ADB-KSP Join Consulting

Support for the establishment of waste-to-fuel technology in the transport sector in Bangladesh

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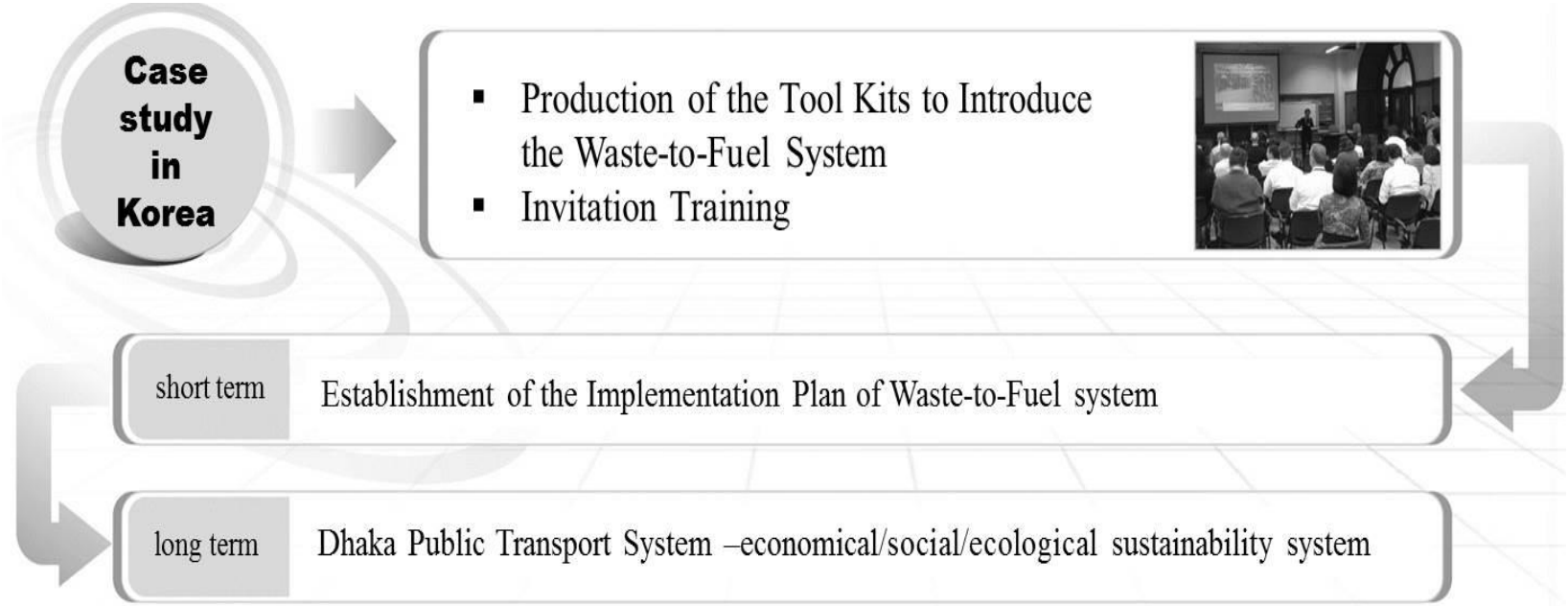
CONTENTS

I

Introduction of Project

1. Project Overview

Name	**Support for the establishment of waste-to-fuel technology in the transport sector in Bangladesh**
Implemented by	The government of Republic of Korea and The Export–Import Bank of Korea
Features	A joint consulting project with Asian Development Bank (ADB) as a part of the Knowledge Sharing Program (KSP)



2. Project Contents and Expected Benefit

2.1 Project Content

- Analysis of the public transport system of Dhaka
- The case study of the waste-to-fuel system in Wonju city and finding implications
- The production of the introduction tool kits for the construction of a waste-to-fuel system
- Workshops for performance improvement
- Establishment of the implementation plan of a waste-to-fuel project

2.2 Expected Benefit

For Bangladesh and Dhaka

- To establish a sustainable transport system and improve urban environment
- To secure knowledge and technologies related to waste-to-fuel project

For ADB

- To enhance the effectiveness of projects supported
- To ensure continuous cooperation with Korea Eximbank and other relevant organizations in Korea

3.1 Analysis of the Public Transport System

Analysis of the public transport system in Dhaka

- Types of public transport and use of each public transport
- The operating state of roads and transport system
- Securing documents and written materials
- Analysis of the current state and major issues

National policies, operating plans and budget of BRT

- Interviews with officials of the public transport related government bodies
- A cooperation system with relevant government bodies

Analysis of the previous improvement plan of the public transport system in Bangladesh

- Relevant document review
- Analysis of existing improvement plans
- Possible links to the waste-to-fuel system
- Investigation of the possible EDCF projects

3.2 Analysis of the Waste to Fuel System in Korea

Introduce Waste to Fuel system in Korea

Case Study of The Waste-to-fuel system in Wonju

- Focus on : Basic information, Project costs including fixed and operating expenses, Financial structure analysis, Operating method and status, Success factors of the establishment and operation of the system, Development and improvement directions
- The system diagram, photos and video materials of the system are produced to ensure more effective understanding.

3.3 Implementation Plan

Current status of the public transport

- Types of public transport and use rate of each type
  - Identifying the features of the public transport & the travel characteristics of passengers
- The operating status of roads and traffic system
- Energy use by the public transport
- Securing documents and records for analysis
- Analysis of operation status and key issues

II Status in Bangladesh

1. Public transport system in Dhaka

1.1 Public transport modes in Dhaka

- The main public transport modes in Dhaka include (automatic / cycle) rickshaws, tempos(three-wheelers), truck buses, trains and taxes. “Dhaka Metropolitan Regional Transport Committee (DMRTC)” is responsible for the management of the public transport. The following table presents the operating status and fares of public transport modes in Dhaka

Bus (Large, Mini and Micro)	Auto-rickshaw	Cycle-rickshaw
		
• Large Bus(Automatic) : 1.45Tk/㎞ • Large Bus (Manual) : 1.2Tk/㎞ • Mini Bus : 1.1Tk/㎞	• Basic fare : 18Tk • 14Tk for the initial 2km and 6Tk per Km • 1Tk per minute while waiting	• 10Tk per km

Note : 1Tk = 13.11 KRW(As of June, 2014)

1.2 Buses in Dhaka

- Buses, which are currently in operation as one of the main public transport modes in Dhaka, are separated as three categories: Large buses for 30~32 passengers, Mini buses for 15~30 passengers and Micro buses for 8~15 passengers
- Since most buses currently in operation in Dhaka use CNG as fuel, it would be possible to secure the business conditions for recycling wastes as fuel

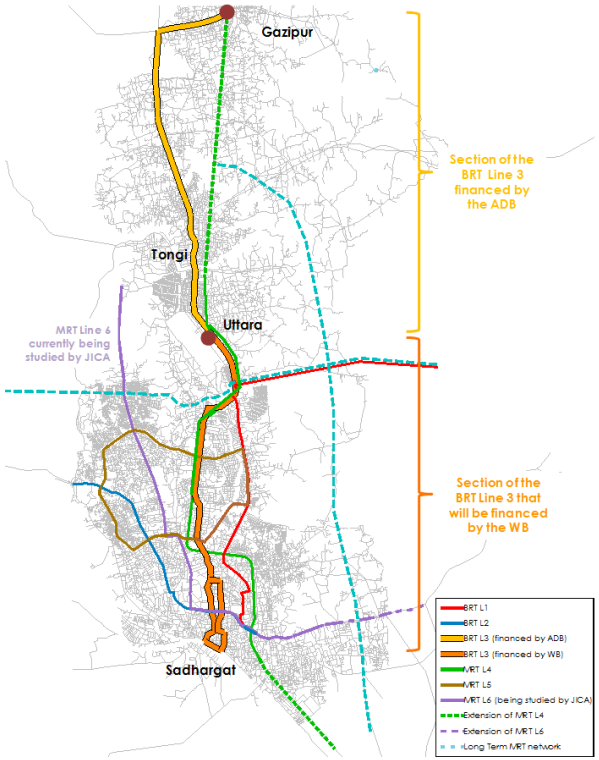
Classification	Number of Route	Number of Bus
Large Bus	103	1,617
Mini Bus	103	2,973
micro Bus	38	937

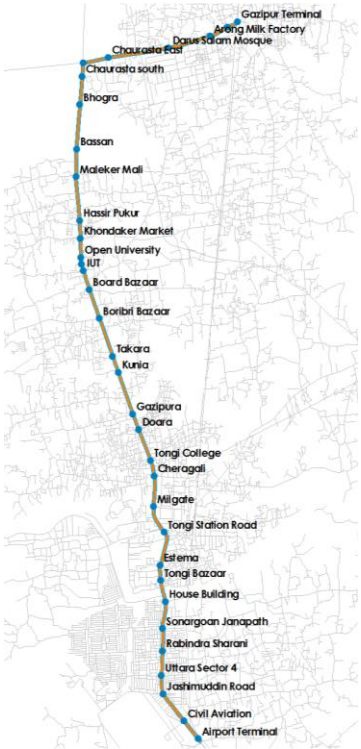
Source: Bangladesh Road Transport Authority, 2007

1. Public transport system in Dhaka

1.4 BRT construction plan

- The government of Bangladesh is working on several projects including BRT, mass rapid transit (MRT) and sky highway to resolve the public transport issues
- Currently, the introduction of BRT, which was established by Asian Development Bank (ADB) and
- World Bank (WB), is in progress in Dhaka. This transport system is closely related to this project





Source: Preparing the Greater Dhaka Sustainable Urban Transport Corridor, 2011, ADB

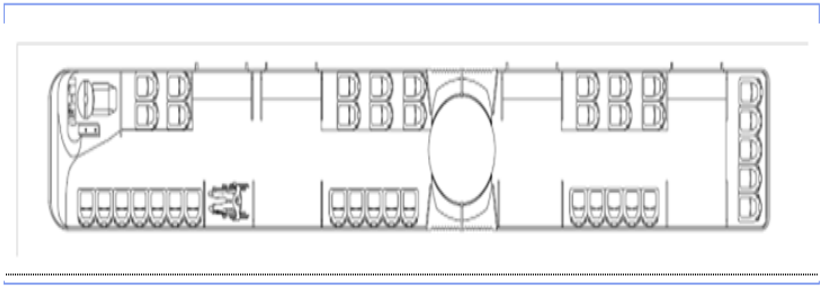
1.5 BRT operation plan

Exterior and Interior Specifications

- Bus can have both single-deck or articulated
- Articulated bus can accommodate up to 140 passengers with 4 doors and 38 mixed seats

Exterior Specification		
Exterior of BRT Bus	Length	18.5m
	Width	2.6m
	Height	3.6 ~ 4.1m(from the paved road surface0
	Turning Radius	15.0m

Source: Transmilenio / Transjakarta



Source: BRT and Corridor Restructuring Implementation Study and Preliminary Design work for the Uttara – Mohakhali – Ramna – Sadar Ghat Corridor in Dhaka

1.5 BRT operation plan

BRT vehicle purchase plan by year and projected cost

- By 2043, 173 BRT bus will be in operation and the following table describes further details of the BRT vehicle plan

Classification	2019	2024	2029	2034	2039	2043
number of vehicles to purchase	47	91	69	97	76	-
retire	-	-	47	91	69	-
operate	47	138	160	166	173	173
purchase costs (USD)	7,232,548	14,003,444	10,617,996	14,926,748	11,695,184	-

Source:「Preparing The Greater Dhaka Sustainable Urban Transport Corridor Final Report. 2011」

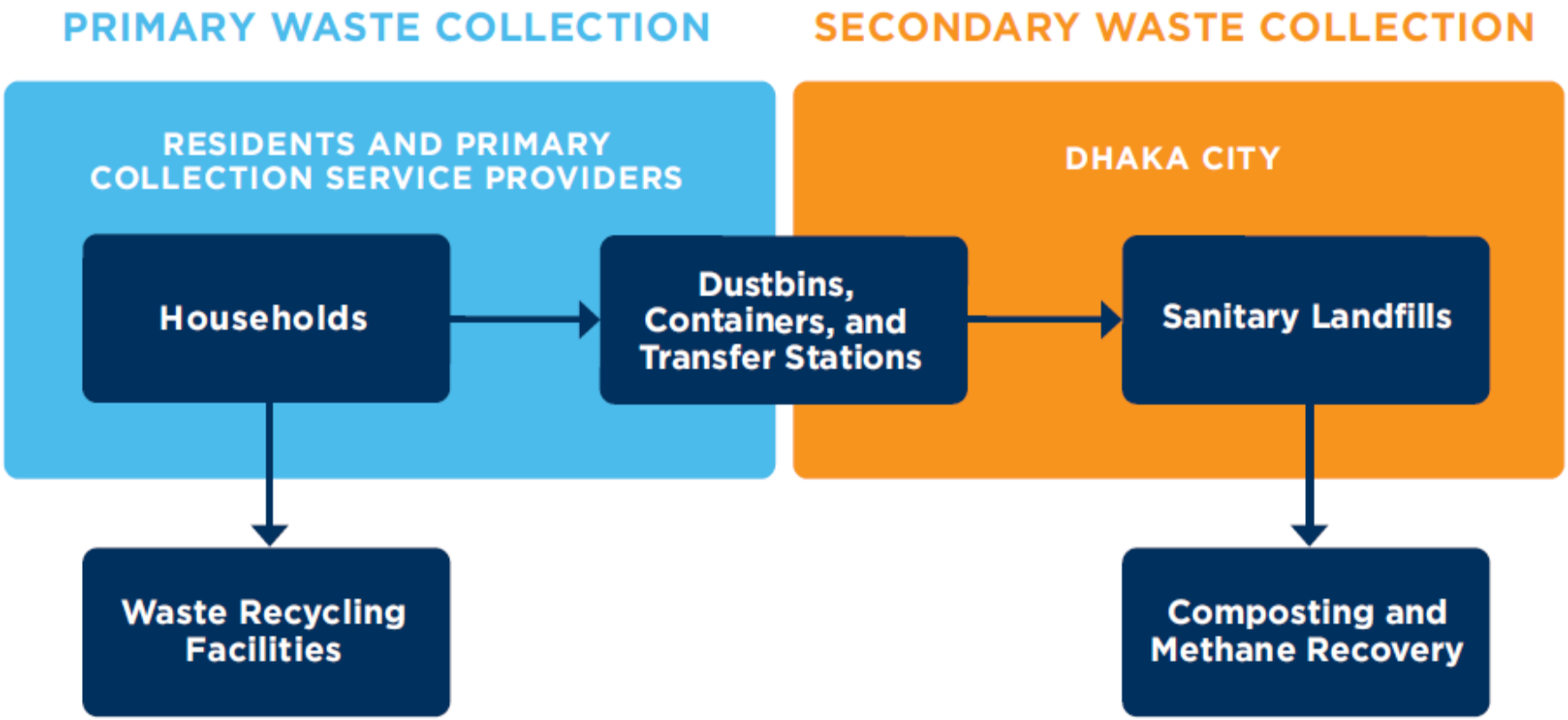
2. Waste Management Status in Bangladesh

2.1 Dhaka Waste Collection and Disposal

- Waste expected in Bangladesh(2015) : 5,000 ton/day
- Waste output in Bangladesh(2004) : 3,400 ton/day
- Bangladesh is one of the world's poorest and most populous nations. Its 150 million people live in an area the size of Iowa and have an average per capita income of about $600 per year, according to the Bangladesh Bureau of Statistics. Because it lacks space for landfills, trash disposal is a major concern.
- 80 percent of the waste is organic – food waste, such as vegetable and fruit peels, meat scraps, and spoiled fish.

2. Waste Management Status in Bangladesh

2.1 Dhaka Waste Collection and Disposal



Source: Adapted from Dhaka City Corporation and Japan International Cooperation Agency.

2. Waste Management Status in Bangladesh

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Overall conditions in expected waste-to-fuel system facility site

- monitoring in Amin Bazar that currently used as landfill site in Dhaka
- wastes are discharged from anywhere in unsanitary conditions
- no social responsibilities for discharging and collecting wastes
- difficulties in collection and transport of the wastes, due to no regulations for waste capacity limit of collection and landfill
- current landfills are operating without any environmental pollution prevention facilities
- potential natural and artificial danger for accidents
- tamping and soil coverage are crucial to enable recycling in the existing landfill sites
- considering the economic feasibility, governmental support to waste collection and transportation are expected to be essential

III Implementation in Bangladesh (Dhaka BRT)

1. Review of BRT fuel consumption

Capacity of BRT bus

- Seating capacity for Zhongtong, Optare, and Xiamen was 78, 56, and 25-27
- Vehicles were 18.0m in total length and ran on two types of fuel (CNG and diesel)
- Diesel is superior to CNG in terms of transport, storage, distribution, production, and sustainability

Classification	Capacity (person/bus)	No. of seat	Length (m)	Fuel	mileage	
					m^3 orL/100km	km/m^3 orL
Zhongtong	180~224	78	18	CNG	38	2.63
Optare	-	56	18	CNG	40	2.50
Xiamen	164	25~27	18	Diesel	35	2.86

Source: 「Preparing The Greater Dhaka Sustainable Urban Transport Corridor Final Report. 2011」

1. Review of BRT fuel consumption

Vehicle specifications for operation in Dhaka

- To calculate the amount of alternative fuel, vehicle specifications and mileage by applicable brand were considered
- Applicable mileage was estimated at 33㎥/100km(3.0km/㎥)

Classification	Capacity (person/bus)	No. of seat	Length (m)	Fuel	mileage	
					㎥ orL/100km	km/㎥ orL
Vehicle Specifications	140	78	18	CNG	33	3.0

1. Review of BRT fuel consumption

Estimation of fuel consumption by year

- Estimated in consideration of the expansion of BRT routes, applicable mileage, and the number of trips
- Fuel consumption estimation for 173 vehicles in 2043 showed that when each bus makes 3.1 trips
- Distance travelled would be 7,797,276km/yr and the fuel consumed would be 2,599,092 ㎥/yr

year	Number of bus	number of trips	Distance(km/year)	fuel consumption (m^3/year)
2019	47	4.6	3,118,911	1,039,637
2024	138	2.0	3,898,638	1,299,546
2029	160	1.9	4,455,711	1,485,237
2034	166	2.2	5,198,184	1,732,728
2039	173	2.5	6,237,821	2,079,274
2043	173	3.1	7,797,276	2,599,092

2. Comparison of waste-to-fuel technology

Criteria	Organic Waste Anaerobic Digestion	Integrated Waste Landfill
Principle	- sort out the organic wastes - construct the anaerobic digestion facility - biogas to fuel through the anaerobic digestion method	- waste landfill - biogas to fuel through the anaerobic digestion after the landfill method
Pros	- short term degrade of organic waste - suitable as resource due to the high portion and amount of organic waste	- enough amount of waste - non-essential of waste sorting process
Cons	- need of organic waste sorting process - competition with the composting system company	- no sanitary landfill site - high costs of sanitary landfill facility construction and transformation
Decision	- from the field investigation, anaerobic digestion system is suitable for Dhaka	

3. Gas potential overview

Substrate	Unit	Food waste	TOTAL Substrate Mix
Volume	t/d t/y	140 51,100	140 51100
Biogas potential MIN Biogas potential MAX	m3/ton VS m3/ton VS	308 667	
Methane content	% CH4	60%	
Biogas potential MIN Biogas potential MAX	m3/ton VS m3/ton VS	185 400	
Biogas potential SET	m3/ton VS	290	
Biogas potential MIN Biogas potential MAX	m3/ton m3/ton	42 90	
Biogas production MIN Biogas production MAX	Nm3/y Nm3/y	2,121,289 4,599,000	
Biogas production SET Biogas production SET	Nm3/min Nm3/y	6.4 3,360,144	6.4 3,360,144
Vehicle fuel SET	Nm3/y	2,062,438	

4. Comparison the waste amount between Dhaka and Gazipur city

Criteria	Dhaka	Gazipur City	Note
① Waste generation amount	5,000 ton/day	350 ton/day	
② Waste collection rate	60%	60%	
③ Total landfill amount (①x②)	3,000 ton/day	210 ton/day	
Food waste (③xRatio)	2,010 ton/day	160 ton/day	criteria: ratio Dhaka: 67% Gazipur: 76%

Source: CCAP (Center for Clean Air Policy). (2012) Dhaka's Integrated Municipal Solid Waste Program. CCAP, p.2

5. Feasibility analysis

Criteria		Wonju, Korea	Bangladesh	Note
Material		220ton/day investment [material-soil residue(include the liquid), food waste, wastewater, organic sludge]	140ton/day investment [material- food waste]	
Facility installation fee		Approx. 259	Approx. 180	
Total gross	Biomethane output	2365200	Approx. 200 thousand	*Unit: hundred million KRW (except output, consumption, sales, and unit cost) *Per year
	On-site consumption	865200	Approx. 50 thousand	
	Biomethane sales	150 thousand	Approx. 150 thousand	
	Unit cost of sales	Approx. 650 won	Approx. 400 won	
	Sales cost	Approx. 10	Approx. 6	
	Waste carry-in commission	Approx. 40 (Approx. 50,000won/ton)	unsettled	
Maintenance expenses	Labor cost	5. 5	2.0	
	Maintenance and inspection	5.0	3.5	
	Chemical treatment fee	5.0	3.5	
	Utility bill	8.0	4.0	
	Waste transit and treat fee	6.5	3.0	
	Waste collecting fee	none	unsettled	
	total	Approx. 30	Approx. 16	

IV Issues

1. Project Issues

Waste collection system

>> How we create proper waste collection system in developing countries? (any good cases?)

Financial feasibility of the project

- Cost for construction and operation

- Wonju project was conducted by PPP (20 years of operation by private partner), because the project is feasible with waste treatment fee from government.

2. Technological Issues

- Quality of gas
- Maintenance
- Way to consider social impact of project (new jobs, environment, health, etc)
- Building consensus for waste management
- Fuel security
- Any global funding?

THANK YOU!

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