Waste-to-Energy Projects on the Maldives – Analysis of the Financial Feasibility

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Photos from Catchment Area 1: Upper North Region or Kulhudhufushi






Contents

Introduction and background

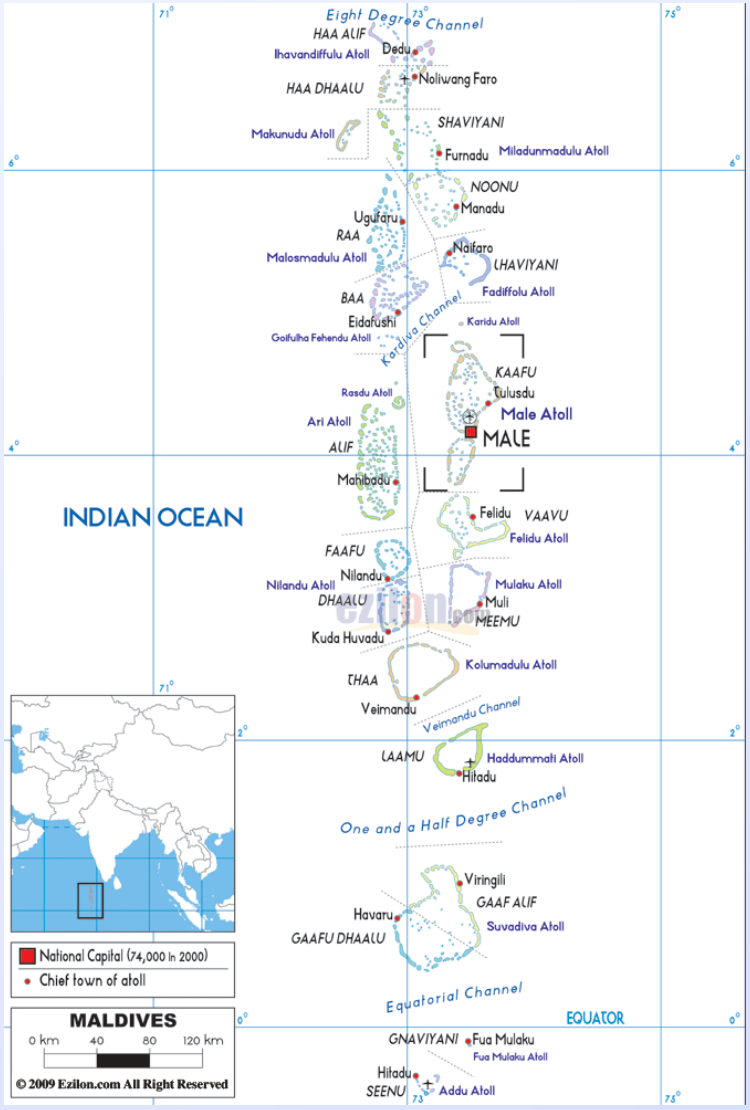
Republic of Maldives

Population: about 400 000 inhabitants

Amount of islands:
1196 thereof 199 inhabited

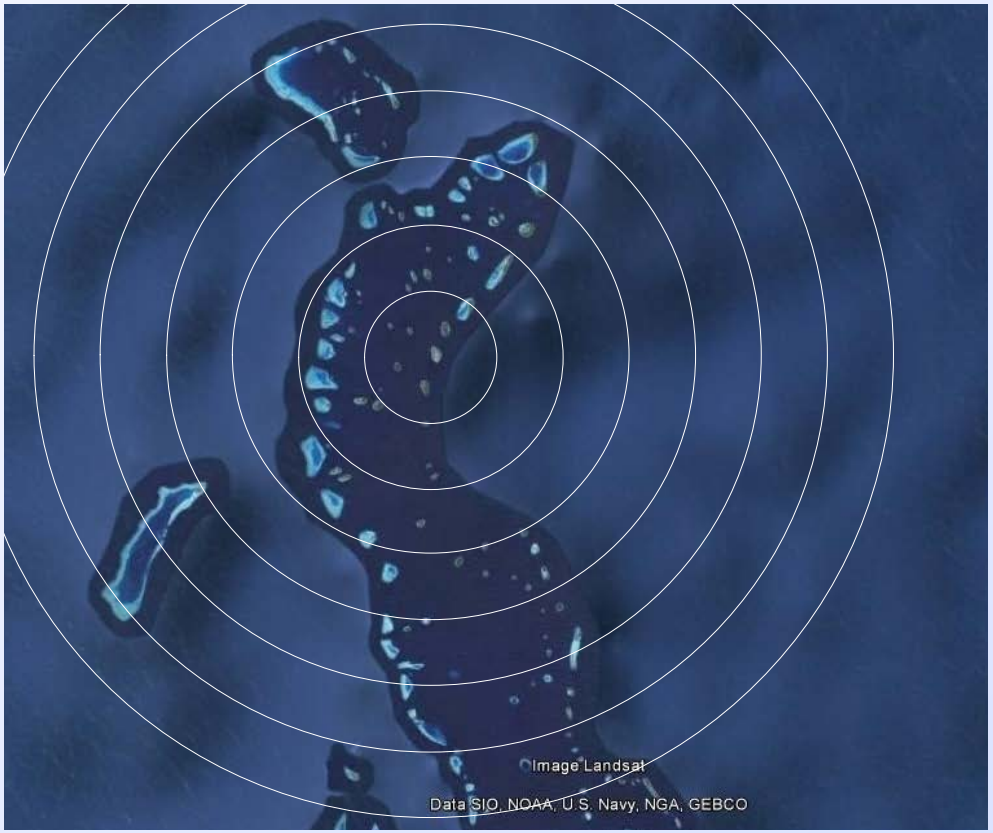
North-South Dimension: 800 km
East-West Dimension: 130 km

Capital:
Malé with ~150 000 inhabitants on 3 islands
on 5.8 km² (~ 2.4 km x 2.4 km)



Introduction and background

Catchment area 1 : Upper North Region



Introduction and background

Name of the project:

Preparing Outer Island Waste-to-Energy Projects - Preparation of the Accelerating Sustainable Private Investment in Renewable Energy Projects

Client: Ministry of Environment and Energy of the Republic of Maldives

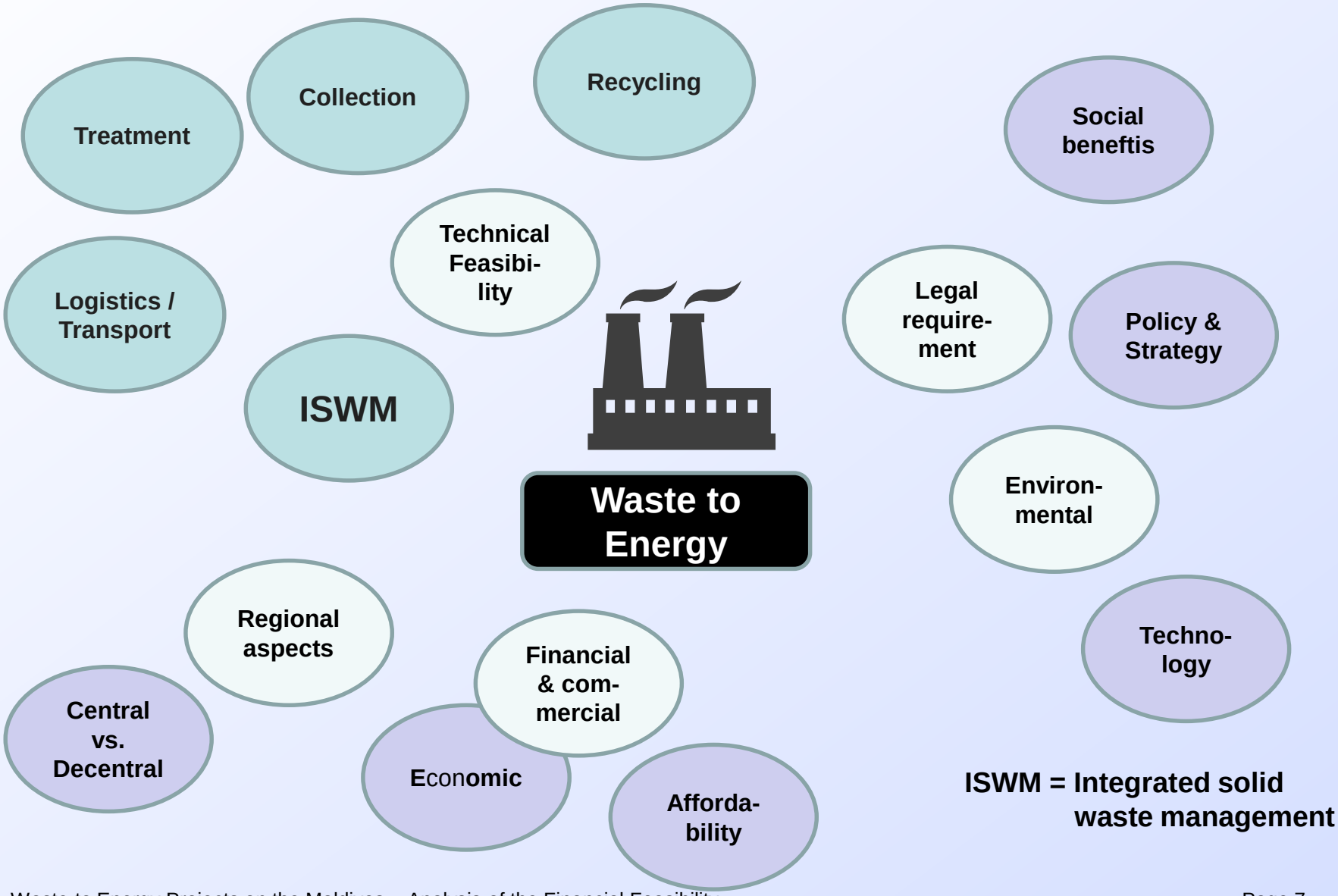
Financier of study: World Bank

Financier of the proposed project: unknown, maybe World Bank

Carried out by Kocks Consult GmbH

Financial analysis carried out by Plejades GmbH Economics

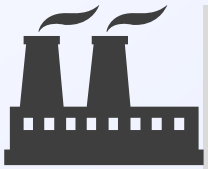
General Aspects of the Feasibility Study



ISWM = Integrated solid waste management

Possible outputs from waste incineration

Incinerator (grate): heat recovery



Grate incinerator

- **Water desalination**
- **Cold water production with ARP***
- **Electricity production**
- **Electricity production & water desalination**

***ARP = Adsorption Refrigeration Plant**

Aspects of this Feasibility Study

Analysed areas and options

Regions / Catchment areas:

- **CA1: Upper North Province with site on Kulhudhuffushi**
- **CA2: North Province with site on R.Vandhoo (uninhabited)**
- **CA3: South Province with site on Addu City / Hithadhoo**

Waste-to-energy variants:

- **Sea water withdrawal and desalination plant**
- **Adsorption refrigeration plant & distribution**
- **Electricity production (Steam boiler, steam engine)**
- **Electricity production and thermal desalination**

Additional necessary components for each option:

- **Collection and transport by trucks and vessels**
- **Sanitary landfill**

Project target: What variant is feasible?

	Variant 0	Variant 1	Variant 2	Variant 3	Variant 4
	Incineration + landfill	Desalination	ARP	Electricity	Electricity + Desalination
Upper North Province / Kulhudhuffushi					
North Province / R.Vandhoo					
South Province / Addu City					

Financial Aspects of this Feasibility Study

Main Questions:

- **Are the proposed investments sustainable?**
- **Are the operators viable?**
- **What are the “best” investments?**
- **Tariffs?**

Technical inputs:

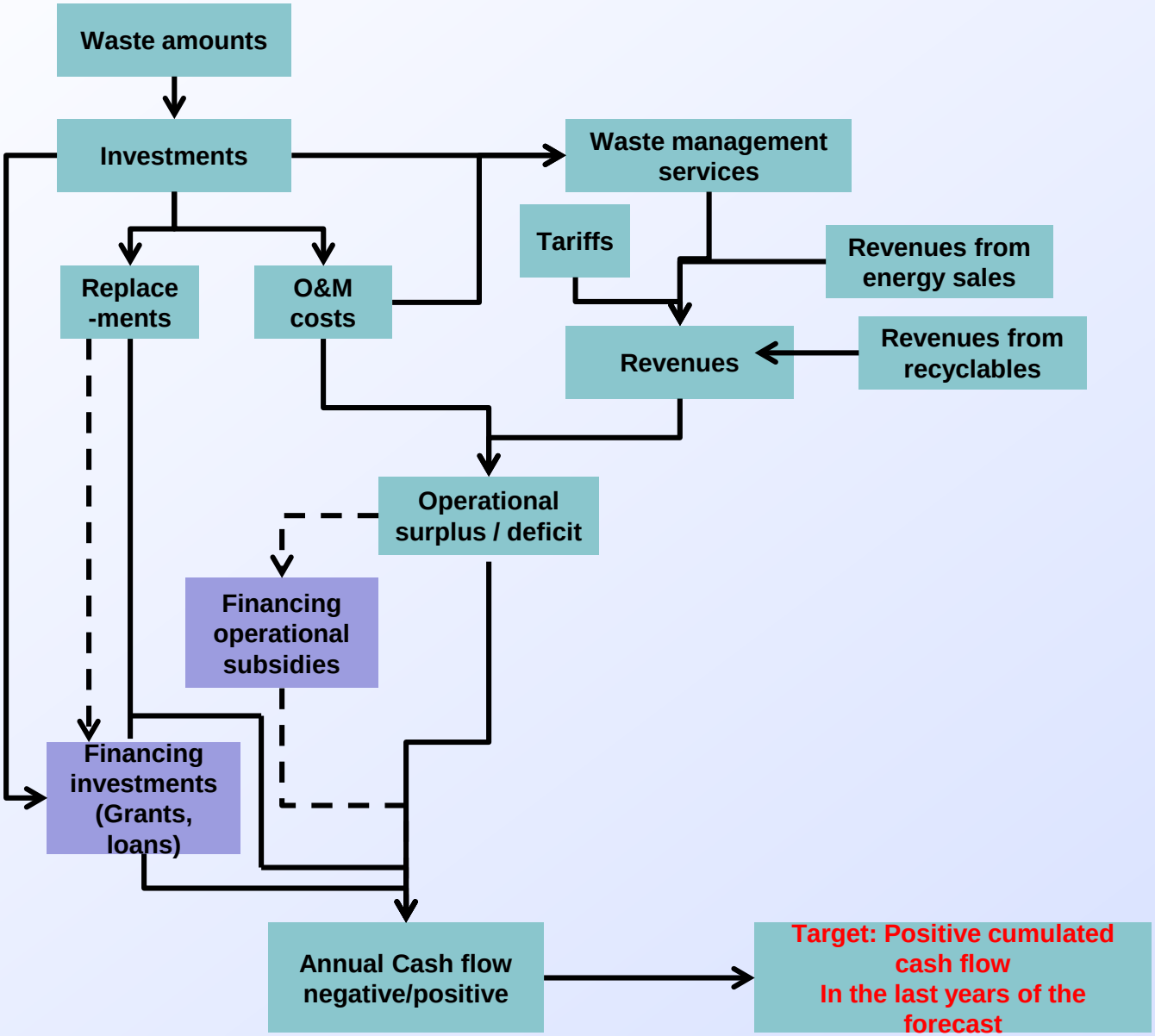
- **Catchment area, related population, tourist resorts**
- **Waste quantities per capita and waste compositions**
- **General technologies esp. incineration technologies**

Financial and technical parts:

- **Investments**
- **O&M costs**
- **Revenues**

Prices: All calculations are made in prices of 2014, no price increases

Financial Analysis - Model Overview



Assumed waste composition households

Waste composition	%	Trend
Organics	70%	constant
Garden waste	*30%*	
Kitchen waste	*30%*	
other organics	*10%*	
Paper & cardboard	7%	constant
Glass	3%	decrease by 1%
Plastics	5%	increase in the next years probably by 2-3 %
Metals	4%	constant
Hazardous wastes (including clinical)	2%	constant
Other (inert & dust)/mixed waste	9%	decrease
Total	100%	

Waste per person: Between 0.8 kg and 1.0 kg per day and capita

Assumed waste composition tourist resorts

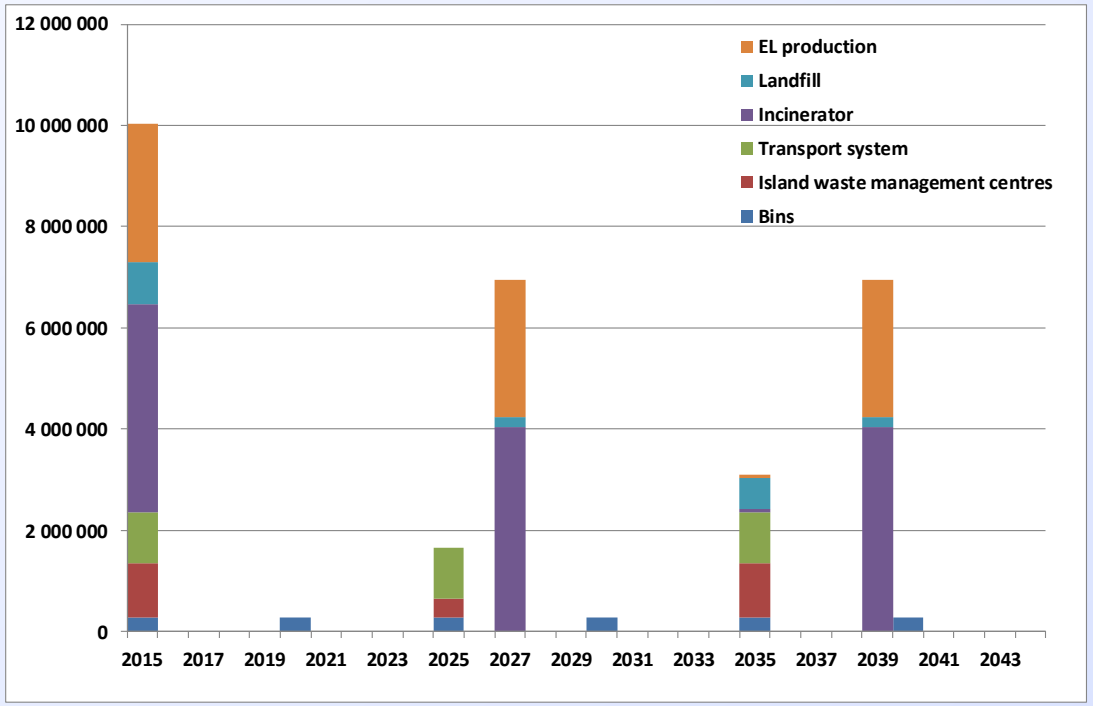
Waste composition	%	Trend
Organics	74%	constant
Garden waste	19%	
Kitchen waste	45%	
other organics	10%	
Paper & cardboard	9%	constant
Glass	5%	constant
Plastics	5%	constant
Metals	2%	constant
Hazardous wastes (including clinical)	0,5%	constant
Other (inert & dust)/mixed waste	4,5%	constant
Total	100%	

Waste in tourist resorts: Between 3.0 kg per day and “bed”

Results for Catchment Area 1: Upper North Region

Investments: Initial investments and replacements in USD

	Life-time	2015
Collection and Transport		
Bins		
120 l bins	5	278 123
240 l bins	5	0
660 l bins	5	0
Subtotal, bins		278 123
Island Waste Management Centres (IWMC)		
IWMC construction	20	700 000
Plastic shredders	10	42 054
Wood Chipper	10	78 221
Can crusher	10	201 860
Glass crusher	10	63 081
Subtotal, Island Waste Management Centres		1 085 216
Transport system		
Vessels 60" feet	10	1 000 000
Subtotal, Transport system		1 000 000
Subtotal Collection and Transport		**2 363 340**
Variant 3		
Incinerator		
Civil works	20	60 000
M&E equipment	12	4 050 000
Subtotal, incinerator		4 110 000
Landfill		
Civil works	20	620 000
M&E equipment / wheel loader	12	200 000
Vehicles and prefabricated buildings	0	0
Subtotal, landfill		820 000
Electricity production / Steam boiler, steam engine		
Civil works	20	50 000
M&E equipment	12	2 700 000
Subtotal, Electricity production / Steam boiler, steam engine		2 750 000
Subtotal Variant 3		**7 680 000**
Total investments and replacements		**10 043 340**

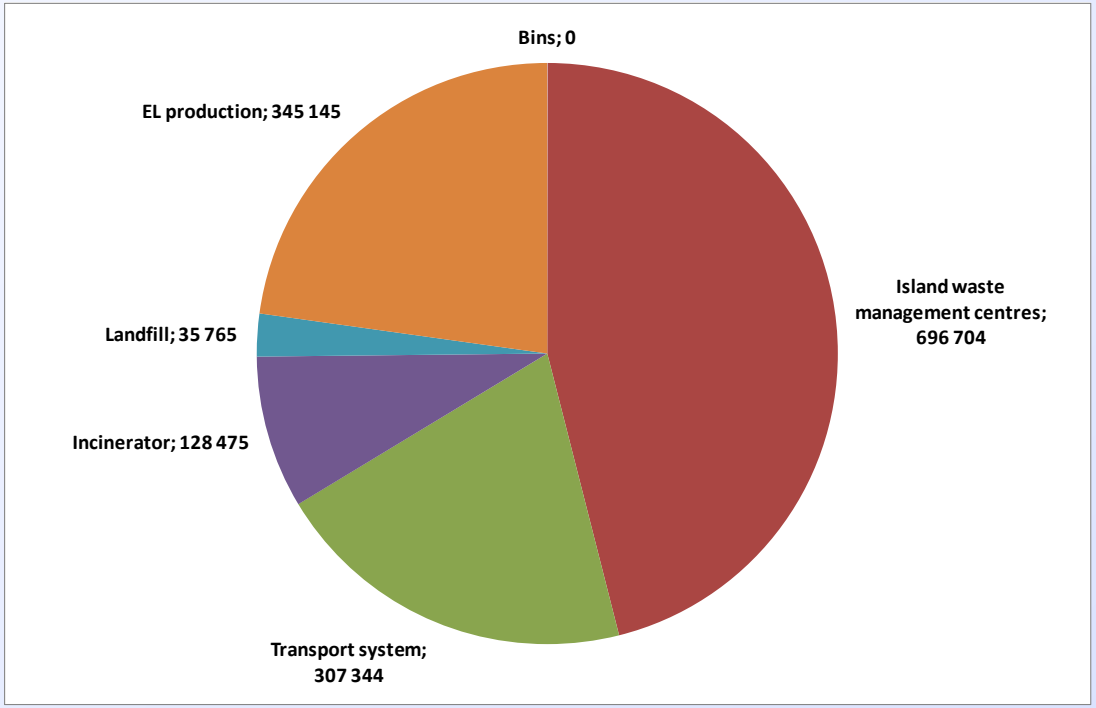


Total for the period from 2015 to 2044	19 491 050
Residual value in 2044	-5 034 813
Total minus residual value	14 456 237

Results for Catchment Area 1: Upper North Region

O&M costs // Operation and maintenance costs in USD

	O&M costs
Collection and transport	
Bins	
Maintenance, bins	0
Subtotal, bins	**0**
Island Waste Management Centres (IWMC)	
Maintenance, IWMC construction	14 000
Maintenance, Plastic shredders	841
Maintenance, Wood Chipper	1 564
Maintenance, Can crusher	4 037
Maintenance, Glass crusher	1 262
Workers, unskilled	675 000
Subtotal, Island Waste Management Centres	**696 704**
Transport system	
Maintenance, Vessels 60" feet	30 000
Labour, captain	9 375
Labour, workers	68 750
Fuel	199 219
Subtotal, Transport system	**307 344**
Subtotal Collection and Transport	**1 004 048**
Incinerator	
Civil works	600
M&E equipment	81 000
Workers, skilled	25 000
Workers, unskilled	21 875
Subtotal, incinerator	**128 475**
Landfill	
Maintenance of civil works	6 200
Maintenance of M&E equipment	4 000
Maintenance of vehicles and buildings	0
Fuel	25 565
Subtotal, landfill	**35 765**
Electricity production / Steam boiler, steam engine	
Maintenance of civil works	500
Maintenance of M&E equipment	54 000
Electricity	284 705
Chemicals	5 940
Subtotal, Electricity production / Steam boiler, steam engine	345 145
Subtotal Variant 3	**509 385**
Total operation and maintenance costs	**1 513 433**



Total annual O&M costs:

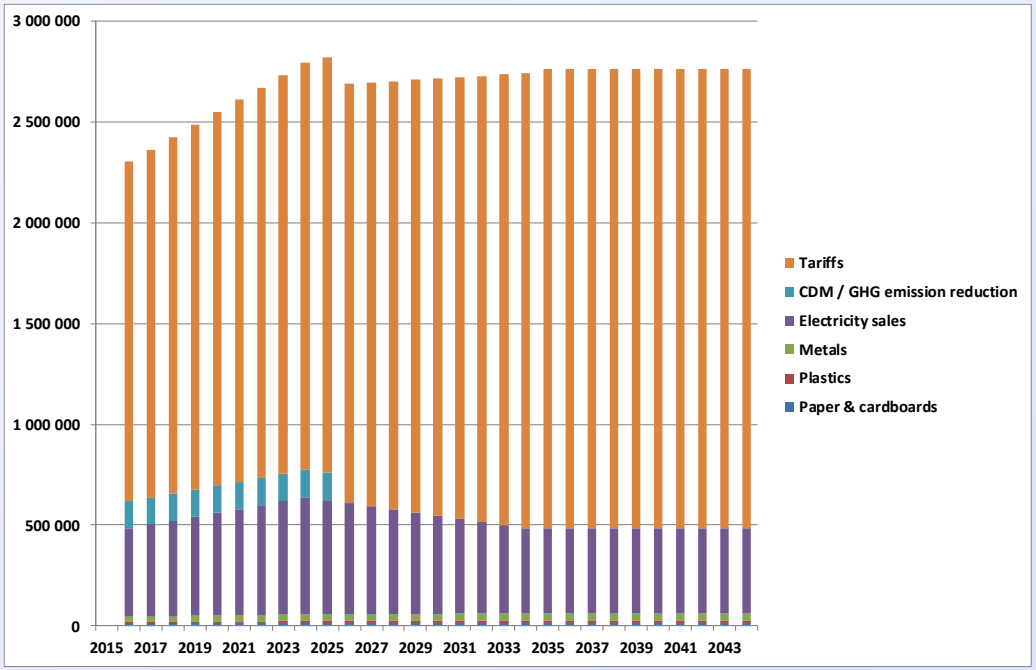
1.5 million USD per year

fuel for transport: 0.2 million USD

Results for Catchment Area 1: Upper North Region

Revenues in USD

Revenues	2025
Paper & cardboards	14 364
Plastics	9 819
Metals	32 004
Electricity sales	566 160
CDM / GHG emission reduction	136 091
Total revenues before tariffs	**758 437**
Tariffs	2 060 681
Total revenues	**2 819 118**



Total O&M costs in 2025: **1.51 million USD**

Total revenues before tariffs in 2015 **0.77 million USD**

Revenues from tariffs in 2015 **2.06 million USD**

→ Operational surplus

→ But still need for financing Initial investments and replacements

Results for Catchment Area 1: Upper North Region
Tariffs and affordability

Tariff per capita (domestic): about 27 USD per year

Fees per "bed" in tourists resorts: about 270 USD per bed

Reason:

- **One "bed" produces three times more waste than a domestic person**
- **People who can afford holidays on the Maldives have also the affordability to pay about 1 USD per night for a waste management system in their holiday area**

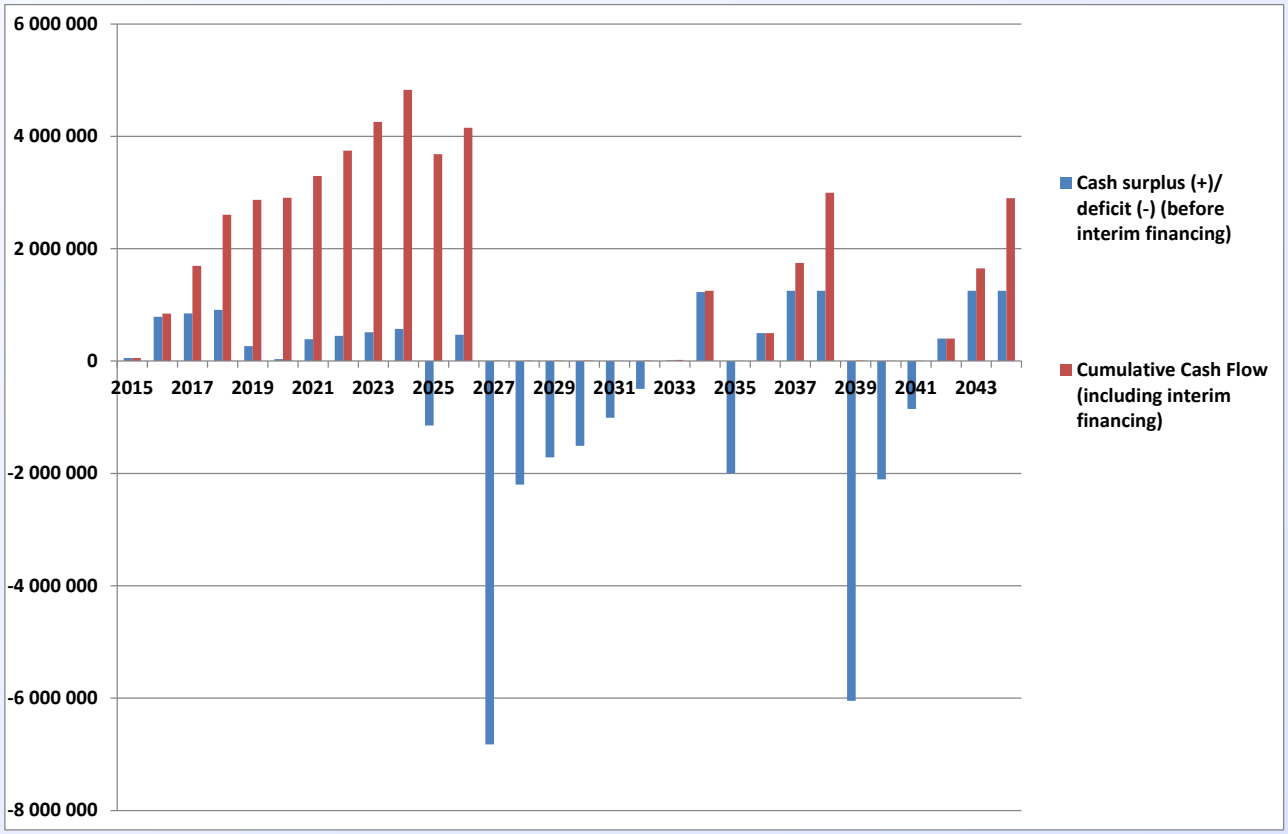
Affordability of the domestic population:

Tariff of 27 USD per year is about 0.3% of the GDP per head → affordable

Results for Catchment Area 1: Upper North Region

Cash Flow

- Cash flow statement can be calculated
- Loan conditions: 3%, grace period 3 years, total 18 years
- Annual interim financing for cash shortages allowed



Result: Proposed investment project is financially feasible

Results for the three catchment areas

	Variant 0	Variant 1	Variant 2	Variant 3	Variant 4	Other variant
	Incineration + landfill	Desalination	Adsorption Refrigeration Plant	Electricity	Electricity + Desalination	Other variant
CA1: Upper North Province / Kulhudhuffushi			*financially feasible**	proposed / financially feasible		
CA2: North Province / R.Vandhoo		proposed / financially feasible				
CA3: South Province / Addu City				financially feasible		proposed

** if pipes system is financed by the customers*

CA3: Waste quantity is (currently) not sufficient for incineration → better sorting and composting + rehabilitation of the existing landfill

Challenges

Modelling challenges

- **In the “engineering world” there exists population growth**
- **Minor changes of waste amounts and compositions**
- **Growing population has no impacts to O&M costs**

Other challenges / points for discussion

- **Feasibility analysis of a steam-boot driven with waste as energy input for the steam engine for waste collection from island to island**
- **Why no import taxes for packaging? Especially for very small countries this seems to be reasonable.**

Questions

Thank you for your attention!

Any Questions?