

The Assessment of E-waste Management in Macau with LCA
Method and Emergy Analysis

by

Qingbin Song

Doctor of Philosophy in Civil Engineering



Faculty of Science and Technology

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Supervisor: Prof. Zhishi Wang

Co-Supervisor: Prof. Jinhui Li

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SONG, Qingbin





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Abstract

At present, e-waste has become one of the fastest growing waste streams in the world. Due to large generation of e-waste and lack of the related laws and treatment facilities, Macau is currently faced with an urgent need to find methods of dealing with e-waste. Therefore, the aim of this study is to learn the status of e-waste, and look for the suitable methods to solve the potential e-waste issues in Macau.

Firstly, the questionnaire survey was carried out to investigate the e-waste status by face to face interview in Macau. Through the survey, we investigated the residents' behaviors, estimated the generation, and flows of e-waste in the households. In addition, we also analyzed the residents' willing to pay (WTP) for recycling the e-waste in Macau to learn the reasons why they don't want to pay and the key factors to influence the WTP.

Secondly, the whole life cycle of e-products was evaluated to learn the current environmental performance by Life Cycle Assessment (LCA) method. The desktop PC was chosen as the typical e-product, because it can lead to general observations and information that can be valuable for the entire e-product industry.

The recycling technologies in mainland China were chosen as the feasible technologies in Macau by comparing with other three recycling technologies, and were adopted in the trial project which was carried out in 2011-2012. In this part, the basic information of trial project was also introduced to learn the detail of e-waste treatment processes.

Finally, the trial project and e-waste treatment enterprises in mainland China were evaluated based on the LCA method and Emergy analysis. Through this part, we can understand the economic and environmental performance of e-waste treatment, and at the same time, the comparison of results will help us to learn the regional

difference of e-waste treatment.

Overall, relevant results could provide decision support to enterprise managers and government sectors, so that they could draw up appropriate laws and policies to promote sustainable development of e-waste treatment in Macau.



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Glossary

Emergy: The amount of available energy of one type (usually solar) that is directly or indirectly required to generate a given output flow or storage of energy or matter.

Emergy Density: Emergy stored in a volume unit of a given material.

Emergy Flow: Any flow of emergy associated with inflowing energy or materials to a system/process.

Emergy Sustainability Index: Emergy yield per unit of environmental loading.

Emergy Yield Ratio: Total emergy released (used up) per unit of emergy invested.

Environmental Loading Ratio: Total nonrenewable and imported emergy released per unit of local renewable resource.

Transformity: Emergy investment per unit process output of available emergy.

White Goods: Heavy consumer durables such as air conditioners, refrigerators, stoves, etc., which used to be painted only in white enamel finish. Despite their availability in varied colors now, they are still called white goods.

List of Abbreviations

ADP	Abiotic Depletion
AP	Acidification Potential
CFCs	Chloro-fluoron-carbon
CML	Centrum Voor Milieuwetenschappen
CPU	Central Processing Unit
CRT	Cathode Ray Tube
CVM	Contingent Valuation Method
ELR	Environmental Loading Ratio
End of Life	End of Life
E-product	Electrical and Electronic Product
EP	Eutrophication Potential
EPR	Extended Producer Responsibility
ESI	Environmental Sustainability Index
EU	European Union
E-waste	Electrical and Electronic Waste
EYR	Emergy Yield Ratio
FAETP	Freshwater Aquatic Ecotoxicity Potential
FDD	Floppy Disk Drive
FR	Flame Retardant
GWP	Global Warming Potential
HDD	Hard Disk Drive
HTP	Human Toxicity Potential
LCA	Life Cycle Assessment
LCD	Liquid Crystal Display

MAETP	Marine Aquatic Ecotoxicity Potential
MIP	Macau Incineration Plant
MOP	Macau Pataca
MSW	Municipal Solid Waste
ODP	Ozone Layer Depletion Potential
QWERTY	Quotes for Environmentally Weighted Recyclability
PBDDs	Polybrominated Dibenzodioxins
PBDEs	Polybrominated Diphenyl Ethers
PBDFs	Polybrominated Dibenzofurans
PC	Personal Computer
PCB	Printed Circuit Board
PCDDs	Polychlorinated Dibenzodioxins
PCDFs	Polychlorinated Dibenzofurans
PCOP	Photochemical Oxidation Potential
PS	Power Supply
PUR	Poly Urethane Resin
PWB	Printed Wiring Board
RoHS	Restriction of Certain Hazardous Substances
TETP	Terrestrial Ecotoxicity Potential
WEEE	Waste Electrical and Electronic Equipment
WTP	Willing to Pay

