

Material- and Energy-Flow Analysis of the Solid Waste as Generated in the Northern Taiwan

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2008.11.10



Outline

- Introduction
- Study Areas
- Purposes of Study
- Methods
 - Material-and Energy-Flow Analysis
 - Material Recycling Index
- Results and Discussion
- Conclusions



Introduction

- Waste minimization has been placed as the top priority in the solid waste management.
- Minimization by “Source Reduction” and “Recycling” .
- Taipei City, Taipei County and Taoyuan County account for 36% of total population and the total solid waste production in Taiwan.

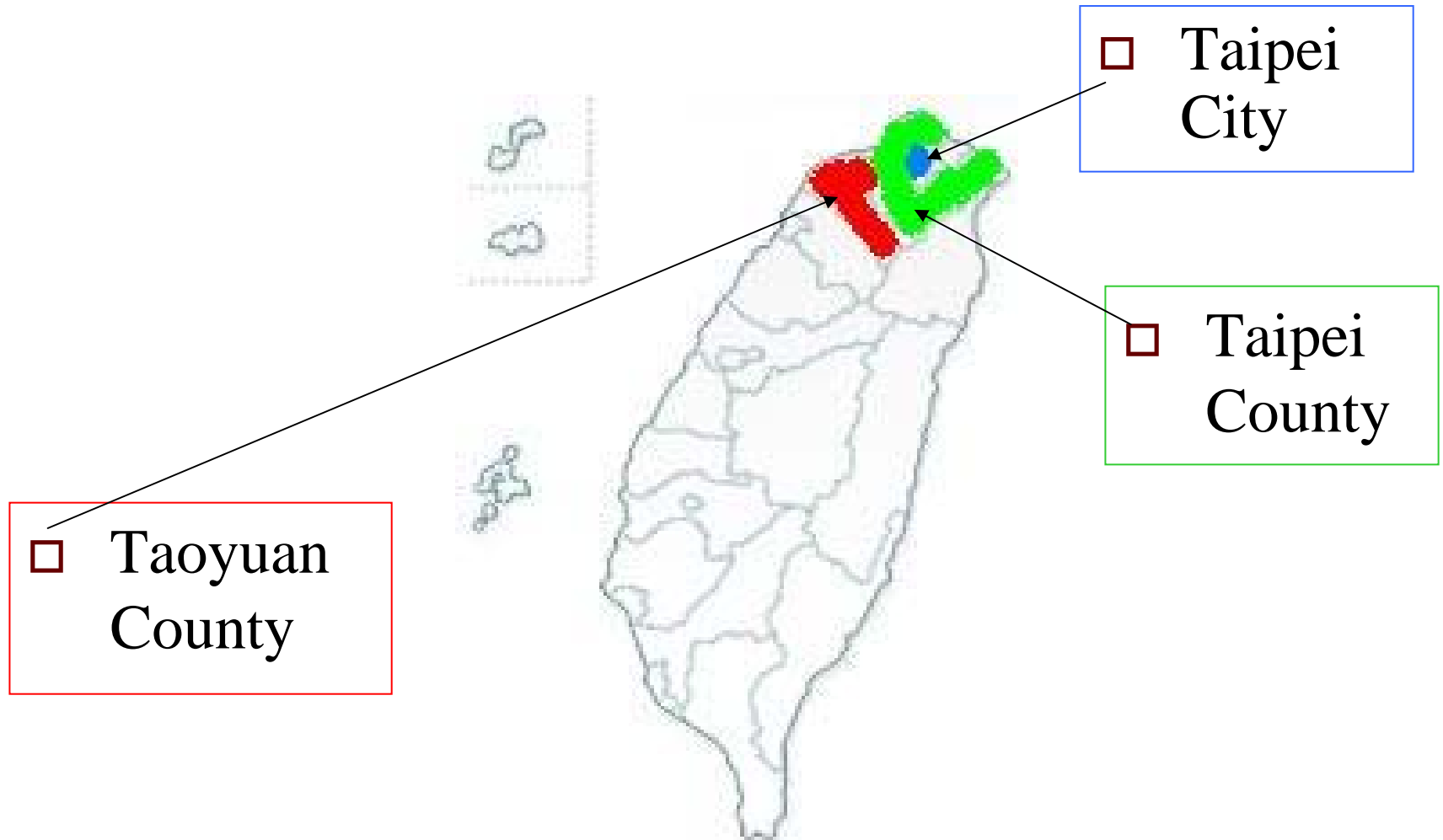


□ Definition of the “recycling-based society” : 5 variables

- Waste reduction
- Reusing
- Recycling
- Energy renewal
- Degree of treatment

□ Taipei city charges the solid waste fee through per-bag policy.

Study Areas






Purposes of Study

- To calculate the mass balance and the energy budget through various solid waste treatment lines.
- To evaluate the performance of waste reduction, reusing, recycling, energy renewal and degree of treatment on the material from the viewpoint of a recycling-based society.

Methods

- Material/Energy Flow Analysis (MFA/EFA) typically takes focus on a given geographical area and is characterized by the systematic physical measurement of the magnitude (expressed in terms of mass/Mcal).
- MFA/EFA has emerged as a primary methodological framework that offers great scope for generic application and the harmonization, integration, and advancement of environmental accounting and systems analysis tools.

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- Three major parameters for building a recycling-based society
 - resources production efficiency
 - product recycling rate
 - garbage disposal rate

 - Measurements made on: waste reduction, reusing, recycling, energy renewal and degree of treatment.

Results and Discussion

Material recycling index of the Recycling-based Society

Material Recyclable type	Recycling index	Weight %	Weighting	
Reuse	Best	x_1	1	Formula: $Im = \sum_{i=1}^4 w_i x_i$ $W_1=1, W_2=0.67$ $W_3=0.33, W_4=0$
Recycle	Good	x_2	0.67	
Heat recycle (Incineration)	Poor	x_3	0.33	
Disposal	Worst	x_4	0	
		100%		

(Taiwan's EPA & Prof. Ma etc.,2001)

□ The garbage treatment of solid wastes in 2005 (Unit: tons/year)

	Total Treatment	Treatment per day	Type				Kitchen waste recycle	Resources recycle
			Incineration	Sanitary landfill	General landfill	Untreated		
Taipei city	559,769	1,533	476,039	83,730	0	0	69,598	327,437
Taipei county	1,030,654	2,824	920,269	110,385	0	0	61,860	229,922
Taoyuan county	454,257	1,245	421,338	21,275	11,164	480	58,918	168,442

□ The garbage treatment (Dry weight) of solid wastes in 2005

		Incineration	Sanitary landfill	General landfill	Untreated	Total
Taipei city	Dry weight (tons/year)	287,623	25,646	0	0	313,269
	%	91.81	8.19	0	0	100
Taipei county	Dry weight (tons/year)	413,937	49,651	0	0	463,588
	%	89.29	10.71	0	0	100
Taoyuan county	Dry weight (tons/year)	189,771	9,582	5,028	216	204,597
	%	92.75	4.68	2.46	0.11	100

□ Energy Flow Analysis of solid wastes in 2005

Taipei city								
Flow		Solid wastes	Garbage treatment	Incineration	Sanitary landfill	Untreated	Fly ash treatment	Recycling & reuse
Amount (tons, Dry weight)		626,154	313,269	287,623	25,646	0	13,437	312,885
Factor per tons	Mcal			-794,400	-250,892	0	-250,892	2,084,000
	Loe			-88.3	-27.88	0	-27.88	232
Total energy (Mcal)		423,554,824	-228,497,516	-228,487,711	-6,434	0	-3,371	652,052,340

Note: “—” means production, “+” means consumption

Taipei county

Flow		Solid wastes	Garbage treatment	Incineration	Sanitary landfill	Untr-eated	Fly ash treatm-ent	Recycling & reuse	Bottom ash treatment
Amount (tons, Dry weight)		683,540	463,588	413,937	49,651	0	21,768	219,952	115,356
Factor per tons	Mcal			-2,232,000	49,131	0	25,948	2,089,000	70,967
	Loe			-248	5.46	0	2.88	232	7.89
Total energy (Mcal)		-453,236,956	-912,716,684	-923,907,384	2,439,408	0	564,836	459,479,728	8,186,456

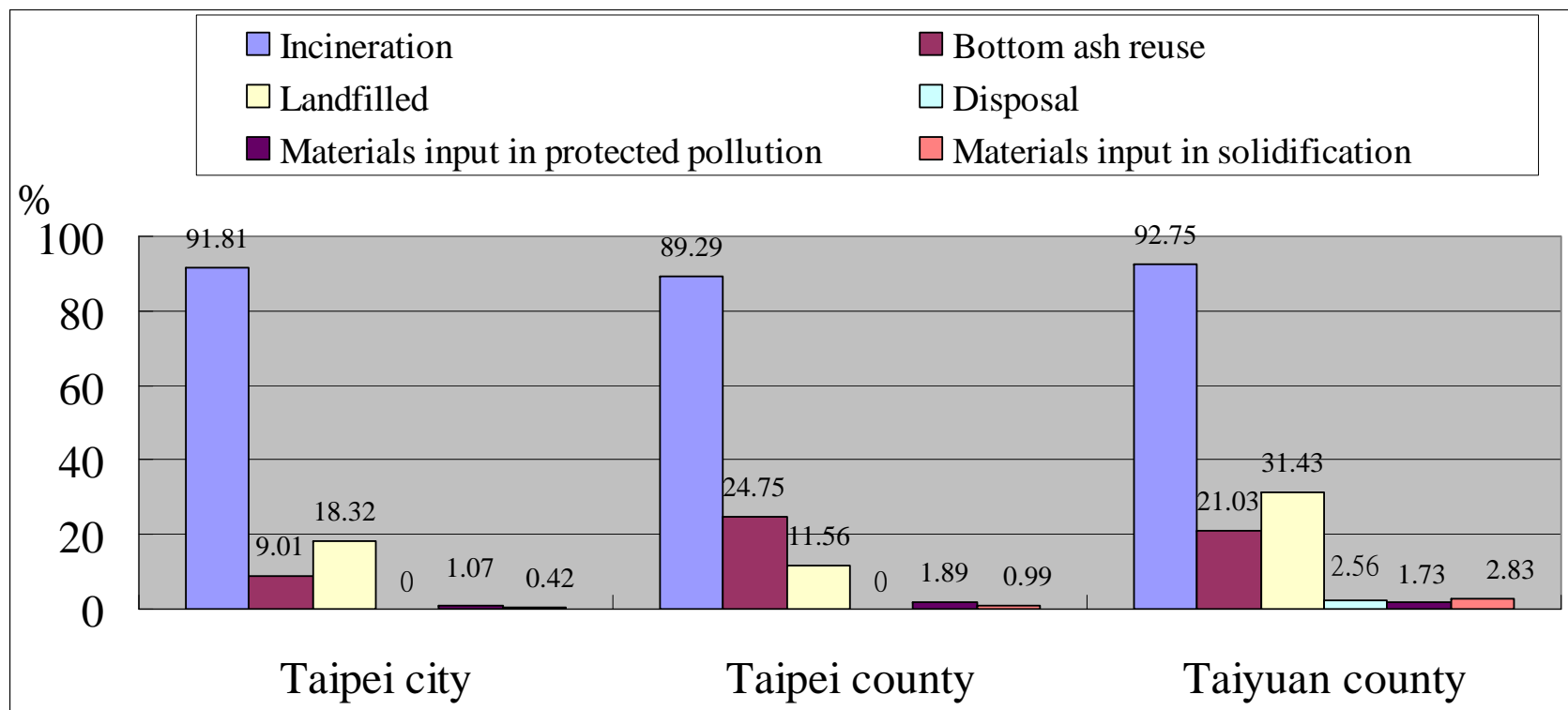
Note: “—” means production, “+” means consumption

Taoyuan county

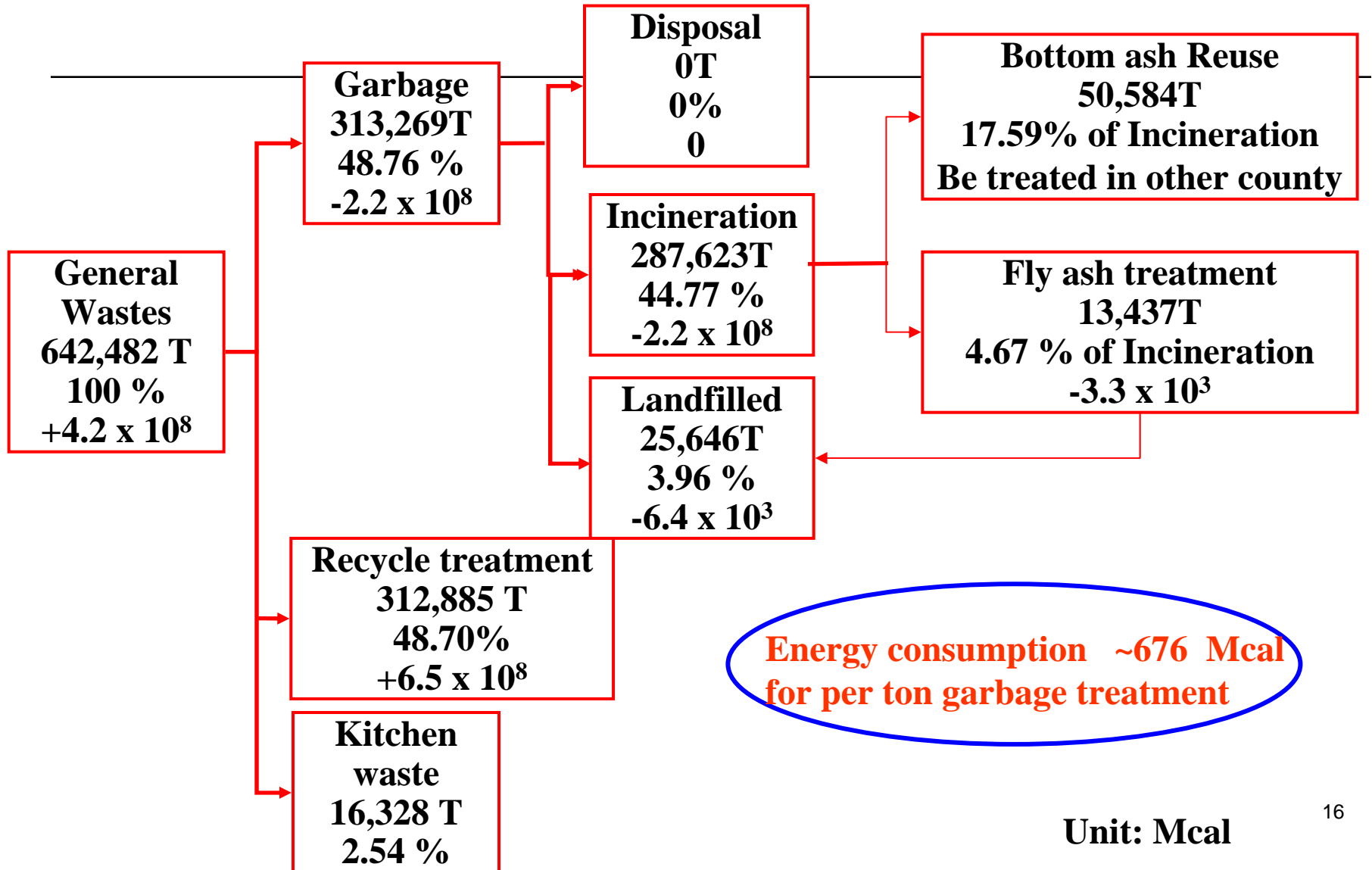
Flow		Solid wastes	Garbage treatment	Incineration	Sanitary landfill	Untreated	Fly ash treatment	Recycling & reuse
Amount (tons, Dry weight)		367,400	204,597	189,771	9,582	5,244	29,186	162,803
Factor per tons	Mcal			-2,393,568	9,588	19,176	12,785	2,084,000
	Loe			-265.95	1.07	2.13	1.4	232
Total energy (Mcal)		-114,382,767	-453,664,219	-454,229,793	91,872	100,559	373,143	339,281,452

Note: “-” means production, “+” means consumption

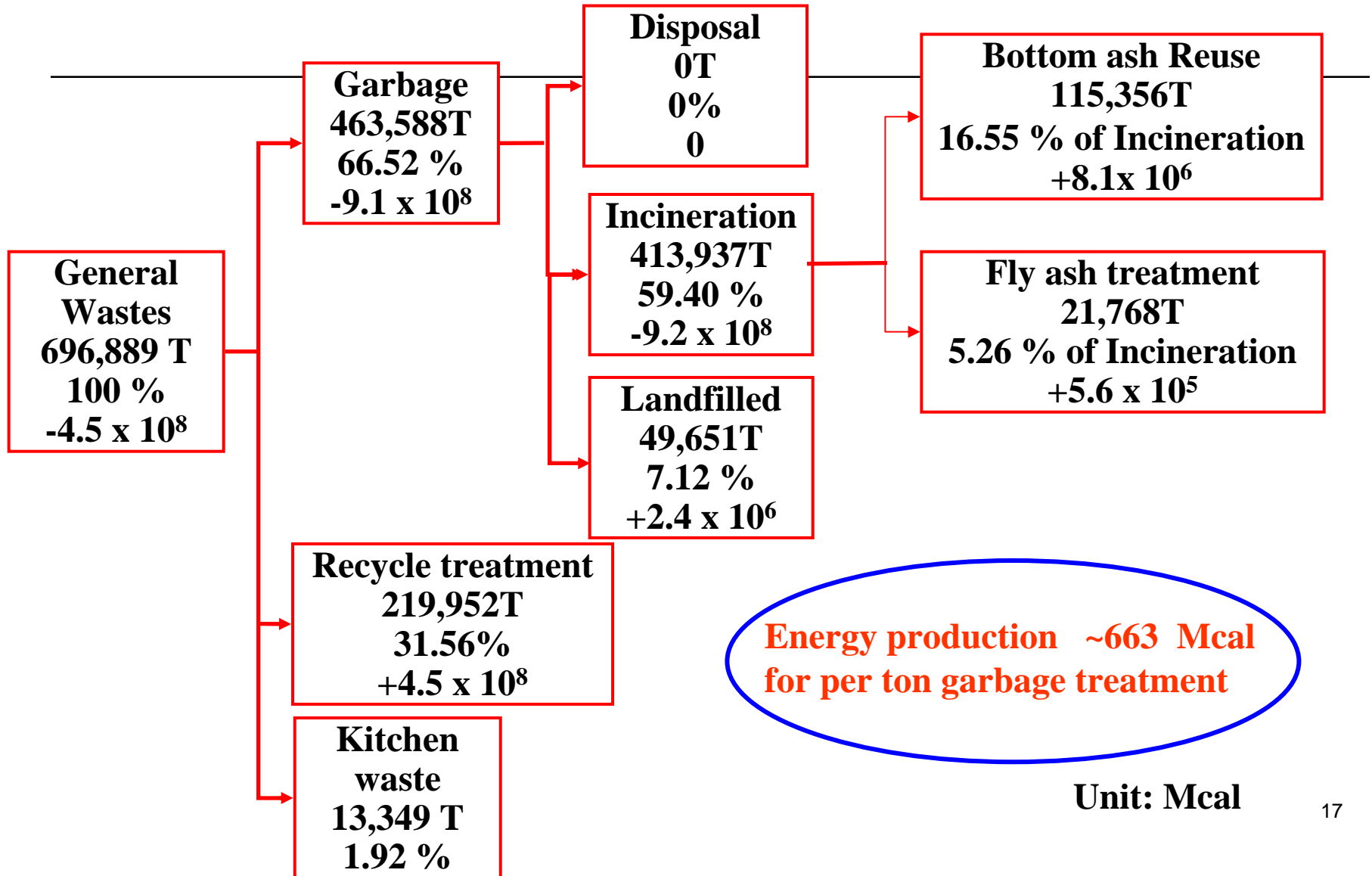
□ Comparison on the MFA results of the general wastes in Taipei city, Taipei county and Taiyuan county



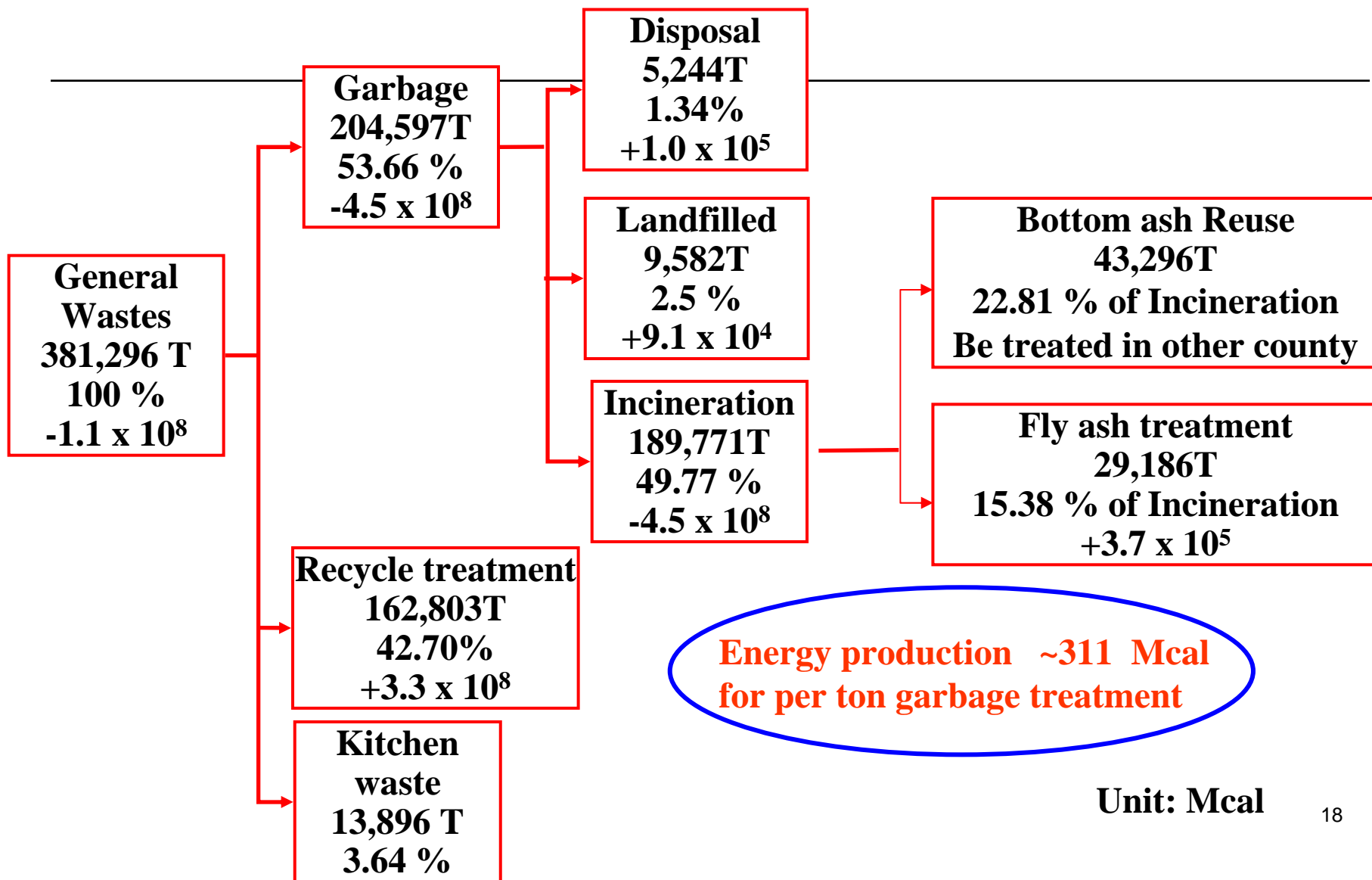
□ MFA & EFA of the Solid wastes in Taipei city, 2005



□ MFA & EFA of the Solid wastes in Taipei county, 2005



□ MFA & EFA of the Solid wastes in Taoyuan County, 2005



□ “Material recycling index” of solid wastes treatment in 2005

County/city			Taipei city		Taipei county		Taiyuan county	
Recyclable type	Recycling index	Weighting	Weight %	Score	Weight %	Score	Weight %	Score
Reuse	Best	1	0	0	0	0	0	0
Recycle	Good	0.67	52.66	35.28	40.86	27.38	46.85	31.39
Heat Recycle(In-cineration)	Poor	0.33	41.67	13.75	50.44	16.65	43.14	14.24
Disposal	Worst	0	5.66	0	8.7	0	10	0
			100%	49.04	100%	44.03	100%	45.63

Conclusions

- Taoyuan County showed the best performance that 92.57% of garbage were turned into energy by incineration treatment.
- All the main productivities of the solid waste treatment in all these three city/counties were the recovery of heat produced by incineration treatments, wherein the heat recovery productivity of Taipei County was the highest, followed by Taoyuan County.
- Taipei city showed the best performance in the score of material recycling index in 2005.
- The results of MFA/EFA provide an understanding and overview of both the direction of materials' flows and the quantity of the solid wastes in these flows.

The End

Thanks for your Attention