Project Dissertation Report on

PUBLIC PRIVATE PARTNERSHIP FOR WASTE TO ENERGY PROJECT

Submitted By:

Vikramaditya Singh

(2K19/EMBA/549)

Under the Guidance of:

Dr. Archana Singh

Associate Professor

DELHI SCHOOL OF MANAGEMENT

Delhi Technological University

Bawana Road, Delhi 110042

CERTIFICATE

This is to certify that the project report titled **“Public Private Partnership for Waste to Energy Project”** is a bona-fide work carried by **Mr. Vikramaditya Singh** of **EMBA 2019-21** and submitted to Delhi School of Management, Delhi Technological University, Bawana Road, Delhi-42.

This is to further certify that this project work is a record of bona-fide work done by him under my guidance. The matter embodied in this project has not been submitted for award of any degree.

Dr. Archana Singh

Associate Professor

DECLARATION

I, **Vikramaditya Singh**, student of E**MBA 2019-21,** of Delhi School of Management, Delhi Technological University, Bawana Road, Delhi – 42, hereby declare that the project report on **"Public Private Partnership for Waste to Energy Project"** submitted, under the supervision of **Dr. Archana Singh** is the original work conducted by me.

The information and data given in the report is genuine to the best of my knowledge.

This report is not being submitted to any other University, for award of any other Degree, Diploma or Fellowship.

Place: **Vikramaditya Singh**

ACKNOWLEDGEMENT

I express my sincere gratitude to Dr. Archana Singh, Associate Professor, Delhi School of Management, Delhi technological University, for her able guidance and channeling throughout the successful completion of the Project work on “Public Private Partnership for Waste to Energy Project.”

I feel to acknowledge my colleagues and peers in the industry for their insightful perspective and knowledge sharing on the topic.

I am thankful to Delhi School of Management, Delhi technological University, for entailing me a platform to do research on the topic and embark with successful completion of the project work.

EXECUTIVE SUMMARY

Waste to Energy (WtE) also known as Energy from Waste (EFW) is the process of generating some useful form of energy in the form of – Mechanical, Electrical, Heat or Thermal Energy from Municipal Waste or garbage- Solid or Liquid. It is a form of Energy recovery mechanism in which the Potential Energy, hidden in the form of Chemical Energy is converted into heat and electrical energy, by primary treatment of waste into fuel source.

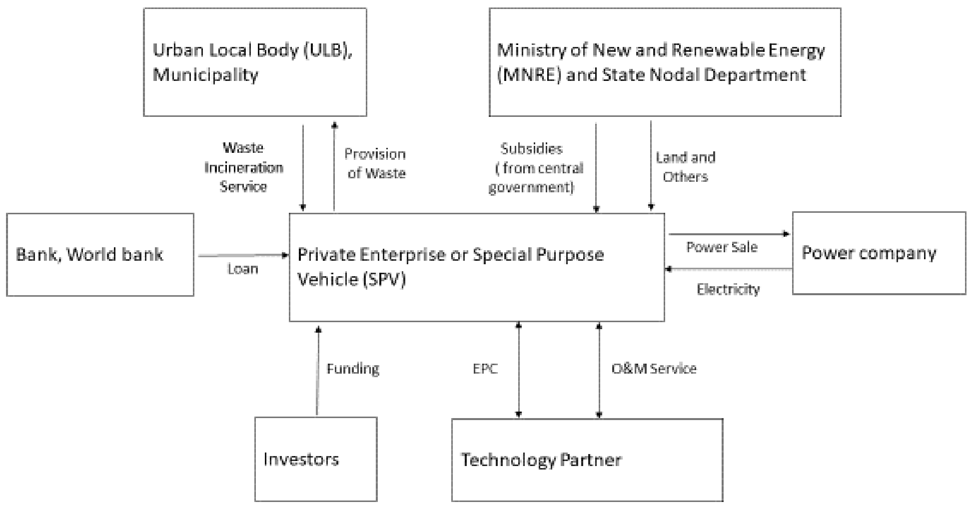
With Asia's high population density and rising urbanization along with population growth, there is a growing need to properly manage municipal solid garbage (MSW). Waste to electricity is a viable and suitable approach for reducing trash volume while minimizing environmental and social consequences.

Waste to Energy plants requires a huge investment, financial planning and stakeholder relationships- Government bodies, private partners in PPP – Public Private Partnership, network based projects. Today, there is a need of sound PPP models and framework which shall imply on effective financing solution and cost analysis of the infrastructure projects. Development and implementation of such projects requires large investment and thereby government is bound to attract private funds from Indian private firms or FDI – foreign direct investment from Asian Development Bank (ADB), World Bank, UNHABITAT, and development funds.

Nevertheless, due to the extended project life time, long gestation period and poor Power Purchase Agreement (PPA), there had been failures of WtE in India in past. Waste to Energy Plant cost depends on the choice of technology and partnership model under PPP frameworks with proper financing pathways. However, success of any project not only depends on the technology selection but also on the proper financing and Cost analysis with sound technical and financial feasibility.

In the view of above, with an objective of designing an efficient, sustainable and viable Waste to Energy Projects, I intend to make the Research Project report on 'Public

Private Partnership for Waste to Energy Project wherein I shall focus on the Technical Feasibility, Financing for WtE, Future scope of such technologies in India and Governance aspects in such Projects.



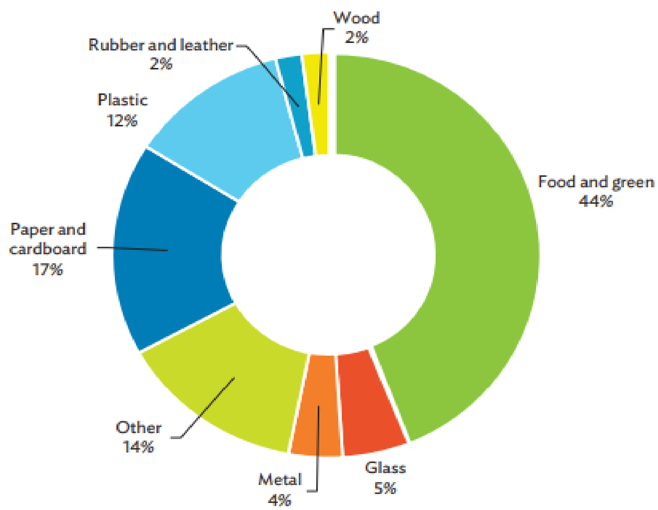


TABLE OF CONTENTS

Chapter 1: Introduction

1.1 WASTE-TO -ENERGY

Municipality Solids and Liquid Waste Management is a scientific solution for addressing the municipal solids waste and Waste To Energy is a treatment and disposal technique of MSW and hence reducing load on Landfills, mitigating tons of Green House Gasses – GHG, reducing the volume of MSW, and Leachate. Energy produced from waste is a renewable energy which can be termed as Green Energy.

It is an energy recovery process in which a hidden energy in the form of chemical energy in waste is converted into Electrical energy which can be directly used by the consumers industrial or households. There has been a continuous shift from the Conventional Energy resources to Renewable Energies like Solar, Wind, Geo-thermal and Tidal energy. Implementation of such renewable energy projects requires sound technology selection and effective financing in terms of Operational Expenses and Capital investments. Government of India- GOI is also planning to incorporate WtE Projects all over India to cater the increasing MSW and thus reducing its impact over Climate Change.

In India, performance of Waste to Energy shows that there were big failures in the past where choice of technology was wrong and later few projects failed due to improper financing techniques, exclusion of private funds, and lack of institutional frame work. The choice and selection of suitable mechanism for WtE depends on source of generation and quality of waste produced. The Energy contents fractions (ECF) is quiet low for Indian waste as compared to the ECFs of euro countries- main reason being the behavioral difference and lifestyle. In India moisture content is very high and dry fraction of waste is very low, also inert content is high enough. These factors- high moisture content and high inert content are the key reasons for failure of many projects under waste to energy scheme.

Waste to Energy is a boon to the Nation and one of the best way to handle the ever increasing Solid waste and converting it to Energy at the same time which can be used by the people who generate that solid waste. These technologies have been successful in European countries but growing with a slow pace in India. This Research Project encompasses the need of Waste to Energy in India- its technical and financial feasibility.

Classification of Waste to Energy

Waste To Energy can be majorly clubbed as:

- Bio-Chemicals Waste -to -Energy Technologies
- Thermo-Chemicals Waste -to -Energy Technologies

Bio-Chemicals Waste to Energy Technologies

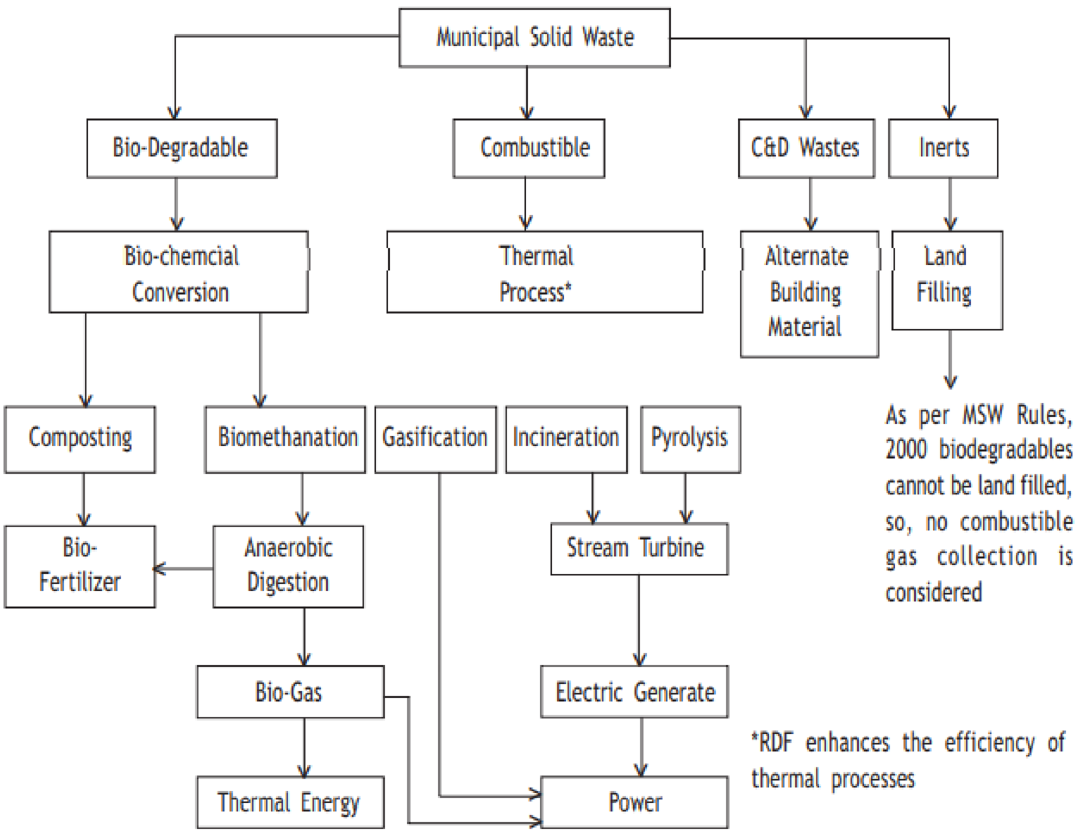
Biomethanation

'Biomethanation' refers to the non-thermal treatment biological process in which organic matter is converted into the biogas, which is a mixture of methane and propane gas.

It is used to extract minerals, nutrients, energy as fuel in the form of Methane gas out of organic content of MSW. There are series of transformation process in Biomethanation which constitutes Hydrolysis, acidification, and liquefaction are performed in the first stage, followed by the transformation of acetates, hydrogen, and carbon dioxide into methane gas in the second stage. The process then produces Biogas with a high methane concentration (55–70%), which can be used directly as a fuel gas and, in some cases, can also be utilized to generate electrical energy using gas engines or gas turbines.

Thermo-Chemical Waste to Energy Technologies

SWM thermos- chemical mechanisms are the technologies that create useful form of energy which is electricity by incineration, gasification, and pyrolysis. MSW must be treated- partially or completely, before using it for any of the above technology. These facilities of converting MSW into fuel and then finally to energy are known as waste to energy facilities. However, here is lack of technological improvements due to poor waste management streams, adding up inert and moisture in the fuel and difficulty in the process. Incineration can be improved at some extent by providing good mechanism to convert raw MSW into more enriched RDF-refuse derived fuel.



Pyrolysis

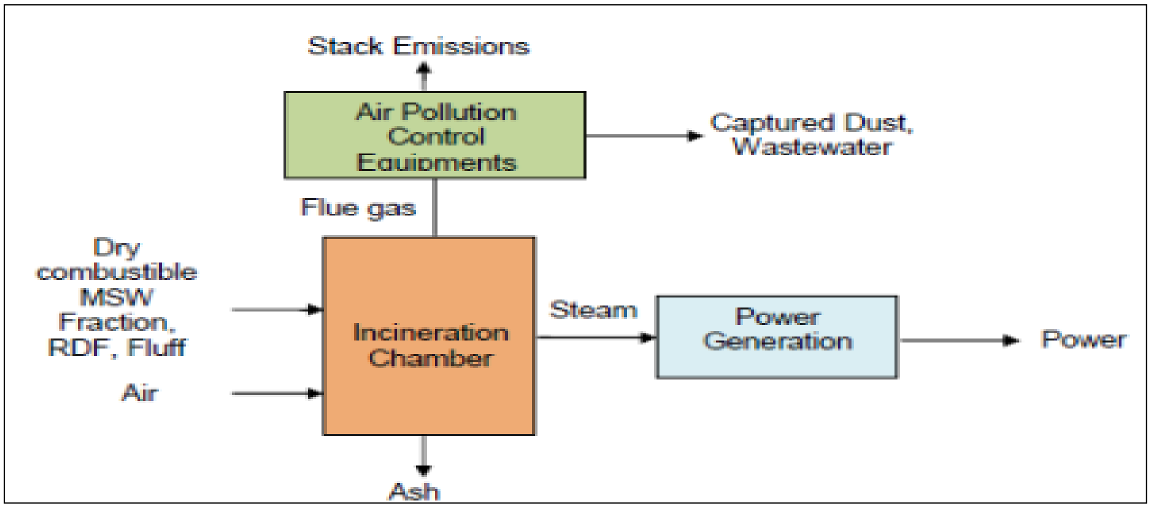
Pyrolysis use heat indexes to break down susceptible combustible polymeric materials, withot the presence of oxygen, hence, producing combustible gases as mixture – methane, carbon dioxide and hydrogen with some complex hydrocarbons, also some liquid and solid residues as by- products. Products of pyrolysis process are: **(i) a combustible Gas mixture; (ii) liquid in the form of bio-oil/tar; (iii) solid residues in the form of carbon black**. In this process low temperatures (400-9000C, but usually about 6500C) are used compared to Gasification. Variance in parameter accounts to variance in proportion of waste and it composition, pyrolysis ha two technologies which exists simultaneously- Quick pyrolysis produces Bio-oil and Slower pyrolysis for creation of Coal-Charcoal otherwise called the carbon dark. Warmth Calorific worth or warmth substance of it falls somewhere in the range of 5 and 15 MJ/Nm 3 dependent on the assortment of MSW and somewhere in the range of 15 and 35 MJ/Nm 3 on RDF as fluctuation factor is likewise dealt with seasons.

Gasification:

Gasification is one which is used for bio mass conversion into energy with help of heat. Gasification will produce combustible gasses as the byproducts such as hydrogen, synthetic fuels and works at relative high temperatures. The synthetic gas is then used for feedstock in chemical industries. The variety of different uses of gas accounts for the profoundness and flexibility and therefore allows it to be merged with other power generating technologies in a conventional manner. There are two processes which accounts for energy production air gasification and oxygen gasification. The objective of the gasification of the waste is to generate power at low levels with minimal air emissions. Temperature ranges from 500 to 1800 degrees with output energy 4-18 MJ-Nm3 net calorific values.

Incineration and Mass Burning

Incineration is defined as the process of converting MSW into energy by combusting the dry waste content and thus producing electrical energy as output. Amount of energy produced depends upon the calorific value of the fuel as input. Most of the incineration is mass incineration in India; however, RDF is widely used and acceptable technology as it results in much cleaner process and more energy output and less residues. Many of the resource recovery items are also removed here – by magnetic separation, air density separation, trommels and shredders for size reduction to improve bulk density.



Incineration process results in huge quantity of liberation of harmful gasses such as SO2, HCL, NOx, Dioxins and Furans, Dust and Fly-ash. An efficient gas cleaning system known as flue gas treatment is used for cleaning and filtering out these gasses.

A good use of chemical as urea, lime and activated carbon are used for the above air/gas cleaning process. Finally all the gasses leaving out the chimney must be absolutely clean and clear complying to the Euro norms or DPCC and state Pollution control board- PCB norms. Bottom ash and fly ash produced as by products can find further usage in road manufacturing and as substitute to many building materials.

Figure 1 : Waste to Energy - Incineration

1.2 PUBLIC PRIVATE PARTNERSHIP

PPP is a long lasting contract or Concession agreement between the Private enterprise and Government counterparts with a purpose of growth of Infrastructure development and improving public services at large, with shared risks and responsibilities is known a Public Private Partnership or PPP/P3. It is increasingly being used by government and public authorities throughout the world as a way of promoting access to infrastructure services for citizenry and economies at a reduced cost.

Many parts of world take Infrastructure and public services like electricity and Clean Water, Air for granted also others live without it. Despite vast and robust development in market still many parts of the developing nation still lack with these basic reliable and safe services.

Such infrastructure projects need careful planning of finances and cost analysis, thereby Project Finance mechanism is used for commercial viability of the project. A special purpose vehicle is made for this purpose. SPV is supported by Debt and Equity funds and syndicate banks. Risks mitigation is done, sensitivity analysis and then final rollout of the project.

Generally, there are two forms of PPP modes: The two forms are based on perspective of public partner or private party assumptions within the partnerships contract, e.g. rights compliances, obligations, and risks.

Availability PPP

This type of PPP is a PPP contract in which the public authorities contract with a private firm to supply public goods, services, or products to the Implementing agencies (IA) at a constant capacity for a set price capacity fee and separate user fees for the use of the public item, product, or service. Fees or tariffs are governed by contract agreements in order to collect expenditures such as debt payment, fixed operating costs, and a return on equity.

There is no fees associated with this initiative; for example, the PPP for School Infrastructure Project (PSIP) entails the private sector providing classrooms which is consistingi of designi, financing, constructioni and maintenancei) for a contracti feei with the Department of Education which is Public partner.

Concession Agreement PPP

It is form of PPP contract in which the Public or government grants the private sector the right to build, operate, own and charge the users of the public good, infrastructure or services with a fee or tariff which can be regulated by public regulators and the concession agreement. Tariffs are structured to provide for recovering of debt services, fixed costs of operations and return on equities

For an example, concession PPP are Waste to Energy Project wherein the Ministry of New and Renewable Energy Resources granted the private sector firm the right to build and operate the Power Project for specific long term period usually 25 years.. Under the contract, the private sector are given the right to collect a revenue from the sale of power through Power Purchase and subsequent contract agreements.

1.3 OBJECTIVES OF THE STUDY

Government of India (GOI) recognize that there is significant deficit in the availability of physical infrastructure across different sector and that is hindering economic development. Since the development of infrastructure requires large investments that cannot be undertaken out of public financing alone and in order to attract private capital as well as the techno managerial efficiencies associated with it, the Government is committed to promoting public private partnerships (PPPs) in infrastructure development and the Government of India recognizes that infrastructure projects may not always be financially viable because of long gestation periods and limited financial returns and that financial viability of such projects can be improved through Government support.

Techno-economic feasibility of the Waste to Energy project is very important in order to save on unnecessary expenditures and allow full energy recover y potential of such projects. Waste to energy are boon for urban development but there has been a history of project failures in the past mainly due to two of the following:

Technical Viability failure

Economic feasibility failure

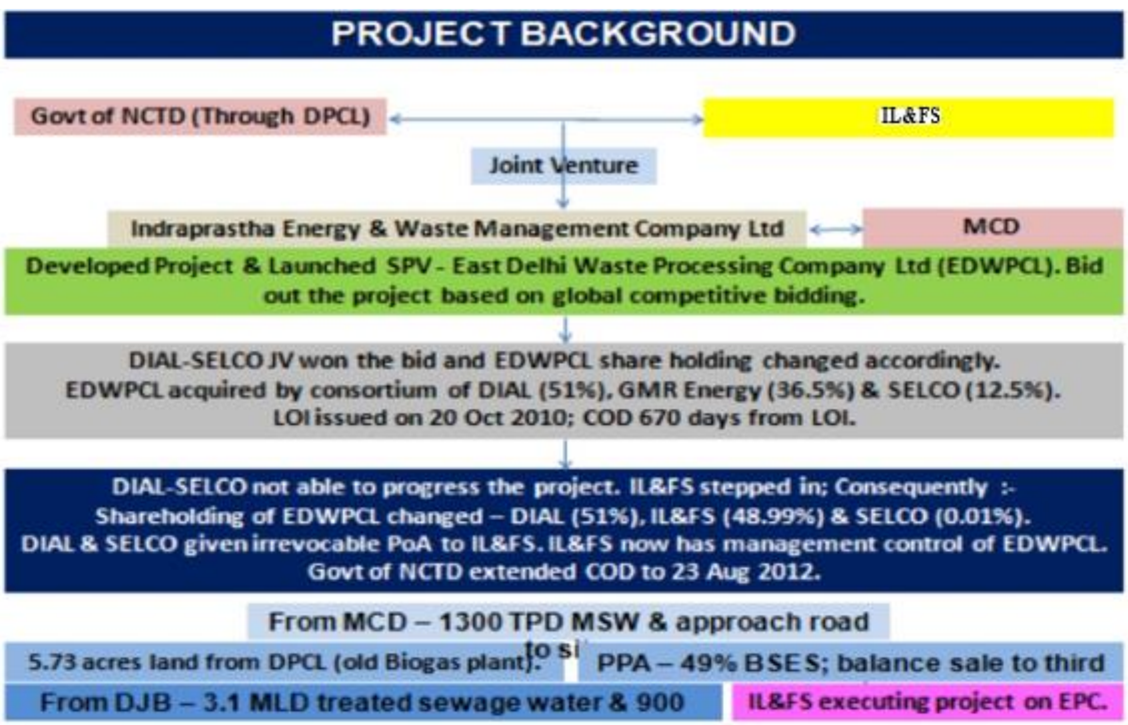
Due to the extended project life time, long gestation period and proper Power Purchase Agreement (PPA), there had been failures of WtE in India in past. “Waste to Energy Plant costs depend on the choice of technology and partnership model under PPP frarneworks with proper financing pathways. To avoid such failures we propose to have a deep understanding of techno -economic prospect of Waste to energy plants in India and gain in this field success. For this, 1 have selected the project Ghazipur Waste to Energy which is a consortium of EDM C- East Delhi Municipal Corporation and lL&FS in PPP project model on BOOT basis.

The main objective of this plan is to improve the urban infrastructure in towns and cities in a planned manner, better financing pattern for infrastructure projects and to promote public and private partnership (PPP) in infrastructure development like Waste to Energy power plants which shall cater the ever increasing municipal waste in future.

1.4 SCOPE OF THE STUDY

Public private partnership for waste to energy depends on deep study of Financial Feasibility, Commercial viability, Technological feasibility, Risk analysis and mitigation, sensitivity analysis. For ascertaining the financial feasibility future Cash flows are predicted based on PPA and raw material expenses.

At present there are 5 successful Waste to Energy Projects in India, out of this 3 are based in Delhi, 1 in Jabalpur and 1 in Lucknow. For the purpose of the study , East Delhi Waste Processing Company Waste to Energy project is chosen which is based out in East Delhi Municipal Corporation area near Ghazipur Landfill and is a successful PPP based Waste to energy Project.



Chapter 2: Literature Review

2.0 DEVELOPMENT OF WASTE TO ENERGY (WTE) IN INDIA

Waste to Energy Concept in India is not new, there had been such projects developed in the past which ultimately failed to perform due to lack of technical and financial viability. These projects have been divided into broad two categories.

- First Generation Projects
- Second Generation Projects

2.1 First Generation Waste to Energy

Timarpur Waste processing Centre- Delhi (1987)

It is the first commercially established WtE plant in India which was developed in the year 1987 by the Municipal Corporation MCD of Delhi where the financial support from Government of Denmark. Its aim was solving the twin problems to address waste and meet electricity shortage faced by Delhi.

Waste Through put – 300 TPD
Electrical Power – 3.75 MW
CAPEX – INR 25 Crore

Figure 2: Timarpur WtE

Reason of Failure – Design Malfunction due to the Mismatch of Calorific Values – CV of the incoming waste and CV as per design. Also, the plant incineration was designed on screened waste perhaps the unscreened garbage resulted in the failure of major equipments.

DST- TIFAC Project- Mumbai (1994)

Department of Sciences and Technology DST, GOI and TIFAC – (Technology, Information, Forecasting and Assessment Council) developed a demonstration project at Mumbai near Deonar dumpsite. RDF- refuse derived fuel pellets were produced out of MSW having the CV of 2400- 2500 Kcal/Kg and moisture of 10-15 %. Later this technology was adopted by different RDF plants in India and transferred the patent ship to M/s SELCO International and M/s Sriram Energy system.

SELCO Waste Management project- Hyderabad (1999)

SELCO International Ltd. arrangement a plant of 750 TPD limits in Gandamgudai Village of Saroornagair Mandal, Rangareddyo District, and Hyderabad in 1999, the plant was subsequently moved up to 1000 ton each day (TPD). In 2003, a loss to energy power plant to create 6.6 MW Power through RDF burning course was likewise arrangement at Elikiatta Village, Shadnagar Mandal, and Mahboobnaigar District Hyderabad.

Reason of Failure - The Financial model of the plant was affected due to the 50 KM distance of transportation of RDF to the plant site. The unit was already paying Rs 10 per ton for the fuel to Municipal corporation as it was using 20 % of biomass fuel. The Andhra Pradesh transmission company (APTRANSCO), reduced the Tariff charges as per Power Purchase agreement (PPA), which caused huge financial losses to the consortium.

Figure 3: SELCO WtE, Hyderabad

Sriram Energy Project, Vijayawada (2003)

M/s Sriram Energy Systems, in 2003,implemented 6.6 MW of waste to energy power plant at Vijaywada which depended on DST innovation. The Plant was made to work on squanders from Vijayawada and Guntur locale which were 40 Kms separated one another. RDF plant in Vijaywada (400 TPD cushion) alongside pelletization plant at Guntur (300 TPD), pellets moved to Vijaywada region and followed with adding power age of 6.6 MW.

Figure 4: Sriram Energy WtE

Reason Of Failure – DST-TIFAC technology was bypassed and which led to the poor quality of RDF produced, in addition to absence of Drying mechanism led to lower calorific value of RDF. Financial Viability- the two toll booths which came up between Vijaywada and Guntur - each way vehicles had to pay around Rs. 100-150 as toll charges, which led to poor OPEX.

Bio- Methanation Project, Lucknow (2003)

Lucknow Nagar Nigam Limited (LNN) alongside Chennai based Enkem Engineers fostered a SPV unique reason vehicle project-Asia Bio Energy India restricted – ABIL. Venture assessed cost was 76 Crore. The plant should utilize 300 MTs of strong waste on everyday schedule to create biogas, which further can be utilized to produce 5 MW Power, by utilizing 5 Gas generators for power age.

Reason of Failure – High soil content around 30-45 % led to the poor digestion process. Such plants are very sensitive to the impurities in the waste field. Unreliable pre treatment added to the problems due to presence of Inerts and foreign materials in fuel mixture.

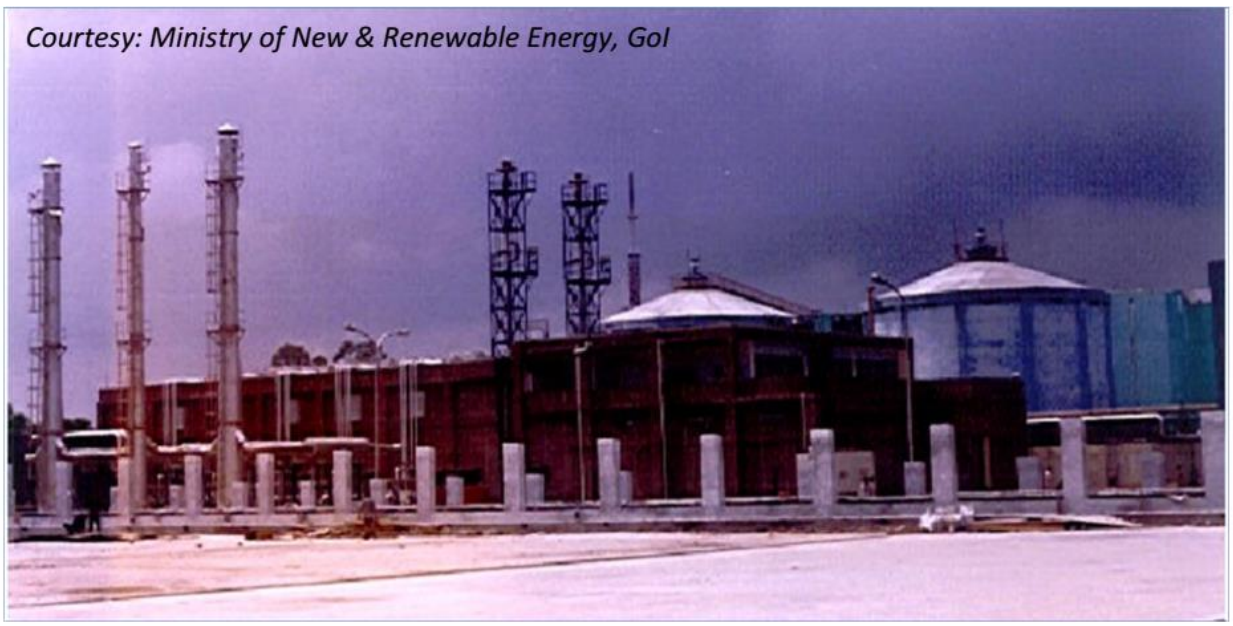


Figure 5: Bio-Methanation WtE, Lucknow

The failure of operation of the first generation waste to energy power plants led to the interference of Supreme Court of India, largest constitutional body, to decide the future of Waste to Energy in India. There were numerous oppositions by environmental agencies and public to stop such plants.

Subsequently, on May 6 , 2005 Supreme court and MNRE formulated a scheme for providing financial assistance for setting up of 5 Pilot projects for power generation from MSW. Main objectives of the “Programme on Energy Recovery from MSW” were:

- To set 5 Pilot Projects for energy recovery from Waste
- Incorporate proper Fiscal, financial and environmental clause in setting up of consortiums for implementation of such plants.

2.2 Second Generation Waste to Energy

Rochem’s Pyrolysis Plant, Pune (2009)

Pune Municipal Corporation Planned to implement a Waste to Energy Project based on Pyrolysis, in which fuel was planned to be converted into Synthetic Gas for producing Green Power. It had a capacity of processing 700 TPD of MSW to produce 378 TPD of RDF and subsequent pyrolysis of the same to produce 12 MW power.

Reason of Failure- Poor financial viability of the project, with huge capital investments required for technology purchase. It is a new technology and lack of experience in Pyrolysis with Indian MSW as fuel.

Figure 6: Pyrolysis WtE, Pune

Timarpur- Okhla WtE Project, Delhi (2012)

The Okhla WtE plant, developed by **Jindal Ecopolis**, process around 2050 tons of MSW and generates 16 MW of power. The estimated Project cost was 175 Crore , which later escalated to 240 Crores. The boiler uses moving grate, mass incineration technology from HBG China. Flue gasses treatments system incorporates Semi-Wet Reactors (SWR) and fabric filters from Wuxi GHPE , China.

Figure 7: Jindal WtE, Okhla, Delhi

The Timarpur PPP project is now in operation, But this PPP is facing some technical problems with the design of boiler and type of waste like high moisture, inerts in the waste. Due to which pollutants like SPM and Dioxins are running very high beyond the limits or standards stipulated by monitoring authorities like DPCC and CPCB. The plant at Okhla is supposed to produce 16 MW of green power by utilizing 450 TPD RDF created at Okhla and 225 TPD RDF delivered at Timarpur and shipped to Okhla according to Environmental Clearance, Okhla Plant, MoEF. PPP contact between South Delhi Municipal Corporation- SDMC and Jindal ITF is an example of PPP in waste to energy sector.

Delhi MSW solutions Limited, Bawana- Delhi, (2015)

M/s Ramky Enviro Engineers implemented Asia's largest Waste to Energy Plant in collaboration with North Delhi Municipal Corporation (NDMC) based on mass incineration technology. The plant capacity as per MoEF is 4000 TPD of MSW to generate 36 MW. FGCS consist of the Lime treatment, Activated Carbon Injection and Bag filters. Power plant consists of two boilers (56 TPH capacities each). This is also a PPP based project between Ramky Enviro Ltd and South Delhi Municipal Corporation (SDMC). Long term Concession agreement is made with PPA with Delhi Electrical Regulatory Commission (DERC). Waste which is a fuel for the plant is provided by SDMC and Electricity produced is sale to BSES.

Land for operation is provided on lease. It is a BOOT type of contract.

<u>Figure 8: Ramky Enviro WtE, Bawana, Delhi</u>

East Delhi Waste Processing Company Limited, Ghazipur- Delhi (2016)

M/s ILFS in association with **East Delhi Municipal Corporation** (EDMC) developed a 12 MW, RDF based Waste to Energy Plant at Ghazipur, Delhi. The technology has been tailor made according to the Indian Waste and based on Euro Emission norms compliant. It is based on the regulations stipulated by DST-TIFAC and an Elaborate 7 stages pre processing facility of MSW into RDF has been set up. The plant has an intake capacity of 1300 TPD waste out of which 700 TPD is RDF and rest is Rejects, Inerts, Soil enricher, Recyclables and moisture.

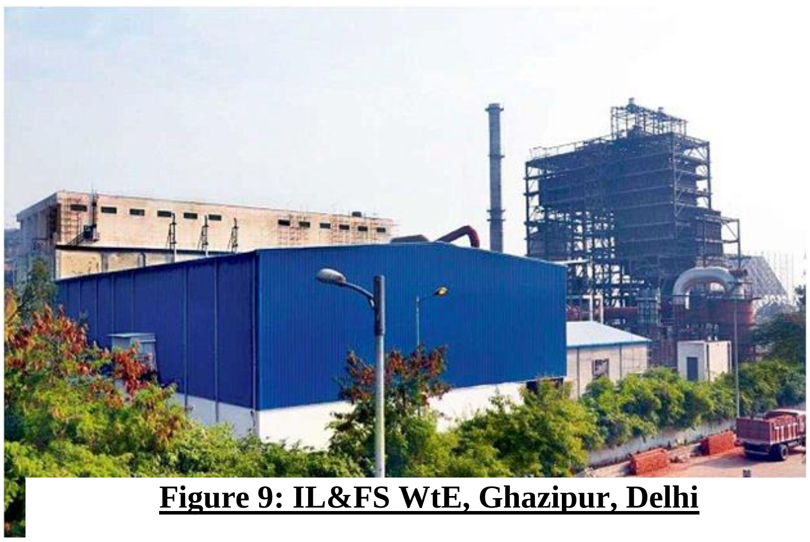


Figure 9: IL&FS WtE, Ghazipur, Delhi

The plant is one of its first kind in India which is based on RDF incineration and Euro norm Compliant. It is a project finance infrastructutre initiatve by East Delhi Municipal corporation and ILFS with many sub contracts - M/s ISGEC Heavy Engineering Ltd. is for the manufacturing of the boiler and M/s Clair Engineering for fabricating the Flue gas treatment system and Keppel Seghers for tailor made design. Total project cost is around 316 Crores and the land area is 5.73 acres.

Chapter 3: Research Methodology

Commercial viability of Public Private Partnership Project for Waste to Energy

The objective of this minor project is to carry out study on the commercial front of the project by having detailed analysis of Financial and Cost ascertains of such projects.

Reason to carry Financial and Cost Analysis:

Public Private partnership projects have chances of failure if not carefully planned. And Waste to energy plant success is highly dependent on the availability of fundsall the time throughout the life cycle of the project. Expected positive returns in the future cash flows does not guarantee that project is commercially viable. Therefore, commercial viability and success of the Waste to energy plant is highly dependant on the detailed financial and cost analysis.

It is also important to ensure that there are enough funds to finance the operations of the project. In the present study a simple Debt- Equity Model is adopted using discounted cash flow analysis for estimation of commercial viability of a WtE project in New Delhi. The Waste to Energy facilities which are operative in the landfills help in earning carbon credits. As per the Asian Development Bank guidelines, financial benefit-cost analysis assess the financial viability of a proposed project, i.e., if the proposed project is financially attractive or not to make investment.

COST ANALYSIS

Government of India (GOI) recognize that there is significant deficit in the availability of physical infrastructure across different sector and that is hindering economic development. Since the development of infrastructure requires large investments that cannot be undertaken out of public financing alone and in order to attract private capital as well as the techno managerial efficiencies associated with it, the Government is committed to promoting public private partnerships (PPPs) in infrastructure development and the Government of India recognizes that infrastructure projects may not always be financially viable because of long gestation periods and limited financial returns and that financial viability of such projects can be improved through Government support.

For the integrated waste-processing complex, various possible source of funding are explored and the following options may be available:

- Grant from MNRE
- Clean Development Mechanism Benefit

As per CERC Guidelines, the tariff for the said project may be calculated by scrutinizing the cost and allowing 14% return on equity.

Projects Implementation Costs:

The base project cost, comprising the construction cost and contingencies & supervision charges for the 10 MW Power Plant has been estimated at 2012 prices. Construction work is assumed to begin in 2012. The construction period is taken as 1 year (starting towards the end quarter of financial year 2012 -2013 and will continue up to end quarter of financial year 2013 - 2014). with the power plant becoming operational towards the end of 2013. The Capital Cost of establishing a 10 MW Power Plant is Rs1000.00 Million.

Operation and Maintenances Costs:

Routine maitenance comprises primarily of maintenance of the power plant, accident repairs and all ancillary works. The annual routine maintenance costs for 10MW Power Plants have been taken @ 5% of the capital cost per annum for first 5 –Years, @ 6% of the capital cost per annum for next 5 – Years, @ 7% of the capital costs per annum for next 5 – Years, @ 8% of the capital cost per annum for next 5 – Years. The Operation and Maintenance Cost is presented in **Table below.**

Cost	First 5 years	Second 5 years	Third 5 years	Last 5 years
Operation And Maintenance (in Million INR)	250	360	420	160

Escalations Costs:

The base costs have been escalated to account for inflation and obtain the actual costs in the year of expenditure. This is in line with the long-term inflation rate generally considered for financial analysis. The escalation cost for 20 years is shown in **Table.** Financing cost, comprising processing fee, sponsor's contingency, etc., has been considered at 2 percent on debt .

Cost	First 5 years	Second 5 years	Third 5 years	Last 5 years
Escalation Cost	6%	7%	8%	9%

Total Project Costs (TPC):

The total cost of the project is the cost at the time of commissioning and includes aggregate of base project cost, escalation cost, financing cost, processing fee and interest during construction (IDC). The TPC at the end of the construction period has been estimated as Rs. 3260.00 million. Total Project Cost is presented in **Table.**

Items	Amount (Million INR)
Base Project Cost	**1000**
O&M Cost	**1190**
Total Project Cost	**2190**

Interest during Construction (IDC):

The interests borne at some point of construction, that's the fee of investment incurred at the debt part of the project, has been calculated on the premise of an hobby charge of 10 percentage consistent with annum, in track with the winning hobby rates. The overall mortgage quantity to be repaid is along with IDC. Total Revenue Generated: The overall sales generated is the sum of sales generated from 10MW energy plant in twenty years and the whole carbon credit score acquired from discount of CO2 at some point of those twenty years period.

Total Revenue Generated:

The total revenue generated is the sum of revenue generated from 10MW power plant in 20 years and the total carbon credit obtained from reduction of CO2 during these 20 years period.

Item	Amount (in Million INR)
Revenue from 10 MW Electricity	10468.50
Revenue from Carbon Credit	313.11
Total Revenue	10781.61

Power Tariff Calculation:

Presently the tariff charge for 1KWH strength in Delhi is Indian Rupees 3.19 (0.06 US$) Thus, general tariff generated from this 10MWh strength plant anticipated might be INR 523.forty-three million (9. forty-seven million USD) in a year. Thus, general sales from strength era in two decades' duration might be INR 10468.50 million" (about 189.34 million USD). The electricity transmission and distribution lack of 29.80% consistent with annum might end result a complete sales loss INR 3119.60 million in two decades duration (about 56. forty-two million USD. A close down/ preservation duration of 35 days consistent with annum with inside the operation of the electricity plant has additionally been considered.

Carbon Credit Revenue:

The estimated reductions in CO_2 would enable the plant to earn carbon credits. Since 1MW electricity generated from solid waste management saves 2 metric tons of CO_2 (15). Thus 10MW electricity generated from solid waste management would save approximately 20 metric tons of CO_2. If it is assumed that 1 metric tons of CO_2 generates revenue of 15 Euro (1 Euro = 1019.25 INR approximately) Hence in the international market, this power plant would generate a carbon credit worth of 313 million INR (equivalent to 5.61 million US $) in 20 years.

Year	Annual CO2 reduction
2010-11	31233
2011-12	59423
2012-13	85478
2013-14	109565
2014-15	102700
2015-16	118719
2016-17	133536
2017-18	147244
2018-19	159928
2019-20	171668

Total Project Revenue:

The total project revenue has been calculated taking into consideration total revenue earned from electricity generation from this 10MW electricity power plant and total revenue obtained from carbon credit during the 20 years period (2012-2032) as shown in **Table**

Year	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Opening Balance		666.70	500	366.68	225.0
Loans	666.70	0.00	33.33	33.33	33.33
Interests and Processing fees	80.0	80.0	64.0	48.0	31.0
Principal Repayment	0.00	166.68	166.68	175.01	183.34
Closing Balance	666.70	500.03	366.68	225.0	74.99
Equity	333.33	0.00	16.67	16.67	16.67

Chapter 4: Case Study

4.0 FINANCIAL ANALYSIS

An Operational and financial appraisal of the Project has been carried out. The Principle of the assessment of the appraisal as well as the income and expenditure profile of the Project is briefly described below:

1. **Income Profile of Project** :

The projects primarily will have four source of revenue, to begin with as follows:

i. Revenue from the Sale of Power
ii. Revenue from the Sale of Refused Derived Fuel (RDF)
iii. Revenue from Tipping fees
iv. Revenue from Carbon Emission Reduction (CER)

2. **Expenditure Profile of Project:**

The operational expense incurred by the project will be on account of the following:

i. Fuel (RDF) Manufacturing Cost for generating power
ii. Transportation cost of RDF for sale to outside agency
iii. Cost of generation of Power from RDF
iv. Wages and salaries of employees across various facilities
v. AMC, maintenance, storage and consumable cost of machinery and equipment
vi. Administration expense for general functioning
vii. Interest on debt and AMC expense on it.

The major assumptions in the financial analysis are as follows:

Parameters	Units	Values
Capacity of Power plant	KW	12000
PLF	%	80
No. of Days of MSW Receipt	Days	365
No. of Days of Operation	Days	330
No. of Working Hours	Hours	24
Gross Generation P.A	Mn/Kwhr	76.03
Total Auxillary Consuption	%	26.0
Net Export to Grid P.A	Million/ KWH	51.32
Debt to Equity Ratio		68:32
Tenure of PMDO Loan	Years	10
Rate of interst of other loans	%	15
Rate of interest of PMDO	%	11
Tarrif Rate of BSES share	49%	3.67
Tariff Rate of Open access	51%	12
Tipping Fees	Rs./WPT	350
RDF sales Price	Rs./Ton	3000
REC Revenue	Rs/KWH	1.5
Rate of CER- First year	Euro/CER	1
Rate of CER- after 1st year	Euro/CER	4

The proposed means of financing for the project is presented in the table given below.

Particular	**%**	**Rs.in Million**
Equity	**32%**	**1000.00**
Debt	68%	2162.06
Total	100%	3162.06

4.1 FINANCIAL ISSUES

The development phase entails high risks and as it is the economic viability of these projects is marginal. Most municipalities are also constraint by financial resource shortages and the augmentation of resources by bringing in private capital is must. The project has to be made attractive from the perspective of private investors to attract investment. And if the private sector were to assume high risks they would expect high returns, which is difficult in case of these projects. Thus, development phase becomes very important and there has to be active support from all entities to help in mitigation of developmental risks.

Development Phase

The development phase includes getting permits and clearances, getting land, tying up MSW/Sewage supply, tying up power sale, tying up water requirements etc. The bankable document will comprise of technical studies, economic and financial analysis, environmental studies, market demand studies, resource mobilization, and development of contractual framework, risk analysis and allocation.

The following steps would be followed:

Step-I: Development of Bankable Projects

- Primary survey for quantification and characterization of the garbage
- Collection and transportation plan to minimize the transportation cost
- Concession agreement with Municipality/local bodies
- Techno-Economic Feasibility Report / DPR
- Ready Statutory / Non-statutory Clearances

- Ready Power Purchase agreement
- Sources of project finance
- Land details with site, soil, water investigations

Step-II: Selection of Developer

- Issue of Request for qualification (RFQ)/Request for proposal (RFP)
- Pre-bid meeting Evaluation and
- Selection of the BOT operator

Step-III: Project execution Assistance

- Monitoring during the implementation period
- Provide assistance for speedy implementation of the project.

4.2 DATA ANALYSIS

The technique outlines a step-by-step process for creating a financial model, including assumptions, estimate, outcomes, and debate. The next sections go over each of these points.

Financial Model:

Out of the several options available for estimation of commercial viability of the power plant, a simple *Debt-Equity Model* based on *Discounted Cash Flow Technique* for estimation of Internal rate of return (IRR) of the established RDF power plant is selected.

Debt-Equity Ratio:

The debt-to-equity ratio method is a financial analysis method that uses relative proportion of shareholders' equity and debt to finance a project. Generally in infrastructure project the external finance are made through debt. However, if the project revenues are insufficient to cover the repayment of the debt principal and the agreed upon interest payment then financing is made by raising equity.

Debt capital *is* necessary for most projects as the concessionaire may not be able to provide the entire investment in the form of equity. The sources of debt are the commercial banks, financial institutions and multilateral organizations. Financial institutions advance capital for longer duration. Multi-lateral agencies, such as the World Bank, the International Finance Corporation, and the Asian Development Bank, provide funds for road development on long term for 20 to 30 years.

Equity is float by the parent companies supporting the project and by the shareholders, who view the project as an attractive investment opportunity. Equity holders get their returns after project requirements are fulfilled. Thus the equity holders may gain a profit or lose their expected return, depending on the success or failure of the project. Equity holders carry the highest risk, and it is natural that they expect high returns (about 20%).

Basic Assumptions of the Financial Model

Financial viability analysis has been done using a spreadsheet based financial model. A period of 20 years (2012– 2032), commencing from the inception date including the construction period, has been considered. Investment costs and capital expenses have been identified in the year in which they are to be incurred. All estimates of costs and revenues have been made at 2012 price levels. A variation of 6 to 9 percent inflation rate per annum has been considered, which is applicable to all cost items.

Resources for the improvement/upgrading of the project would be raised from a mix of debt and equity sources. A debt-equity ratio of *66.67: 33.33* (i.e. 2:1), as per current

The financials profit benifit and cost analysis involves the following major steps:

(i) Determination of Annual Project Revenues
(ii) Estimation of Project costing
(iii) Estimation of Annual project Net Profits/ benifits
(iv) Assumption of of the appropriate Discount rate
(v) Estimation of Average incremental Financial costs
(vi) Determination of financial NPV- net present value
(vii) Estimation of the Annual Internal Rate of Returns (IRR)
(viii) Algorithm for Risks and Sensitivity analysis

Earnings, expenses, and net benefits for the project are estimated both with and without projects condition. These are calculated using constant prices for a certain year (e.g., constant 2004 prices) and the official exchange rate at the time of evaluation. The project's income are solely made up of user fees, with no government subsidies.

market trends, has been assumed. A five-year payback timeframe for construction loans has been explored, which comprises a four-year construction phase and a one-year moratorium once construction is completed. The interest rate on long-term debt is set at 10%, which is in line with current capital market lending rates. The rate used to calculate IDC is also 10%. The project's viability is determined.

For a twenty-year analysis period, the financial analysis is conducted using the following assumptions. Table 3 lists the basic assumptions that are taken into account when performing financial analysis. These assumptions are based on market conditions in India, such as commercial bank interest rates, conditions for infrastructure loans by banks/financial institutions, relevant handling fees by financial institutions institutions, moratorium period for infrastructure loans authorised by financial institutions, market inflation, and infrastructure development time period, among others.

Items	**Assumptions**
Debt- Equity	2:1 (66.67:33.33)
Interest Rate	10%
Processing Fee	2%
Loan repayment Period	5 years
Moratorium	1 yr
Infrastructure Development	1 year
Inflation	6 % (2013-18), 7%(2019-24), 8%(2025-30), and 9%(2031-36)
Securty Deposit Period	5 yr

Cash Outflows and Cash Inflows

Total Cash Outflow:

The project's total cash outflows comprise the program's capital costs as well as loan interest charges. The overall project costs TPC are 2190.00 million INR, and the interest payments are 303.00 million INR, as shown above. As a result, total outflows amount to 2493.00 million INR.

Total Cash Inflows:

Total Cash Inflow accounts for money generated from the sale of energy as well as money generated from the sale of carbon credits. According to the PPA, the total income earned from electricity production and sale is 10468.50 million INR and 313.11 million INR, respectively. Under the section total project cost and net income earned, the entire outflows and inflow are described.

4.3 RESULTS AND FINDINGS

Financial rate of return analysis is carried out to find whether the project is financially viable in future. Also, what are the net returns to the sponsors, and government stakeholders once the project is in operation. This is done by calculating IRR and comparing it with target IRR. Hypothesis: The project is financially and commercially successful if the project IRR and Equity IRR are higher than the target IRR. The Debt to Equity model is used to do the analysis in this case. Table 8 illustrates this. The internal rate of return of a project is determined by comparing total inflows to total outflows, or internal rate of return of net cash flow and net equity flow statement.

Year	Yr-0	Yr-1	Yr-2	Yr-3	Yr-4	Yr-5	Yr-6	Yr-7	Yr-8	Yr-9	Yr-10
Net Cash Flows	-1080	107.6	84.8	112.8	142.4	186.8	201.0	208.6	227.4	247.5	269.0
Net Cash Flows from Equity	-413.3	-59.1	-48.5	-28.9	-7.6	236.8	251.0	268.6	287.4	307.5	329.0
Year	**Yr-11**	**Yr-12**	**Yr-13**	**Yr-14**	**Yr-15**	**Yr-16**	**Yr-17**	**Yr-18**	**Yr-19**	**Yr-20**	
Net Cash Flows	292.1	320.2	340.6	373.5	409.0	447.3	493.8	544.6	589.9	650.2	
Net Cash Flows from Equity	352.1	380.2	410.6	443.5	479.0	517.3	563.8	614.6	669.9	730.2	

Net Cash Flow: The net cash flows are the differences between total cash inflows and total cash outflows.

Net Cash Flow from Equity: The difference between all in-flows and equity value minus principal payment minus interest payment is the net cash flow from equity. Table 9 shows the statement of net cash flows. For the next 20 years, the net cash flow is 5169.01 million INR. Similarly, equity-related net cash flows total 6284.01 million INR.

Result of Financial Rate of Return (FIRR): Commercial viability of the project is calculated on the basis of Project IRR and Equity 'IRR. The project is said to be viable if According to World Bank (WB) and Asian Development Bank (ADB) guidelines, the Financial Internal Rate of Return (FIRR) is greater than 12 percent. Table 9 shows the net cash flow statement, which was used to compute the IRR. The project IRR was found to be 17.25 percent, while the equity IRR was found to be 24.64 percent. As a result, both the project and equity IRRs are commercially viable.

The results of the financial analysis are summarized in **Table below.**

Indicators	20 Years Period
Project IRR Target	14.00%
Actual Project IRR (%)	17.25%
Actual Equity IRR (%)	24.64%

Presently the tariff charge for 1KWH strength in Delhi is Indian Rupees 3.19 (0.06 US$) Thus, general tariff generated from this 10MWh strength plant anticipated might be INR 523.forty three million (9.forty seven million USD) in a year. Thus, general sales from strength era in two decades duration might be INR 10468.50 million" (about 189.34 million USD). The electricity transmission and distribution lack of 29.80% consistent with annum might end result a complete sales loss INR 3119.60 million in two decades duration (about 56.forty two million USD. A close down/ preservation duration of 35 days consistent with annum withinside the operation of the electricity plant has additionally been considered.

Chapter 5: Conclusion

This financial analysis of the Public Private Partnership based Waste to Energy Project reviews the merits of the project based on RDF incineration also accessing for interests of the project private companies to enter into the contract on Concession agreement basis taking BOOT model- Build, Own, Operate and Transfer type PPP.

This analysis through NPV and IRR has shown the extent to which the BOOT concessionaire or the private company can recover the equity and shows the estimated revenue in the future. If there is any gap or lack of finances it can be fulfilled by Government subsidy, revised tariff in PPA and grants from foreign development organizations. The viability is obtained by both Equity IRR and Project IRR The discounted cash flow approach is a technique for estimating the future value of a business. Also, In order to account for inflation in future years, costs and income have been indexed here.

Prime conclusion drawn from the above results and discussion shows that for such huge infrastructure projects which triggers a huge amount of money, Public Private Partnership is most feasible model. Secondary the conclusions drawn from this study is that the various assumptions, modalities, figures, costs, sensitivity analysis and risk allocation shows that it is very difficult to out turn the viability of the project in establishing the policy.

Results show that Project – East Delhi Municipal corporation, Waste to energy is commercially viable through Public Private Partnership mode. The study's main findings include the uncertainties of the WTE facilities supply chains, which includes the quality or heat value of the waste collected, as well as the form of WTE facility capital and operational cost recovery. A PPP for a WTE project has a fair probability of succeeding if these challenges are addressed.

REFERENCES

1. Asian Development bank, “Handbook of economic analysis of water projects”, chapter 5
2. United nations, Environmentally sound waste management, chapter 21, Agenda 21
3. Williams R. (2013), “Sustainable management and green economy”
4. Sushmita Mohapatra, Journal of Environment and Waste Management,
5. BYPL, Power Purchase Agreement
6. Reka Soos, Climate and Clean Air Coalition, ISWA
7. Fiona Marshall, WtE in Delhi, research paper, JNU