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Measured. Managed. Maximized.

Financial Analysis of Solid Waste Management Projects – The Basics and Practical Challenges in Asia

Asian Development Bank Online Course on Municipal Solid Waste Management towards Circular Economy

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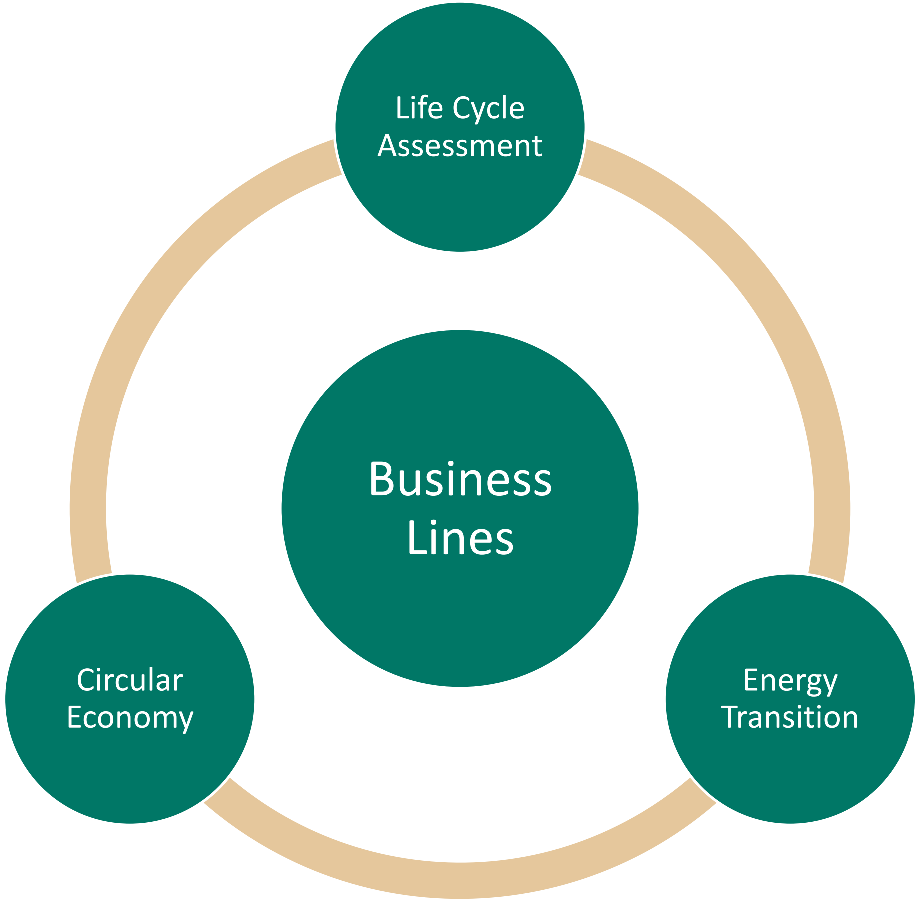
Presentation Agenda

- Introduction to Financial Analysis of SWM
- Analyzing SWM Projects – Technical Aspects
- Analyzing SWM Projects – Financial Aspects
- Examples of Financial Analysis of SWM
- Analysis Challenges in Developing Asia

Introduction to PXP Sustainability

- Assist businesses, non-profit organizations, and development agencies measure and achieve their sustainability goals.
- Driven by systems thinking, evidence-based methods, and stakeholder engagement.
- Provide services covering
  - Quantitative assessments (environmental impact analysis, financial analysis)
  - Qualitative assessments (market surveys, review industry trends)
  - Capacity building (workshops, 1-on-1 training/technical support)
- Focus on Southeast Asia region.



Introduction to SWM Financial Analysis

- Solid waste management (SWM) is essential to prevent waste from overwhelming landfills and spread of diseases.
- Financial analysis of SWM projects is necessary to understand the monetary costs of solutions and compare against different types of systems, technologies, and business models.
- Generally, the same method is applied in computing the financial costs and revenue, but the costs and revenue that are included or excluded in the analysis depends on the target audience and objectives.

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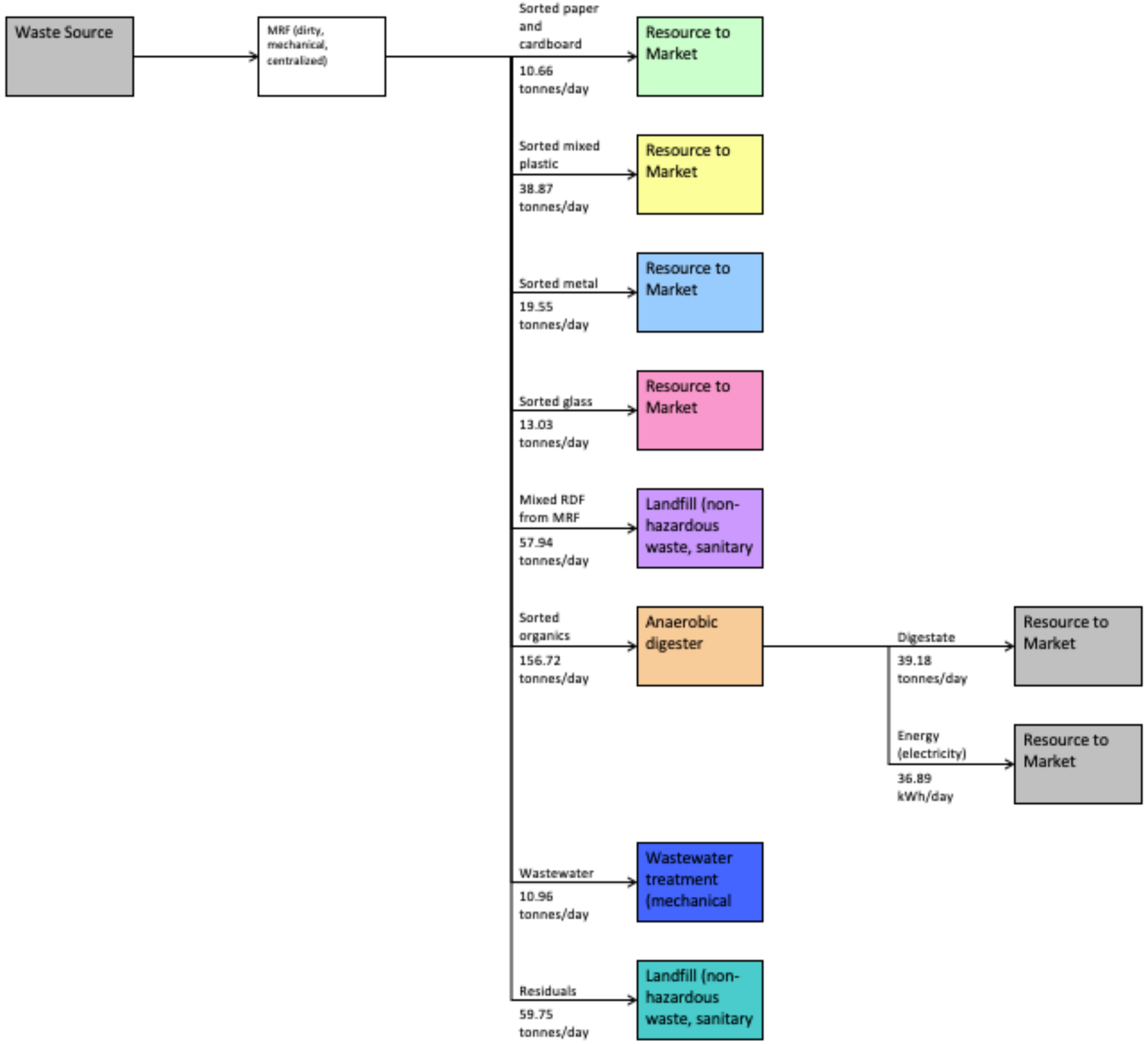
Example of SWM Project - Entities



SWM entities in example:

- Sorting facility
- Anaerobic digester (biogas)
- Recycling of sorted paper and carboard, metals, glass, plastic
- Landfill of remaining waste

Revenue sources:

- Electricity from biogas
- Recyclable materials

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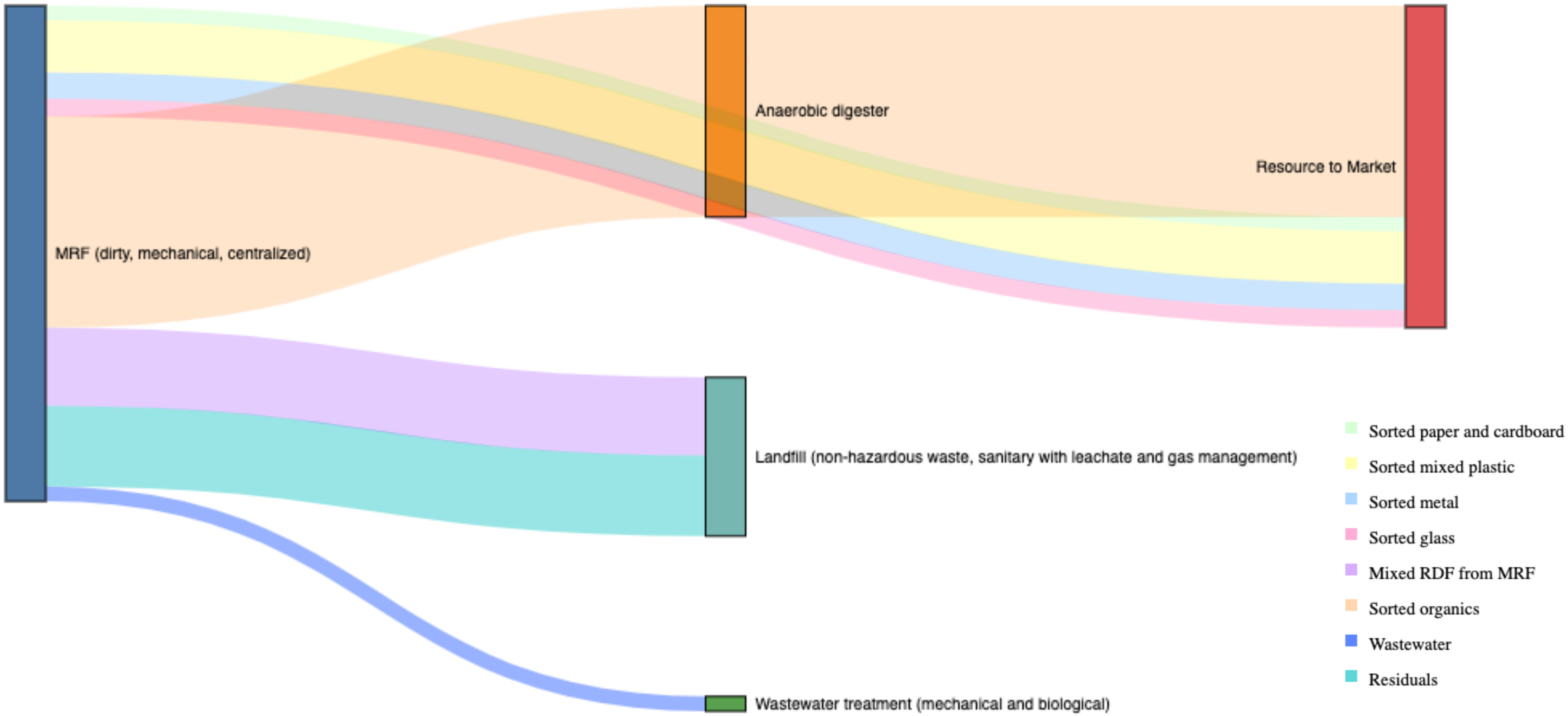
Example of SWM Project - Sankey diagram



SWM Financial Analysis Audiences

Audience type	Purpose of financial analysis	Financial indicators
Project developer	• Measure the profitability of the project • Determine amount of capital investment required • Determine when the project will recover its initial investment	• Net present value • Capital expenses • Annual profit/loss • Payback period
Government	• Determine the costs the government is expected to pay to operate the SWM project • Estimated tax revenue that can be generated from the SWM project	• Annual costs • Subsidies • Tax revenue
Financier	• Measure the expected interest that can be earned on the project • Determine if the project will be financially feasible (net profit or loss) • Determine the loan repayment period	• Net present value • Loan repayment period

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Rigor of Financial Analysis

Analysis level	Basic	Investment ready
Purpose	• Compare different types of waste management systems or individual technologies • Identify which parts of the SWM project have the highest costs and revenue • Estimate total project costs and profitability before going to investment	• Request for a loan from a bank • Determine initial investment project developer expected to pay
Rigor of analysis required	Data required (minimal) • CAPEX: lump sum • OPEX: lump sum • Revenue: Gate fees, tipping fees, electricity sale price, recyclable material sales • Mass and energy inputs and outputs Calculations • Annual profit/loss • Net present value • Payback period	Data required (in addition to basic level) • CAPEX: Detailed breakdown by equipment item • OPEX: Detailed breakdown by item (e.g. labor, electricity, fuels, maintenance, consumables, taxes, land rental, etc.) Calculations (in addition to basic level) • Factor in depreciation of equipment • Factor different types of taxes • Loan repayment period

SWM Financial Analysis Process

Step 1	Determine objectives and scope of financial analysis
Step 2	Map out entities in the SWM project
Step 3	Collect technical specifications data for SWM project
Step 4	Collect financial data for SWM project
Step 5	Carry out calculations to generate financial indicators of interest

Analyzing SWM Projects

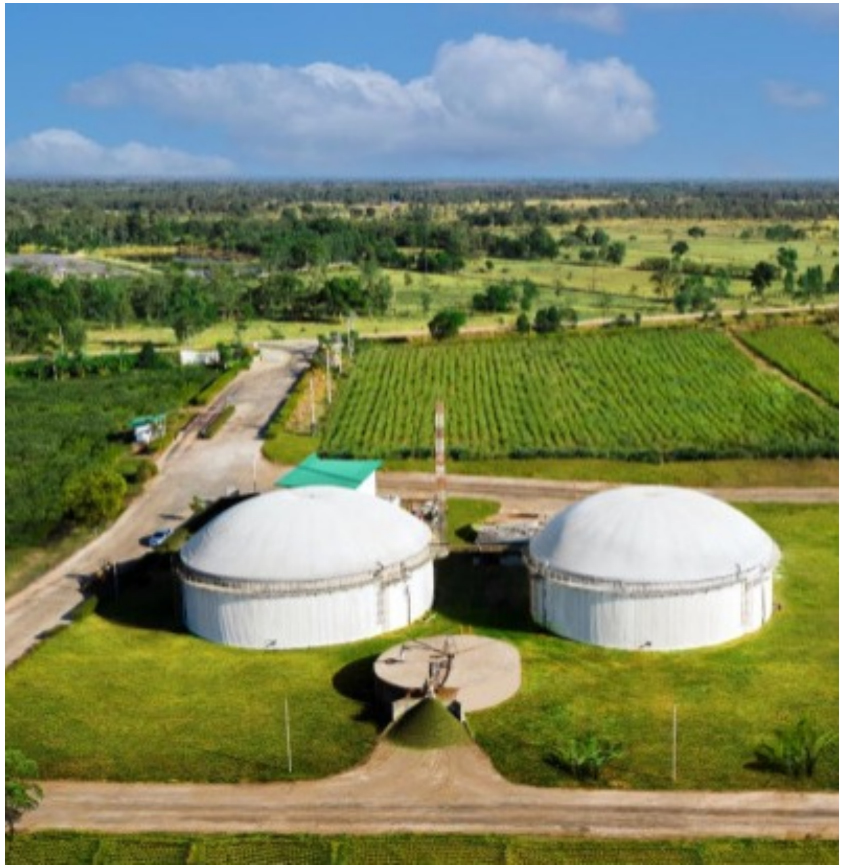
Technical Aspects

Common Technical Terms - Waste

Term	Definition
Capacity	Amount of waste technology is designed to treat, unit: tonnes/day
Calorific value	Heating value of a substance, unit: kilocalories/kg
Fresh waste	Waste that is collected before being sent for treatment
Legacy waste	Waste that is already disposed at a landfill
Municipal solid waste	Waste generated by the public (e.g. households, municipalities)
Industrial waste	Waste generated by businesses and industries
Waste composition	The mix of different types of materials found in the waste stream
Mass balance	Mass of materials that enters and leaves a process or system
Energy output	Total amount of energy (electricity or heat) created from a waste treatment process, unit: MWh or MJ
Net energy output	Amount of energy (electricity or heat) from a waste treatment process after subtracting energy consumed by the waste treatment process, unit: MWh or MJ

SWM Technology Data - Example

Anaerobic digester (biogas)



Source: Bangkok Post

Specification	Value
Capacity	250 tonnes/day
Waste (input)	Sorted organics
Operation	10 hours/day, 6 days/week
Biogas (output)	110 m^3/tonne
Electricity (output)	59 MWh/day
Digestate (output)	63 tonnes/day
Land space required	4 hectares
Labor	Management, 2 pax Working, 50 pax

**Specifications listed are for instructional purposes and do not reflect image of technology shown*

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Analyzing SWM Projects

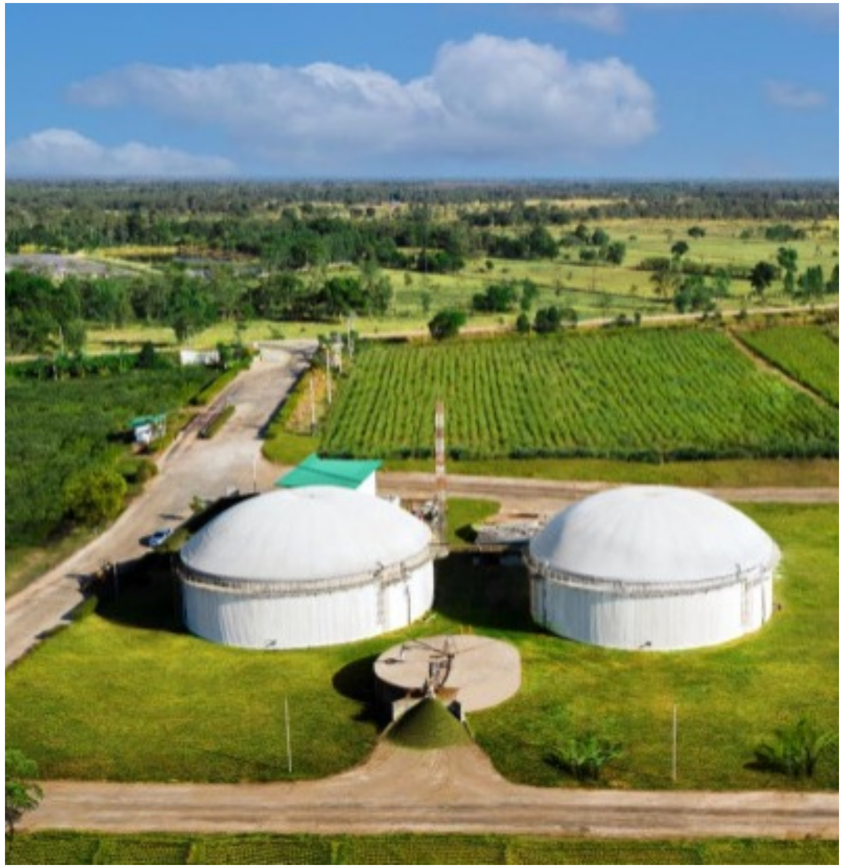
Financial Aspects

Common Technical Terms - Financial

Term	Definition
Tipping fee	Financial cost of disposing waste to the landfill, unit: $/tonne
Gate fee	Financial cost of treating the incoming waste at the facility using a specific technology, unit: $/tonne
Tariff (electricity)	Price of electricity charged to consumers, unit: $/kWh
CAPEX	Financial cost of capital goods (e.g. equipment, land purchase) typically year zero
OPEX	Any financial costs incurred for operating the facility (e.g. labor, electricity, fuel,
Revenue	Amount of money the facility receives for treating the waste.
Marginal cost of power	Price of electricity generated from a new powerplant, unit: $/MWh
Profit	The amount of money the project makes after costs
Loss	The amount of money the project has lost due to costs being higher than revenue
Net present value	Difference between the present value of cash inflows and the present value of cash outflows over a period of time. Present value factors in the interest rate of the cash flow during a specific year.
Payback period	The time (years) it will take for the project to recover the cost (money spent)

SWM Financial Data - Example

Anaerobic digester (biogas)



Source: [Bangkok Post]

Financial factor	**Value**
CAPEX	$4,700,000
OPEX (per year)	
Land rental	$139,000
Labor	$498,857
Electricity	$70,000
Other	$500,000
Revenue (per year)	
Gate fees	$1,500,000
Electricity sales	$2,451,220
Sale of recyclable materials	None

**Financial amounts listed are for instructional purposes and do not reflect image of technology shown*

Financial Analysis Calculation - Developer

Measured through calculating the **net present value (NPV)** based all the cash flows in each year. Four factors are typically considered which are

- Capital expense (CAPEX) at year zero
- Annual operation costs (OPEX)
- Annual revenue
- Annual profit (annual OPEX minus annual revenue)

Example cash flows from project developer perspective:

Type	Cash in	Cash out
Fixed	• Loan from financier • Subsidy	• Equipment • Equipment replacement • Land purchase
Variable	• Gate fee for treating waste • Materials sold via recycling • Electricity and fuel sales	• Tipping fee (remaining waste sent to landfill) • Waste collection • Labor • Land rental • Maintenance • Energy (electricity and fuels) • Consumables • Annual loan payments

All cash flows are discounted to the present value following the formula:

Present value = Future value $(1 + r)^{-t}$, where r = discount rate (%) and t = year

Financial Analysis Calculation - Government

Measured through calculating the **net present value (NPV)** based all the cash flows in each year. Four factors are typically considered which are

- Capital expense (CAPEX) at year zero
- Annual operation costs (OPEX)
- Annual revenue
- Annual profit (annual OPEX minus annual revenue)

Example cash flows from government perspective:

Type	Cash in	Cash out
Fixed	• Annual government budget	• SWM project subsidy
Variable	• Tax revenue associated with SWM project	• Gate fee • Tipping fee • Purchase of electricity (if sold to a state-owned utility)

All cash flows are discounted to the present value following the formula:

Present value = Future value $(1 + r)^{-t}$, where r = discount rate (%) and t = year

Financial Analysis Calculation - Financier

Measured through calculating the **net present value (NPV)** based all the cash flows in each year. Four factors are typically considered which are

- Capital expense (CAPEX) at year zero
- Annual operation costs (OPEX)
- Annual revenue
- Annual profit (annual OPEX minus annual revenue)

Cash flows from financier perspective

Type	Cash in	Cash out
Fixed		• Loan to project developer
Variable	• Loan repayment each year (including interest)	

All cash flows are discounted to the present value following the formula:

Present value = Future value $(1 + r)^{-t}$, where r = discount rate (%) and t = year

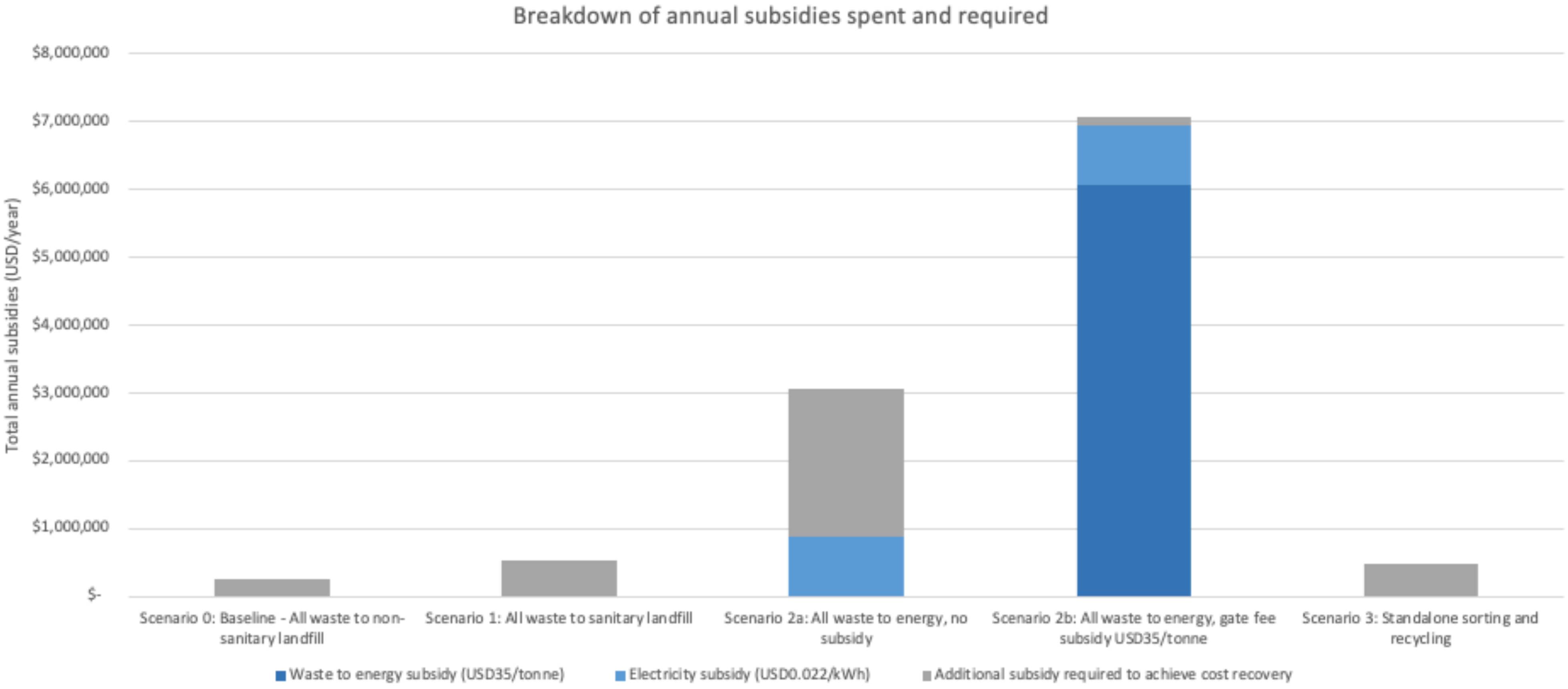
Examples of Financial Analysis of SWM Projects

Indonesia and Cambodia

Synopsis of Indonesia Case Study

- **Objectives and Scope:**
  - City in Indonesia
  - Waste tonnage and composition: 600 tonnes/day, 45% organics, 15% paper and cardboard, 20% plastics
  - Compared the net present value over 20 years to determine annual shortfall of the project that the government would be expected to pay
- **Technologies compared:** Sorting facility, mass burn incinerator with energy recovery, anaerobic digester, recycling of paper, plastics, glass, and metals
- **Scenarios analyzed:**
  - Baseline: All waste sent to existing non-sanitary landfill
  - All waste sent to sanitary landfill
  - All waste sent to mass burn incinerator (with and without subsidy from the government)
  - Waste sorted with organics going to anaerobic digestion, recycling of paper, plastics, glass, and metals, remaining waste going to sanitary landfill

Indonesia Case Study Key Findings

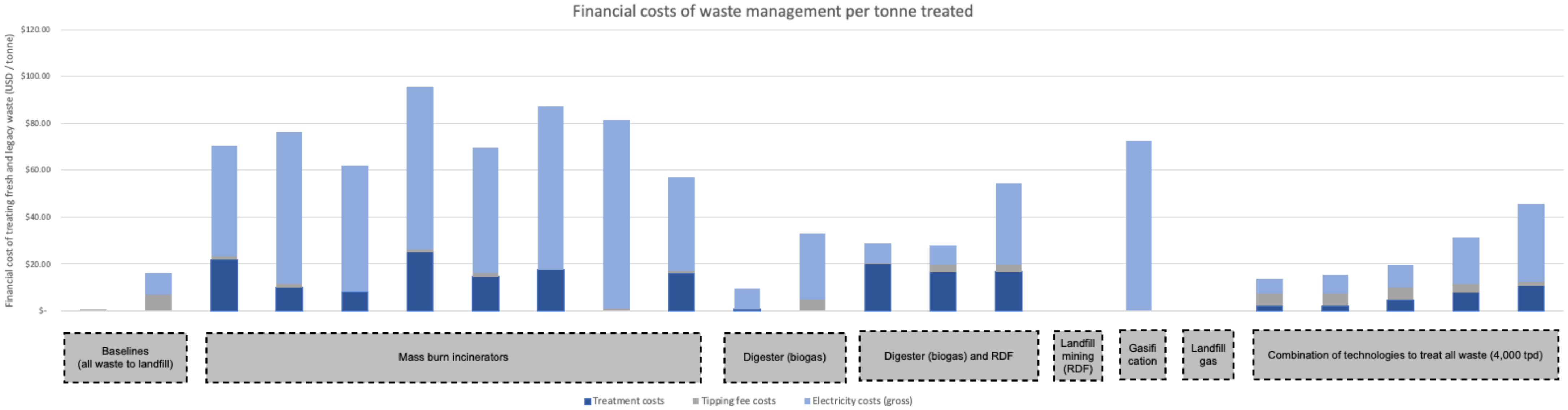


- Waste to energy (scenario 2a) had the highest annual shortfall. The revenue from selling electricity was not high enough to recover the annual costs at a waste heating value of 2,000 kcal/kg waste and overall conversion efficiency of 10%.
- Sorting and recycling scenario 3 had lower annual shortfall compared to waste to energy, but higher than existing baseline

Synopsis of Cambodia Case Study

- **Objectives and Scope:**
    - Region in Cambodia
    - Waste tonnage and composition: 4,000 tonnes/day, 50% organics, 15% paper and cardboard, 10% plastics, 10% metals
    - Compared the financial cost the Government of Cambodia would be expected to pay to operate the waste management system.
    - Financial costs measured in tipping fees, gate fees, and electricity purchases the Government would pay
- **Technologies compared:** Mass burn incinerators, digesters (biogas), refused derived fuel (RDF) recovery, mining legacy waste in landfill to recovery RDF, gasification, landfill gas recovery
- **Scenarios analyzed:**
    - Baseline 1: All waste sent to existing non-sanitary landfill
    - Baseline 2: All waste sent to sanitary landfill
    - Individual technologies
    - Portfolio of technologies to meet full waste tonnage

Cambodia Case Study Key Findings



- The financial cost per tonne of waste of the portfolio scenarios increased because each subsequent scenario has more waste management technologies added to the system. This increases the associated gate fees and PPA prices. Overall, the portfolio scenarios showed lower financial costs per tonne of waste treated compared to the large-scale mass burn incinerators.
- The most expensive systems had a single large mass burn incinerator designed to treat all MSW, a high gate fee, and a high PPA price higher than the marginal cost of electrical power.
- Landfill mining had zero costs to the Government because the solution proposes to mine the landfill for RDF to be used by the company directly and the business model did not charge a gate fee.

Challenges in Financial Analysis of SWM Projects

Technical and Financial Aspects

Challenges in SWM Financial Analysis

Technical

- **Mass imbalance:** There are some instances where there are missing mass and energy inputs/outputs and estimates have to be made to fill in the gaps.
- **Calorific value of waste:** Some technologies will state a particular energy output, but it is based on a calorific value that does not represent the waste stream being analyzed.
- **Recycling and recovery rates:** These terms are often used interchangeably. Important to determine the amount of material recovered after sorting and material remaining after recycling.

Financial

- **Landfill operation costs:** Detailed breakdown of costs for maintaining the landfill is often unavailable publicly or not tracked.
- **Tipping fees:** Fees for disposing waste at a landfill may not be publicly available
- **CAPEX vs capacity:** CAPEX does not scale up linearly in cost according to capacity of technology, making it hard to estimate different sizes.
- **OPEX level of detail:** Annual cost of operating the technology/facility might not be available at a detailed level by line item.

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Summary

- Financial analysis of SWM helps us understand the costs of such systems to achieve environmental benefits and compare against other technologies and business models
- Financial analysis generally follows the same calculation process, but varies in what types of costs (cash out) and revenue (cash in) are considered based on the perspective and objective of the analysis.
- Analysis of SWM requires collection of technical data regarding the waste treatment technology and system followed by prices associated with each physical input/output
- In developing Asia, the necessary technical and financial data required to conduct a meaningful analysis may be missing, but reasonable estimates can be made based on data about technologies applied in similar contexts.

Questions & Comments

For further inquiries, send an email to pkerdlap@pxp-sustainability.com