Creating a circular value chain with electronic waste in China

A Creator Space™ White Paper

BASF
We create chemistry

Contents

At the Creator Space™ Shanghai, more than 500 experts co-created ideas to address urban living challenges.

I. Acknowledgements

China's consumption power, as well as products produced in China, have a profound impact on the global market. Hence, even small steps in China can have a major impact on sustainability. Only conscious choices today will allow our children and grandchildren to enjoy a livable environment. With this vision in mind, scientists, businesses, artists, government officials, industry associations, NGOs and students came together at the Creator Space tour Shanghai stop to examine and discuss the power of consumers.

We would like to express our gratitude to the participants from all of these circles for dedicating their time and sharing the insights which form the basis of this publication.

II. About this whitepaper

At Creator Space™ Shanghai, a week-long event in March 2015, more than 500 urbanization experts, business professionals, non-governmental organizations (NGOs), members of academia and interested citizens came together to brainstorm ideas and to collaborate on challenges in the areas of electronic waste, textile production and food safety.

At the center of the week's activities was a two-day Summit. There, the goal was to understand the complexities of current attempts to solve environmental, social and business challenges in the three areas (electronic waste, textile production and food safety). Teams did this by analyzing value chains and where they fail or succeed in providing aligned incentives for a given goal.

Particularly in the area of electronic waste, participants identified a variety of challenges and possible solutions. This paper summarizes the outcomes of their discussions and can thus be used as a basis to further explore the potential of the proposals.

As a leading chemical company, BASF can provide contributions at several points along the electronics life cycle. With the leadership and collaboration of diverse contributors, the recommendations outlined in this white paper can be developed further to be used as models involving industry, government and civil society, with the goal of reducing the amount of e-waste in China - and its environmental and human impact. These solutions may be for profit or non-profit, and may enable economic, environmental and social progress related to e-waste.

In its 150th year in 2015, BASF celebrated by connecting people and ideas around the globe. It launched a co-creation program, called Creator Space™, aimed at addressing challenges of urban living, energy and food with existing and new partners. The global Creator Space™ tour took place in six cities: Mumbai, Shanghai, New York City, São Paulo, Barcelona and Ludwigshafen. At each tour stop, BASF connected industry experts, scientists, representatives from government, NGOs and society, as well as artists, to co-create solutions for a locally relevant challenge. The resulting white paper series consolidates findings from each tour stop as a basis for continued collaboration. At Creator Space Shanghai in March 2015, participants worked on solutions for the urban living problems created by e-waste, textile production and food safety. The focus was on understanding the value chain and incentives along it, to develop solutions for more effective e-waste management. These proposals may help pave the way to develop e-waste solutions.

3 Context: Challenges of China's transition to urban living

3 Context: Challenges of China's transition to urban living

Since 2011, more people have been living in China's urban areas than in rural areas. The number was estimated at **700 million** as of 2013. By **2020**, about **60%** of China's people will live in cities .

Urban Population in 2000:
579,000,000 People

3%

Urban Population in 2010:
778,000,000 People

Average annual rate of urban population growth 2000 - 2010

60%

By **2020**...

...about **60%** of China's people will live in cities .

This migration into urban areas brings with it lasting change for Chinese society. People who formerly lived at a subsistence level or had an agrarian focus are adopting consumption-oriented lifestyles, since they no longer grow their own food or make many of their own goods when living in a city.

This puts a drain on resources and creates environmental stresses including air, water, and soil pollution. Additionally, the transition has a global impact since it means higher greenhouse gas emissions. Still, a more comfortable, consumption-oriented lifestyle remains a priority for many members of China's emerging middle class.

At the Creator Space tour stop in Shanghai, participants explored the impact of production, consumption and disposal methods in three mainstream industries: electronics, textiles, and food. Throughout these core industries, what drives choices of how to produce, consume and dispose of basic goods can be at odds with longer term national goals, including environmental protection and public health.

In addition to misaligned incentives, many value chains suffer from lack of transparency: untapped resources within the value chain are not visible to those with the opportunity to make use of them.

Participants at Creator Space™ Shanghai investigated the potential of a "circular economy" approach to critical industries to address misaligned incentives and a lack of transparency. Under the circular economy model, waste becomes a valuable production input into sustainable production processes. Circular economy models also help compensate for scarce raw materials and can reduce
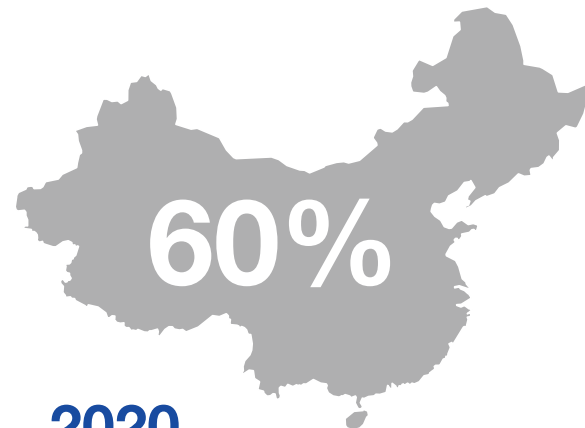
pressure on the regenerative capacity of the natural environment, not only through re-used materials, but also reduced waste.

This white paper explores the urban living problems explored at the BASF Summit and some of their possible solutions, with a strong focus on market-based solutions for e-waste that assign a value to waste and ensure incentives are aligned for its proper disposal or reuse.

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Electronic waste in China – current situation

4 Electronic waste in China – current situation

Overview/introduction

As mobility, quality of life, incomes and consumption rise in China, people increasingly need electronic devices - to communicate more easily, make their lives more comfortable, or as a status symbol.

This appetite for electronics devices, along with a willingness to discard functioning devices for newer ones, and lifestyle products, result in large amounts of electronic waste.

As of **2011**, some **3.62 million tons of electronic waste** were discarded in **China**, including TVs, refrigerators, washing machines, air conditioners and computers, but not including mobile phones.

2011   **3.62** million tons

Using a broader definition of e-waste as "devices with electric cords or batteries," China had **6.0 million tons of e-waste in 2014**, according to the United Nations University.

2014   **6.0** million tons

The amount of **global e-waste** reached **41.8 million tons in 2014**, with **China and the US** accounting for one third of that total .

USA — **41.8 million tons** — China
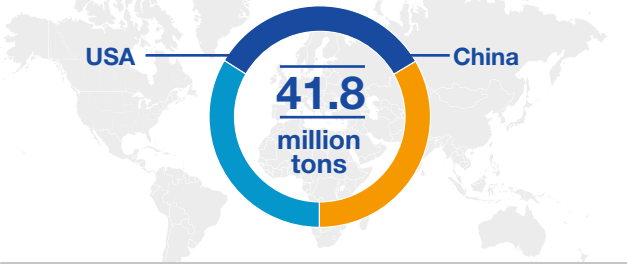
Most electronics are non-biodegradable and substances they contain, ferrous and non-ferrous metals such as lead, cadmium, mercury, arsenic, plastics and brominated flame retardants, can potentially make their way into water and food systems. In addition, during the informal recycling of e-waste, pollution can result from open burning of coated wire, heating of printed circuit boards to remove electronic components, and acid baths for extracting gold.
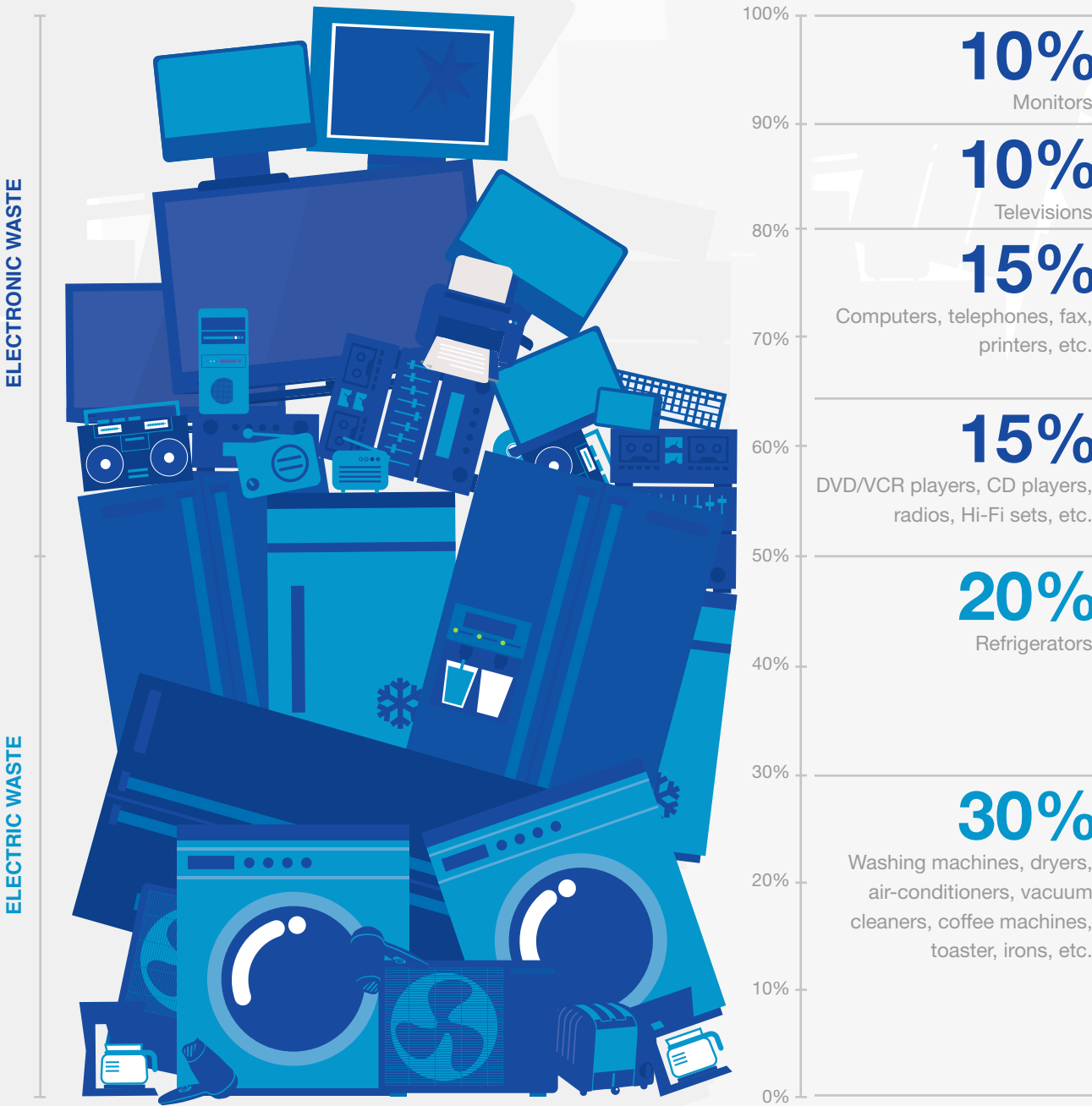
As such, e-waste is a major sustainability challenge for society and for the electronics industry. Public visibility of the issue has risen following a series of news reports highlighting its potential impact on children's health.

Along each step of the product lifecycle of an electronic device, many stakeholders can uniquely contribute to better e-waste management, including producers, retailers, users, disposing parties and governments. In addition, groups like NGOs and media have a role to play.

Governments, for instance, can incentivize citizens and producers to increase recycling rates and proper disposal channels respectively. They can even set stricter rules and regulations to penalize the irresponsible disposal of e waste behavior; producers can design products with longer lifecycles; and media can help by highlighting the consequences of failing to properly manage e-waste.

At the Creator Space™ tour Shanghai, stakeholders explored the idea of a formalized public collection method for end consumers, to ensure the effective recycling and disposal of e-waste. Elements include a system to give e-waste a resale value by assigning it a price, and an exchange program for swapping old items for new ones. An important aspect of any such program would be to ensure that incentives do not counteract each other. They must be constructed at multiple points in the value chain and consider the motivations of all stakeholders so that behavior is influenced in a way that is best for society at large - and not only the convenience of individuals

What is e-waste?

ELECTRONIC WASTE

ELECTRIC WASTE

10% Monitors
10% Televisions
15% Computers, telephones, fax, printers, etc.
15% DVD/VCR players, CD players, radios, Hi-Fi sets, etc.
20% Refrigerators
30% Washing machines, dryers, air-conditioners, vacuum cleaners, coffee machines, toaster, irons, etc.

International sources of electronic waste

As a developing country with low wages, and a country that is familiar with electronics due to widespread domestic production, China was on the receiving end of a large portion of the world's electronic trash for many years. In 2000, the Chinese government banned the import of second-hand electronic equipment, but China continues to receive waste from other countries. For example, as the United States has not ratified the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, it continues to legally send waste to China for disposal or recycling.

In some cases, electronic waste enters China through Hong Kong and then makes its way to cities with strong formal and informal e-waste disposal capabilities. Separately, e-waste is known to move through Vietnam to China. Waste from the US and Japan, for instance, is shipped to the port of Haiphong in northern Vietnam and transported to the border at Mong Cai. Vietnam has banned the import of e-waste but has an exemption to the ban if the purpose of the import is re-export.

With multiple pathways into China, researchers say it is difficult to determine actual volumes of waste entering China.

Domestic handling of electronic waste

According to the authors of the paper "Present status of e-waste disposal and recycling in China" (2012), domestic e-waste in China usually experiences one of three fates. First, many citizens store their old home appliances at home rather than dispose of them, unless they are offered a good price to sell the rubbish. A second path is to donate waste, for instance to poor people in western China. The third option is for the electronic waste to be recycled.

Similarly, another report cites a **2009** survey of **1,173** Beijing residents with an average household disposal need of **1.93** electrical and electronic products over three years. It showed **41.79** percent of these waste items were disposed of through various recycling channels, **36.79 percent** were discarded as municipal waste, while the remaining **21.62 percent** were stored at home.

36,79%
stored at home

21,62%
municipal waste

Electronic waste

41,79%
various recycling channels
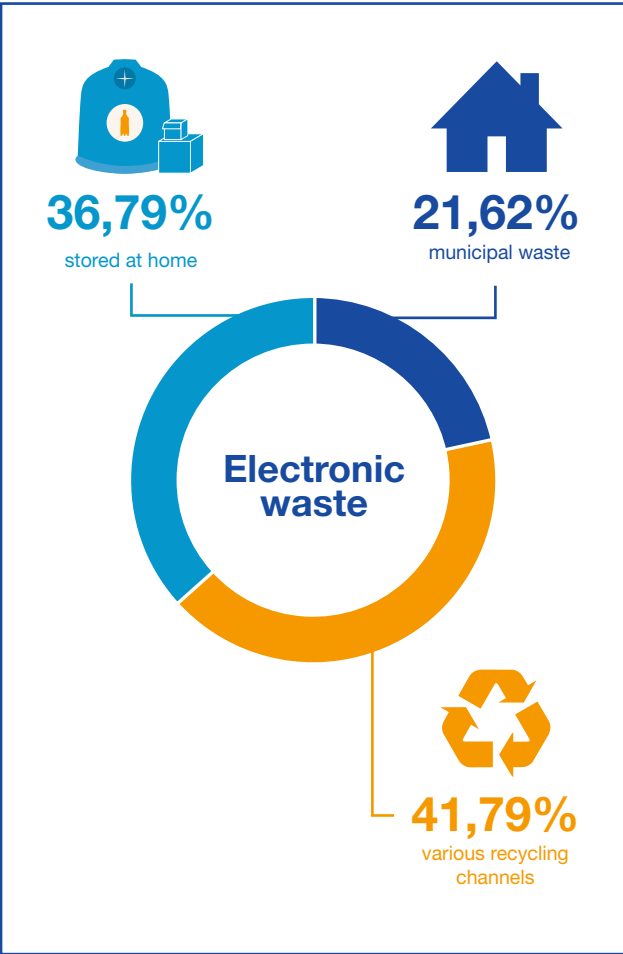
Chinese industry creates strong demand for low-cost, second-hand products and raw materials for re-manufacturing. This demand is often met by China's informal e-waste handling sector, which employs roughly

440,000 people for collection (2007) and an estimated 250,000 for recycling.

The informal sector, which has fewer environmental protections in place than the formal sector, is well established, and formal recycling facilities often do not process at capacity because they lack a supply of raw e-waste.

Problems in current waste handling systems

Current systems for handling electronic waste, whether foreign or domestic, pose risks for the people working in the industry and for the natural environment.
Especially in the informal sector, practices including open burning, desoldering, and leaching are used to recover such metals as copper, steel, aluminum and gold from wires, capacitors and other components.

"Desoldering of the circuit boards is operated over the coal-fire grill ❶. The circuit boards are placed in a pool of molten lead-tin solder and heated until the chips are removable ❷. Acid baths are applied to partially extract gold from the chips after removal from the circuit board ❸. After most components of the board are picked over, the rest of the boards then often go to large scale burning or acid recovery operations in order that further remaining metals are partly recovered."

Tin (Sn)

❶

❷

Sn Sn Sn Sn

❸
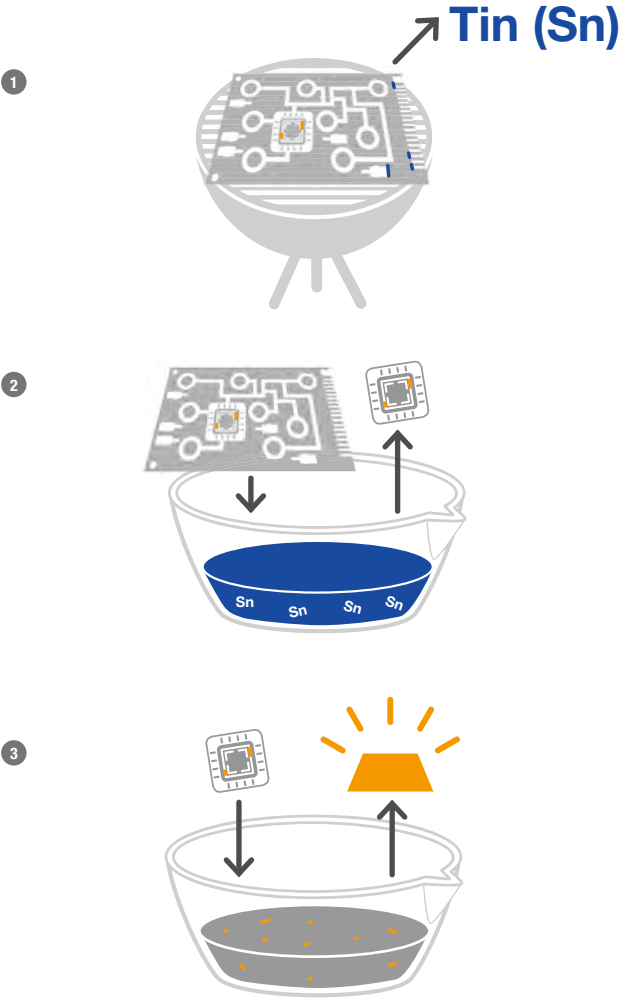
In this way, exposure can potentially occur through skin contact, inhalation and/or the intake of contaminated food and water.

The industry's structure today prevents the alleviation of these problems. For example, when waste management contracts are linked to the volume of electronic waste processed, those companies have less financial incentive to develop services related to the recovery of that waste. Likewise, most producers do not have to take into account the future costs of product disposal. According to one report, "The principle of extended producer responsibility (EPR), in which manufacturers and importers pay a portion of the future costs of disposal in order to reduce the social costs of waste management, has not taken hold in China."

United States of America

Nanhai
Hongkong
Haiphong

5

Electronic waste – situation analysis and ideas for improvements

5 Electronic waste – situation analysis and ideas for improvements

Participants at Creator Space™ Shanghai examined the electronics value chain, including producers, retailers, users, disposing parties and the government, and articulated the incentives of each party.

Stakeholder	demands...	provides...	could/should have...
Producers - incl. Design & Material	Cheap, offers design flexibility, easy to assemble, quality in line with the brand	Brand e.g. social identity, functionality, suitable operational quality, right price point	Designed with long use in mind; design of electronic components that would improve waste disposal options; designed to be easy to disassemble; chemicals and plastics not harmful for humans and environment when extracted; cost of disposal already calculated into price; pre-fab modules for user self-repairs; limited need for rare-earth materials; better ability to forecast demand to avoid over-production; lower environmental impact from production processes;
Retailer	Cheapest goods to sell at highest margins; consumers to buy as many products as possible from their stores.	Branding; are customer-facing and provide customer support; act as bridge between user and producer	Home pick-up programs for waste; in-store return for store vouchers; donation boxes for old electronics; other incentives for proper disposal; campaigns to promote responsible consumption; willingness to sell products without excess packaging
User - e.g. consumer	Cheap products; desired design and functionality; status symbols	Purchasing power; power to reject brands; trendsetting abilities	Increased awareness of official and regular way of recycling e-waste; willingness to reject products that don't match sustainability values; willingness to pay more for actual environmental and social cost of end product; willingness to consume fewer electronics and use them longer; direct access to disposing parties to better understand impact of e-waste; willingness to buy products without excess packaging
Disposing party	As much product to dispose of as possible; waste bought at the lowest-possible price; strong demand for second-hand e-waste that disposing party can sell	Ability to dismantle and sort e-waste; abundant low-cost labor in the informal sector; lack of regulation in informal sector on where to place e-waste and how to handle it	Dialogue with other members of value chain on how to reduce e-waste; dialogue and programs for returning components to producers; clear pricing for e-waste based on social, economic and environmental costs; means to dispose of e-waste without leading to any human or environmental harm
Government	E-waste to be disposed of safely and legally; provide basis for market development and job creation	Significant influence on markets and citizens in China	Established standard for e-waste; stronger ability to implement regulations; tighter control to prevent e-waste imports; willingness to shut down illegal e-waste disposal parties; willingness to encourage reuse and recycling through policies and penalties

Producers

Producers want to make products with the right designs at the right production prices to offer goods at a quality in line with the producer's brand. In general, producers follow guidelines established by the government. This leaves the onus on the government to create and enforce strong regulations for e-waste disposal.

Potential for improvement therefore lies in the development of high standards for waste-disposal established by producers; electronics with longer-planned utility; design of electronic components that would improve waste disposal options; and pre-fabricated modules that allow users to replace or fix items themselves.

Retailers

Retailers in China sell several hundred million electronic products per year, including televisions, refrigerators, washing machines, computers and mobile phones. Some of these retailers participated in a test program of the Chinese government in 2009 called the "Old for New Program." Participating retailers accepted a certificate certifying proper disposal of old home appliances and offered consumers a 10 percent discount based on that certificate. Those retailers were then reimbursed by the government for providing the discount. However, this system proved to be too costly for the government and the test program was ended in 2011.

Possible areas to explore include home pick-up programs, discounts to consumers for proper disposal that will in turn drive volumes for the sale of new products, and improvements to packaging sustainability.

Users

Consumer choices - including which goods to buy, whether to buy at all, and which disposal channel to select - have a significant impact on electronic waste production and management. Users of electronics typically recycle electronics through formal or informal sectors, give them to charity, or keep them for later, in case the old item becomes valuable in some way. Reports say that Chinese consumers prefer to sell their old equipment to those disposing parties which offer the best prices, which typically means informal parties.

Consumers can potentially contribute to a solution by gaining a better awareness of what actually happens to the waste once it leaves a person's possession, as well as by favoring goods that can be disposed of properly, as well as those with more sustainable packaging.

Disposing parties

Disposing parties include electronic waste collectors and those who dispose of the waste in the formal and informal sectors in China. The informal sector has an elaborate collection network that provides reliable supply to its treatment enterprises, but is difficult to regulate and prone to using unsustainable waste handling methods. Formal e-waste treatment companies may even lack waste to treat because of inadequate collection networks: A total of 130 e-waste recycling enterprises were registered on the e-waste Dismantling Enterprise List in 2013, and as of May 2012, some 53 e-waste treatment enterprises in 15 provinces and cities had the necessary licenses to be formal recyclers.

Disposing parties have a great deal to contribute to a circular economy approach for electronic waste management through constant dialogue with other members of the value chain, as well as setting clear pricing for electronic waste based on actual social, economic and environmental costs. They should also link up with government and regulatory bodies especially at those industrial parks and areas for setting up a well-equipped central collection system for better management of waste.

Government

A critical link in the value chain, governments are a source of incentives in the form of regulations, taxation or subsidies. In China, responsibility for supervising activities is spread across multiple agencies.

Opportunities for improvement lie in government support for a private-sector initiative similar to the recently announced cap-and-trade program to control carbon emissions, as well as more stringent enforcement of better practices in the informal treatment industry. More incentives should be granted by regulatory bodies to encourage all stakeholders like private collectors and disposal bodies to recycle all electronic wastes especially devices with a short life cycle like mobile phones, computers and electrical appliances.

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Potential solutions and challenges

6 Potential solutions and challenges

These hypothetical possibilities for more alignment in e-waste management incentives are some of the ideas that emerged out of the Summit discussions. Groups of experts from different disciplines met to brainstorm these ideas and, in some cases, to deepen them in a first step.

Improved packaging information

One group suggested revising the contents of **packaging** information to help educate consumers about the importance of environmental impact, health impact and means of recycling. The purpose would be to encourage consumers to change unsustainable waste habits.

Electronic waste collection machines

Another group thought it was important to formalize a public e-waste collection method for end-consumers with **collection machines** at strategic locations, such as retail stores, campuses, metro stations and parks, for instance.

Stakeholder incentive program

A third idea is to develop a scheme in which all **stakeholders contribute** to effective e-waste management and are motivated to participate via incentives that are not only effective but aligned to keep the scheme working. In other words, the incentives would have to address some of the hypothetical possibilities outlined above for each stakeholder group - e.g. the "could-haves" and "should-haves."

Current practices for electronic waste are often hazardous for health and environment and include for example illegal dumping and burning of cables and of plastic encased devices to extract metals. New solutions, including the whole value chain, are needed.

Photos: Basel Action Network CC BY-ND 2.0.

Previous programs to tackle challenges of electronic waste in China

A national program to pilot formalized e-waste treatment began a decade ago and focused on building four recycling plants (Qingdao Haier, Hangzhou Dadi, Beijing Huaxing and Tianjin Datong). A follow-on program worked to establish a collection system that would ensure a constant supply of waste to the facilities. Called "Home Appliance Old for New Rebate Program," the follow-on program ran from June 2009 to December 2011 and provided consumers with economic incentives to turn over their waste.

However, the program and its subsidies became too expensive for the government. According to the report "E-waste in China: A country report" by the United Nations University (2013), "When one new TV [was] sold and one old TV [was] collected, the government [paid] three subsidies (to the consumer, collection company and recycler), which [could] add up to between $41 and $68 per unit." Furthermore, it said site visits by the authors to several recyclers in 2012 revealed that the volumes of e-waste collected from consumers through formal channels had declined considerably since government subsidies ceased at the end of 2011. This indicated to the researchers that, in the absence of subsidies, consumers were likely to once again sell their waste appliances to the informal sector, which offers both competitive prices and home pick-up.

According to the report, a total of 130 e-waste recycling enterprises were registered on the e-waste Dismantling Enterprise List, and as of May 2012, some 53 e-waste treatment enterprises in 15 provinces and cities had received the necessary licenses to be formal recyclers.

VOLUMES OF E-WASTE COLLECTED

no more government subsidies

2009-2011
Home Appliance Old for
New Rebate Program

The government paid
three subsidies:
1 consumer
2 collection company
3 recycler

2000
national program to pilot
formalized e-waste treatment
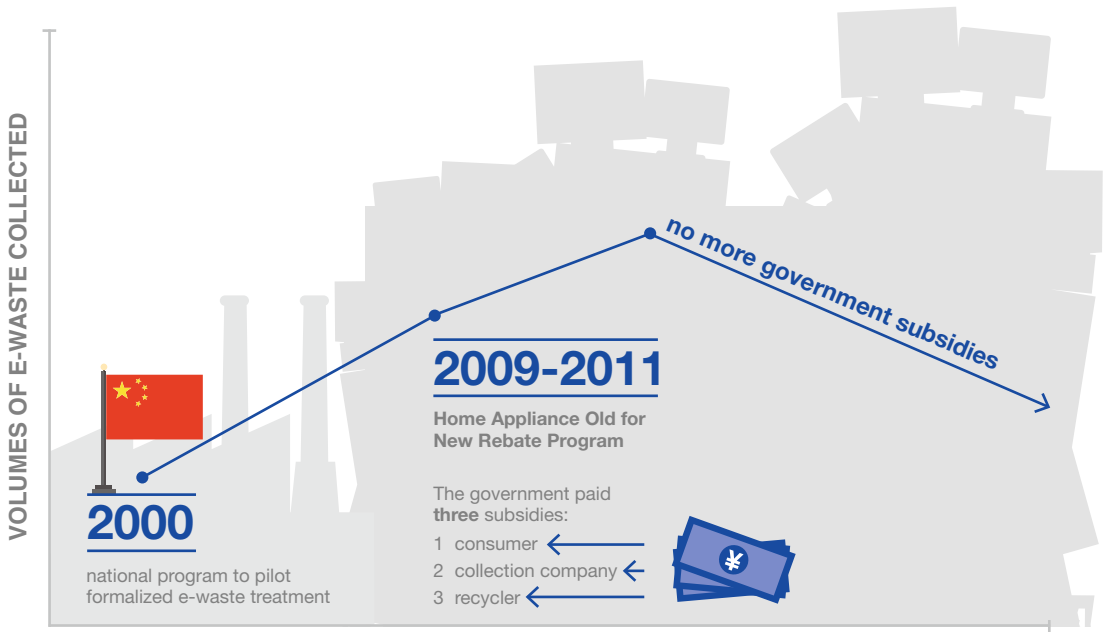
7 Recommended framework: producer- and consumer-funded, incentivized recycling

7 Recommended framework: producer- and consumer-funded, incentivized recycling

Improving the rates of electronic waste recycling and reducing its impact will require participation from a broad group of stakeholders. Participants at Creator Space Shanghai discussed a potential framework to address this.

Both producers and consumers can participate financially by paying a fee into a fund that puts a price on the true cost of disposing of an electronic item. Consumers' fees could be refunded by the retailer upon successful disposal and/or recycling of the electronic item. The amounts that both producers and consumers take back out of the pot will depend on the length of time that the consumer uses the electrical item: The longer you own, the more you get back.

A circular supply chain solution

An e-waste management scheme where incentives are properly aligned to encourage reuse and proper disposal is in line with the vision behind the "circular economy," or a circular supply chain.

A recent Club of Rome report defined the concept of circular economy as follows: "The ‚circular economy' is an industrial system that is restorative by intention and design. The idea is that rather than discarding products before their value are fully utilized, we should use and re-use them. Presently only a few percentage points of the original product value is recovered after use."

Through the proposal BASF is exploring, the onus will not be on the government to manage or provide subsidies, but on the producer and consumer to carry the true costs. The role of lawmakers, in this scenario, is to set the regulatory framework for the market to operate.

Market opportunity for incentivized recycling

According to Accenture Strategy, the circular economy will be worth $4.5 trillion by 2030, due to new business models, technologies and capabilities in which "waste" does not mean rubbish only, but also "lost economic opportunities, lost resources and underused assets."

$4.5 trillion by 2030

Applying these ideas to the problem of e-waste, we see that the business model is a recycling business model that creates production and consumption systems in which everything that used to be considered waste is revived for other uses. Companies either recover end-of-life products to recapture and reuse valuable material, energy and components, or they reclaim waste and by-products from a production process. In the case of e-waste, this may mean that materials harvested from e-waste can form the basis for new products or can be combined and transformed into wholly new products.

Way forward

Before this can happen, stakeholders must have a full view of the entire product lifecycle and product value chain (including aligned and misaligned incentives). Then they can apply their creativity about where, when and how processes and production can be changed to create new products and businesses from residual products and capacities. In the end, this can reduce the amount of e-waste and/or allow for safer handling.

The benefit is clear: With a deeper understanding of the value chain for electronics in China, companies can move toward a circular economy model for the industry and develop innovative product and service offerings. And, what's more, they can better protect humans and the environment from the harmful side effects of electronic waste.

producers/consumers

fees could be refunded

paying a fee

disposal and/or recycling

FUND

8 Circular economy proposals for other industries

8 Circular economy proposals for other industries

Textiles

People in urban areas are conscious about fashion and more likely to buy clothes to be part of the fad, discarding them before they are worn out. What happens to the environment and overall well-being, though, when the dyes from textile production contaminate groundwater, or emissions from textile factories contribute to air pollution?

"Fast fashion," and with it the attitude that clothes are disposable, has long-term effects on the environment. China, in particular, feels the impact: It produces approximately 30% of the world's textiles, leaving behind dye residues that can contaminate groundwater, as well as synthetic materials in landfills.

At the same time, China's domestic consumption of both consumer and industrial textiles has rapidly increased over the last 25 years. It is one of the largest producers globally of raw materials for textiles, including chemical fibers and cotton, which is water-intensive to grow and often require large amounts of fertilizers. Despite being a source of pollution, the textiles industry is of national economic importance to China. As growth began to slow in China in

2015, policymakers may have concerns about increasing environmental regulations on such a critical industry.

Still, leaders understand that both the economy and national health will suffer if the problems of contaminated groundwater and water shortages are not tackled. Likewise, they know that supporting more energy-efficient textile production processes not only reduces carbon emissions, it helps companies become more competitive internationally.

At Creator Space™ Shanghai, participants explored how stakeholders involved in textile production can come together to promote more responsible textile production. For instance, stakeholders could work together to provide technical training to reach sustainability goals, develop a label that indicates sustainable production, or create a textile industry alliance for sustainability. They could also follow in the steps of Waste2Wear, a company BASF is cooperating with that develops and sells textiles made out of recycled plastics.

Improvements can take place in various lifecycle phases of textile production. In the design stage, for instance, producers can promote longer fashion cycles and consider how to extend the life of garments. Or clothes could be designed to be multifunctional and cross-seasonal to reduce the amount of waste. In addition, industry associations and governments can set and enforce standards for the volume of toxic matter contained and needed to produce in fabrics.

As a provider of chemicals and chemical solutions including electronics chemicals, BASF can provide sustainable materials and smart solutions to traditional and electronic textile producers and work to increase demand among consumers for sustainable and e-textiles.

Food Safety

When Chinese travelers visit Europe, it's not uncommon for people to purchase daily food necessities like milk powder to bring home in large quantities. After tainted milk caused a scandal in 2008, media and watchdogs are keen to highlight other incidents. Recently, expired meat was sold to global brands, and out-of-date food was found to be recycled.

Given the urgency of food-safety matters, and the long times it can take for regulation to be implemented and enforced, stakeholders can work independently to improve the situation, with initiatives to promote transparency and engagement throughout the food value chain.

For instance, stakeholders can develop programs that increase awareness about safety in food production and about accountability, to lessen the fears of consumers.

At Creator Space™ Shanghai, stakeholders explored these ideas by analyzing the value chain associated with food. They considered how to use technology tools to educate consumers and provide tracking of food products back to the origin of their raw materials.

Such systems would not only help consumers quell their fears, they would put pressure on brands to be more accountable throughout the supply chain.

Food is impacted by unabated urbanization in China. As incomes rise and people leave the countryside, they diversify their diets, begin eating out and start to consume packaged food. All these changes have an impact on food production, food storage and food safety as well.

BASF can potentially help improve the situation as a supporter of sustainable ways to produce food, keep it safe and reduce the impact of food production on the environment.

One important part of the tour was the art installation "Uncertain Space" created by the artists Alexander Brandt and Yang Qingqing. They show the future as an open process of possible choices, using the three phases of many curiosity-driven and exploratory journeys: alarm on a societal issue, question on its source and creating solutions. It is an irregular structure made of steel and wood, covering an area of about 80 square meters.