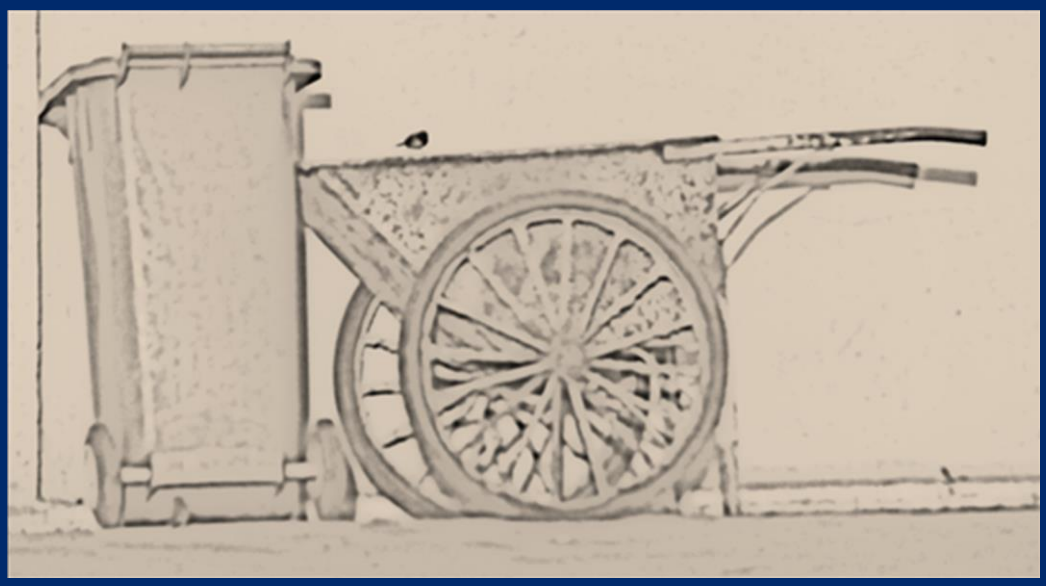
TA-8566 REG: Mainstreaming Integrated Solid Waste Management in Asia - Solid Waste Management Team (46248-001)

Prefeasibility Study – Refuse Derived Fuel Project

Municipality of Buriram, Thailand



December 2016

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List of Abbreviations

ADB.	Asian Development Bank
CAPEX.	Capital Expenditure
EPC.	Engineering, Procurement, and Construction
FX.	Forex
LAO.	Local Administrative Organizations
MSW.	Municipal Solid Waste
NPV.	Net Present Value
OFMSW.	Organic Fraction Municipal Solid Waste
OPEX.	Operational Expenditure
PFS.	Pre-feasibility Study
PPP.	Public Private Partnership
RC.	Reinforced Concrete
RoE.	Return on Equity
RDF.	Refuse Derived Fuel
THB.	Thai Baht
VGF.	Viability Gap Funding
VfM.	Value For Money

Executive Summary

Local Administrative Organizations across Thailand are being encouraged by both the national government and civil society to explore means of more effective waste disposal. As only minor investment costs would be involved in optimizing current Buriram landfill operations, the focus is on investments that reduce both incoming and existing waste in the landfill. Currently, the investment with the greatest perceived return is refuse derived fuel - a process in which waste is separated and prepared to RDF 2 quality specification then transported and sold to modern cement kiln owners that buy it as a coal substitute for heating.

Both interviews and anecdotal evidence suggested that RDF projects for small cities in Northeast Thailand were unlikely to be viable due to small waste quantities and high transport costs amongst other factors. However, small to medium size domestic developers persist in selling RDF solutions in the region so it is important that a prefeasibility study reviews project economics as they stand today under a base case model and further develops upside case scenarios so as to give guidance on the factors that could make such projects viable in the future. In the meantime, it is important to delineate how international standard analysis used for this PFS may differ from business models used by smaller scale local developers. In particular, this PFS assumes:

(i) Equipment that is proven internationally and with a suitably long life has been chosen in lieu of cheaper less reliable alternatives

(ii) Prices of coal for which RDF is a substitute are not assumed to increase dramatically

(iii) Recycling revenues are viewed to be highly speculative and upside at best. Therefore particularly when making capital investments for the long term, they are not viewed as reliable for a medium to long term base case. It should be noted that a high number of insolvencies that have impacted this industry in recent years.

(iv) An investment payback period of 10 years is used in lieu of longer i.e. up to 20 year payback given that alternative technologies would likely overtake current RDF processes within even the shorter time frame.

The prefeasibility report findings are in line with expectations of difficult economics as the base case shows a significant negative return. Solutions to reach sufficient positive economics would need to take into account the high investor returns needed for a high-risk project. Such solutions can be broadly divided into two categories. Most immediate would be *subsidy based* – via direct Buriram tipping fees paid to the RDF developer and/or central government capital subsidies under the Viability Gap Funding (VGF) categorization.

Otherwise solutions would be *market based* price which related to identifying future revenue increases or expense reduction. For the moment, each identified alternative taken alone is far too severe to be practical however combinations of PFS alternatives may be looked at as being more viable.

1. Introduction

The purpose of this pre-feasibility report under Asian Development Bank RETA 8566 is to summarize and preliminarily assess key commercial and technical issues for a proposed Refuse Derived Fuel (RDF) plant which would be located on the premises of the Municipality of Buriram's existing landfill. This report should be read together with the Buriram Solid Waste Action Plan which features a proposed terms sheet and bid parameters. This study acts as a pre-cursor to a Final Full Feasibility Study along with fully developed Prequalification and Bidding Documents inclusive of a Draft Detailed Contract, which could potentially follow on from this RETA.

2. Project Description

2.1. Project Rationale

The Municipality of Buriram is considering alternatives to dispose of a significant portion of both fresh and existing waste so as to prolong the life of its existing landfill. At present, the mass of fresh waste delivered to the landfill of 81 tons per day is considered too small to economically operate a Waste-to-Energy plant. Even if waste tonnage is sufficient, there are technical impediments in Northeast Thailand for such plants to connect to the electricity grid as currently configured. In this vein, the attraction of a Refuse Derived Fuel (RDF) business operator to the landfill would be interesting if it would be economically viable.

2.2. Project Objective

Buriram's existing landfill is considered by the consultants for this assignment to be reasonably well operated and with some modest modifications (suggested in this assignment's Integrated Solid Waste Management Plan) has the potential to comply with international standards.

Given that having sufficient landfill capacity is not an urgent issue because the existing site airspace capacity is still sufficient, the use of RDF to yield more long term capacity can be considered a medium to long term need. This is fortunate because under present conditions, the base case financial model for this project shows it not to be viable without some form of outside assistance via municipal payments for waste evacuation, viability gap funding, etc. The likelihood of this outcome was discussed between ADB, the consultants and the Municipality during meetings in late August. It was agreed that the Prefeasibility Report would include this base case (even if at a negative or below market return) and consider alternative cases, which point to different factors that would make the overall project viable if changed.

2.3. Scope of Work Required by RETA 8566

RETA 8566 requires that this Prefeasibility Study covers both technical and commercial aspects for this Public-Private-Partnership project which has been identified in the Integrated Solid Waste Management Strategy. This must include a financial analysis of the private investor's investment costs, revenue streams and gap in funding (if any).

3. Context

3.1. Policy Context (objectives of PPP structure)

Buriram does not currently outsource any of its major solid waste management functions to the private sector. However, it is prepared to outsource RDF separation and sales on the assumption that this technology is better implemented and operated by the private sector. In addition, private sector companies are best able arrange for ongoing transport and sale of RDF and any recyclable material to end use customers.

3.2. Technical Context

3.2.1. Proposed RDF Manufacturing Process

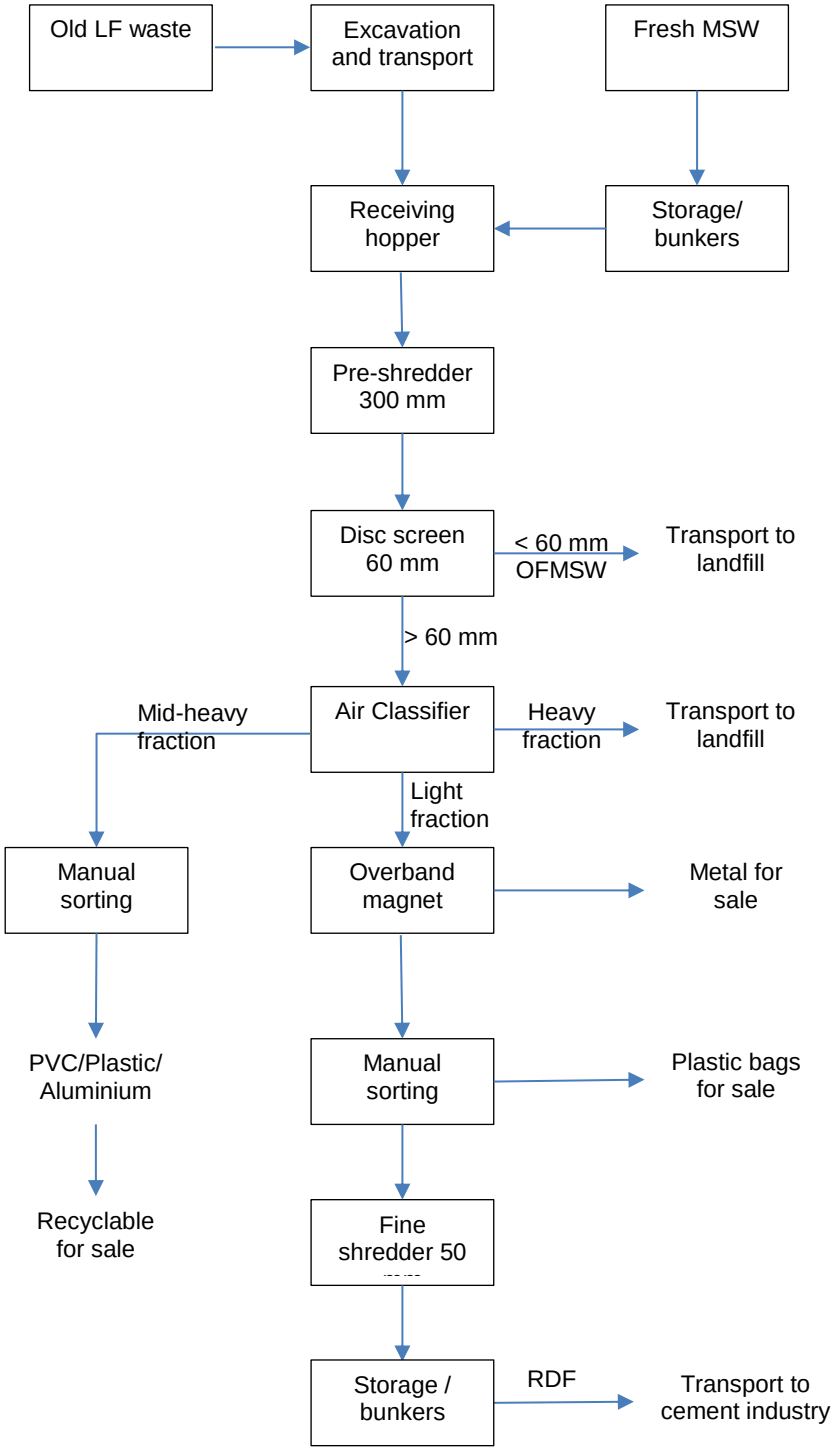
The block process diagram of the proposed RDF manufacturing plant is shown in Figure 3-1. Brief descriptions of each piece of major equipment are presented below. The design and costs are based on proven international standard equipment.

- **Storage / bunker**

The storage or bunker can be separated for the fresh MSW and for each product. This could be reinforced concrete (RC) bunkers with top and front openings. Each bunker should have drainage at the bottom to remove leachate or wastewater. The RC bunker can be made from acid resistance concrete with a hardened liner surface to minimize corrosion from acidic leachate. The receiving bunker should be designed to have a capacity of 1-3 days.

- **Receiving hopper**

The fresh MSW or old waste mined from landfill can be taken from the storage/bunker and dropped into the receiving hopper to start the process of RDF production. In some configurations, the receiving hopper could be located above the primary shredder which means waste can be feed directly into the primary shredder.



- **Figure 3-1 Proposed RDF Manufacturing Process**

- **Pre-shredder**

The pre-shredder is to reduce waste to a size of less than 150 mm. The aim is to open the big bags so the contents can be sorted properly using the downstream machines. There are various type of technologies available commercially in the market. In Thailand, most pre-shredders are sourced from foreign countries as they are more robust and durable. Most pre-shredders use a combination of stationary and moving blades to cut open big bags. Hence, there is a high wear and tear rate on the blades of the pre-shredder. The unit can also be called the primary shredder or bag breaker/opener.

- **Disc screen**

This unit applies to a size separation process with the aim of removing smaller particles (mainly Organic Fraction of MSW) from fresh MSW stream or old waste. The disc screen is more suitable than a trommel for MSW in Thailand as the MSW is very wet with a moisture content of around 40-60%. The disc screen contains rotating steel discs to impact the contents of the MSW. The opening space between each disc allows for smaller particles to drop down below and be transferred to other processes.

- **Air Classifier**

The air classifier is a process which separates MSW based mainly on the content density. This process applies rising air jets to the material stream. As a result, the light fractions are blown upward and the heavy fraction falls down below. The light fraction usually contains plastic bags and other plastic materials which are light and have lower density. These materials can be processed into RDF for sale to the cement industries. The heavy fraction is usually reject or non-biodegradable materials which can then be sent to the landfill for final disposal.

- **Overband magnet**

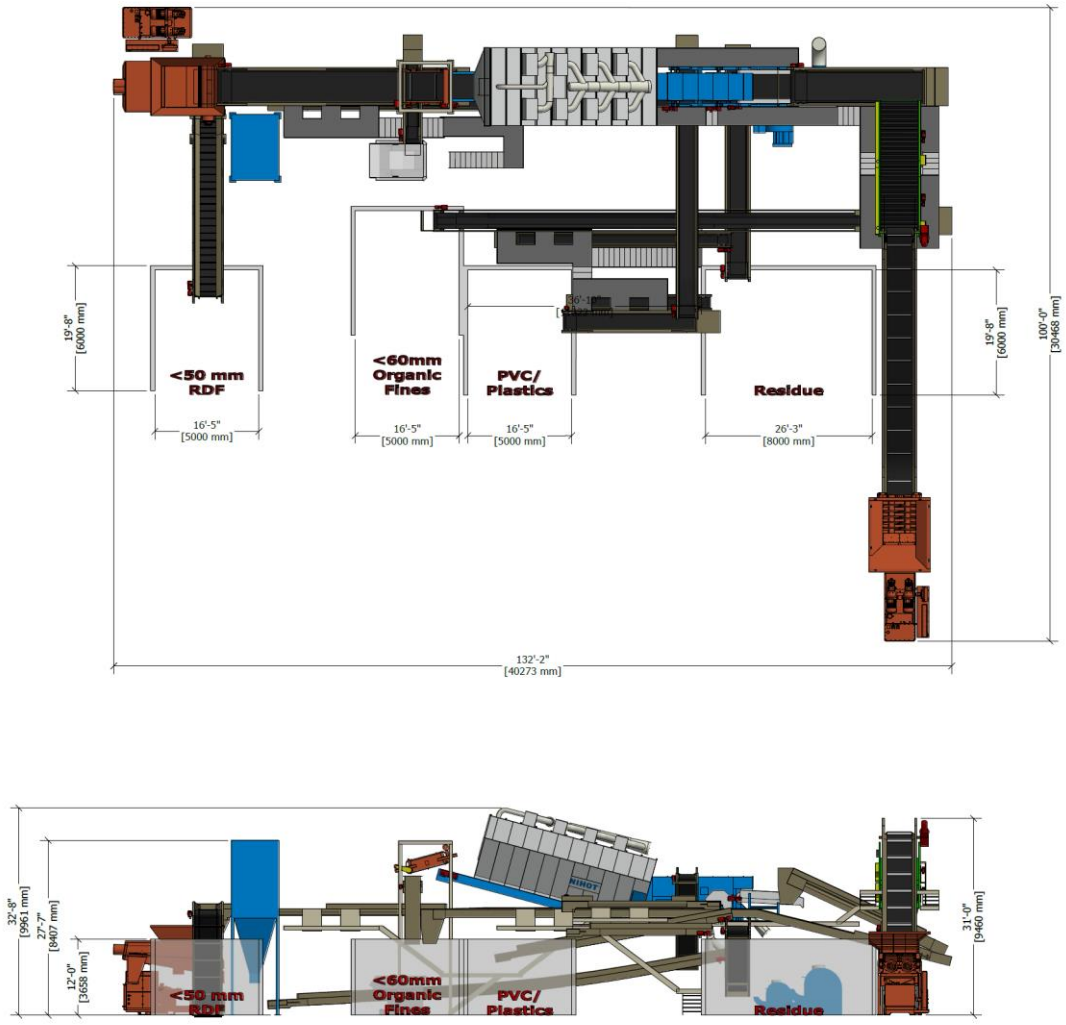
The overband magnet uses a powerful magnet to remove metal from the waste stream and deliver it to a storage area where it can be collected for sale.

- **Manual sorting**

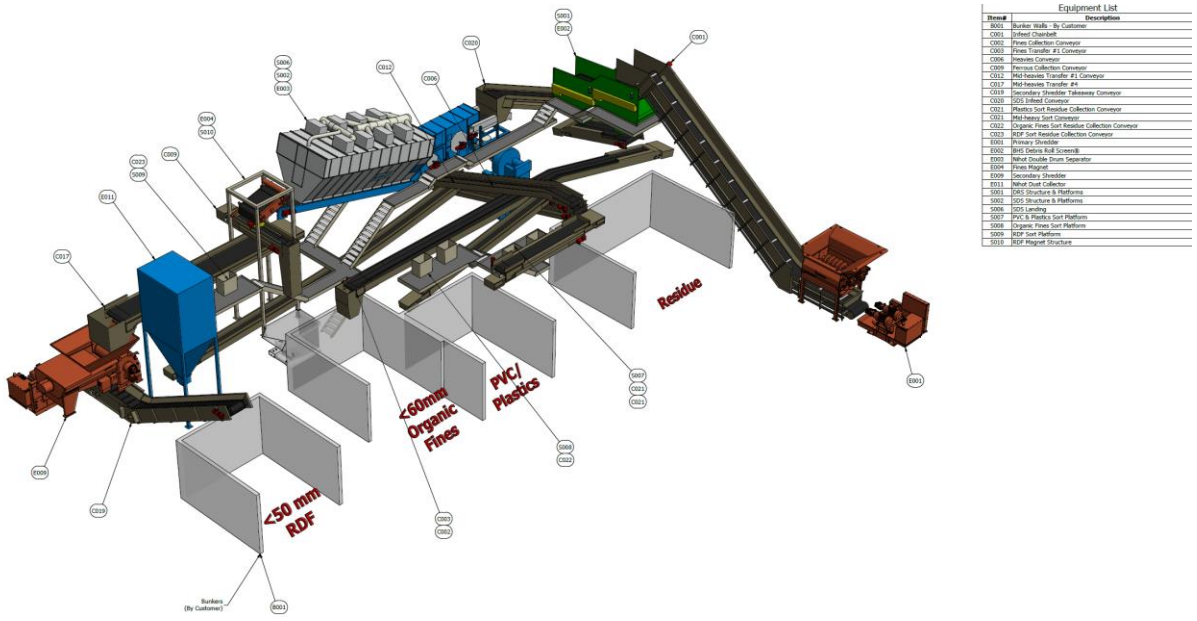
In essence, the manual sorting is a long conveyor belt that has staff on both sides to collect or remove particular types of waste from the waste stream. For example, in the RDF stream, the staff can remove unwanted materials such as non-metals, OFMSW, ceramic, bones, etc. This unit can be expensive in some advanced countries. Since the labor cost in Thailand is still relatively less expensive, this unit would be useful in the almost final production stage of RDF. It is most important to train the staff to be careful regarding what to remove.

- **Fine shredder**

This machine is to cut materials into small particle sizes by using rotating blades. The final sizing depends on the use of the product. In the case of RDF, the buyer may require that the RDF be shredded into a particular size for feeding into the cement kiln or RDF boiler. Hence, it is important to design this system according to the requirements of the buyers.



- **Figure 3-2 Example of RDF Manufacturing Plant (Layout and Section)**



- **Figure 3-3 Example of RDF Manufacturing Plant (3D model)**

3.3. Institutional Context

Under a PPP contract, Buriram Municipal landfill officials would regularly interface with the private company to (i) ensure that outgoing RDF tonnage is correctly weighed and recorded for concessionaire fee calculation purposes and (ii) private company contractual obligations (such as returning non-RDF refuse to designated areas) are met.

3.4. Market Sounding

In September and October 2016, meetings were held with two major international project developers and one major domestic project developer with active track records in management of solid waste disposal management for Local Administrative Organizations (LAO's). As the focus was on independent developers, RDF buyers were not the focus of this survey. Principal feedback from the meetings consisted of the following:

- Volumes of fresh waste per day at Buriram landfill are quite low compared to those of LAO's with RDF facilities in operation or under development in Thailand. Potentially high transport costs to RDF end users located well outside of Northeast Thailand are a further drag on project economics.
- Siam City / SGC and TPI Polene are the main cement company customers for RDF in Thailand. These companies use increasingly stringent procedures for waste acceptance for supplementary fuels. This is reducing sales volumes as a percentage of RDF delivered amounts.
- In Thailand, RDF recovery is only operational during the dry season.
- For the present recoveries of other valued material particularly plastic bags have become as important or more important in revenue generation. This increases the need for manual workers in the separation process.
- Thailand PPP law procedures, which approve LAO projects at the central government level, are too long and difficult to make implementation of RDF projects viable. Until such procedures are decentralized and simplified, it is better to draft contracts to meet structures that fall outside the PPP law. This would limit projects to 10 year tenures under local laws as opposed to 20 year limitation available under Thailand PPP law.
- There are no recognised NGO's active in Northeast Thailand waste sector issues.

4. Technical Due Diligence

4.1. Waste Characteristics

Measured waste characteristics are described at length in Section 4 of the completed Integrated Solid Waste Management Plan of this assignment. A brief description is provided below.

Waste audits for Buriram Municipality were conducted in 2011 and 2014. Both survey showed that food waste and plastic are the majority composition of MSW accounting for more than 50% of the MSW. The average composition between the two waste audits. The average results showed compositions of MSW as follows: food waste 51.0%; plastic bags and other plastic 21.0%; paper/cardboard 11.0%; glass 4%; green/garden waste 3%; fabric and leather 3%; miscellaneous (rubber) 3%; aluminium and other metals 2%; ceramic 1%; hazardous waste 0.5%; and others waste 0.5%. These values were applied as a basis for the RDF plant design and mass balance.

The MSW composition for both wet and dry season in Thailand can be slightly different. Since the data from both waste audits were more than 2 years old, it is suggested that the waste audits shall be undertaken for both wet and dry seasons. The updated data shall be applied for the detailed design of the RDF plant.

5. Viability

5.1. Revenue Potential

5.1.1. RDF Sales

Sales of RDF are assumed to be made primarily to modern large scale cement plants in Thailand as supplementary fuel (replacing coal) for cement kilns. The rate used is the current estimated rate paid by TPI Polene for a RDF Type 2 (after sorting) and a lower heating value of 4000 Kcal/kg.

The projections assume considerable long distance transport costs given the location of such cement kilns in other distant geographic regions in Thailand.

As RDF projects in Thailand and other countries are dealing with cement producers with heightened concern over cement contamination and meeting national emission standards, there is a trend amongst international and leading domestic cement companies to set specifications that are hard to meet for mixed MSW. Unless these RDF quality specifications issued by users can be carefully implemented during waste separation at the landfill, there is a risk that a significant portion of RDF delivered to the cement plant may be rejected.

5.1.2. Waste Removal Fee

The base case cash flow assumes that the Buriram municipality would be required to pay the concessionaire a waste removal fee. This fee is set at the highest possible level – which is the tipping fee rate paid to Buriram by outside municipalities and Buriram based large volume costumers of THB 500 / ton.

5.1.3. Sale of Recoverables

While the concessionaire would be given a right to remove recoverable items (such as plastic bags, metals and glass), the income from this activity is highly speculative and cannot be relied upon for a long term project cash flow projection. It remains very much an additional (albeit unquantifiable) upside business for a private concessionaire.

5.2. Site Issues

The RDF Investor would be given the right to use an adequate amount of land with the existing landfill for its facilities inclusive of some buffering. The most appropriate location for an RDF processing facility would be the southeast corner of the existing landfill.

5.3. Waste Separation: Fresh Waste vs. Landfill Mining

Fresh waste is based on “daily waste delivered to the landfill” as projected in Table 9.2 of RETA 8566 Buriram Integrated Solid Waste Management plan. Landfill mining volume is estimated based on the overall capacity of the RDF equipment but assumes an estimated annual aggregate shutdown period of 6 months per year for the rainy season.

5.4. Financial metrics

The Project’s financial metrics are depicted below. The crucial financial metric in any private sector participation is the expected Return on Equity (RoE) and we believe this should be 30% given the project’s risk profile, limited number of buyers and volatility of RDF as this hinges on crude oil market prices. The base case capex are more than 238 million THB and annual OPEX stand at 29 million. The RDFs selling price is set at 1200 THB/ton. Given the project’s high risk profile we have assumed no gearing and fully equity financed. Period of analysis is 10 years to accommodate the project’s high risk profile. Details on capex, opex and revenues are included in the annex. The resulting RoE is (-) 19% confirming this is not a viable business proposition.

- **Table 5-1 Project Financial Metrics**

INPUT		OUTPUT	
CAPEX (THB)	238,379,767	Return on Equity	-19%
OPEX (THB)	29,866,195		
Selling price RDF (THB/ton)	1,200		
Concession term post construction (yrs)	10		

6. Risks

6.1. Sensitivity Analysis

The purpose of the sensitivity analysis is to deepen the understanding of how realistic and robust the above presented financial metric of RoE is. The approach taken was reviewing what is actually required to attain an acceptable RoE of 30% and, to this end, look at various scenarios presented below. An upfront viability gap funding of 80% of capex (by extension, 20% of capex would then be financed by the concessionaire) would result in a 30% RoE. Alternatively, a waste removal fee of THB 880 per ton of RDF (from both fresh and mined waste) would be required resulting in a 30% RoE. Finally, if the RDF sales price is examined, it would have to increase from the current 1200 THB/ton to a steep 12,500 THB/ton attaining an RoE of 30%.

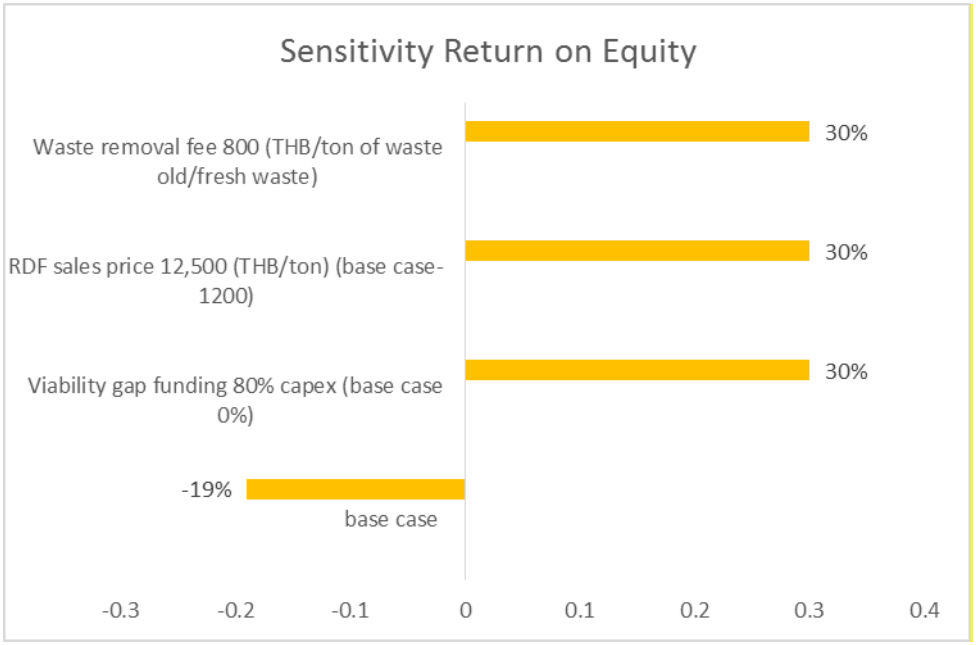


Figure 6-1 Sensitivity Return on Equity

6.2. Key Risks

The nature of any Public Private Partnership structure is to allocate risks to those with the most competence to bear them. For the RDF plant, the Engineering Procurement Construction Contractor bears many of the construction related risks. Once the project is in its operation stage, although an agreed RDF removal fee paid by Buriram Municipality covers part of the revenues, most other risks related to project revenues and expense management are risks to be managed by the private company. RDF sales carry multiple risks that make for a high risk high return project. These include cyclical price risk, RDF volume and quality acceptance risk at sales point and transport cost risk. The following table lays out many of the most important risks for a business of this type and provides a suggested allocation:

6.3. Risk Matrix Covering RDF Project Risks

- **Table 6-1 Construction Period Risks**

Category	Description	Allocation	Mitigation
Project Completion Delay Risk	Delay Past Commercial Operations Start Date	Private Investors EPC Turnkey Contract	Sponsors to manage open contract risk and pay for delay related costs Liquidated Damages up to a cap
Cost Over-run Risk	Project Costs Exceed Project Budget	Private Investors, EPC Turnkey Contract	EPC fixed price contract subject to agreed variation orders Sponsors to manage open contract risk and pay for cost overrun costs
Physical Completion Risk up to Tested Availability Minimum Level	Shortfall below Guaranteed Performance	EPC Turnkey Contract	Liquidated Damages up to a cap Sponsors
Foreign Exchange devaluation and inflation on constructions costs	FX devaluation and Inflation	EPC Contractor	Turnkey contract should be all in THB
Natural Force Majeure – Physical Loss	Cost increases due to physical damage. Constitutes Variation Order under EPC Contract	Commercial Insurance	Physical Loss Insurance
Natural Force Majeure – Delay Risk	Loss of revenues from late start – up. Constitutes Variation Order of EPC Contract	Commercial Insurance	Delay in Start-up Insurance

- **Table 6-2 Operating Period Risks**

Category	Description	Allocation	Mitigation
RDF Produced Volume	RDF volume extracted from Landfill	Private Investors	Waste Audit and Major Existing on-site refuse for Landfill Mining
General Fresh Waste Volume	Minimum waste volume arriving at the landfill. Municipality to provide compensation if volume falls below minimum level of 40 tpd	Municipality	Buriram municipality controls collection and landfill. Buriram handles relationships with other outside municipalities using its landfill
RDF Sales Prices	RDF Prices paid at point of sale at Cement Kiln Sold at Final Destination	Private Investors	Purchase contracts of up to 3 years with selected investors As a coal replacement for cement kiln fuel, prices are highly volatile.
RDF Sales Volumes	Cement plants often reject major portions of RDF waste at acceptance point	Private Investors	RDF landfill site separation to match cement plant specifications seems difficult to achieve.
Plastic, Metal and Glass Sales Amounts and Prices		Private Investors	Prices are very volatile so a short or long term price collapses are probable during multiple periods over a 10 year operations life.
Performance Shortfall in the Plant	Plant Performance Shortfall	Individual Equipment Suppliers	Warranties from Equipment Suppliers
Minor and Major Maintenance Risk	Costs exceeding budget	Sponsors and/or Operator	Private investor is responsible for correctly estimating reliability and life of equipment in its budget
Transport Cost Risk	RDF must be transported from Landfill Site to Cement Kilns	Private Investors	Transport costs are significant given the distance from Buriram to the likely cement kiln buyers.
Domestic inflation risk	Operating cost increase due to inflation	Municipality	Waste Removal Fee will be adjusted yearly based on official inflation rate
Cost Overrun on Operations and Maintenance	Project Costs Exceed Project Budget	Private Investors	Private investors must manage expenses.
Natural Force Majeure	Private operator must procure commercial insurance for own risks	Commercial Insurance of Private Investor	Physical Loss Insurance to cover equipment losses and Loss of Revenue Insurance
Currency Risk	Foreign Exchange	Municipality	Investors very likely to be

Category	Description	Allocation	Mitigation
	Devaluation for US$ capital cost recovery portion of tariff		domestic
Capital Control and Profit Repatriation	(Foreign Investors Only)	Municipality	Investors likely to be domestic

- **Table 6-3 Risk Common to Both Construction and Operating Period**

Category	Description	Allocation	Mitigation
Political Force Majeure	Mainly Change in Law, Contract Frustration	Private Investors	Well documented contract requiring defined compensation from Municipality

7. PPP Commercial Structure

7.1. Principles Used

The RDF Project operates as a public-private-partnership inasmuch as the PPP contract would give RDF operator the operator exclusive rights to fresh and existing waste at its landfill, and would agree that MSW is sent to the landfill. The RDF Concessionaire would need to work effectively with Buriram's landfill management team to facilitate efficient operation of both facilities.

7.2. Proposed PPP Model

Under the above principle, only Build-Own-Operate or Build-Own-Operate-Transfer models for Public-Private-Partnership would be applicable. Ultimately the Municipality should have the right to take back the asset, so a Build-Own-Operate-Transfer model is proposed.

A 10-year contract is assumed for the contract as this was until recently the legal limit under a municipally approved scheme. Given the changing technologies associated with RDF and WtE, 10 years already represents a long period[1] for RDF investors. Therefore, even though new means of approving PPP projects for MSW could be governed by the to-be-enacted Maintaining the Country Cleanliness and Tidiness Act B.E., making longer contract terms legally possible, the PFS maintains its assumption of a 10-year maximum period.

[1] Typically WtE plants would better candidates for 20- to 30-year contacts given their reliance on much more stable Feed-in Tariffs and Tipping fees.

8. Implementation Plan

8.1. Next Steps

8.1.1. Subsidy driven approach

The City of Buriram would need to take a policy decision on whether it has a strong intention to push the RDF solution forward and use subsidy mechanisms to bring project economics into line with target investor returns, or prefers to let the market factors take their course.

In this case, it should first determine the amount of tipping fee it is willing to pay for RDF. Two alternative methodologies would be (i) refuse delivery fee of THB 500/ton paid by other municipalities and third party commercial / institutional customers and (ii) weighted average tipping fee of THB 400 / ton by including “free” service for Buriram residential waste.

Once Buriram is clear on its own assumed tipping fee contribution, then it should be possible to calculate the amount of capital cost contribution necessary to make the project economics work. Such capital costs might be applied for on a grant basis from the central government.

Under this scenario, Buriram should pursue the competitive bid structure outlined in the action plan so as to minimize its own tipping fee contribution.

8.1.2. Market Driven Approach

Given the findings of the PFS, Buriram may get few if any offers from highly qualified, experienced companies for RDF facilities. Given the paucity of realistic bids in the short to medium term, a quasi-negotiated approach rather than a full competitive bid approach may be necessary. In the event that any such detailed offers do arrive, Buriram should not enter into any RDF contracts in the near future until and unless it thoroughly understands the technical and commercial assumptions used by the bid proponents. Due diligence should also check the sales volume and price assumptions with the small number of realistic cement kiln customers. In this way, the risk of bankruptcy by an RDF operator would be reduced.

While the upside case for this PFS has focused on prices, other factors that materially impact project economics are cost savings from reduction in international prices of good quality equipment and operating period transport costs from the landfill to cement kilns.

Annex 1: Financial Model

- **A: Macro economic**

No.	Item	Unit	Value
1.	Corporate Income Tax	%	25%
2.	Inflation CPI	%	3.0%
3.	USD/THB	THB	34.96
4.	Escalation Revenues	%	0.0%
5.	Escalation OPEX	%	3.0%
6.	Operating Days Per Year	#	365

- **B: Project Timetable**

Item	Unit	Value
Construction period	Years	2
Year -2	%/total construction	0%
Year -1	%/total construction	50%
Year 0	%/total construction	50%
Concession term	Years	10

- **C: CAPEX**

No.	Items	Price in USD	Price in THB	Value
1.	Equipment	4,635,162	166,865,837	
2.	Civil works	1,986,498	71,513,930	
3.	Total	**6,621,660**	**238,379,767**	
	Sensitivity	1		
4.	Electrical/Mechanical		years depreciation	20
5.	Civil works		years depreciation	50
6.	Annual depreciation E&M		US$	231,758
7.	Annual depreciation civil works		US$	39,730
8.	Annual depreciation E&M		THB	8,343,292
9.	Annual depreciation civil works		THB	1,430,279

- **D: OPEX**

No.	Item	Price	Unit	Price	Unit
1	Electrical cost	3,300,717	Baht/year	**91,687**	USD/year
2	Chemical and petro cost	2,753,925	Baht/year	**76,498**	USD/year
3	Maintenance cost	6,716,485	Baht/year	**186,569**	USD/year
4	Labour cost	3,600,000	Baht/year	**100,000**	USD/year
	Total	**16,371,128**	**Baht/year**	**454,754**	USD/year

- **E: Revenue**

		Daily Fresh MSW Delivered to RDF Plant	Amount of Fresh MSW from Outside Municipality and Large Sources	Projected RDF	Availability for fresh MSW	Income from Selling RDF
			80%	20%	365	1200 THB/tonne
Year	Operation Year	Tonnes/day	Tonnes/day	Tonnes/day	Days/year	THB/year
2016	-2	90.2	-	-	-	-
2017	-1	90.8	-	-	-	-
2018	0	91.4	-	-	-	-
2019	1	92.1	73.2	18.4	100%	8,067,960
2020	2	97.9	77.8	19.6	100%	8,576,040
2021	3	98.5	78.3	19.7	100%	8,628,600
2022	4	99.2	78.9	19.8	100%	8,689,920
2023	5	100	79.5	20	100%	8,760,000
2024	6	100.7	80.1	20.1	100%	8,821,320
2025	7	101.5	80.7	20.3	100%	8,891,400
2026	8	99.1	78.8	19.8	100%	8,681,160
2027	9	105	83.5	21	100%	9,198,000
2028	10	105.8	84.1	21.2	100%	9,268,080
2029	11	106.5	84.7	21.3	100%	9,329,400
2030	12	107.3	85.3	21.5	100%	9,399,480
2031	13	108.1	85.9	21.6	100%	9,469,560
2032	14	108.8	86.5	21.8	100%	9,530,880
2033	15	109.5	87.1	21.9	100%	9,592,200
2034	16	108	85.9	21.6	100%	9,460,800
2035	17	112.9	89.8	22.6	100%	9,890,040
2036	18	113.7	90.4	22.7	100%	9,960,120
2037	19	114.6	91.1	22.9	100%	10,038,960
2038	20	115.5	91.8	23.1	100%	10,117,800

- **F: Funding and Senior debt**

No.	Item	Unit	Value
Funding			
1.	Required Return on Equity	%	30%
2.	gearing ratio debt	%	0%
3.	gearing ratio equity	%	100%
4.	net working capital/% total revenues	%	10%
Senior debt			
5.	Interest rate	%	0%
6.	Loan tenor	years	10
7.	Grace period interest payment	years	0
8.	dividend payout ratio available cash	%	1
9.	WACC	%	30.0%

- **Income Statement (THB)**

Income Statement (THB)		Year									
		-3	-2	-1	0	1	2	3	4	5	6
1	**Revenues**					**33,256,519**	**34,606,106**	**34,745,719**	**34,908,600**	**35,094,750**	**35,257,631**
2	**Operating expenditures**					**29,866,195**	**29,866,195**	**29,866,195**	**29,866,195**	**29,866,195**	**29,866,195**
3	**Operating results (EBITDA)**					**3,390,324**	**4,739,911**	**4,879,524**	**5,042,405**	**5,228,555**	**5,391,436**
4	**Other costs**					**9,773,570**	**9,773,570**	**9,773,570**	**9,773,570**	**9,773,570**	**9,773,570**
4.1	Depreciation costs civil works					1,430,279	1,430,279	1,430,279	1,430,279	1,430,279	1,430,279
4.2	Depreciation costs E&M					8,343,292	8,343,292	8,343,292	8,343,292	8,343,292	8,343,292
4.3	Interest bank loans					0	0	0	0	0	0
5	**Net profit/loss before corporate income tax**					**-6,383,247**	**-5,033,659**	**-4,894,047**	**-4,731,165**	**-4,545,015**	**-4,382,134**
6	**Corporate income tax**					**0**	**0**	**0**	**0**	**0**	**0**
7	**Net profit/loss after corporate income tax**					**-6,383,247**	**-5,033,659**	**-4,894,047**	**-4,731,165**	**-4,545,015**	**-4,382,134**

- **Income Statement (THB) Con't**

Income Statement (THB)		Year							
		7	8	9	10	11	12	13	14
1	**Revenues**	**35,443,781**	**34,885,331**	**36,258,188**	**36,444,338**	**36,607,219**	**36,793,369**	**36,979,519**	**37,142,400**
2	**Operating expenditures**	**29,866,195**	**29,866,195**	**29,866,195**	**29,866,195**	**29,866,195**	**29,866,195**	**29,866,195**	**29,866,195**
3	**Operating results (EBITDA)**	**5,577,586**	**5,019,136**	**6,391,992**	**6,578,142**	**6,741,024**	**6,927,174**	**7,113,324**	**7,276,205**
4	**Other costs**	**9,773,570**	**9,773,570**	**9,773,570**	**9,773,570**	**9,773,570**	**9,773,570**	**9,773,570**	**9,773,570**
4.1	Depreciation costs civil works	1,430,279	1,430,279	1,430,279	1,430,279	1,430,279	1,430,279	1,430,279	1,430,279
4.2	Depreciation costs E&M	8,343,292	8,343,292	8,343,292	8,343,292	8,343,292	8,343,292	8,343,292	8,343,292
4.3	Interest bank loans	0	0	0	0	0	0	0	0
5	**Net profit/loss before corporate income tax**	**-4,195,984**	**-4,754,434**	**-3,381,578**	**-3,195,428**	**-3,032,547**	**-2,846,397**	**-2,660,247**	**-2,497,365**
6	**Corporate income tax**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
7	**Net profit/loss after corporate income tax**								

- **Income Statement (THB) Con't**

Income Statement (THB)		Year						
		15	16	17	18	19	20	21
1	**Revenues**	**35,443,781**	**34,885,331**	**36,258,188**	**36,444,338**	**36,607,219**	**36,793,369**	**36,979,519**
2	**Operating expenditures**	**29,866,195**	**29,866,195**	**29,866,195**	**29,866,195**	**29,866,195**	**30,420,322**	**30,420,322**
3	**Operating results (EBITDA)**	**5,577,586**	**5,019,136**	**6,391,992**	**6,578,142**	**6,741,024**	**6,373,047**	**6,559,197**
4	**Other costs**	**9,773,570**	**9,773,570**	**9,773,570**	**9,773,570**	**9,773,570**	**9,773,570**	**9,773,570**
4.1	Depreciation costs civil works	1,430,279	1,430,279	1,430,279	1,430,279	1,430,279	1,430,279	1,430,279
4.2	Depreciation costs E&M	8,343,292	8,343,292	8,343,292	8,343,292	8,343,292	8,343,292	8,343,292
4.3	Interest bank loans	0	0	0	0	0	0	0
5	**Net profit/loss before corporate income tax**	**-4,195,984**	**-4,754,434**	**-3,381,578**	**-3,195,428**	**-3,032,547**	**-3,400,524**	**-3,214,374**
6	**Corporate income tax**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
7	**Net profit/loss after corporate income tax**	**-4,195,984**	**-4,754,434**	**-3,381,578**	**-3,195,428**	**-3,032,547**	**-3,400,524**	**-3,214,374**

- **Income Statement (THB) Con't**

Income Statement (THB)		Year			
		22	23	24	25
1	**Revenues**	**37,142,400**	**37,305,281**	**36,956,250**	**38,096,419**
2	**Operating expenditures**	**30,420,322**	**30,420,322**	**30,420,322**	**30,420,322**
3	**Operating results (EBITDA)**	**6,722,078**	**6,884,959**	**6,535,928**	**7,676,097**
4	**Other costs**	**9,773,570**	**9,773,570**	**9,773,570**	**9,773,570**
4.1	Depreciation costs civil works	1,430,279	1,430,279	1,430,279	1,430,279
4.2	Depreciation costs E&M	8,343,292	8,343,292	8,343,292	8,343,292
4.3	Interest bank loans	0	0	0	0
5	**Net profit/loss before corporate income tax**	**-3,051,493**	**-2,888,611**	**-3,237,643**	**-2,097,474**
6	**Corporate income tax**	**0**	**0**	**0**	**0**
7	**Net profit/loss after corporate income tax**	**-3,051,493**	**-2,888,611**	**-3,237,643**	**-2,097,474**

- **Sources and Application of Funds (THB)**

Sources and Application of Funds	Year									
	-3	-2	-1	0	1	2	3	4	5	6
Cashflow operating activities										
Net profit					-6,383,247	-5,033,659	-4,894,047	-4,731,165	-4,545,015	-4,382,134
Depreciation					9,773,570	9,773,570	9,773,570	9,773,570	9,773,570	9,773,570
Net cash flow operating activities	**0**	**0**	**0**	**0**	**3,390,324**	**4,739,911**	**4,879,524**	**5,042,405**	**5,228,555**	**5,391,436**
Cashflow investment activities										
Investment civil works	0	0	35,756,965	35,756,965						
Investments E/M	0	0	83,432,919	83,432,919						
Net cashflow investment activities	**0**	**0**	**-119,189,884**	**-119,189,884**	**0**	**0**	**0**	**0**	**0**	**0**
Cashflow financing activities										
Loan disbursements	0	0	0	0						
Equity contributions	0	0	119,189,884	119,189,884						
Principal debt servicing	0	0	0	0						
Net cashflow financing activities	**0**	**0**	**119,189,884**	**119,189,884**	**0**	**0**	**0**	**0**	**0**	**0**
Free cashflows	**0**	**0**	**0**	**0**	**3,390,324**	**4,739,911**	**4,879,524**	**5,042,405**	**5,228,555**	**5,391,436**
Free cashflow accumulated	**0**	**0**	**0**	**0**	**3,390,324**	**8,130,235**	**13,009,759**	**18,052,164**	**23,280,719**	**28,672,155**

- **Sources and Application of Funds (THB) (Con't)**

Sources and Application of Funds	Year							
	7	8	9	10	11	12	13	14
Cashflow operating activities								
Net profit	-4,195,984	-4,754,434	-3,381,578	-3,195,428	-3,032,547	-2,846,397	-2,660,247	-2,497,365
Depreciation	9,773,570	9,773,570	9,773,570	9,773,570	9,773,570	9,773,570	9,773,570	9,773,570
Net cash flow operating activities	**5,577,586**	**5,019,136**	**6,391,992**	**6,578,142**	**6,741,024**	**6,927,174**	**7,113,324**	**7,276,205**
Cashflow investment activities								
Investment civil works								
Investments E/M								
Net cashflow investment activities	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Cashflow financing activities								
Loan disbursements								
Equity contributions								
Principal debt servicing								
Net cashflow financing activities	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Free cashflows	**5,577,586**	**5,019,136**	**6,391,992**	**6,578,142**	**6,741,024**	**6,927,174**	**7,113,324**	**7,276,205**
Free cashflow accumulated	**34,249,741**	**39,268,877**	**45,660,870**	**52,239,012**	**58,980,036**	**65,907,210**	**73,020,533**	**80,296,738**

- **Sources and Application of Funds (THB) (Con't)**

Sources and Application of Funds	Year					
	15	16	17	18	19	20
Cashflow operating activities						
Net profit	-4,195,984	-4,754,434	-3,381,578	-3,195,428	-3,032,547	-3,400,524
Depreciation	9,773,570	9,773,570	9,773,570	9,773,570	9,773,570	9,773,570
Net cash flow operating activities	**5,577,586**	**5,019,136**	**6,391,992**	**6,578,142**	**6,741,024**	**6,373,047**
Cashflow investment activities						
Investment civil works						
Investments E/M						
Net cashflow investment activities	**0**	**0**	**0**	**0**	**0**	**0**
Cashflow financing activities						
Loan disbursements						
Equity contributions						
Principal debt servicing						
Net cashflow financing activities	**0**	**0**	**0**	**0**	**0**	**0**
Free cashflows	**5,577,586**	**5,019,136**	**6,391,992**	**6,578,142**	**6,741,024**	**6,373,047**
Free cashflow accumulated	**85,874,324**	**90,893,461**	**97,285,453**	**103,863,596**	**110,604,619**	**116,977,666**

- **Sources and Application of Funds (THB) (Con't)**

Sources and Application of Funds	Year				
	21	22	23	24	25
Cashflow operating activities					
Net profit	-3,214,374	-3,051,493	-2,888,611	-3,237,643	-2,097,474
Depreciation	9,773,570	9,773,570	9,773,570	9,773,570	9,773,570
Net cash flow operating activities	**6,559,197**	**6,722,078**	**6,884,959**	**6,535,928**	**7,676,097**
Cashflow investment activities					
Investment civil works					
Investments E/M					
Net cashflow investment activities	**0**	**0**	**0**	**0**	**0**
Cashflow financing activities					
Loan disbursements					
Equity contributions					
Principal debt servicing					
Net cashflow financing activities	**0**	**0**	**0**	**0**	**0**
Free cashflows	**6,559,197**	**6,722,078**	**6,884,959**	**6,535,928**	**7,676,097**
Free cashflow accumulated	**123,536,863**	**130,258,941**	**137,143,900**	**143,679,828**	**151,355,924**

Annex 2: Value for Money (VFM) Analysis

Given the constraints of the current PFS, we have prepared a quantitative VfM assessment only and have excluded other qualitative decision making variables such as Government funds availability, contract management and bidding capacities. The NPV of total revenues minus total life cycle costs (CAPEX and OPEX) gives an indication of the VfM in both procurement strategies. In the public procurement options, due to in-transparencies and in-efficiencies of public entities in general, we assume both CAPEX and OPEX distortions presented below. VfM then equals the difference in NPV between both procurement strategies and we can observe below that the PPP procurement has a clear VfM advantage vis-a-vis the public procurement.

Value for Money PPP vs Public Procurement ***NPV cashflow to project and discounted with WACC***	
CAPEX distortion in public sector procurement	50%
OPEX distortion in public sector procurement	20%
NPV (THB) PPP procurement	-153,626,244
NPV (THB) public procurement	-367,317,624

Annex 3: Summary of Investment Cost

Item	Description	THB	USD	Remarks
Investment for 1st year	Only for processing of 100 tonnes per day of fresh MSW	233,879,767	6,496,660	Excluding cost on licenses and permits fee.
Additional investment for 2nd year	For processing of 100 tonnes of LF mining	4,500,000	125,000	
		238,379,767	6,621,660	

Remarks

1. All prices exclude Thai Value Added Tax 7%
2. Applied currency conversion rate: 36 THB = 1 USD
3. In this project, it is assumed that the owner does not apply for BOI exemptions. Hence imported taxes are included.
4. If the owner of this plant applies for Board of Investment of Thailand (BOI) for promotion of renewable energy projects, they can receive the following privileges.
    a. Exemption of import taxes for all imported machineries and equipment.
    b. No income tax for the first 8 years, then 10% tax rate for the following 5 years and then 20% tax rate for the following years