Why the remanufacturing in China lost balance?

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Efficiency and feasibility of product disassembly: A case-based study

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The figures showing the balance

Cas	Profitability	Country/region	
1	Break even	Belgium	mponents
2	Loss making	China	ıd-of-life fridges
3	Intermediately profit	Japan	'cling of automotive components
4	Intermediately profit	Japan	onents for manufacturing new photocopiers
5	Break even	Australia	·hold appliances
6	Highly profitable	Japan	ıcturing of single-use cameras
7	Highly profitable	United States	ng of engine components
8	Intermediately profit	Brazil	ıotive components
9	Break even	South Korea	ng of automotive components
10	Intermediately profit	Brazil	ıotive components
11	Break even	Belgium	·hold appliances
12	Loss making	China	ɛperimentation of air condition exterior parts
13	Intermediately profit	Norway	aste electrical and electronic equipment (WEEE)
14	Loss making	China	reuse of end-of-life refrigerators
15	Highly profitable	United States	ıotive components
16	Intermediately profit	Brazil	of medical systems
17	Break even	Brazil	ng of engines

REFURBISHMENT, REMANUFACTURING, AND MATERIALS RECYCLING

Refurbishment aims to restore products to working order, though possibly with a loss of functional quality.

Remanufacturing conserves the product identity and seeks to bring the product back into an “as new” condition, by carrying out the necessary disassembly, overhaul, and replacement operations.

Recycling denotes material recovery without conserving any product structure.

The remanufacturing process is divided into: disassembly, testing, repair, cleaning, parts inspection, updating, parts replacement and reassembly.

Disassembly objective and considerations

- The main objective:

separation of specific fractions of products that will allow the recovery and recycling processes faster and more efficient.

- There are many limitations:

that hinder the identification of the most favourable disassembly strategy. This is mainly due to the lack of information about the products' usage condition, which results in uncertainty of quality of EoL products.

- Complementary to disassembly:

monitoring and quality verification techniques are required to determine the usage condition of products and components.

- Proper planning (disassembly depth):

Current economic analyses demonstrate that full disassembly is rarely the optimal solution, owing to the high disassembly costs. Selective disassembly, based on the planned EoL destination of individual components, could be a viable alternative.

Design for Disassembly and/or Remanufacturing

Principles:

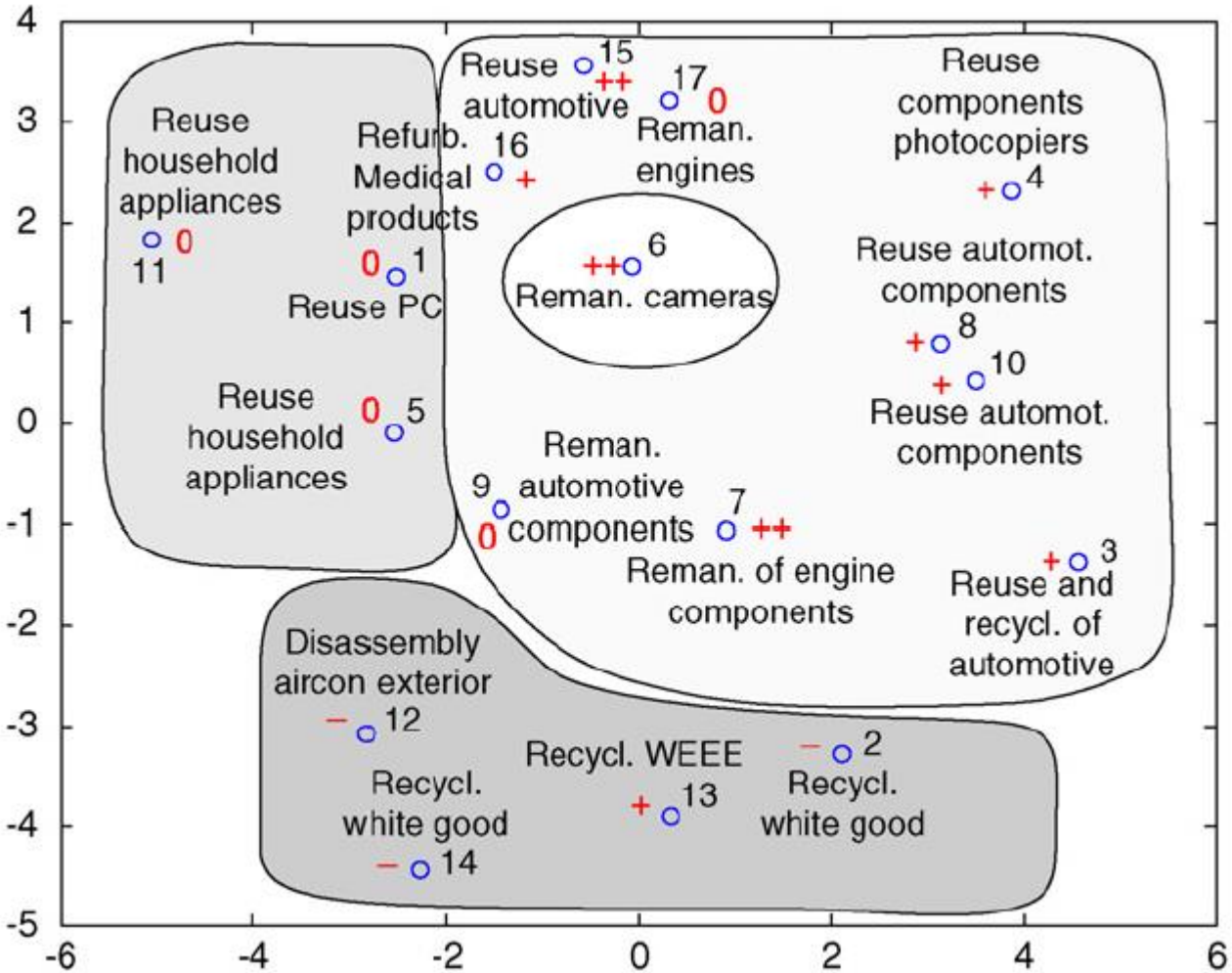
- ease of disassembly,
- ease of cleaning,
- ease of inspection,
- ease of replacing parts,
- ease of handling,
- wear resistance, and
- ease of reassembly.

Others, should be considered during the design

- The adaptability of products,
- The costs of the disassembly process,
- The economical benefits of component reuse or material recycling,
- Costs of final disposal,
- Environmental impact of each EoL alternative.

*There are many published papers on this field

Analysis of the cases



MDS (multidimensional scaling) representation of similarity between individual cases and distinguished clusters

a dedicated product design allows highly efficient, fully automated disassembly, the Fuji single-use cameras case (Case 6) forms a separate category.

9 cases related to disassembly and reuse of systems with a high residual reuse value. These cases show a positive average profitability. The majority of these initiatives (7 Cases 3, 7, 8, 9, 10, 15 and 17) concerns automotive components.
Refurbishment and remanufacturing of products with a relatively high residual value, such as copier machines (Case 4) and medical instruments (Case 16), can also be considered as part of this cluster.

a number of cases related to the refurbishment of devices with an intermediate residual value, such as household appliances (Cases 5 and 11) and personal computers (Case 1). These operations typically run at break even level.

A last cluster covers cases with recycling as principal target. Different examples of WEEE treatment are included in this category (Cases 2, 12, 13 and 14).
The cases are characterised by a low to negative profitability, with Case 13 forming an exception. This last case is characterised by mainly destructive treatment with a high degree of automation. It forms a border case for disassembly, since only limited detoxification efforts can be considered as disassembly actions.

Profitability is higher in countries with a better established legislative system for EoL treatment. The fact that these countries are at the same time characterised by a high salary cost does not necessarily seem to form a negative factor.

Where automation is technically feasible, a high degree of automation seems to positively influence profitability.

Case number	Destination of subassemblies or components	Type of disassembly	Automation level
1	Reuse/remanufacturing/material recycling	Partial disassembly	1
2	Reuse/material recycling/incineration without energy recuperation/landfill	Full disassembly	2
3	Spare parts management/material recycling	Partial disassembly	2
4	Reuse/material recycling	Full disassembly	Not specified
5	Remanufacturing/spare parts management/ material recycling/landfill	Partial disassembly	2
6	Reuse/material recycling	Full disassembly	2
7	Remanufacturing/material recycling	Full disassembly	4
8	Spare parts management/material recycling/landfill	Partial disassembly	2
9	Remanufacturing	Partial disassembly	2
10	Remanufacturing/spare parts management/material recycling/landfill	Full disassembly	3
11	Reuse/remanufacturing/spare parts management	Partial disassembly	2
12	Reuse/material recycling/landfill	Full disassembly	3
13	Material recycling/incineration with energy recuperation/landfill	Full disassembly	2
14	Reuse/material recycling/incineration without energy recuperation/landfill	Full disassembly	2
15	Spare parts management	Partial disassembly	3
16	Reuse/incineration without energy recuperation/landfill	Partial disassembly	3
17	Remanufacturing/spare parts management/material recycling/landfill	Full disassembly	2

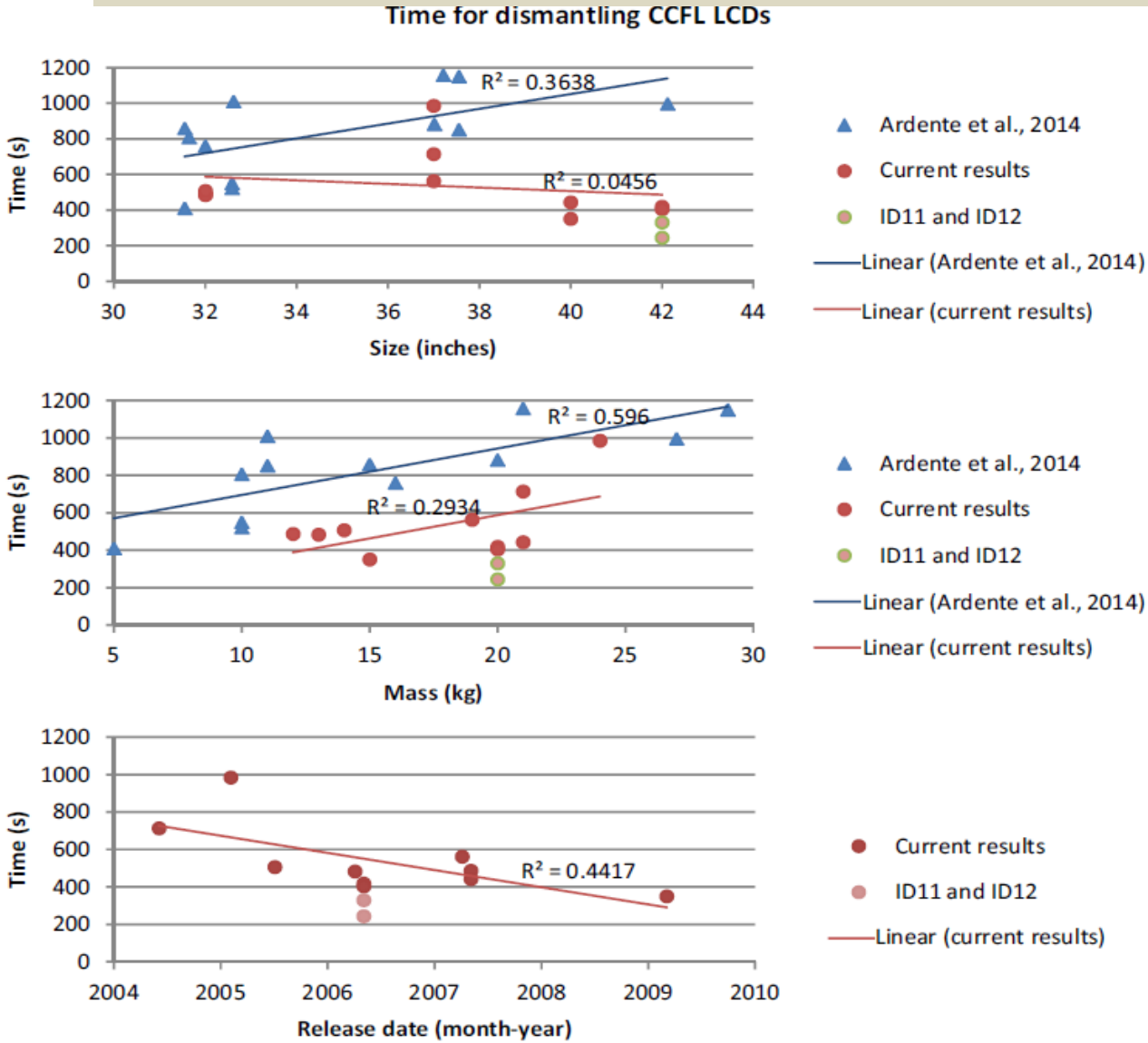
*Automation level: (1) fully manual; (2) manual with semi-automatic hand tools; (3) partially automated; (4) fully automated.

Towards disassembly automation

Disassembly cannot be considered economically feasible unless a breakeven between costs and benefits is achievable.

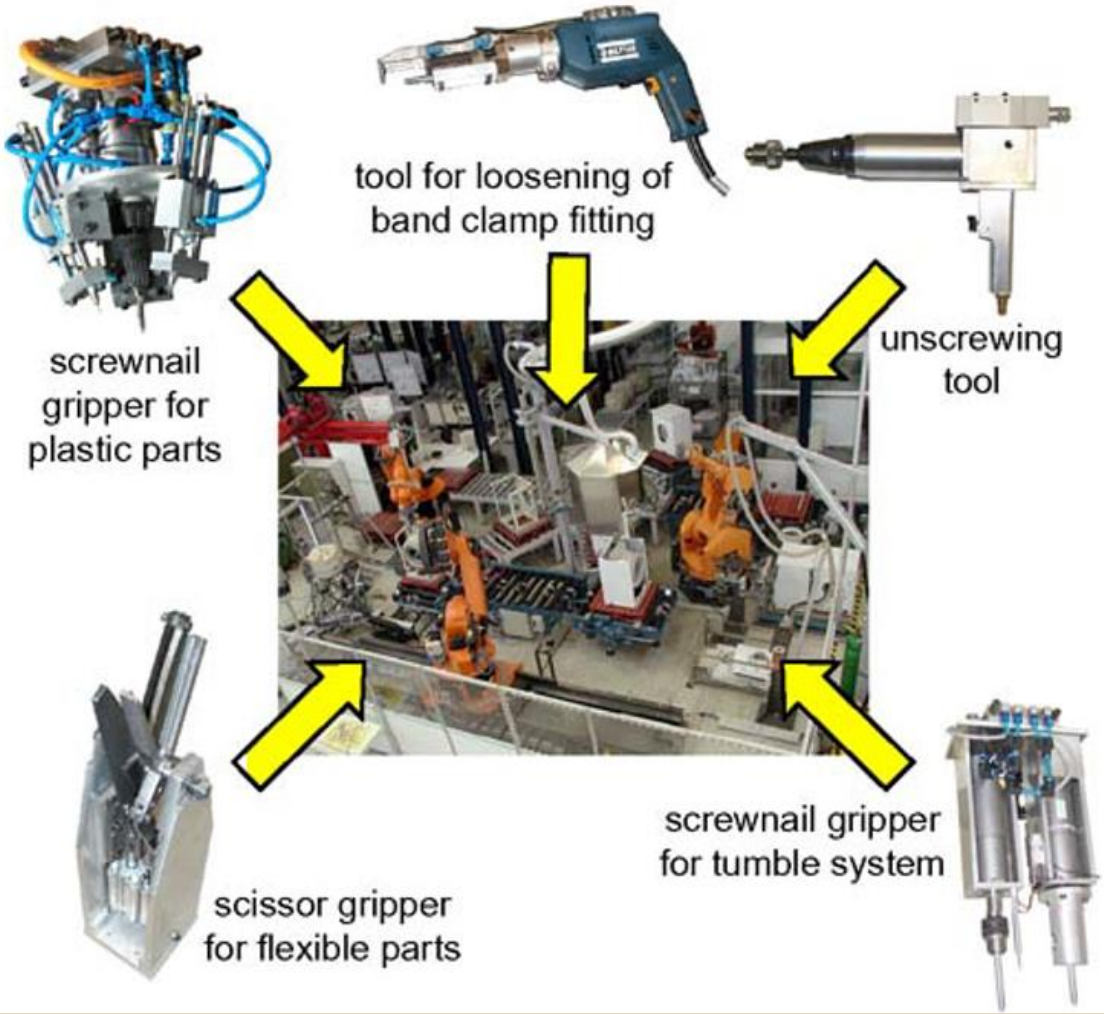
- Manual operations, supported by (possibly electrically or pneumatically driven) hand tools. A wide range of tools is used, but changeover between tools is typically decided by the operator.
- Partially automated operations, also known as hybrid disassembly, refers to using a number of setups in which only specific operations are supported by automated systems. This approach is often used in cases where large numbers of similar products are treated in a partially destructive disassembly procedure. The automated steps involve heavy duty work in which the concerned parts are not recovered as functional components.
- Fully automated operations are supported by generic systems such as industrial robots. When dealing with conventional fasteners, such as, bolts, screws, rivets or spot welds, the technical complexity can be enormous. Factors such as non-uniformity of returned product models, customer specific maintenance history, and deformation or corrosion of products, make non-destructive disassembly automation a hard task. Since the economic benefits to be expected from such operations are easily outbalanced by the involved costs, non-destructive automation of generic disassembly systems remains an academic objective.

Manual dismantling time for each LCD unit



Time for dismantling CCFL LCDs according to their size, mass and release date. Comparison with previous results from Ardente et al. (2014).

Hybrid disassembly system for washing machines



The system consists of three co-operating robots, the front working area is for automated disassembly, the back area for manual work.

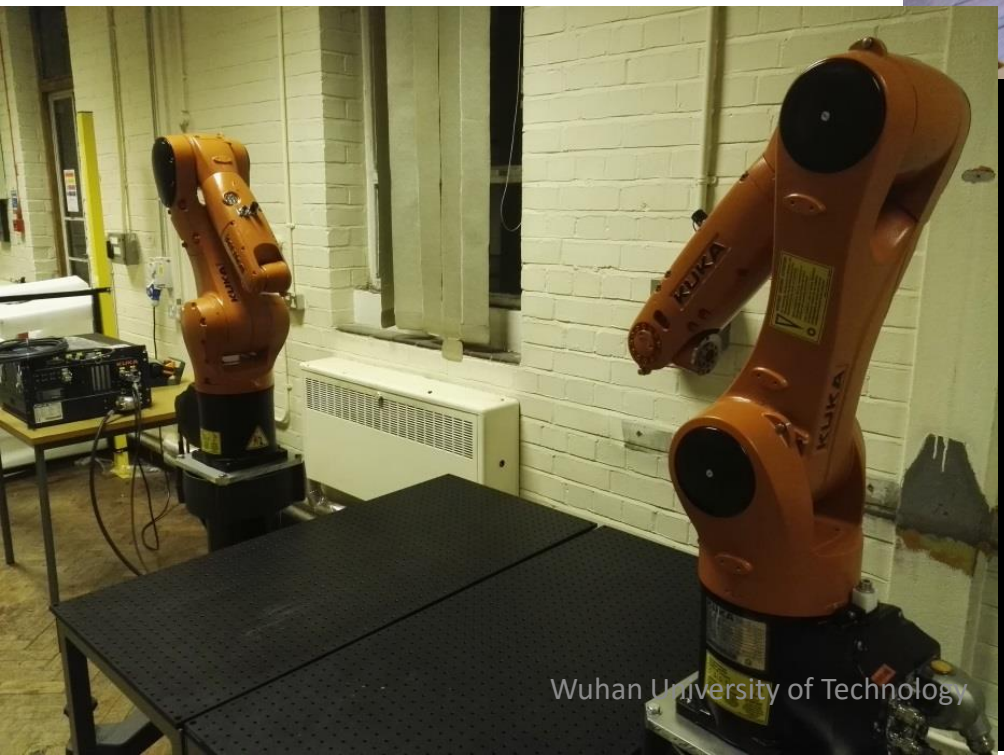
Seliger G, Basdere B, Keil T, Rebafka U (2002) Innovative Processes and Tools for Disassembly. Annals of the CIRP 51(1):37–40.

Dedicated disassembly automation systems

This automated remanufacturing system is constructed by applying existing automated production technologies, including various automated machines, robots, and AGVs. Difficulty resides within the variety of input products and the importance of inspection and cleaning.

- Firstly, sorting and identification of input products and rejection of broken or other manufacturer's products are important. Actually, almost half of the space of the remanufacturing system is used for the lining up, identification, and sorting operations.
- Secondly, robust cleaning and repair processes, applicable to varying conditions of used products, are essential.
- And thirdly, sample inspection is not a robust approach in remanufacturing. Therefore, all reusable modules are inspected in this system.

AUTOREMAN



Research on remanufacturing in China

The birth of remanufacturing can be traced to the times of world war two (WW2) when resources became scarce and automotive industry was enforced to perform remanufacturing (Automotive Parts Remanufacturers Association, 2015). However, after times of war the remanufacturing industry experienced continuous growth over the years driven primarily by the economic and competitive advantages.

In the beginning of the 2000s, China with its staggering population and rapidly developing industry realized its mismatch between economic development and resulting environmental impacts. As a consequence, the government of China formally accepted the concept of CE as a new development strategy in 2002 and approved the first law “Circular Economy Promotion Law of the People's Republic of China” which took effect in January 2009 (The Standing Committee of the National People's Congress China, 2008).

the concept of CE (circular economy) is considered as a solution for harmonizing ambitions for economic growth and environmental protection.

Example Publications in Journal of Cleaner Production

General issues:

Policies on end-of-life passenger cars in China: dynamic modeling and cost-benefit analysis

Zhiguo Chen [a], Dingjiang Chen [a,*], Tao Wang [b], Shanying Hu [a]

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Evaluating remanufacturing industry of China using an improved grey fixed weight clustering method-a case of Jiangsu Province

Wenjie Liu [a,*], Chenfan Wu [a], Xiangyun Chang [b], Ye Chen [a], Sifeng Liu [a]

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An inter-sectoral comparison of green supply chain management in China: Drivers and practices

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Motives and barriers of the remanufacturing industry in China

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Integration of Life Cycle Assessment with computer-aided product development by a feature-based approach

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Electrical products related:

A life-cycle assessment of household refrigerators in China

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Determinants of residents' e-waste recycling behaviour intentions: Evidence from China

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E-waste collection channels and household recycling behaviors in Taizhou of China

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Comparative environmental life cycle assessment of waste mobile phone recycling in China

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[c] Rural Energy & Environment Agency, Ministry of Agriculture, Beijing 100026, PR China

Survey and analysis of consumers' behaviour of waste mobile phone recycling in China

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Perspective of electronic waste management in China based on a legislation comparison between China and the EU

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China's toxic informal e-waste recycling: local approaches to a global environmental problem

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Automotive related:

Viability of remanufacturing practice: a strategic decision making framework for Chinese auto-parts companies

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Implementing extended producer responsibility: vehicle remanufacturing in China

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Analyzing internal barriers for automotive parts remanufacturers in China using grey-DEMATEL approach

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Sustainability evaluation of end-of-life vehicle recycling based on emergy analysis: a case study of an end-of-life vehicle recycling enterprise in China

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Life cycle assessment of end-of-life vehicle recycling processes in China—take Corolla taxis for example

Wenchao Li [a], Hongtao Bai [a, *], Jianfeng Yin [a, b], He Xu [a, **]

[a] *College of Environmental Science and Engineering, Nankai University, Tianjin 300071, PR China*
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Comparative Life Cycle Assessment of remanufactured liquefied natural gas and diesel engines in China

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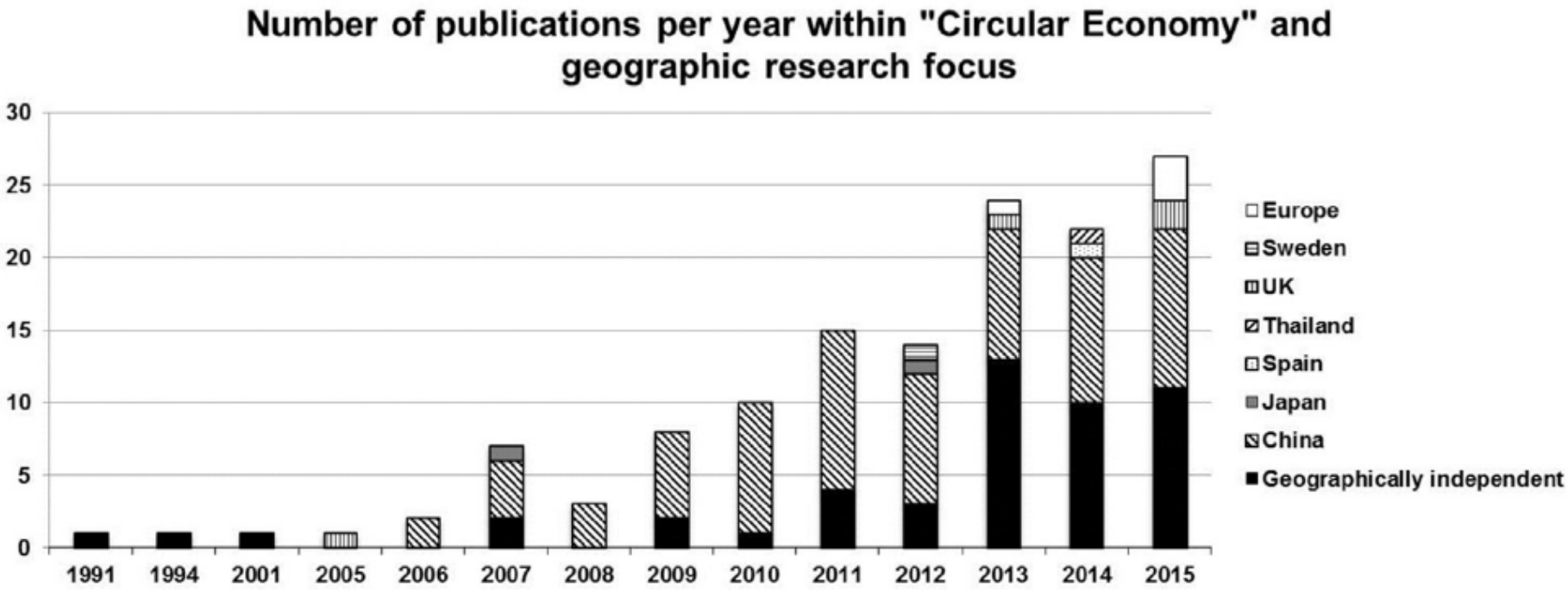

*M. Lieder, A. Rashid / Journal of Cleaner Production 115 (2016) 36-51

However, major part of these attempts has been lacking a systematic approach and therefore the CE approach appears not only apposite but also inevitable.

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