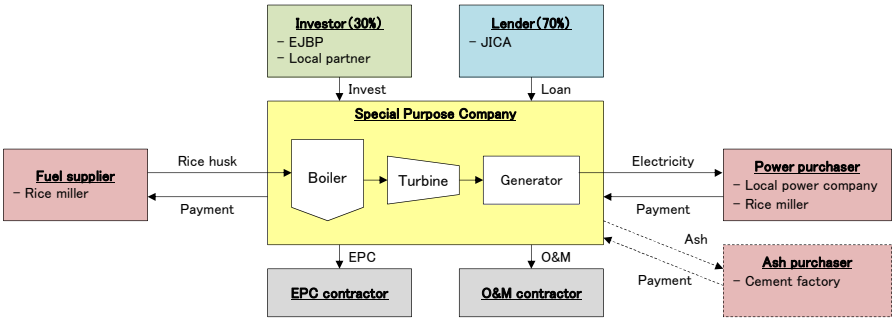
Incinerated rice husk ash packing plant

3.2 Project Business Model

Figure 12: Summary of the results of the business model study

Item	Description
Identification of client, project site selection	・ The following outlines the requirements of the rice milling plant to be targeted as a client under the project. These requirements are based on information obtained from the local business

	environment survey. 1. The plant must produce milled rice at a rate of 100 tons/day (i.e., the amount capable of supplying approximately 50% of the rice husk amount needed for 1-MW power generation) or more and have a sufficient supply of excess rice husks available. 2. The plant must not have an in-house power plant that uses rice husks as fuel, and must currently be paying high power prices (in order to secure power-selling advantage from the project). 3. The milling plant must have at least 2 ha of empty space on the company's grounds in order to make new land acquisition for the project unnecessary. ・ A comparative study that took the above requirements into account was conducted for seven rice milling plants that were visited individually during the survey. This study led to the selection of Lor Ngor Pheng Rice Mill (hereafter "LNPRM"), located in Kampong Cham Province, as the priority client.
Differentiation from competing companies	・ The following outlines differentiators with competitors (i.e., other entrants into the rice husk power business) in the project. 1. Use of the BOOT scheme by the project can help the rice miller (i.e., the client) avoid the burdens of initial cost, operation during design and construction, maintenance, etc. 2. Providing benefits through introduction of the BOOT scheme (e.g., inexpensive power, freedom from maintenance, free transfer of plants following contract termination, etc.) will create exclusive rice husk trade and secure stable supplies of fuel. 3. The project will meet standards in environment-related laws (drainage water quality, atmospheric emissions) and, with regard to rice husk ash, employ an incineration management method that can produce amorphous silica, which has low impact on human health. Thus, the project can reduce the risk that the rice miller (the client) will need to take environmental measures in the future.
Project	・ The following framework will be used in implementing the

implementation framework	project: 

3.3 Formulation of the Project Plan

Figure 13: Summary of the results of the project plan study

Item	Description
Project schedule	・ Commercial operation is to begin in January 2017. ・ Foundation work during the dry season (November to May) is a control condition.
Generation capacity, etc.	・ 1,000 kW (gross), 880 kW (net). ・ Generation capacity will be set based on the yearly amount of rice husk that can be realistically anticipated under current conditions and the power plant's fuel consumption.
Fuel procurement plan	・ Fuel will be procured at a fixed price of 5 USD/ton from LNPRM, which will be the main supplier. Fuel will be procured at a flexible price of 10 USD/ton x 10%/year (incentive) from another rice milling plant near the project site that will serve as the sub-supplier. ・ Because the main supplier's portion of the initial procurement ratio (main = 77%, sub = 23%) will be raised by 6.7% each year, overall procurement costs will not change, and may actually decline.
Power sales plan	・ 100 kW x 24 hours x 330 days = 792,000 kWh/year will be sold on a "take or pay" basis to LNPRM at a rate of 0.16 USD/kWh. ・ 780 kW x 24 hours x 330 days = 6,177,600 kWh/year will be sold on a "take and pay" basis to power distribution businesses at a rate of 0.12 USD/kWh.
Rice husk ash disposal plan	・ 14,256 tons/year of rice husk fuel x 16% = 2,281 tons of rice husk ash will be produced. ・ Given that negotiations on terms and conditions for planned sales

	to cement plants in Cambodia will take place based on actually produced rice husk ash, the sales figure is set at 0 USD/ton at the present time.
Project operation plan	・ O&M cost of 149,440 USD/year + SPC operation cost of 37,491 USD/year = 186,931 USD/year (project operation cost)
EPC estimate	・ Placement of an order with a Thai EPC company at an EPC cost of 4,027,500 USD is anticipated. ・ Selection will be made based on past experience in the field, estimate amount, implementation framework, etc. ・ A Japan-made turbine generator will be used.
Funding plan	・ Total fund procurement = 4,510,018 USD (includes EPC cost, project preparation expenditure, operation expenditure for initial year, and interest during construction) ・ Capital stock = 1,489,740 USD (33%), financing = 3,020,277 USD (67%)
Financing program	Anticipated use of JICA's overseas financing scheme (yen-based 15-year payment plan with 2-year grace period at 4% fixed interest)
Result of project feasibility calculation	・ P-IRR＝6.26% (11-year recovery) ・ E-IRR＝10.81% (9-year recovery)

Annual financial plan

a)Profit and Loss Statement

	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Project year	Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Operation year	Year	0	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Sales	**USD**	**0**	**0**	**868,032**	**868,032**	**868,032**	**868,032**	**868,032**	**868,032**	**868,032**	**868,032**	**868,032**	**868,032**	**868,032**	**868,032**	**868,032**
Power sales	USD	0	0	868,032	868,032	868,032	868,032	868,032	868,032	868,032	868,032	868,032	868,032	868,032	868,032	868,032
Ash sales	USD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cost of goods sold	**USD**	**0**	**0**	**237,330**	**236,296**	**231,544**	**226,528**	**221,248**	**220,720**	**220,720**	**220,720**	**220,720**	**220,720**	**220,720**	**220,720**	**220,720**
Fuel cost	USD	0	0	87,890	86,856	82,104	77,088	71,808	71,280	71,280	71,280	71,280	71,280	71,280	71,280	71,280
O&M cost	USD	0	0	149,440	149,440	149,440	149,440	149,440	149,440	149,440	149,440	149,440	149,440	149,440	149,440	149,440
Gross profit on sales	**USD**	**0**	**0**	**630,702**	**631,736**	**636,488**	**641,504**	**646,784**	**647,312**	**647,312**	**647,312**	**647,312**	**647,312**	**647,312**	**647,312**	**647,312**
Depreciation and amortization	USD	0	0	201,375	201,375	201,375	201,375	201,375	201,375	201,375	201,375	201,375	201,375	201,375	201,375	201,375
Project related cost	USD	0	0	18,091	18,091	18,091	18,091	18,091	18,091	18,091	18,091	18,091	18,091	18,091	18,091	18,091
Company administration cost	USD	0	0	19,400	19,400	19,400	19,400	19,400	19,400	19,400	19,400	19,400	19,400	19,400	19,400	19,400
Others	USD	2,250	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Operating profit	**USD**	**−2,250**	**0**	**391,836**	**392,870**	**397,622**	**402,638**	**407,918**	**408,446**	**408,446**	**408,446**	**408,446**	**408,446**	**408,446**	**408,446**	**408,446**
Interest payment	USD	120,811	120,811	120,811	111,518	102,225	92,932	83,638	74,345	65,052	55,759	46,466	37,173	27,879	18,586	9,293
Withholding tax (interest)	USD	16,914	16,914	16,914	15,613	14,312	13,010	11,709	10,408	9,107	7,806	6,505	5,204	3,903	2,602	1,301
Property tax	USD	0	0	3,826	3,625	3,423	3,222	3,021	2,819	2,618	2,417	2,215	2,014	1,812	1,611	1,410
Income before tax	**USD**	**−139,975**	**−137,725**	**250,285**	**262,114**	**277,662**	**293,474**	**309,550**	**320,874**	**331,669**	**342,464**	**353,260**	**364,055**	**374,852**	**385,647**	**396,442**
Profit tax	USD	0	0	0	0	0	0	61,910	64,175	66,334	68,493	70,652	72,811	74,970	77,129	79,288
Net income	**USD**	**−139,975**	**−137,725**	**250,285**	**262,114**	**277,662**	**293,474**	**247,640**	**256,699**	**265,335**	**273,971**	**282,608**	**291,244**	**299,882**	**308,518**	**317,154**

b)Balance Sheet

	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Project year	Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Operation year	Year	0	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Total assets	**USD**	**4,370,043**	**4,232,318**	**4,250,273**	**4,280,058**	**4,325,391**	**4,386,536**	**4,401,847**	**4,426,218**	**4,459,224**	**4,500,866**	**4,551,145**	**4,610,060**	**4,677,612**	**4,753,801**	**4,838,626**
Fixed asset	USD	4,027,500	4,027,500	3,826,125	3,624,750	3,423,375	3,222,000	3,020,625	2,819,250	2,617,875	2,416,500	2,215,125	2,013,750	1,812,375	1,611,000	1,409,625
Cash	USD	342,543	204,818	424,148	655,308	902,016	1,164,536	1,381,222	1,606,968	1,841,349	2,084,366	2,336,020	2,596,310	2,865,237	3,142,801	3,429,001
Liabilities	**USD**	**4,370,043**	**4,232,318**	**4,250,273**	**4,280,058**	**4,325,391**	**4,386,536**	**4,401,847**	**4,426,218**	**4,459,224**	**4,500,866**	**4,551,145**	**4,610,060**	**4,677,612**	**4,753,801**	**4,838,626**
Debt	USD	3,020,277	3,020,277	2,787,948	2,555,619	2,323,290	2,090,961	1,858,632	1,626,303	1,393,974	1,161,645	929,316	696,987	464,658	232,329	0
Paid in capital	USD	1,489,740	1,489,740	1,489,740	1,489,740	1,489,740	1,489,740	1,489,740	1,489,740	1,489,740	1,489,740	1,489,740	1,489,740	1,489,740	1,489,740	1,489,740
Retained earnings	USD	−139,975	−277,700	−27,415	234,699	512,361	805,835	1,053,475	1,310,174	1,575,509	1,849,481	2,132,089	2,423,333	2,723,214	3,031,732	3,348,885

c)Cash flow statement

	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Project year	Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Operation year	Year	0	0	1	2	3	4	5	6	7	8	9	10	11	12	13
CF from operating activities	**USD**	**−139,975**	**−137,725**	**451,660**	**463,489**	**479,037**	**494,849**	**449,015**	**458,074**	**466,710**	**475,346**	**483,983**	**492,619**	**501,257**	**509,893**	**518,529**
Income before tax	USD	−139,975	−137,725	250,285	262,114	277,662	293,474	309,550	320,874	331,669	342,464	353,260	364,055	374,852	385,647	396,442
Depreciation and amortization	USD	0	0	201,375	201,375	201,375	201,375	201,375	201,375	201,375	201,375	201,375	201,375	201,375	201,375	201,375
Profit tax	USD	0	0	0	0	0	0	−61,910	−64,175	−66,334	−68,493	−70,652	−72,811	−74,970	−77,129	−79,288
CF from investing activities	**USD**	**−4,027,500**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Payment to EPC contractor	USD	−4,027,500	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CF from financing activities	**USD**	**4,510,018**	**0**	**−232,329**	**−232,329**	**−232,329**	**−232,329**	**−232,329**	**−232,329**	**−232,329**	**−232,329**	**−232,329**	**−232,329**	**−232,329**	**−232,329**	**−232,329**
Debt financing	USD	3,020,277	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Debt repayment	USD	0	0	−232,329	−232,329	−232,329	−232,329	−232,329	−232,329	−232,329	−232,329	−232,329	−232,329	−232,329	−232,329	−232,329
Equity financing	USD	1,489,740	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Free cash	**USD**	**342,543**	**−137,725**	**219,331**	**231,160**	**246,708**	**262,520**	**216,686**	**225,745**	**234,381**	**243,017**	**251,654**	**260,290**	**268,928**	**277,564**	**286,200**
Accumulated free cash	**USD**	**342,543**	**204,818**	**424,148**	**655,308**	**902,016**	**1,164,536**	**1,381,222**	**1,606,968**	**1,841,349**	**2,084,366**	**2,336,020**	**2,596,310**	**2,865,237**	**3,142,801**	**3,429,001**

ROI statement

a)Benchmark for Investment

	Value	Remarks
Project-IRR	9%	WACC
Equity-IRR	20%	
Expected return rate of shareholde	20%	
Equity ratio	33%	
Interest	4%	

b)Investment Index

	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Project year	Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Operation year	Year	0	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Investment costs	USD	-4,510,018	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Project revenues	USD	0	0	572,471	575,007	581,262	587,781	532,653	532,419	531,762	531,105	530,449	529,792	529,136	528,479	527,822
Annual benefits	USD	-4,510,018	0	572,471	575,007	581,262	587,781	532,653	532,419	531,762	531,105	530,449	529,792	529,136	528,479	527,822
Accumulated benefits	USD	-4,510,018	-4,510,018	-3,937,547	-3,362,540	-2,781,278	-2,193,497	-1,660,844	-1,128,424	-596,662	-65,557	464,892	994,684	1,523,820	2,052,298	2,580,120
Project-IRR	**%**	**6.26**														
Project-NPV	**USD**	**-720,802**														
Project payback period	**years**	**11**														
Equity investment costs	USD	-1,489,740	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Equity revenues	USD	0	0	219,331	231,160	246,708	262,520	216,686	225,745	234,381	243,017	251,654	260,290	268,928	277,564	286,200
Annual benefits	USD	-1,489,740	0	219,331	231,160	246,708	262,520	216,686	225,745	234,381	243,017	251,654	260,290	268,928	277,564	286,200
Accumulated benefits	USD	-1,489,740	-1,489,740	-1,270,409	-1,039,249	-792,541	-530,021	-313,335	-87,590	146,791	389,808	641,462	901,752	1,170,680	1,448,243	1,734,443
Equity-IRR	**%**	**10.81**														
Equity-NPV	**USD**	**-489,941**														
Equity payback period	**years**	**9**														

3.4 Project Risks

Figure 14: Summary of the results of the project risk study

Item	Description
Rice husk procurement risk (Estimation of the effect of rising rice husk procurement costs on the project plan)	・ Estimation shows that a cash shortage will not occur even if a 70% shortage in the amount of procured rice husk arises and is covered by purchasing husk at 15 USD/ton. ・ In the above-mentioned case, the break-even point in the procurement price (i.e., the point where a cash shortage occurs) is 30 USD/ton.
Power sales risk (Estimation of the effect of falling power sales price on the project plan)	・ Estimation shows that the break-even point for the power sales price (i.e., the point where a cash shortage occurs) is when the currently planned price of 0.12 USD/kWh falls by about 30% to 0.08 USD/kWh (below roughly the price level that currently exists in Thailand).
Exchange risk (Estimation of the effect of fluctuations in the exchange rate on the project plan)	・ Under the project plan, only loan repayment will be yen-based (other items will be settled in US dollars), and thus risk of fluctuations in the dollar-yen exchange rate exists. ・ Estimation shows that the break-even point in exchange rate fluctuation (i.e., the point where a cash shortage occurs) is when the current rate of 95 yen to 1 dollar rises 30% to 66.5 yen to 1 dollar.

3.5 Environmental and Social Consideration

Figure 15: Summary of the results of the environmental and social considerations study

Measure	Basic pre-implementation principles concerning the natural and living environments
Drainage water	・ Drainage water generated by the project (drainage from equipment cleaning, site cleaning, etc.) will be partially recycled, with the remainder appropriately treated to regulatory standards and released.
Waste	・ Rice husk ash generated by the project will be appropriately managed within a limited area by building a storage space equipped with anti-scattering equipment.
Atmospheric	・ Exhaust gases generated by the project will be passed

emissions	through a dust collector and appropriately treated to regulatory standards before their release.
Noise	・ Installation of soundproof covers and other countermeasures will be taken for highly noisy equipment (e.g., fans, turbine generator, etc.). Structural anti-vibration countermeasures, such as installation of soundproof material and independent machine foundations, will be also studied. ・ In planning the facility layout, noise sources will be arranged away from the premises' boundaries so as to produce adequate distance decay effect.
Labor environment	・ The facilities design will take worker health into account. As demanded by the work environment, areas will be established where workers must wear protective equipment (e.g., the ash storage area, etc.). Drainage water and exhaust will be sufficiently monitored.

4. Future Issues (Sales Possibilities for Rice Husk Ash)

The project will use 14,256 tons of rice husk per year as fuel for power generation. This amount will produce 2,281 tons of rice husk ash per year (approximately 16%). When the survey examined the degree to which the previously discussed project feasibility would improve if rice husk ash from the rice husk power plant were sold to other companies, it found that, if the sales price were around 75 USD/ton, the project's E-IRR would be 20.04% and capital stock recovery period would be six years.

In Thailand, where many rice husk power plants exist, rice husk ash is commonly sold. When rice husk ash is sold as cement material, the trading price can reach as high as 100 USD/ton. This suggests that receiving a price of 75 USD/ton is realistic. Moreover, when the Angkor rice husk power plant provided a sample of its rice husk ash to a major cement company in Cambodia, the cement company confirmed that the ash has usefulness as cement material. Consequently, the two sides are engaged in discussions to determine specific terms and conditions for ash sales. Looking forward, the survey team will pay close attention to rice husk ash business negotiations undertaken by the Angkor rice husk power plant, and will reevaluate the project's feasibility when the rice husk ash sales price in Cambodia becomes clear.