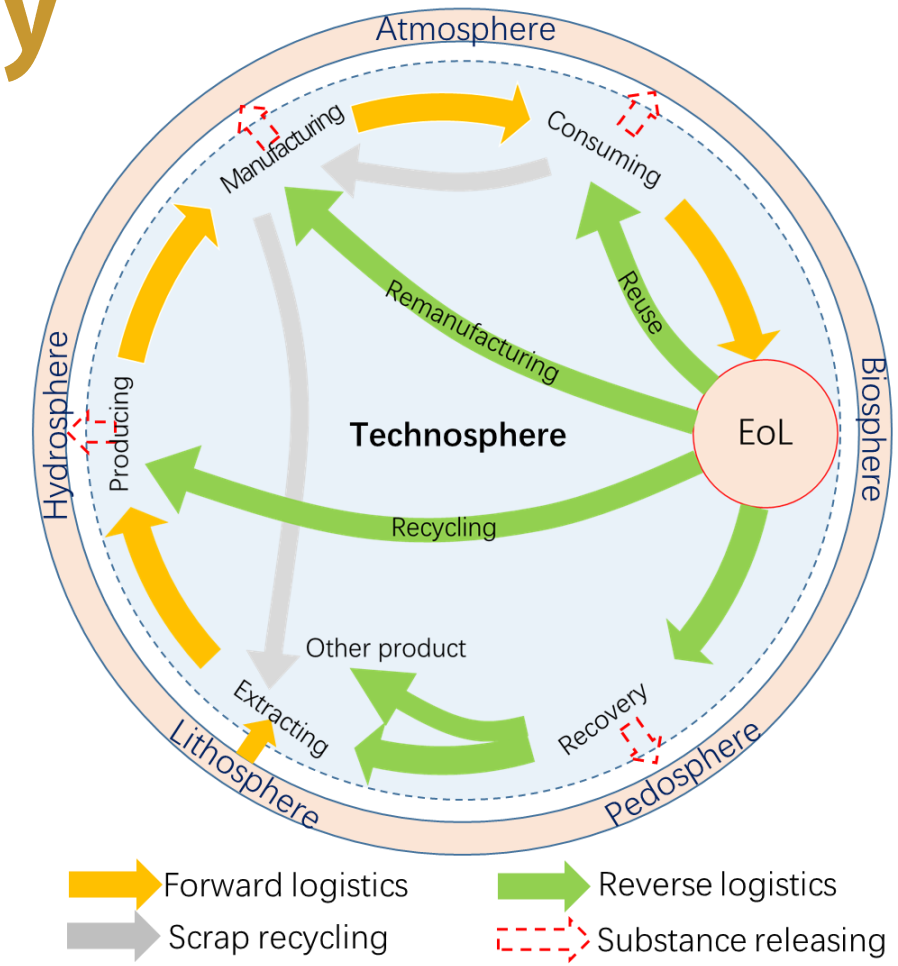
switchasia
REGIONAL POLICY ADVOCACY

Funded by the European Union

Policies of Circular Economy

Case as E-waste Management



Dec. 2, 2019, Beijing

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China

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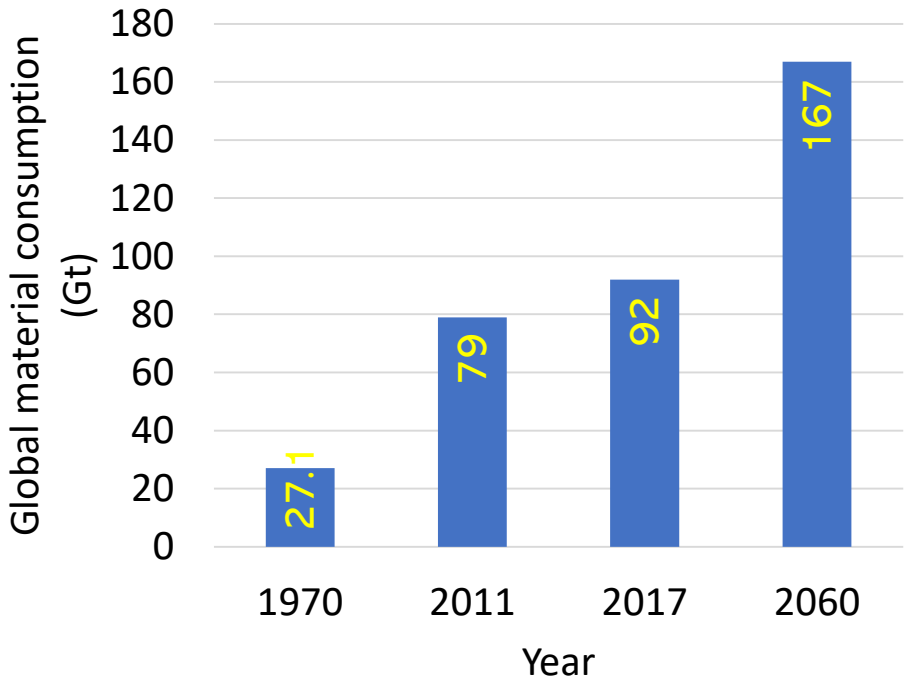
Policies of Circular Economy

1 Circular Economy and Its Policies Needs

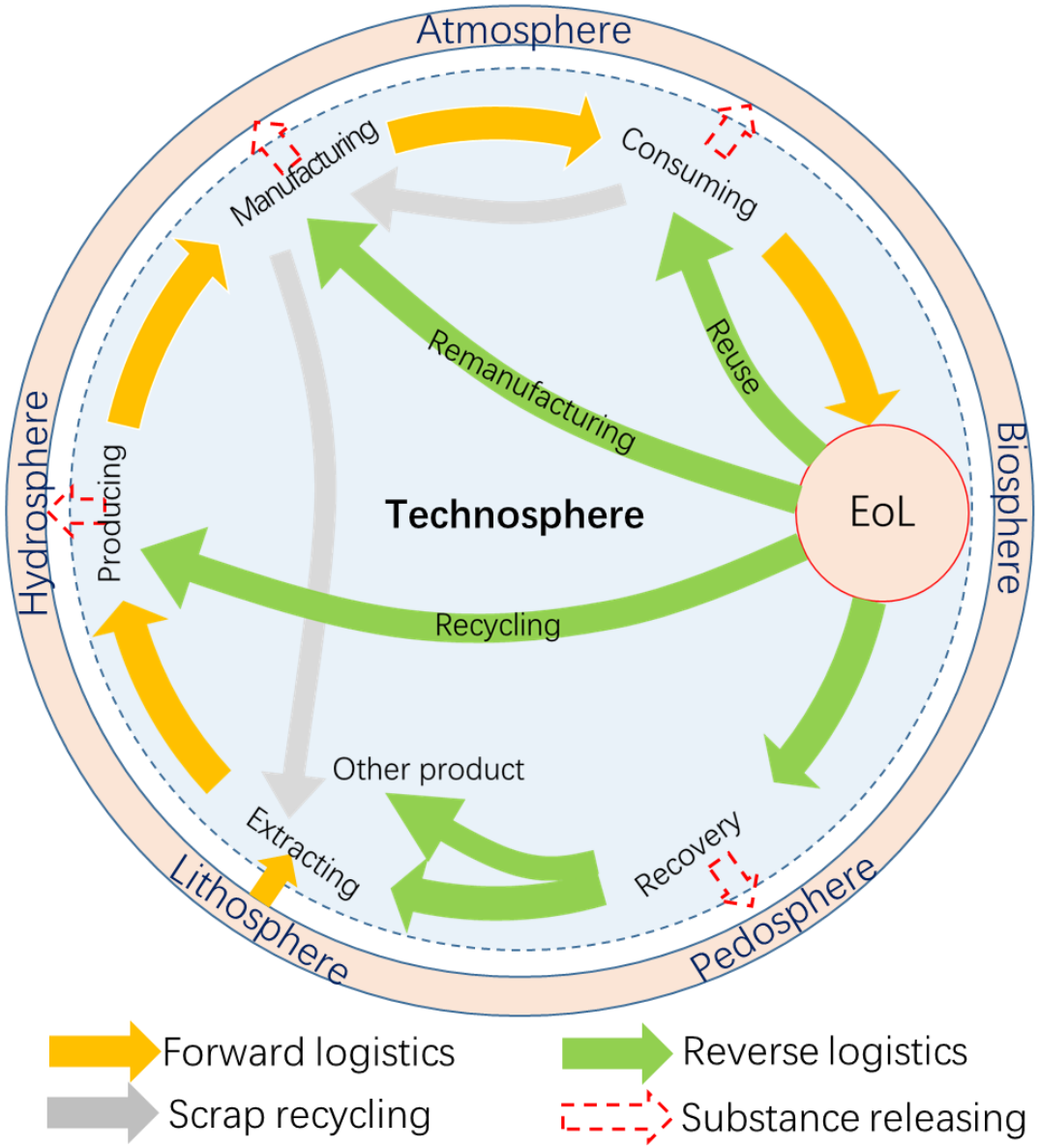
2 Policies towards the Problems Solving: E-waste Problem

3 Case of Solving the E-waste Problem

Material Flow Subject to Resource and Environmental Problem



IRP, 2019; OECD, 2019



Zeng & Li, 2018

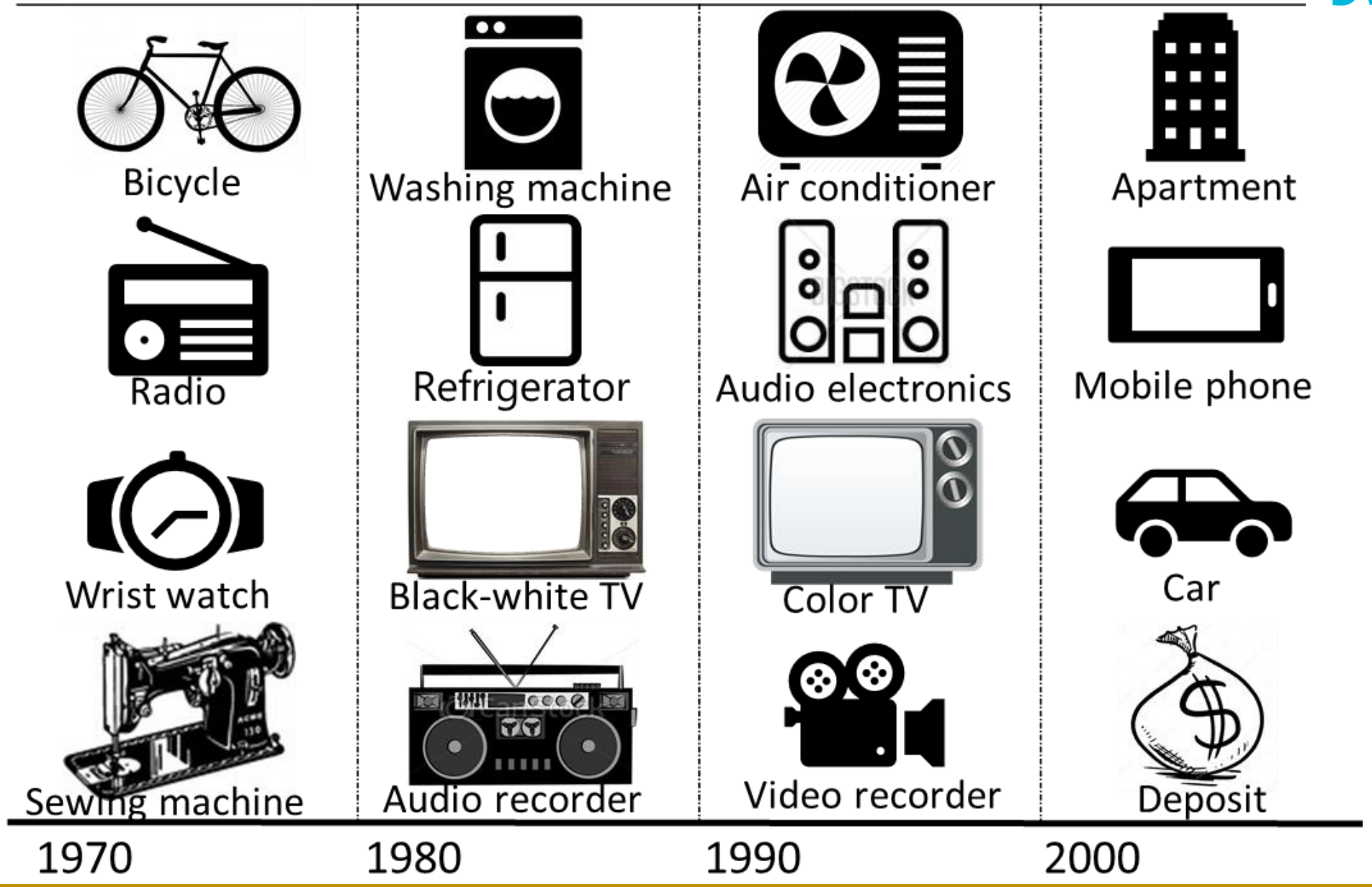
Products Updating and Diversity from 1900 to 2020

StEP, UNU, and UNEP IETC have been working extensively on e-waste issues and made an attempt to look into the future of the problem in order to initiate policy level discussions on the challenges and opportunities ahead. Having insight into the future will help policymakers and industries, as well as other stakeholders, to make better strategic decisions. Forecasting is also necessary vis-à-vis strategic concepts towards sustainable development, such as circular economy and the UN's Agenda 2030.

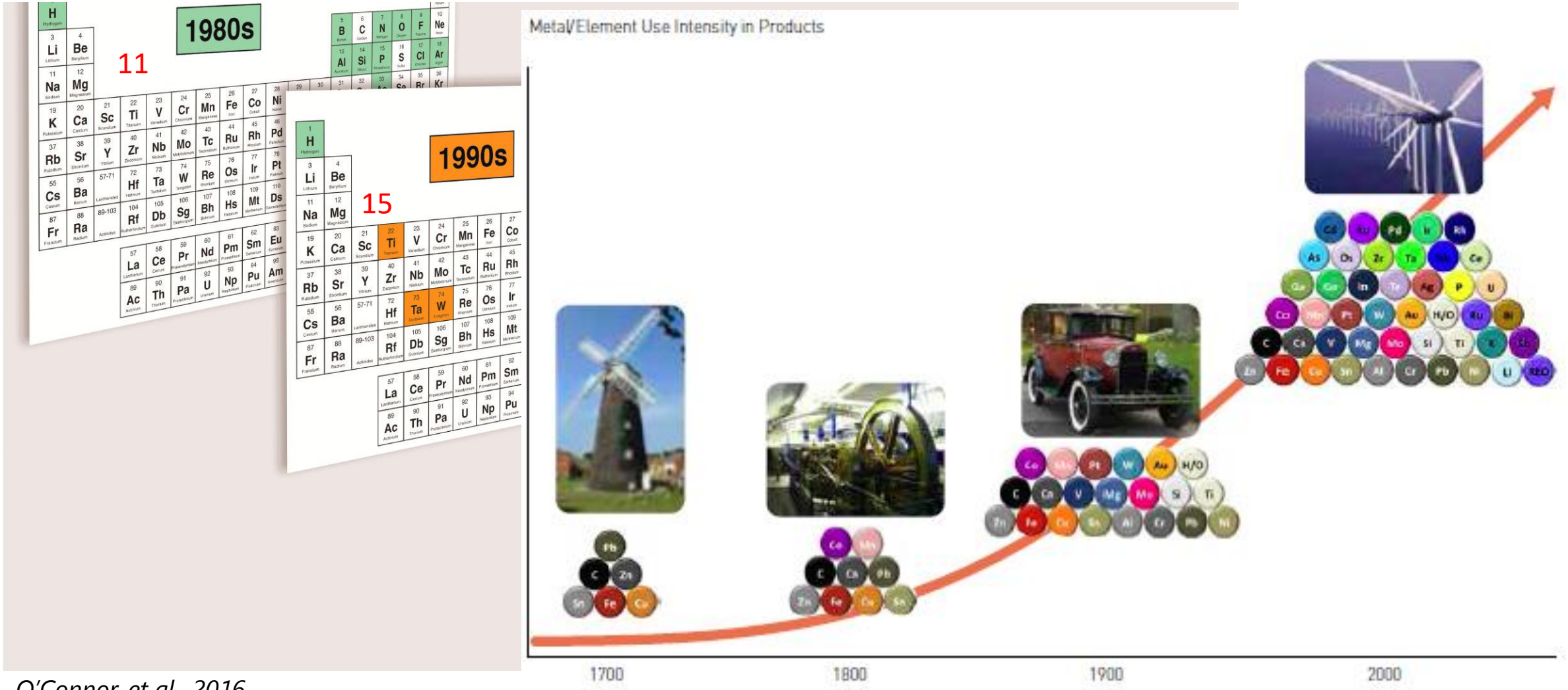
We cannot expect immediate success with these concepts without an active search solutions. The complicated nature of production, use, and disposal of electronics require significant changes in order for the processes to become sustainable.

1900 1920 1940 1960 1980 2000 2020

Evolution of "Four Big Items" from 1970s to 2000s in China

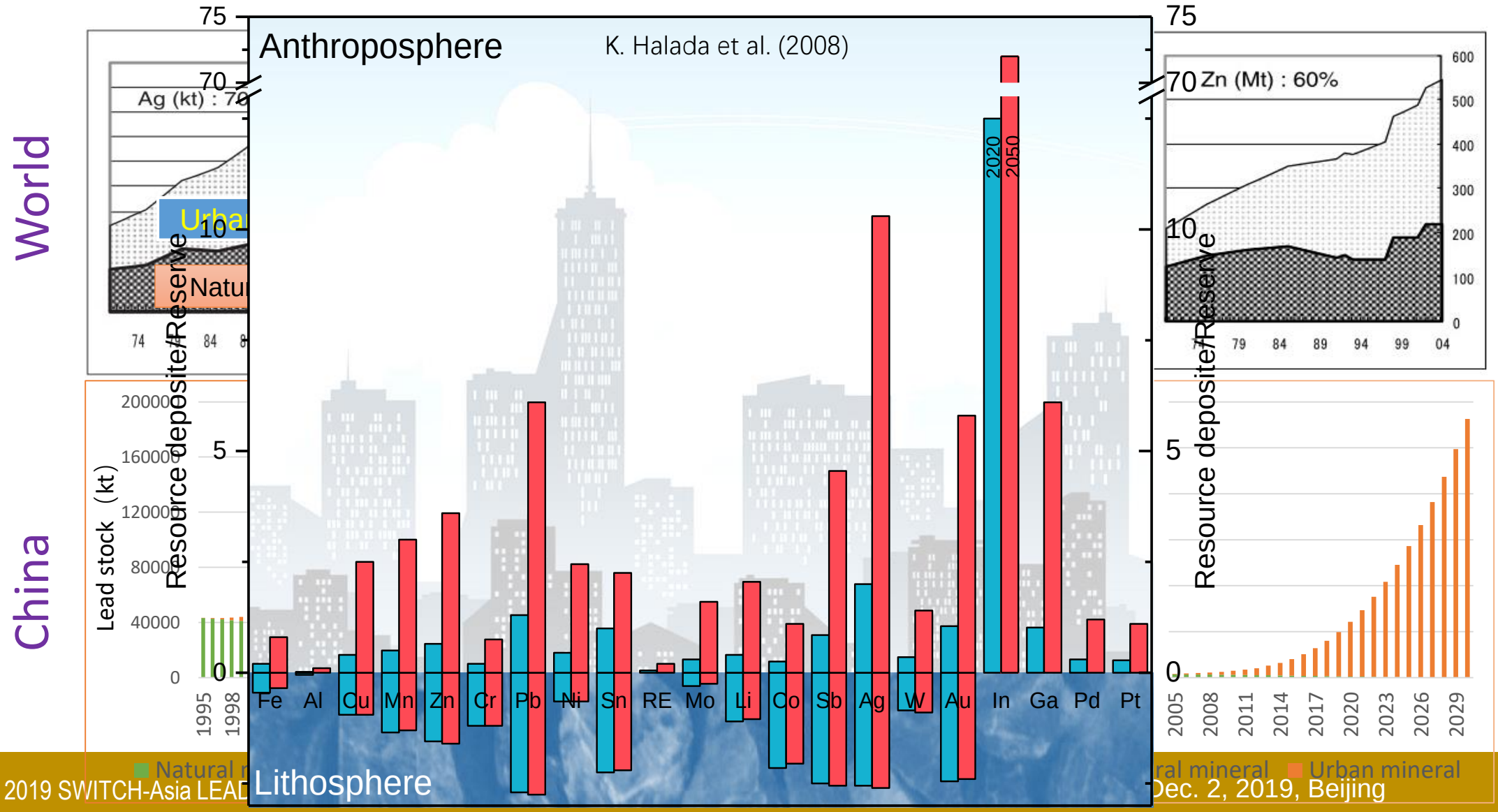


Elements Distribution in the Evolving Products



O'Connor, et al., 2016

Natural resource reserve is depleting…



Nakamura & Halada, 2015

Zeng & Li, 2018

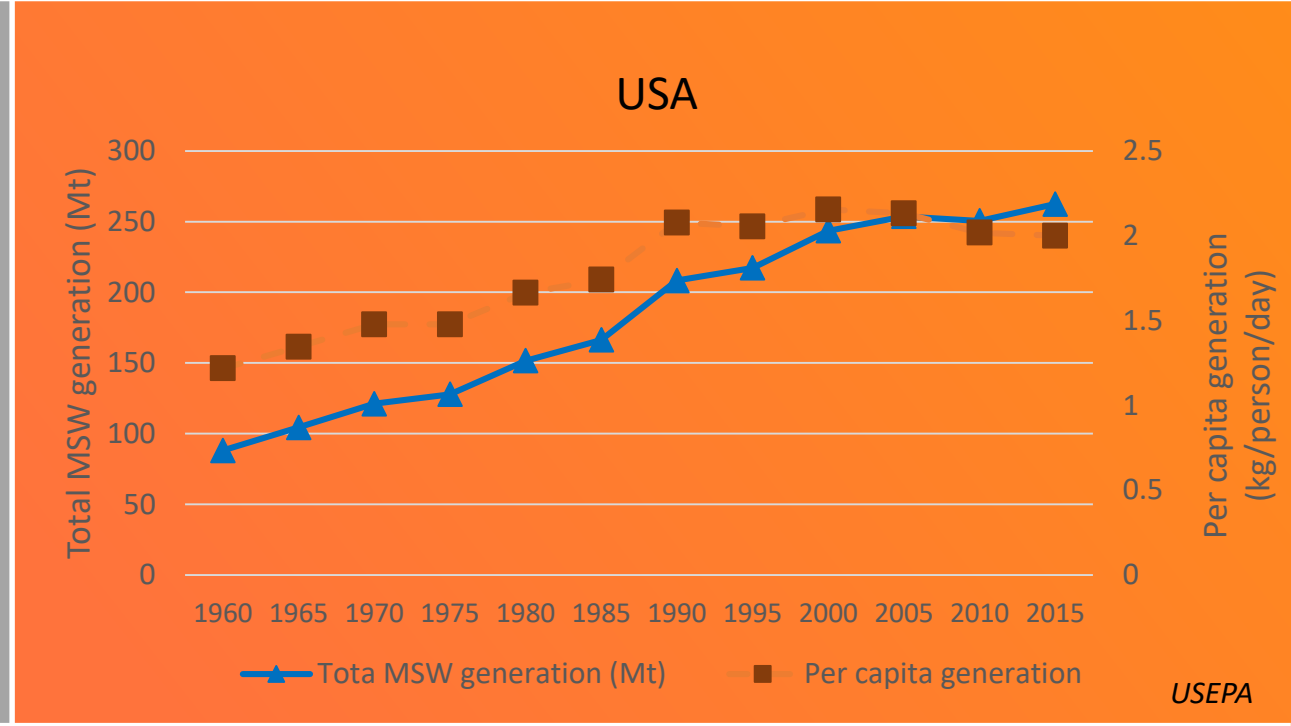
Global Yearly Waste Generation (2010)

2 billion tons
municipal solid waste

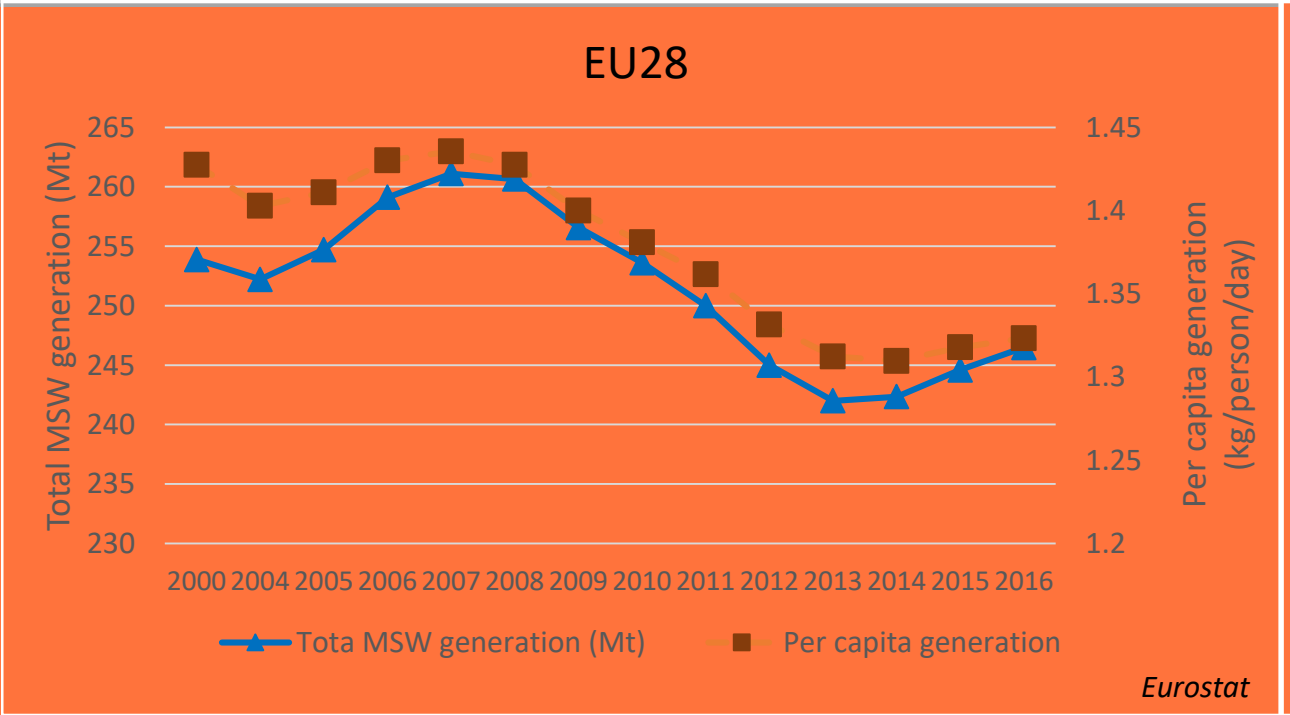
7-10 billion tons waste
from household, commercial, industrial and construction industry

The total amount is still rapidly increasing!

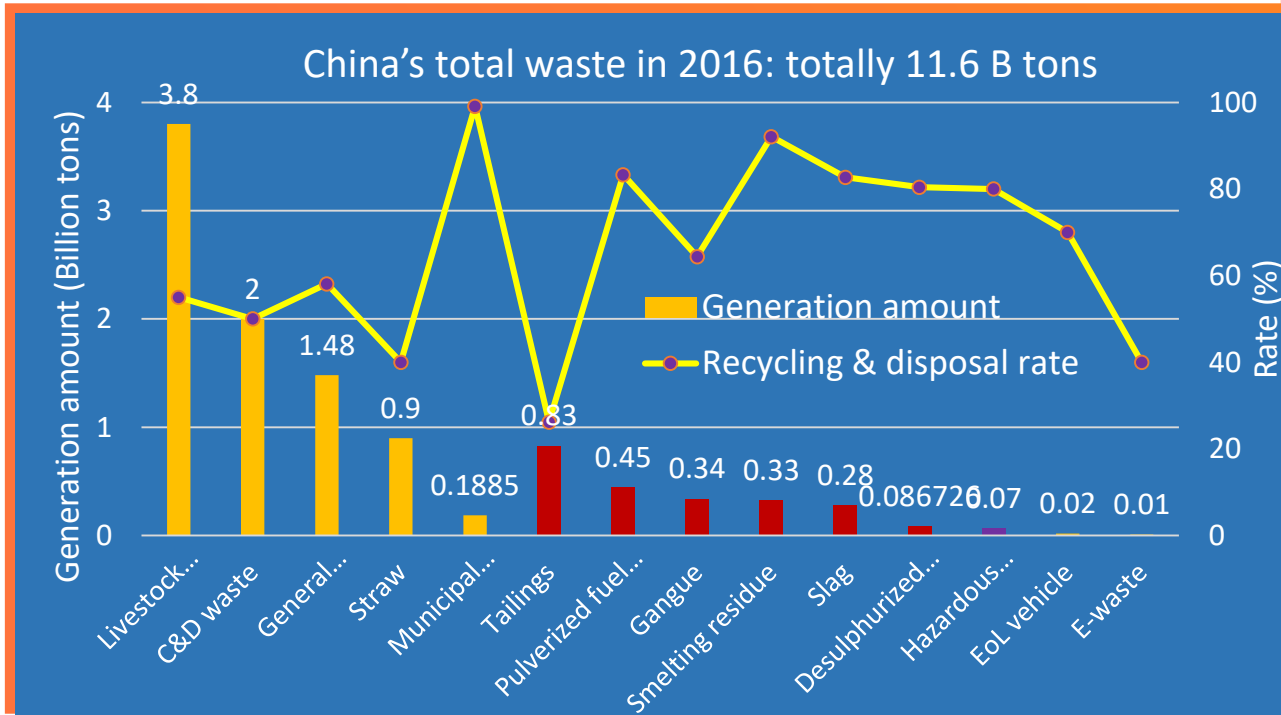
UNEP & ISWA



USEPA



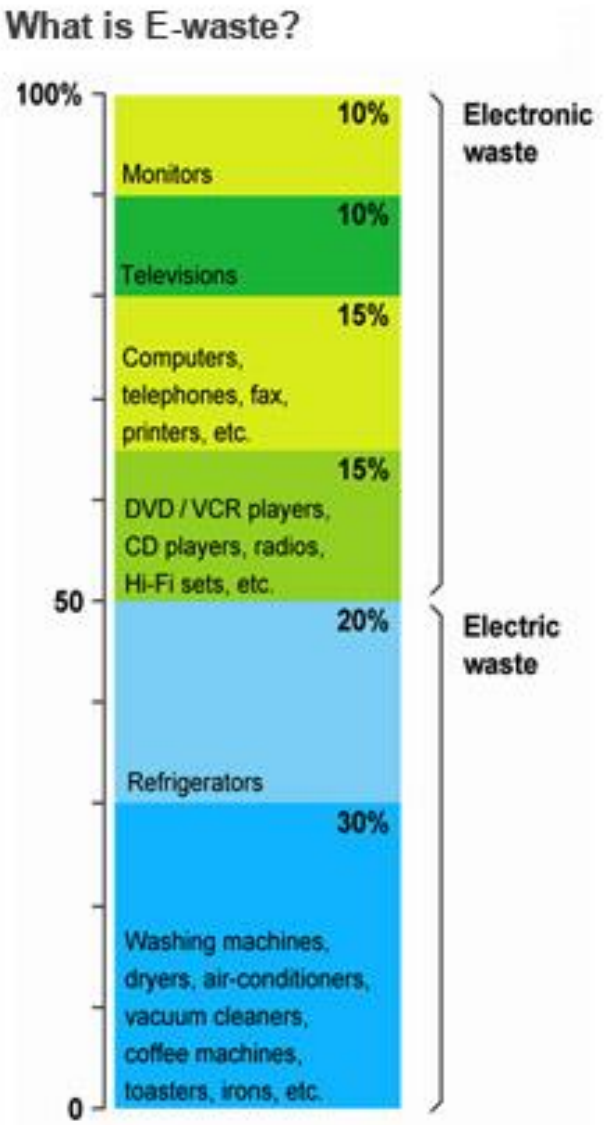
Eurostat



Concept of WEEE/E-waste

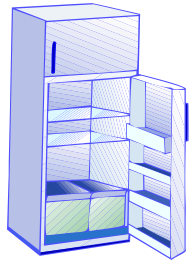
- WEEE is waste electrical and electronic equipment.

- E-waste is a term used to cover items of all types of electrical and electronic equipment and its parts that have been discarded by the owner as waste without the intention of reuse. (StEP)



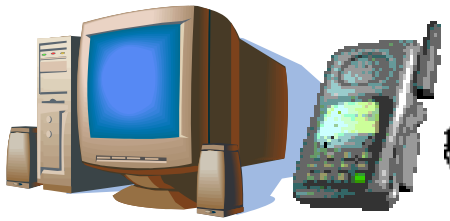
Scope of WEEE

Category 1: large household appliances



Category 2: small household appliances

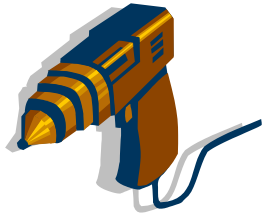
Category 3: IT & Telecoms equipment



Category 4: consumer equipment

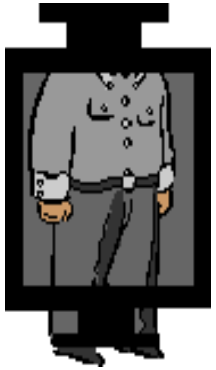
Category 5: lighting equipment

Categoty 6: electrical & electronic tools

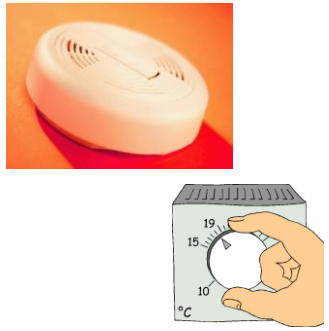


Category 7: Toys

Category 8: medical equipment systems



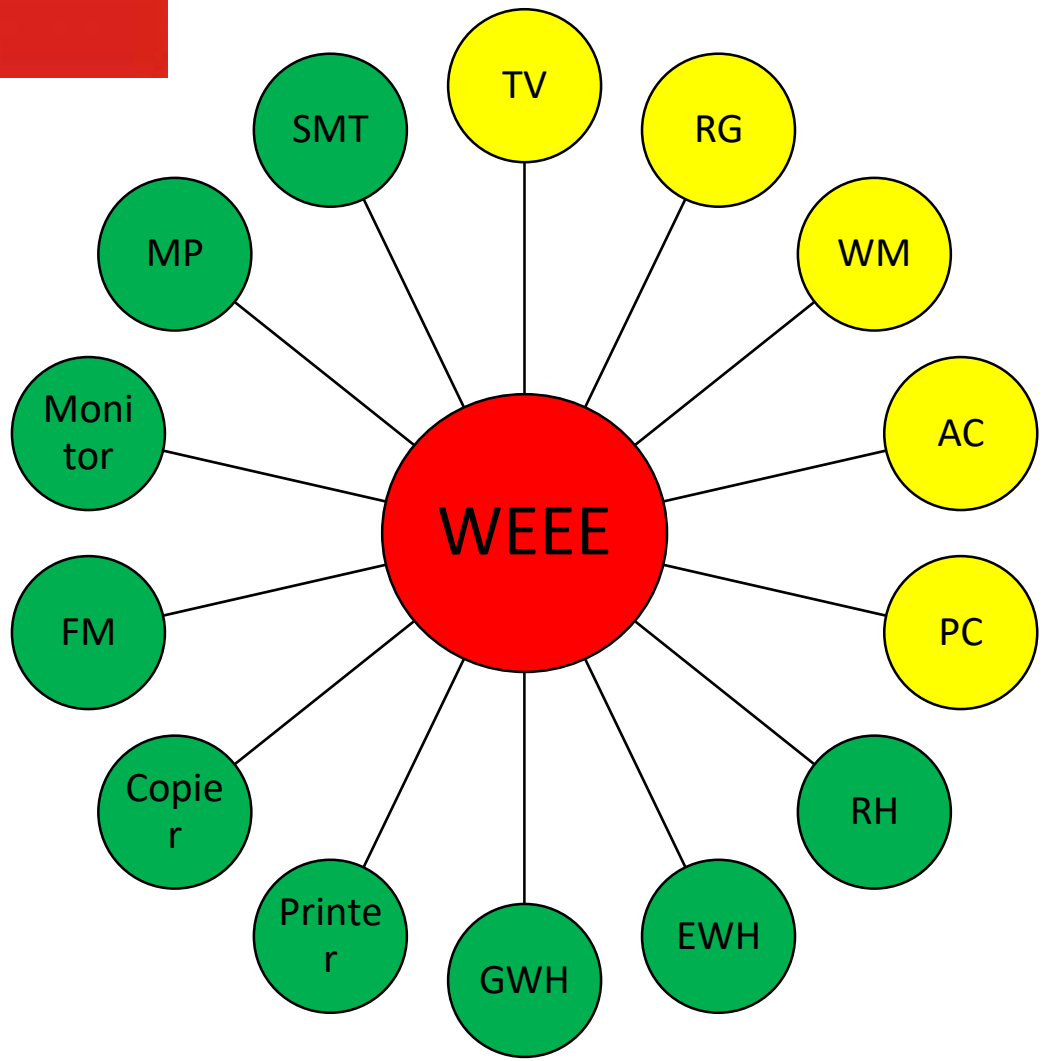
Category 9: monitoring & control equipment



Category 10: automatic dispensers

The scope of the WEEE directive is **10** categories of EEE.

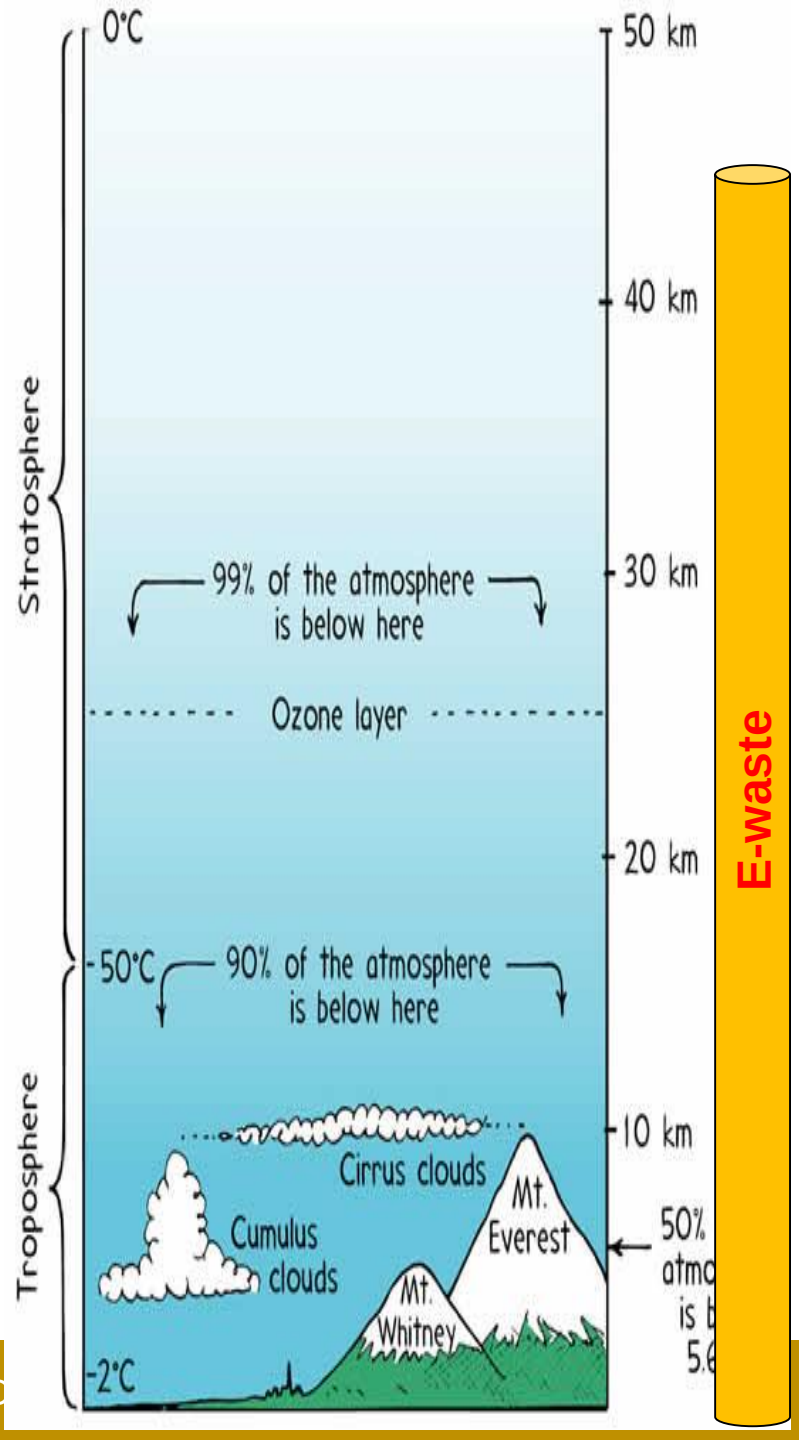
Scope of WEEE



Television, TV; refrigerator, RG; washing machine, WM; air conditioner, AC; microcomputer, MC; range hood, RH; electric water-heater, EWH; gas water-heater, GWH; printer, PT; copier, CP; fax machine, FM; monitor, MN; mobile phone, MP; single-machine telephone, SMT.

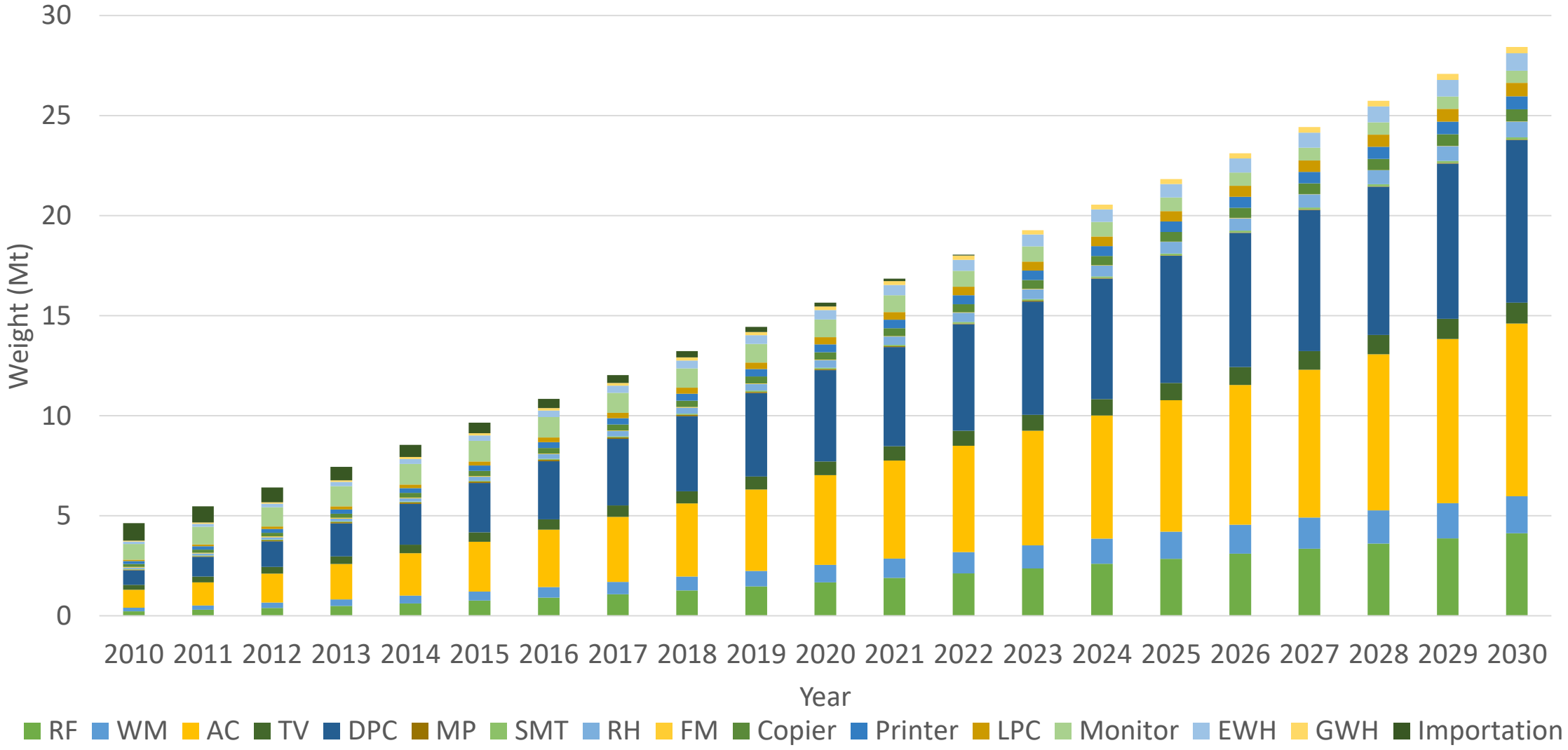
E-waste Generation

- E-waste has become the **fastest increasing waste steam** in global generation amount. About 50 million metric tons of e-waste is generated per year.
- If this amount was stacked up in a one-acre square, it would extend upwards for 45.5 km. If the estimated amount of e-waste generated every year would be put into containers on a train it would go once around the world!



http://www.ban.org/files/BAN_2012_Annual_Report.pdf

Total E-waste Generation in China



I. Resource stock in e-waste

Weight-share	Fe	Al	Cu	plas-tics	Ag (ppm)	Au (ppm)	Pd (ppm)
Monitor-board	30 %	15 %	10 %	28 %	280	20	10
PC-I							
Mob							
Port							
DVD							
Calc							

Mobile phones (a)

1600 million units/year

x 250 mg	Ag ≈	400 t	Ag
x 24 mg	Au ≈	38 t	Au
x 9 mg	Pd ≈	14 t	Pd
x 9 g	Cu ≈	14,000 t	Cu

~1300 million Li-Ion batteries

x 3.8 g	Co ≈	6100 t	Co

PCs & Laptops (b)

350 Million units/year

x1000 mg	Ag ≈	350 t	Ag
x 220 mg	Au ≈	77 t	Au
x 80 mg	Pd ≈	28 t	Pd
x ~500 g	Cu ≈	175,000 t	Cu

~180 million Li-ion batteries

x 65 g	Co ≈	11,700 t	Co

Urban Mine (a+b)

Mine production		Share
Ag:	22,200 t/a	3 %
Au:	2,500 t/a	5 %
Pd:	200 t/a	21 %
Cu:	16 M t/a	1 %
Co:	88,000 t/a	20 %

M. Reuter *et al.*, "Metal recycling: opportunities, limits, infrastructure, A Report of the Working Group on the Global Metal Flows to the International Resource Panel," (UNEP, 2013).

E-waste's impact on demand for crucial metals

Metal	Use	World mine production per year	Demand for electronics (%)	Years of reserves left	Consumption met by recycled materials (%)
Gold	Bonding wire, contacts, etc.	2,500 tonnes	12	45	43
Silver	Contacts, switches, lead-free solder, conductor, etc.	20,000 tonnes	30	29	16
Tin	Lead-free solder	275,000 tonnes	33	40	26
Copper	Cables, wires, connectors, PCBs, transformers	15 million tonnes	30	61	31
Indium	Flat screen displays, semicondutors	480	79	13	0

Source: McCann, D.; Wittmann, A., *Solving the E-Waste Problem (Step) Green Paper: E-waste Prevention, Take-back System Design and Policy Approaches*. United Nations University/Step Initiative: 2015.

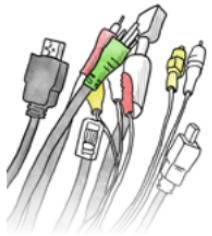
II. Toxicity in e-waste

E-WASTE IS TOXIC

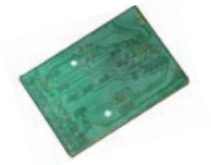
e-Waste contains dangerous amounts of toxic substances, such as—

Lead and cadmium in circuit boards and cathode ray tubes (CRTs);

Brominated flame retardants on circuit boards, plastic casings, and cables, that releases highly toxic dioxins and furans when burned to retrieve copper from the wires;



Mercury in switches, circuit boards, and flat screen monitors;

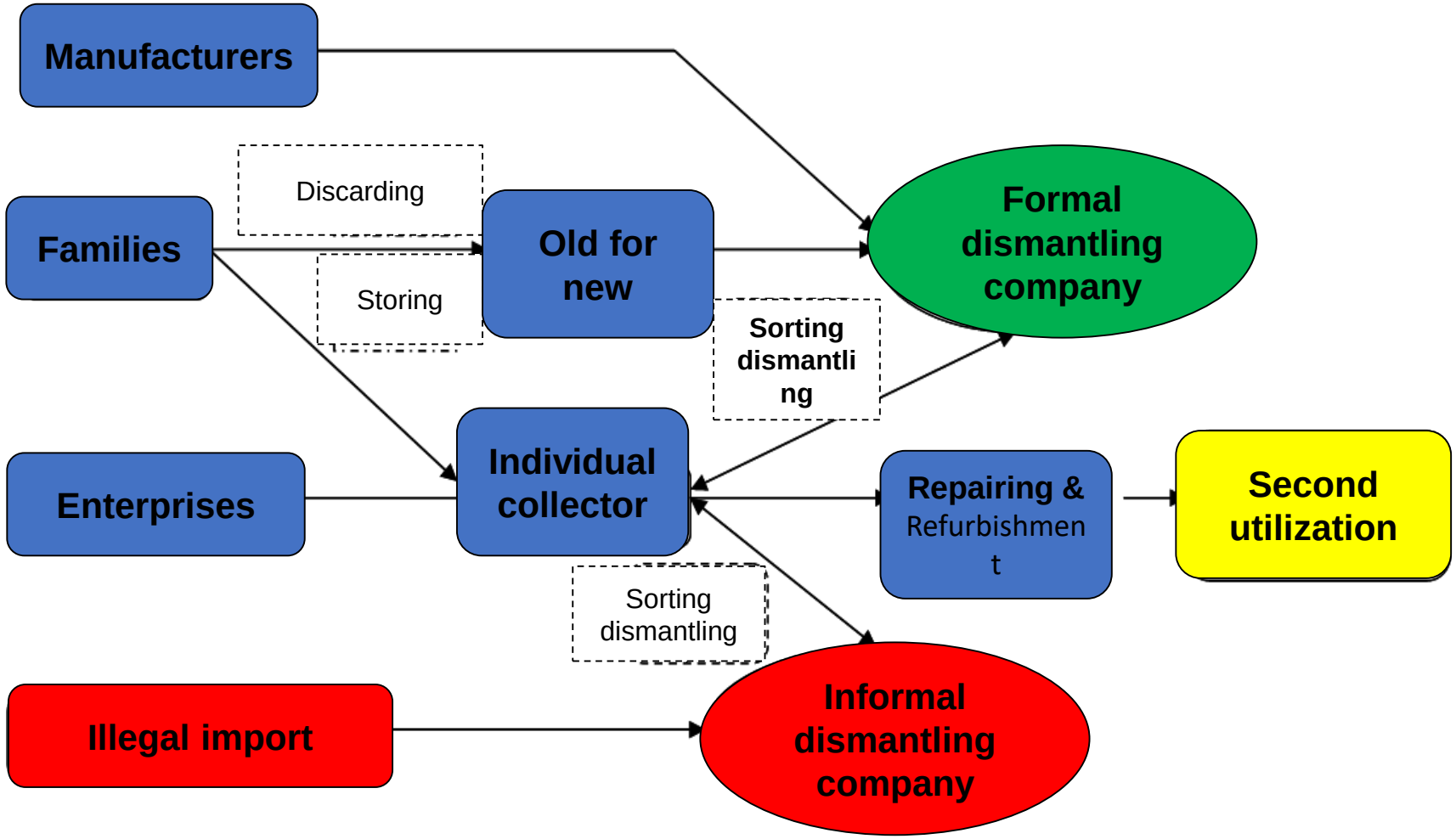


MERCURY easily accumulates in living organisms and concentrates through the food chain, especially in fish. This affects not only the people who dismantle our electronics, but also the billions of people around the world who consume fish.

Mercury is known to cause serious damage to the human body. The developing fetus is highly susceptible through maternal exposure to mercury.

An estimated **22%** of the yearly world consumption of mercury is used in electrical and electronic equipment.

Flow of WEEE in China



Global flow of E-waste

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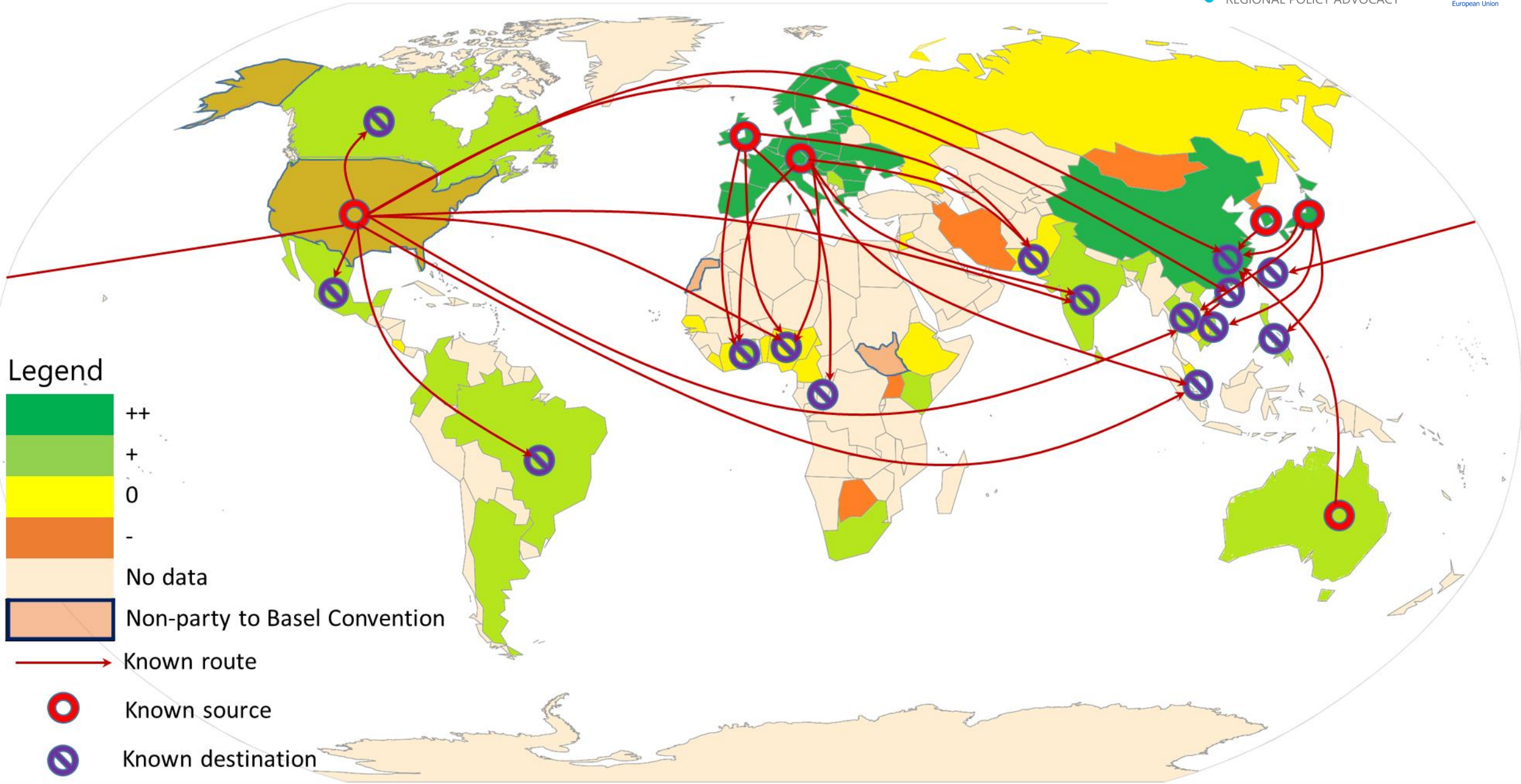


How to improve recycling rate: collection

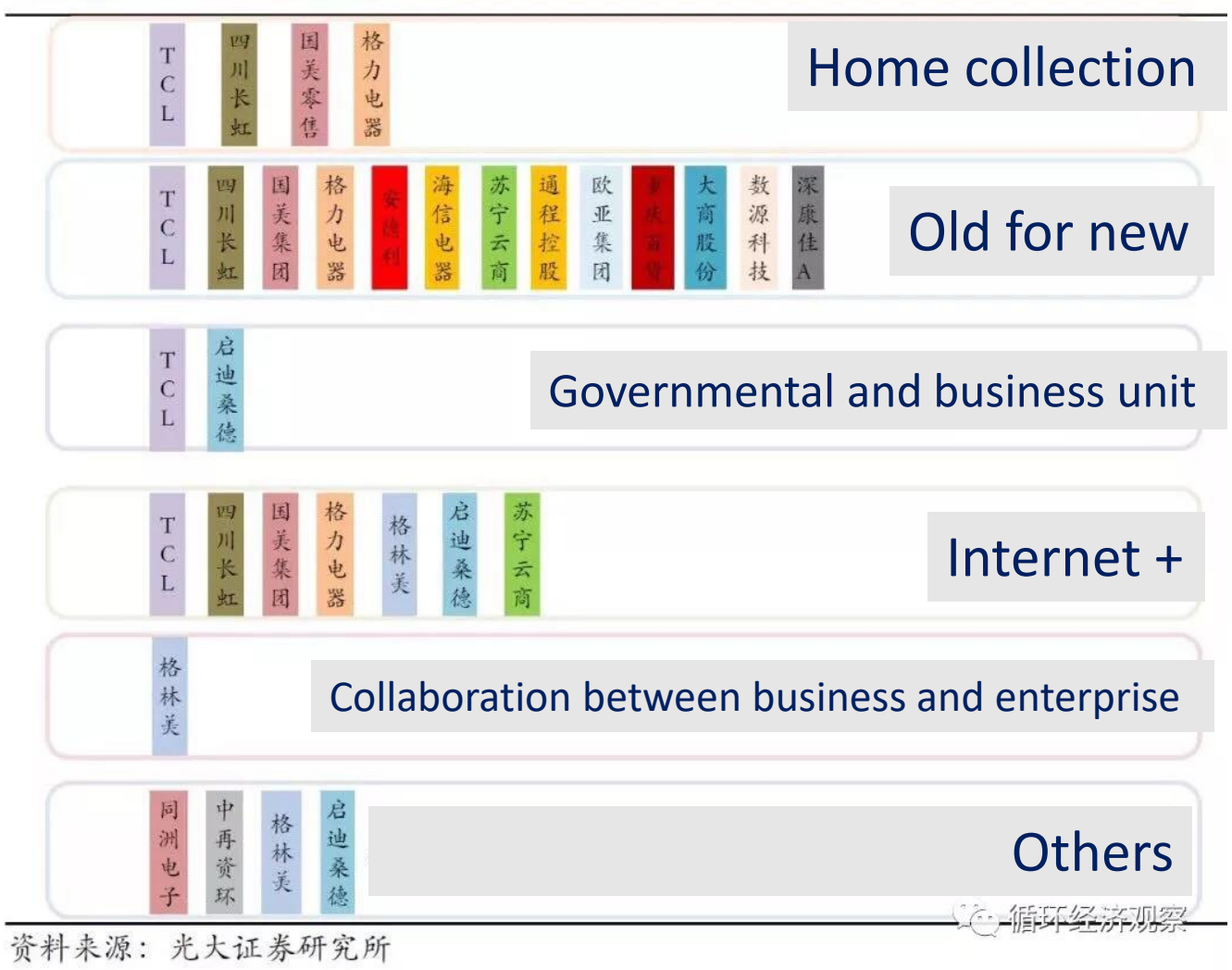
Main collection channels:

- Individual collector
- Second-hand market
- “Old for New” Policy
- Repair store
- Treatment enterprise
- Pilot of renewable resources
- Production enterprise
- Internet + : APP

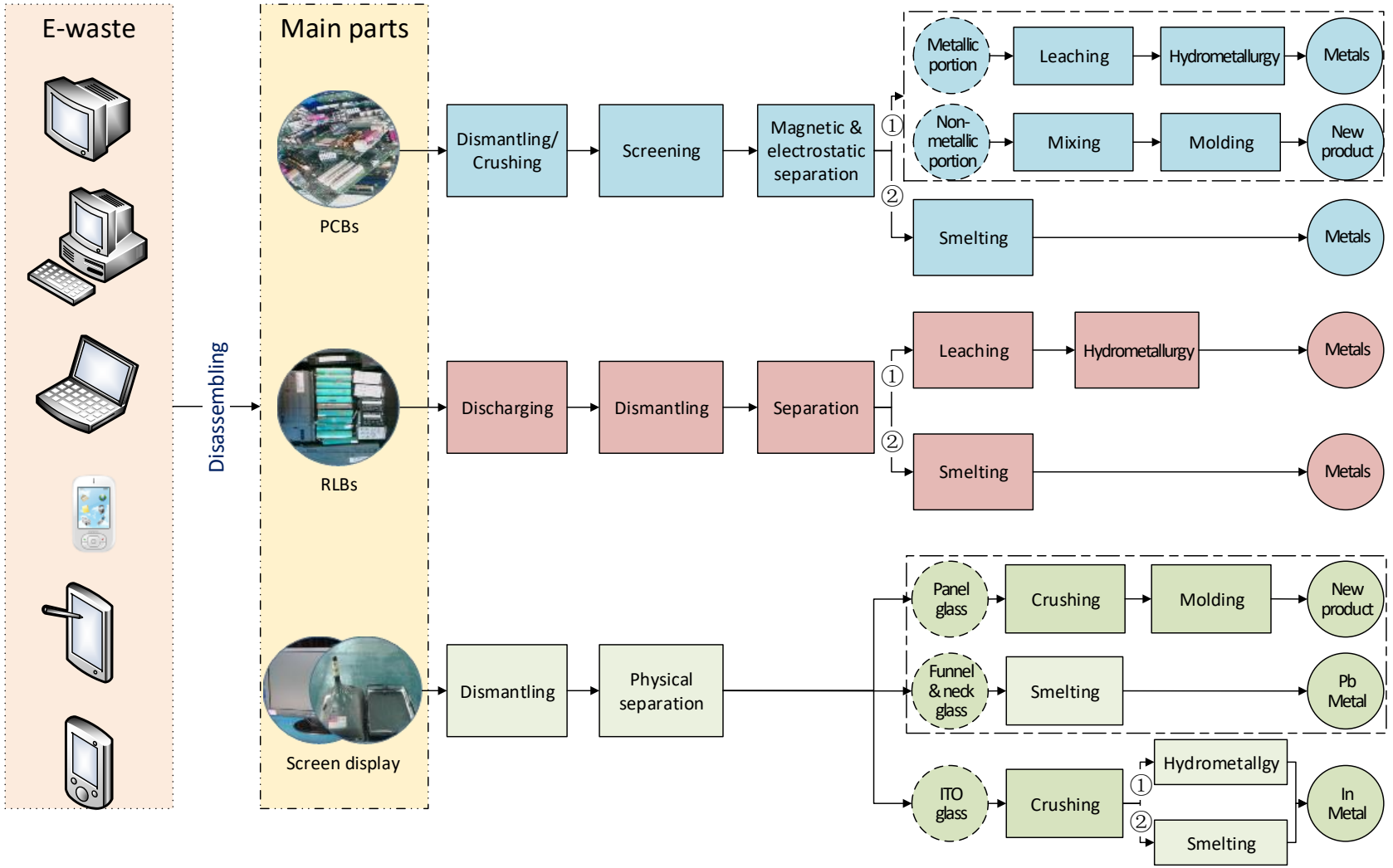
Individual

Second-hand market

How to improve recycling rate: collection

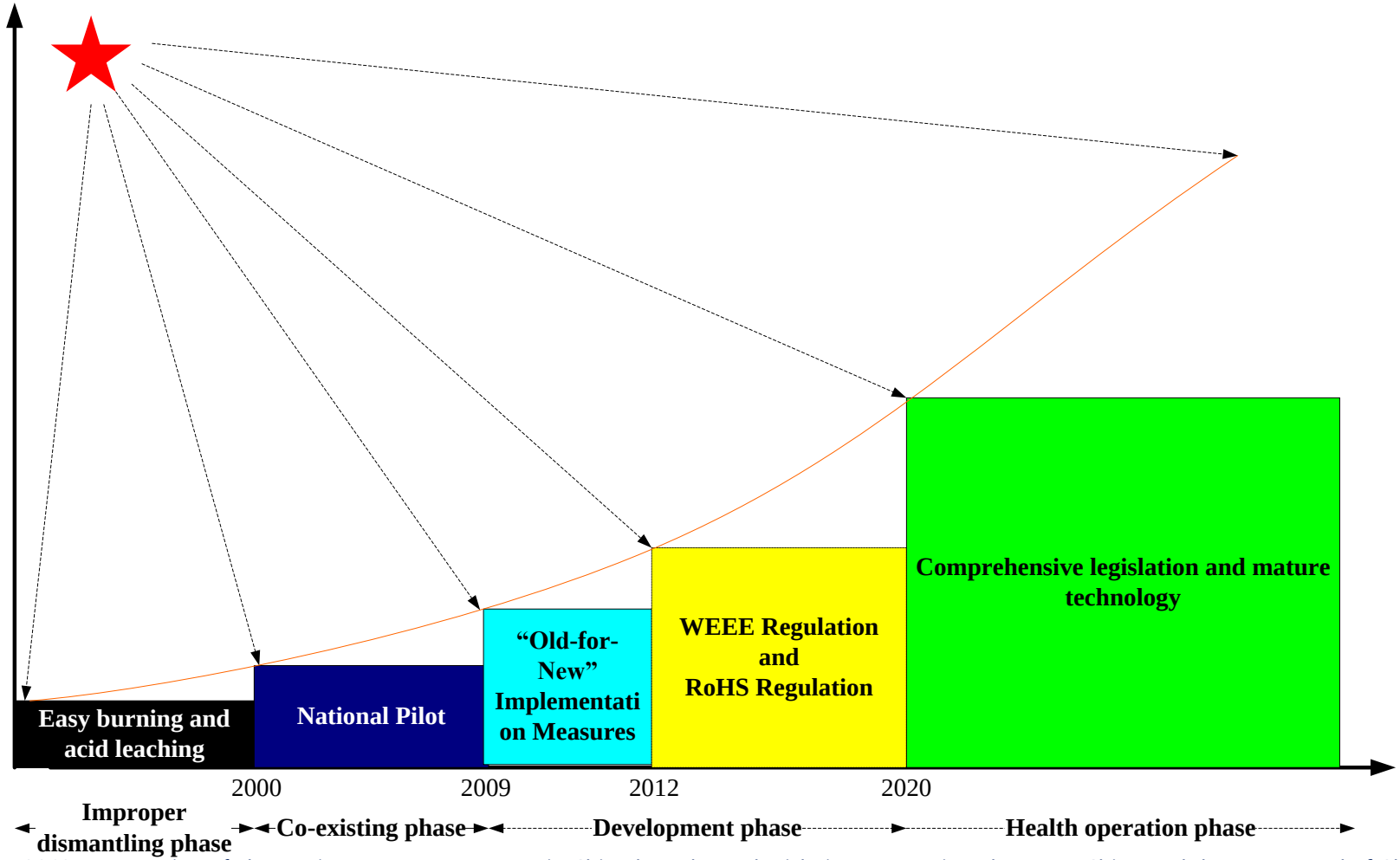


How to improve recycling rate: technical etficiency

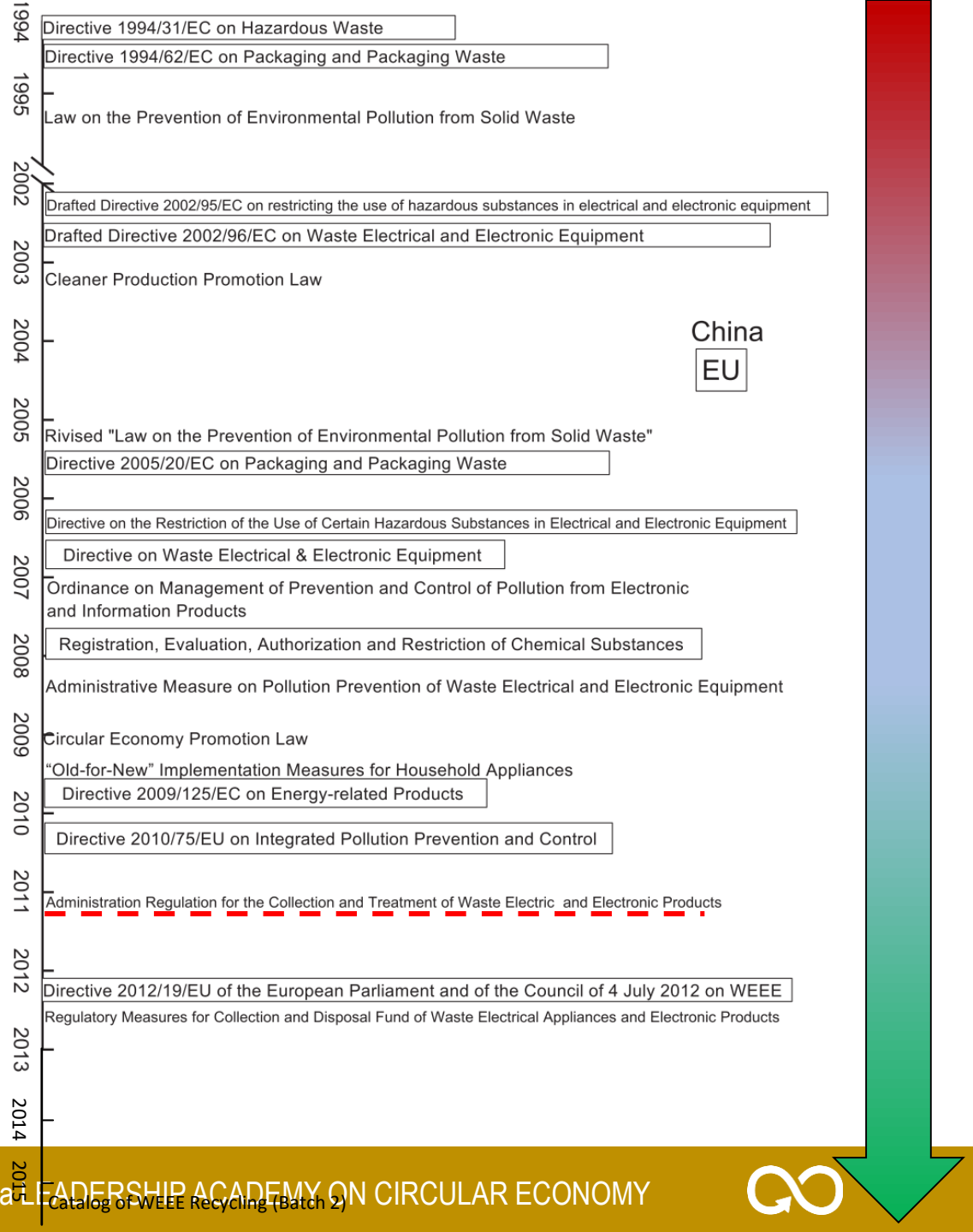


Note: ① popular in developing countries, ② predominate in industrial nations.

Outlining management progress of e-waste in China



Source: Zeng X, Li J, Stevels ALN, & Liu L (2013) Perspective of electronic waste management in China based on a legislation comparison between China and the EU. *Journal of Cleaner Production* 51(0):80-87.



WEEE regulation in hobble

Regulations and policies related to e-waste

- 2003， Technical Policies of Pollution Prevention and Control for Waste Batteries
- 2006， Technical Policies of Pollution Prevention and Control for Waste Household Appliances and Electronic Products
- 2006， Pollution Control Management Method for Electronic Information Products
- 2007， Administrative Measures for the Prevention and Control of Environmental Pollution by Electronic Waste
- **2009， The Regulations for the Administration of Recycling and Treatment of Waste Electric and Electronic Equipment (**Chinese WEEE)
- 2010， Technical specifications of pollution control for processing waste electrical and electronic equipment
- 2009-2011, “Old for new” policy
- 2012, Catalog of WEEE Recycling (Batch 1)
- 2015, Catalog of WEEE Recycling (Batch 2)

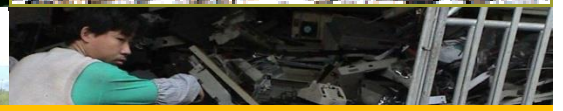
Chinese WEEE legislation system

Catalogue	● In September 2010,《The catalogue of disposal of Waste Electrical and Electronic Equipment (The first list) 》
Plan	● In September 2010,《Notice on the Formation of the Development Plan of the Treatment and Disposal of Waste Electrical and Electronic Equipment(2011-2015) ● In November 2010,《Guide on the Development Plan of the Treatment and Disposal of Waste Electrical and Electronic Equipment》
Permit	● In December 2010,《Administrative Measures on Qualification Permit of the Treatment and disposal of Waste Electrical and Electronic Equipment 》 and 《Guide on Qualification Verification and Approval on Treatment Enterprises of Waste Electrical and Electronic Equipment 》
Information system	● In November 2010,《Guide on Establishment of Data Information Management System and Information Submission of Treatment Enterprises of Waste Electrical and Electronic Equipment
Fund	● In November 2010,《Guide on Subsidy Approval of Treatment Enterprises of Waste Electrical and Electronic Equipment 》 ● In May 2012, 《Administrative Measures on Collection and Use for Treatment Fund of Waste Electrical and Electronic Equipment

Informal recycling

- Before 2000, the majority of e-waste in China was processed in backyards or small workshops using manual disassembly and open burning.
- The techniques used in recycling of e-waste are often primitive, without the appropriate facilities to safeguard environmental and human health.



China is not only the largest producer and consumer of electronics, but the country ever most seriously polluted from illegal e-waste importation and informal recycling.


National pilot



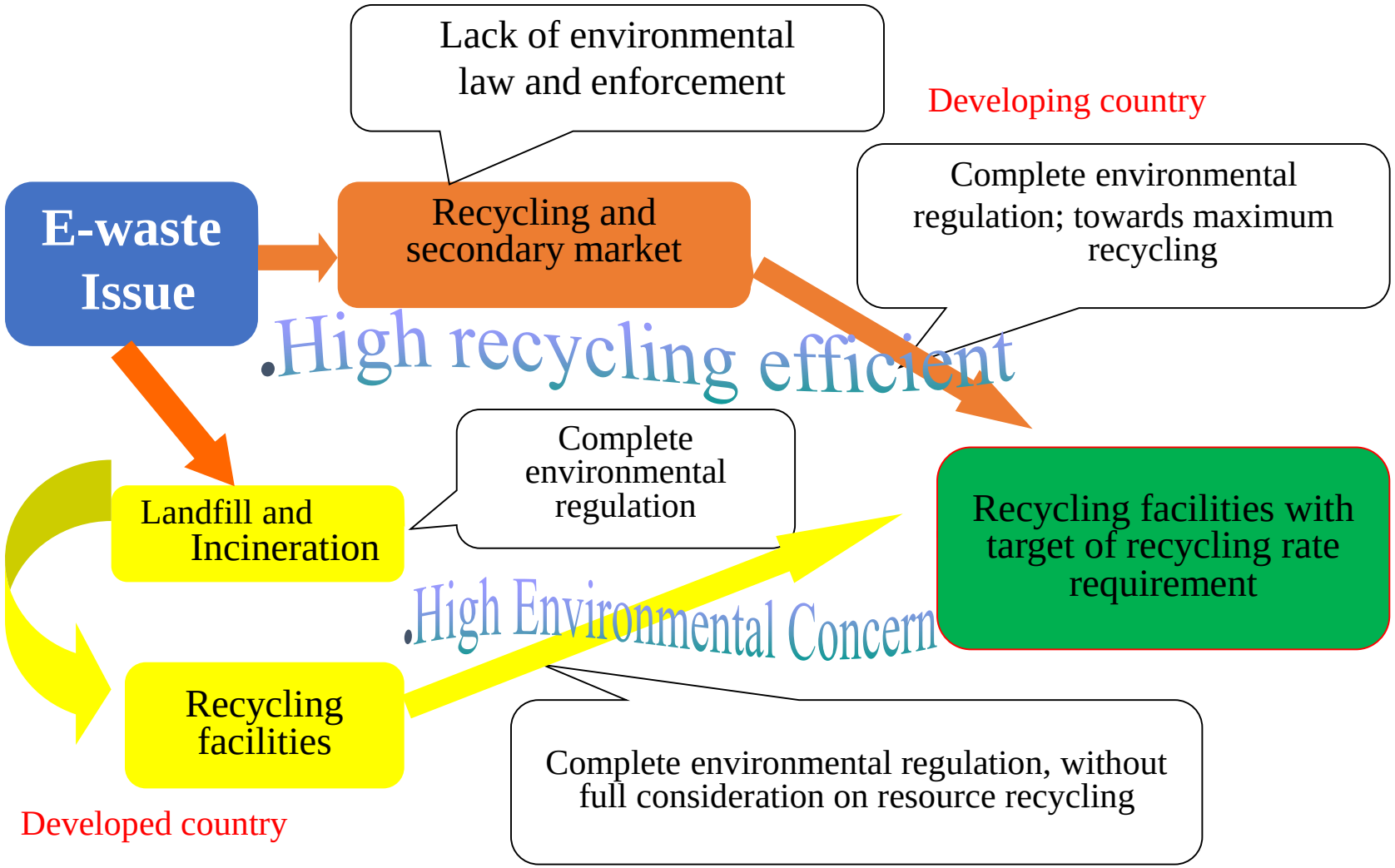








Where We Need to Start?



2000	2009	2012	2020	

Scrap computer dismantling

Separating the funnel and panel glass

Furnace for LCD and thermal shock treatment of PCBs

Spent LiBs recycling process

Movable plant of e-waste recycling in Macau

Nowadays

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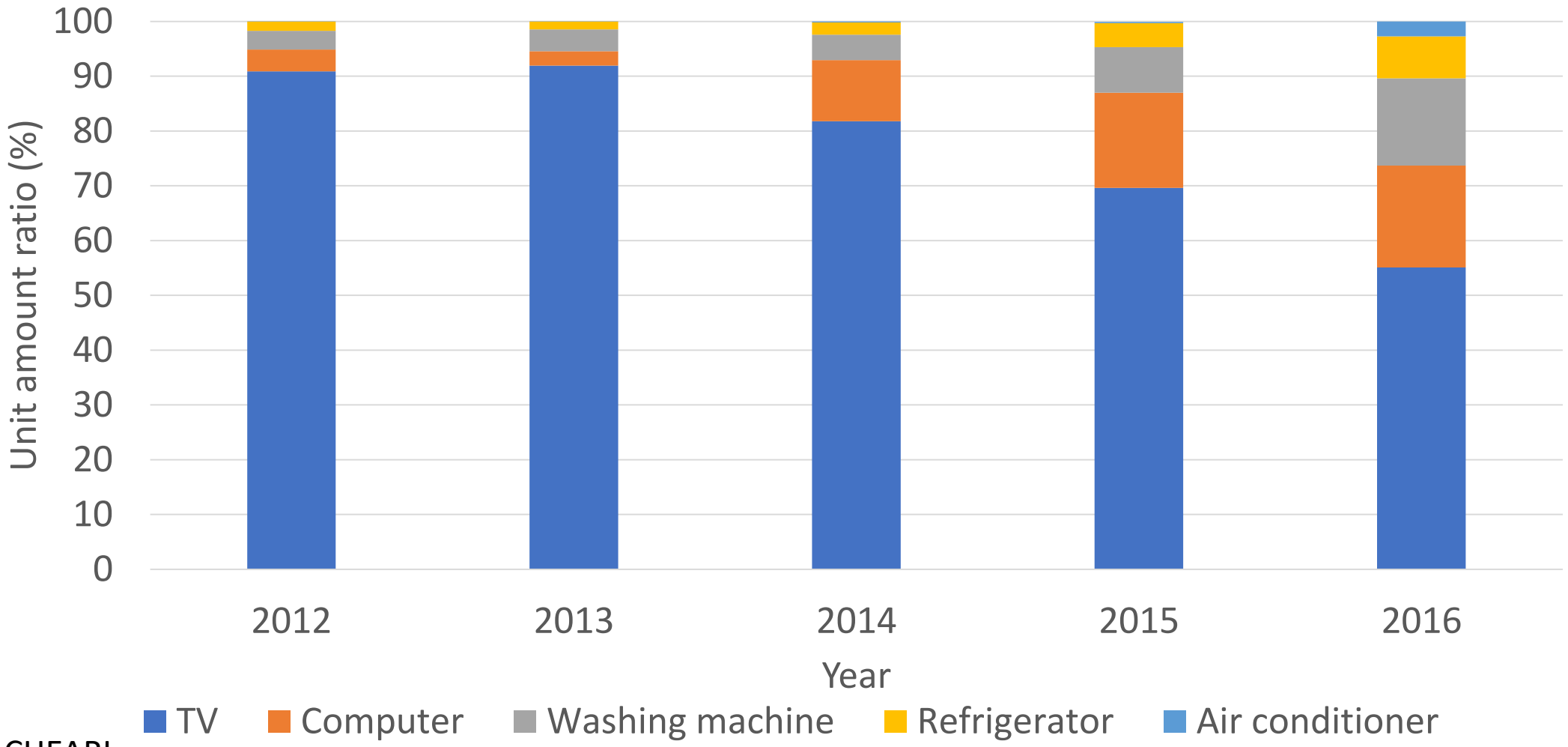
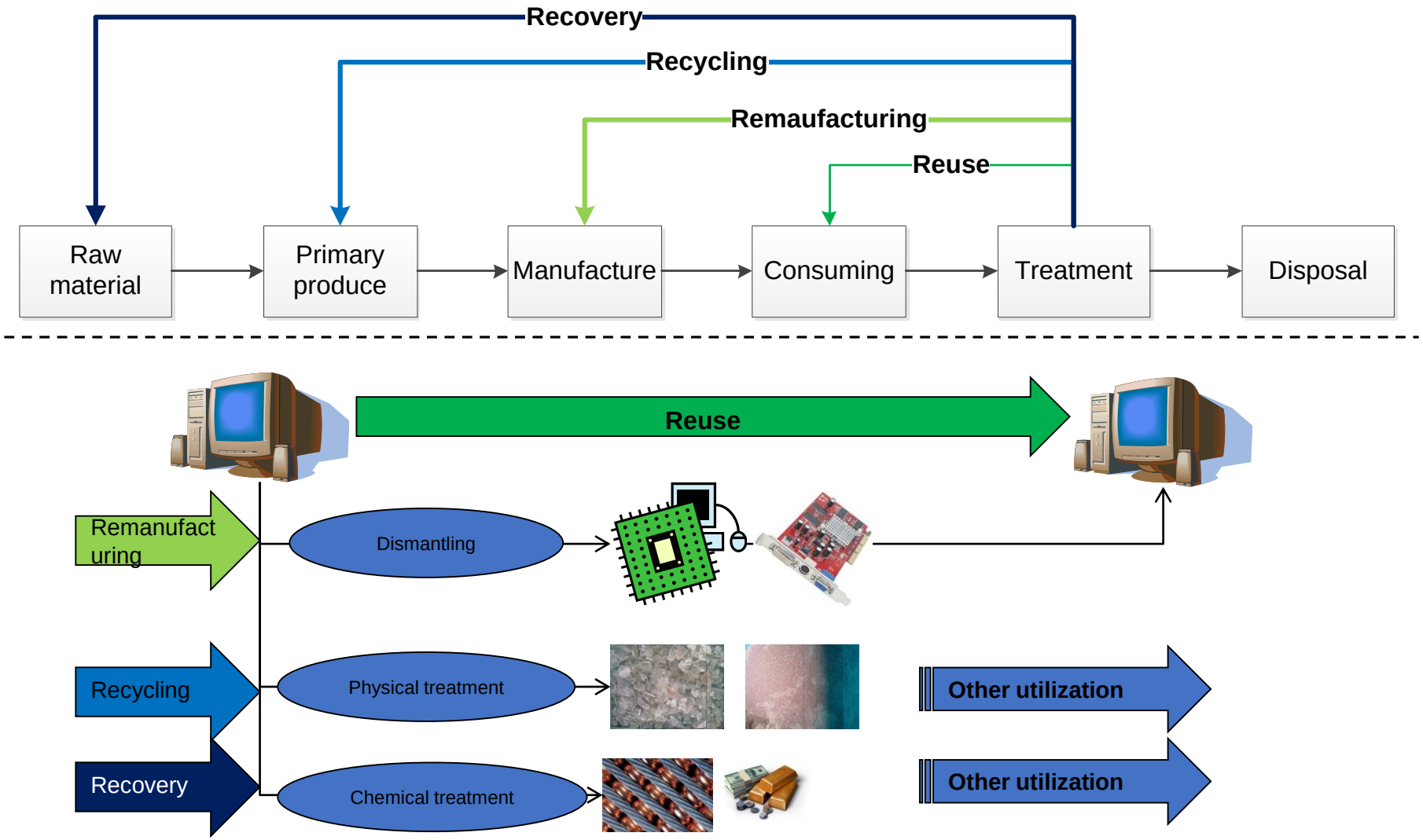
Share of treated WEEE



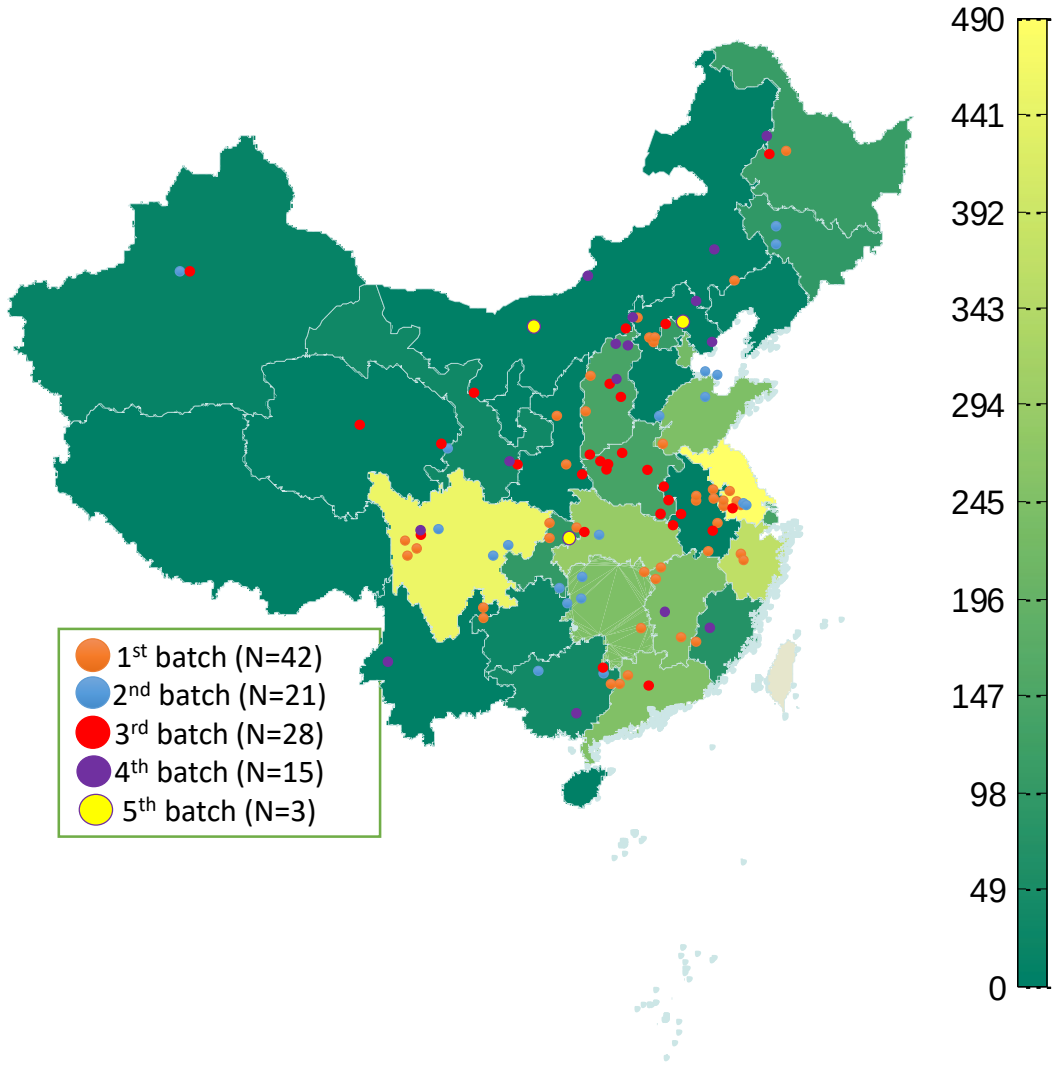
Data source: CHEARI

1. Close-loop technical system is emerging

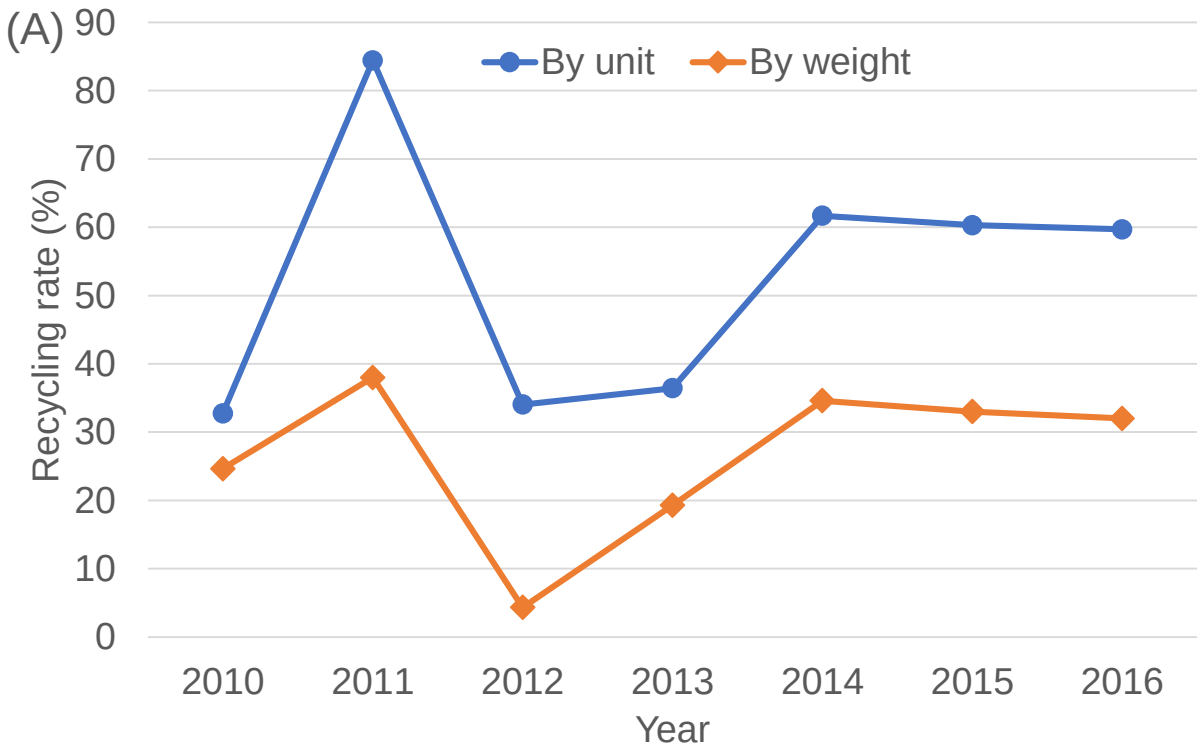


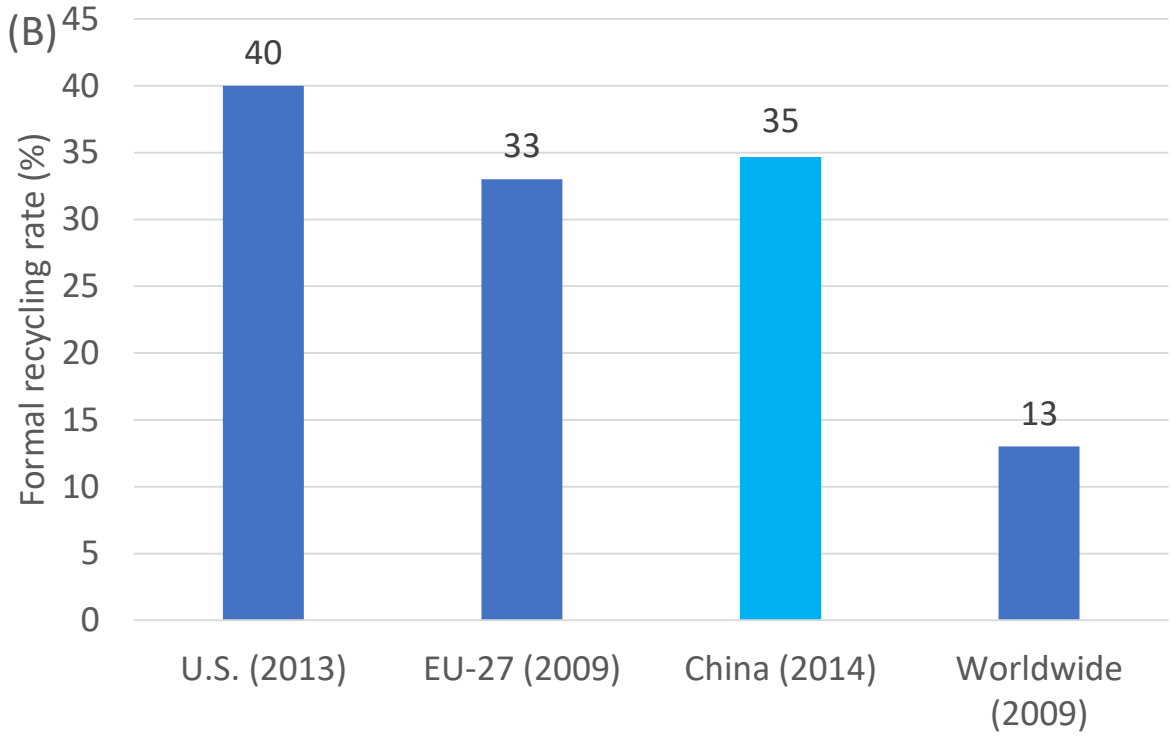
2. E-waste recycling industry

About 109 licensed and certified enterprises across the country had been authorized to receive the subsidies, creating a capacity to process 150 million units of WEEE annually.



China's formal recycling rate of e-waste and those comparisons

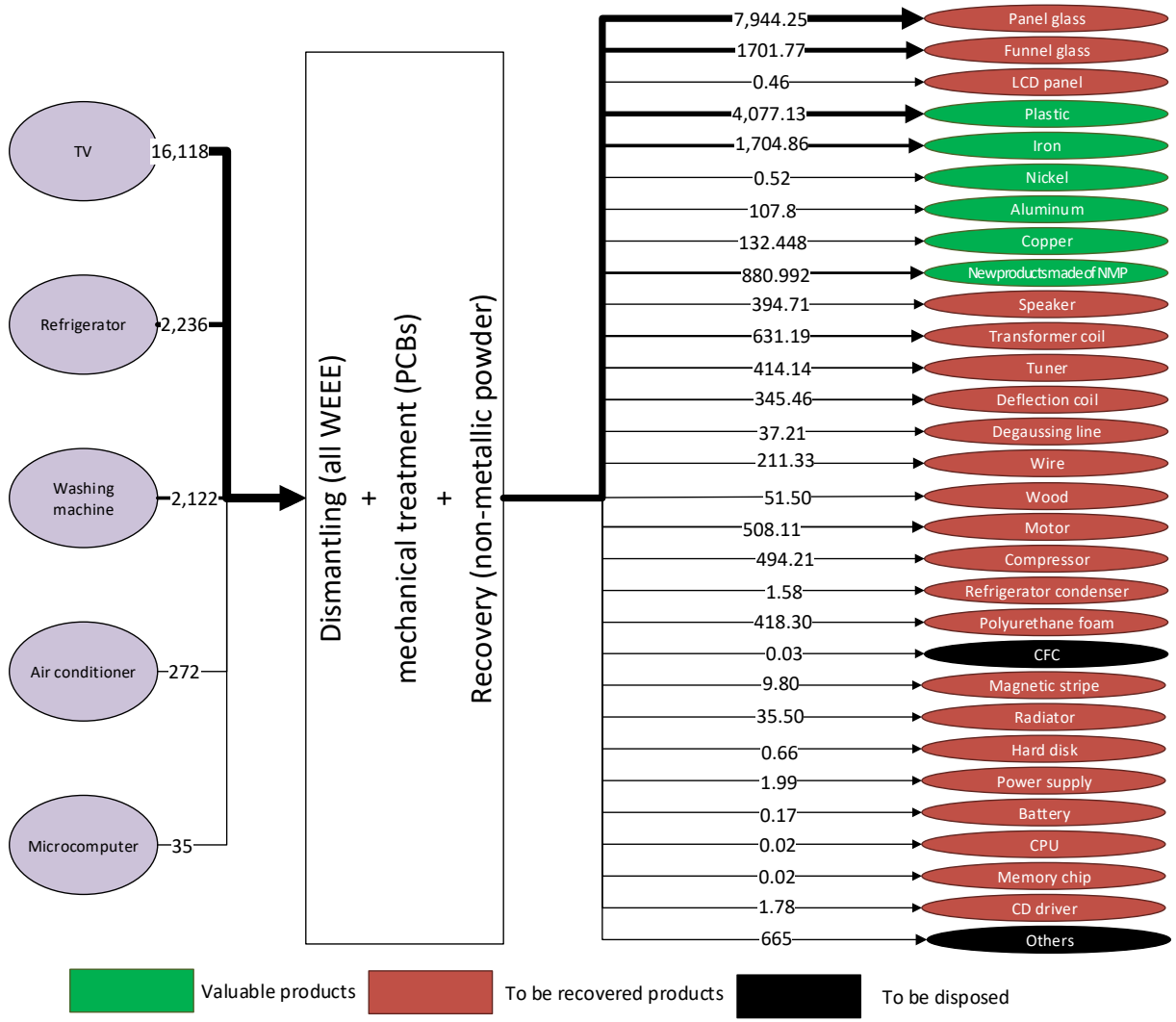




The formal recycling rate was increased from 5% in 2006 to 35% in 2014 (by weight), which was higher than the average of EU.

Zeng, X.; Mathews, J. A.; Li, J., Urban Mining of E-Waste is Becoming More Cost-Effective Than Virgin Mining. *Environmental Science & Technology* **2018,** *52*, (8), 4835-4841.

3. Resource performance



The current material recycling rate with formal process is around 33.4%

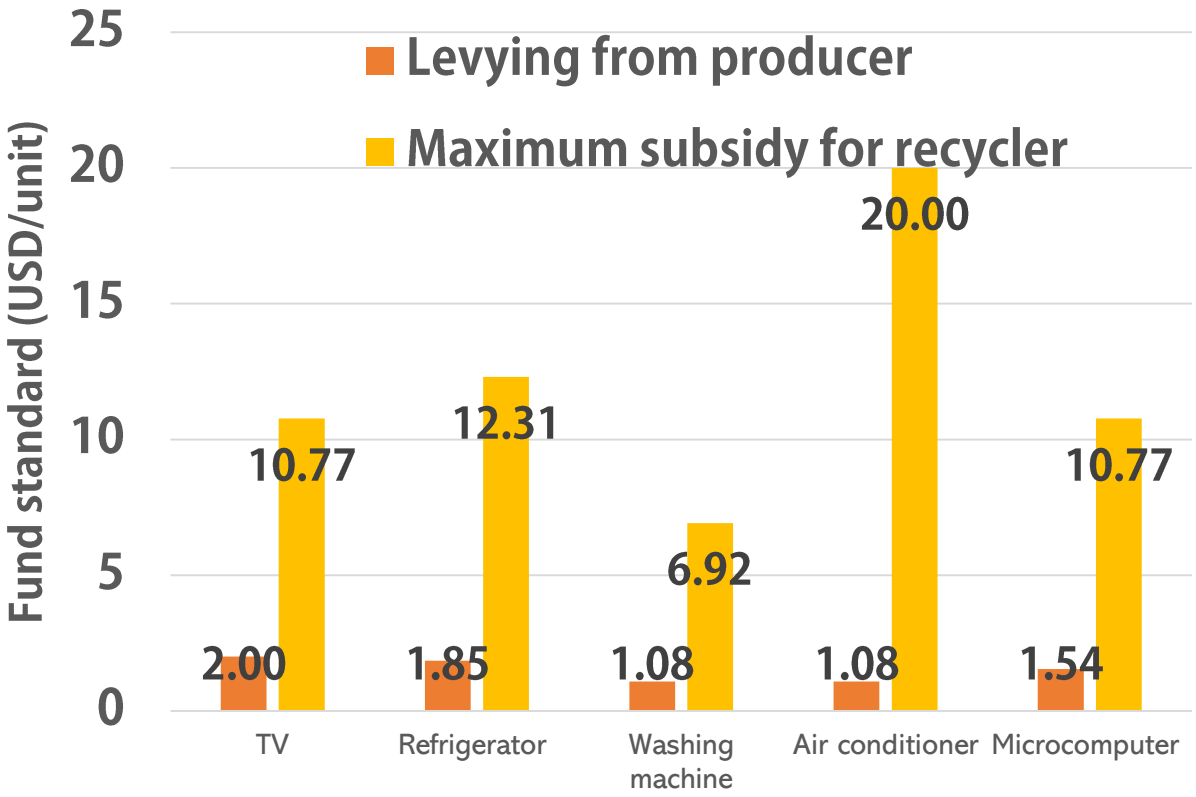
4. Environmental performance

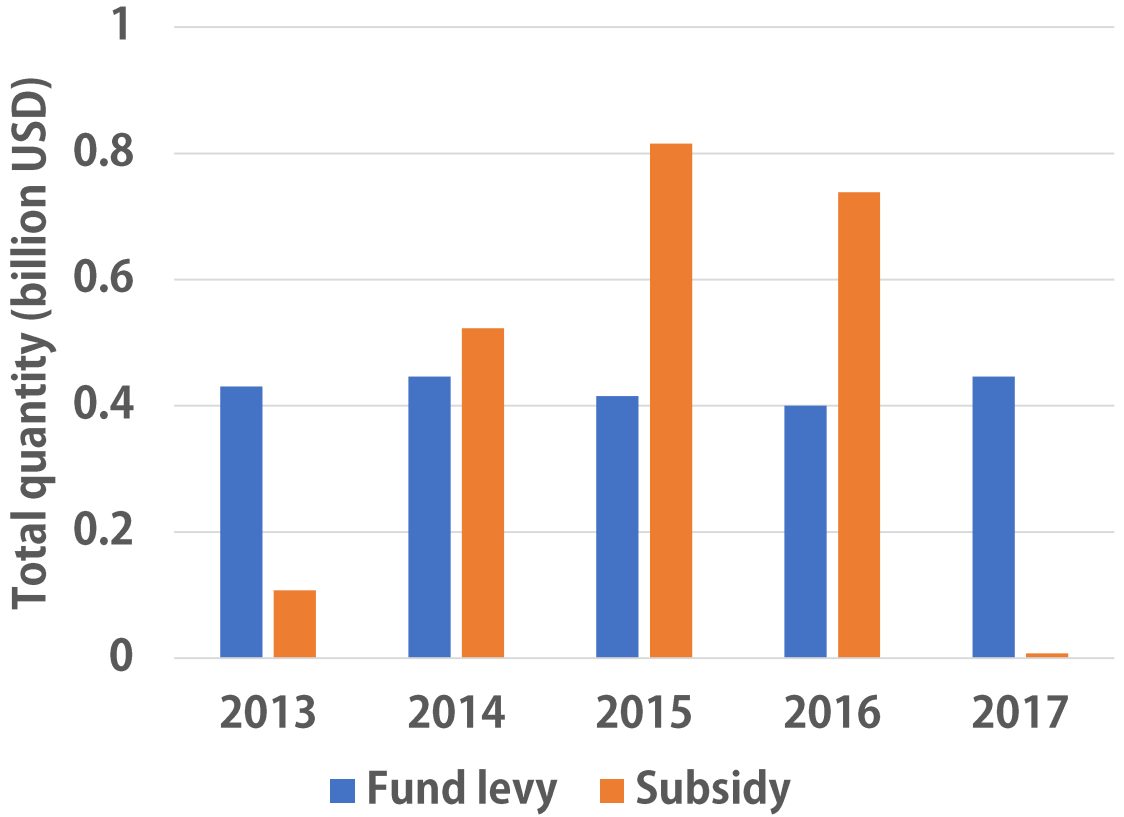
- Assuming 5% of recycling rate and 25% composition of Lead in CRT funnel glass, the Lead emission reduction in 2013 was about 1,800 tonnes. Approximately 2.1 tonnes CFC refrigerant could be collected for safe disposal, which means the equivalent CFC has been declined to discharge.
- All of this additional activity has stimulated the economy by creating more than 10,000 new jobs in the e-waste recycling industry.

Summary of experience

1) The most effective regulatory core in China, in contrast to the regulations in developed countries, is the 'old-for-new' policy and the WEEE 'producer-pays' funding.
2) Environmental maintenance and management costs have been internalized to significantly change the e-waste flow and destroy the economic incentives that historically drove the informal recycling sector.
3) China needed to develop its own approach to recycling WEEE; it would not have been feasible to try to duplicate other countries' experiences or processes.
4) An effective and practical management system has been well established, including permitting, reporting, auditing, inspection, information systems, and funding systems.

1. Imbalance between fund levies and subsidies

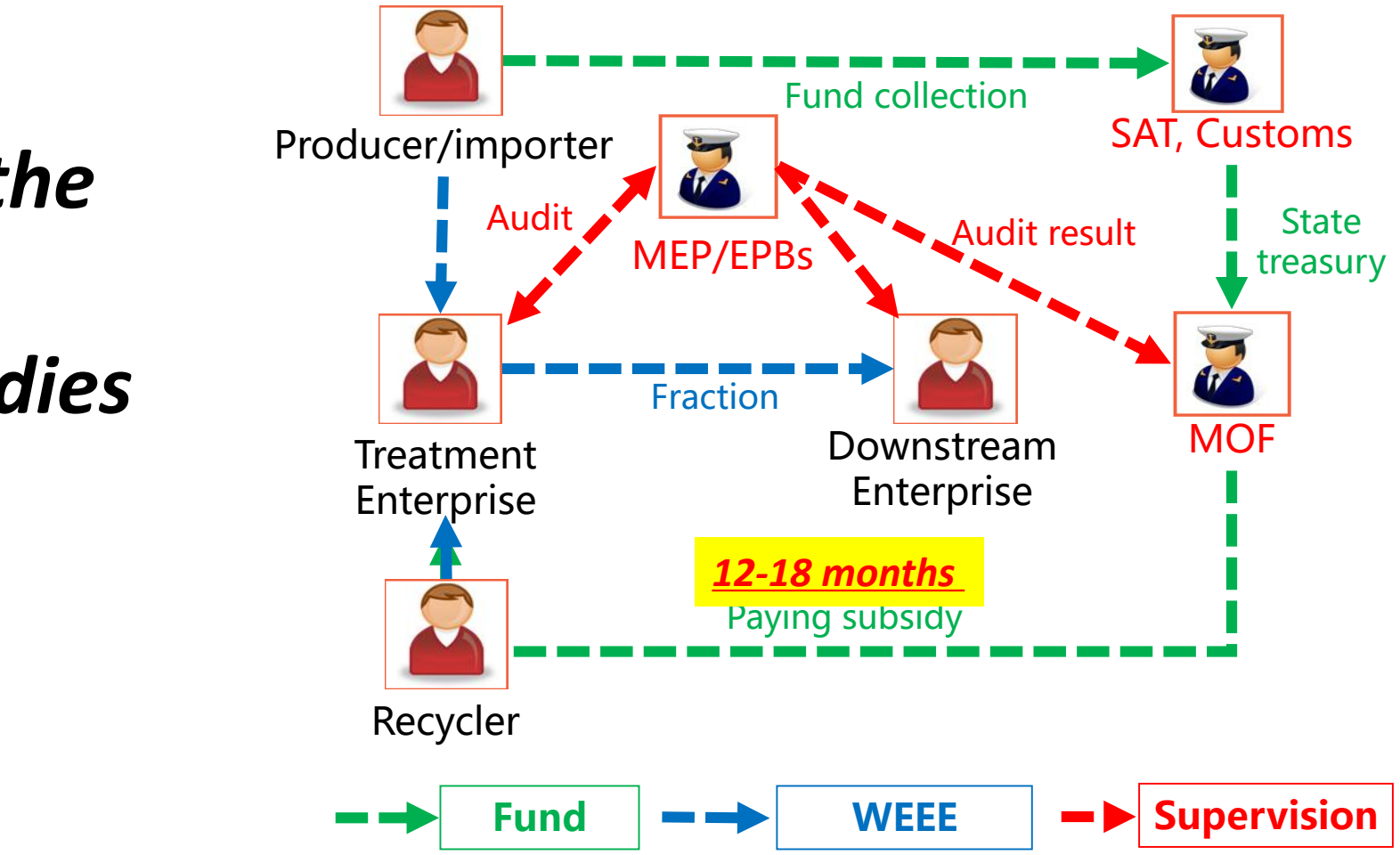




The imbalance between fund levies and subsidies may lead to an unsustainable WEEE funding policy.

2. Procedure of subsidies utilization

Tedious procedures related to auditing the operations and dispersing the subsidies have decreased the efficiency of the payment system.



3. Expanding of e-waste recycling industry

- The e-waste recycling industry has grown so rapidly that neither domestic nor foreign processing technologies have been fully transferred or utilized.

- Currently, because the deep recovery industry for e-waste in China is still in its infancy, the government subsidies include grants for e-waste pre-processing involving dismantling and mechanical treatment.

4. Eco-design for environment

- Eco-design is not widely practiced by Chinese EEE producers.
- Only a few of the large EEE producers participate in e-waste recycling in China.

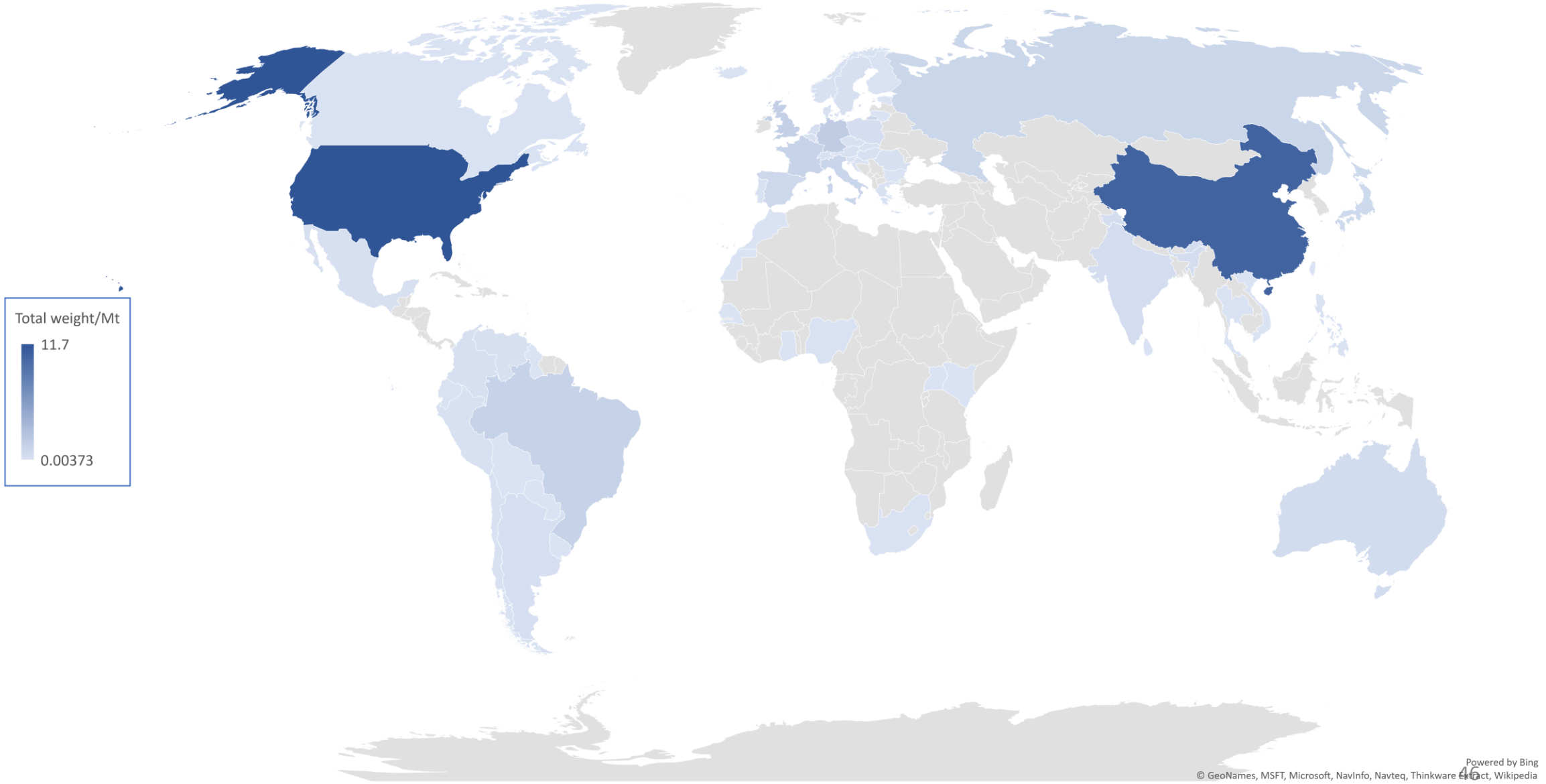
类别	股票名称	股票代码	简介
生产者	格力电器	000651.SZ	公司是目前全球最大的集研发、生产、销售、服务于一体的国有控股专业化空调企业。从2011年开始，格力电器投资数十亿元在全国设立了**五家再生资源公司（其中四家被纳入废弃电器电子产品处理基金补贴名单，年拆解产能1100万台）**，对废弃家电进行无害化拆解处理。依托格力销售公司的销售、售后、物流等网络，整合格力渠道资源，建立以各种销售、售后网点为回收站点，以公司为集散中心以及分拣中心的有格力特色的三位一体再生资源回收体系。同时，格力网上回收商城可以实现在线预约上门回收。
	TCL集团	000100.SZ	公司是中国最大的、全球性规模经营的消费类电子企业集团之一。公司已形成多媒体、通讯、华星光电和TCL家电、通力电子五大产业集团。2009年成立TCL奥博（天津）环保发展有限公司，被纳入第一批废弃电器电子产品处理基金补贴企业名单。2014年，TCL宣布与百度合作，推出百度回收站项目，以大数据的方式来推进废旧家电回收业务，打造绿色回收产业链。目前公司旗下有**三家拆解公司享受基金补贴，年拆解产能600万台。**
	四川长虹	600839.SH	公司是一家具有全球竞争力的消费电子系统供应商和内容服务提供商。2010成立四川长虹格润再生资源有限责任公司，被纳入第三批废弃电器电子产品处理基金补贴企业名单，**年拆解产能210万台**。子公司开发了“E回收网”回收服务平台，专注于为用户提供家用电器、手机数码等产品安全环保的回收处置服务。
第三方	中再资环	600217.SH	公司是中华全国供销合作总社旗下中国再生资源开发有限公司的控股公司，**公司拥10家废弃电器电子产品拆解企业，年拆解产能2700万台。**公司的全国回收网络包括70多家分拣中心和5000多个回收网点。
	格林美	002340.SZ	公司以“城市矿山+新能源材料”为战略，创新驱动废旧电池与动力电池材料、稳健发展电子废弃物循环利用，快速完善报废汽车循环利用，夯实钴镍钨传统业务，积极发展环境治理五大产业链。**目前公司旗下7家拆解公司享受基金补贴，年处理量1500万台。**
	启迪桑德	000826.SZ	公司长期致力于废物资源化和环境资源的可持续发展，主营业务为固废处理处置工程系统集成和特定地区市政供水、污水处理项目的投资及运营服务。是目前A股市场唯一一家主营业务为固废处理处置的上市公司。**目前公司旗下10家拆解公司享受基金补贴，年拆解产能2259万台。**2015年6月5日，定位于再生资源全产业链服务平台易再生网正式上线，通过与再生资源行业协会合作，提供再生资源回收、行业资讯和交易信息。

资料来源：Wind，光大证券研究所

5. New catalogue of e-waste

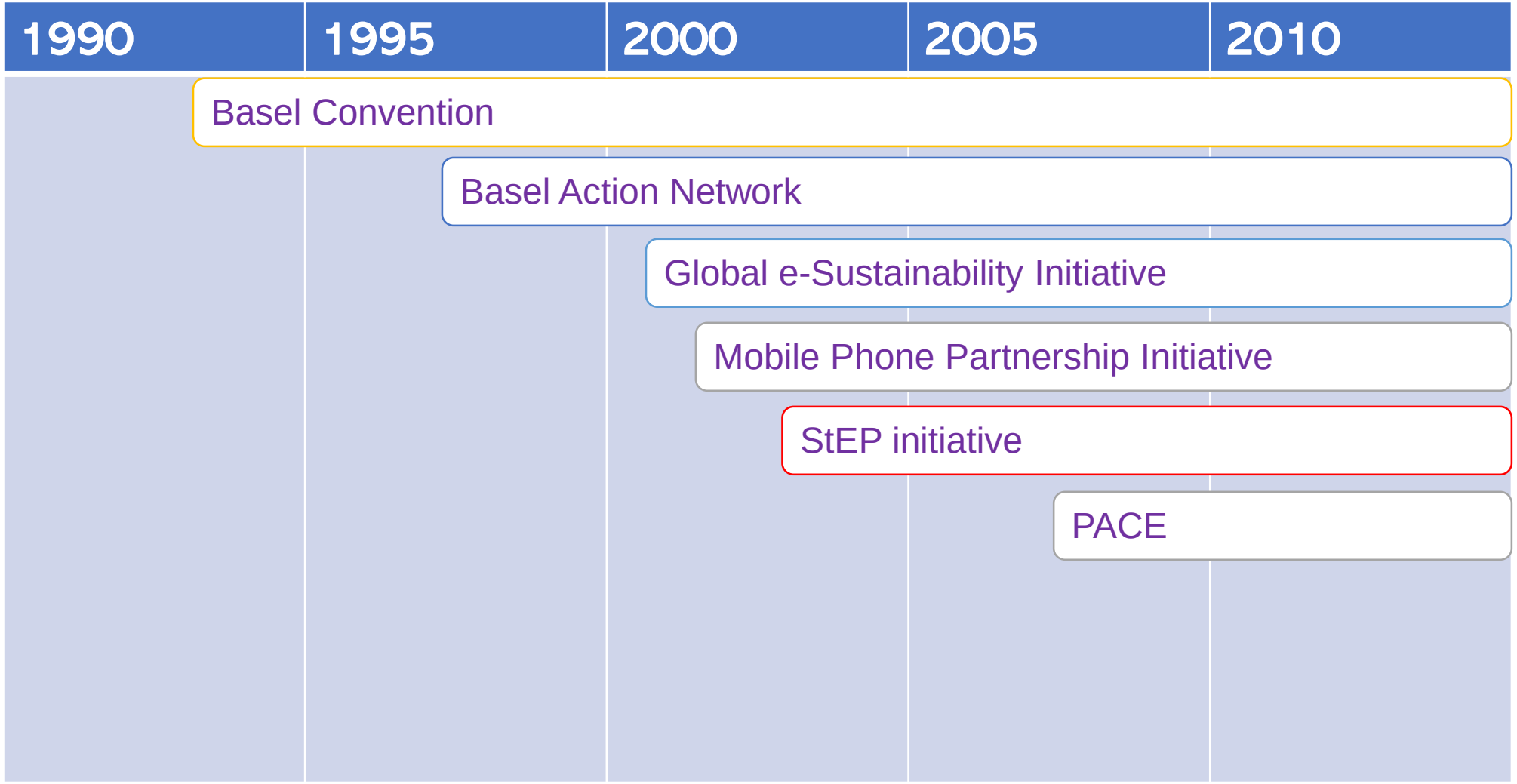
- The new catalogue, which adds nine new categories of e-waste to regulation requirements, puts enormous pressure on some stakeholders.
- In light of the current low recycling rate (<35%) for microcomputers, refrigerators, and air conditioners, the nine added WEEE categories create enormous challenges to the government planning and recycling enterprises arrangement.
- The management system—both software and hardware—will have to be redesigned and the recycling capacity enlarged.

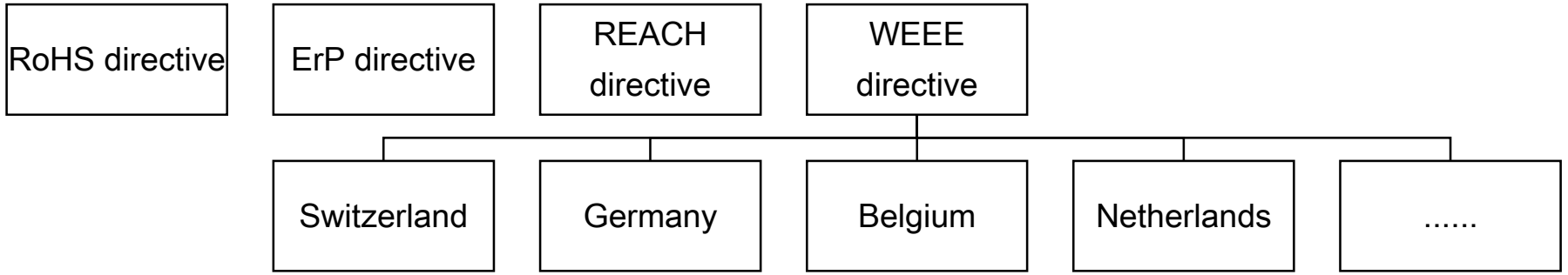
Global E-waste Generation Map

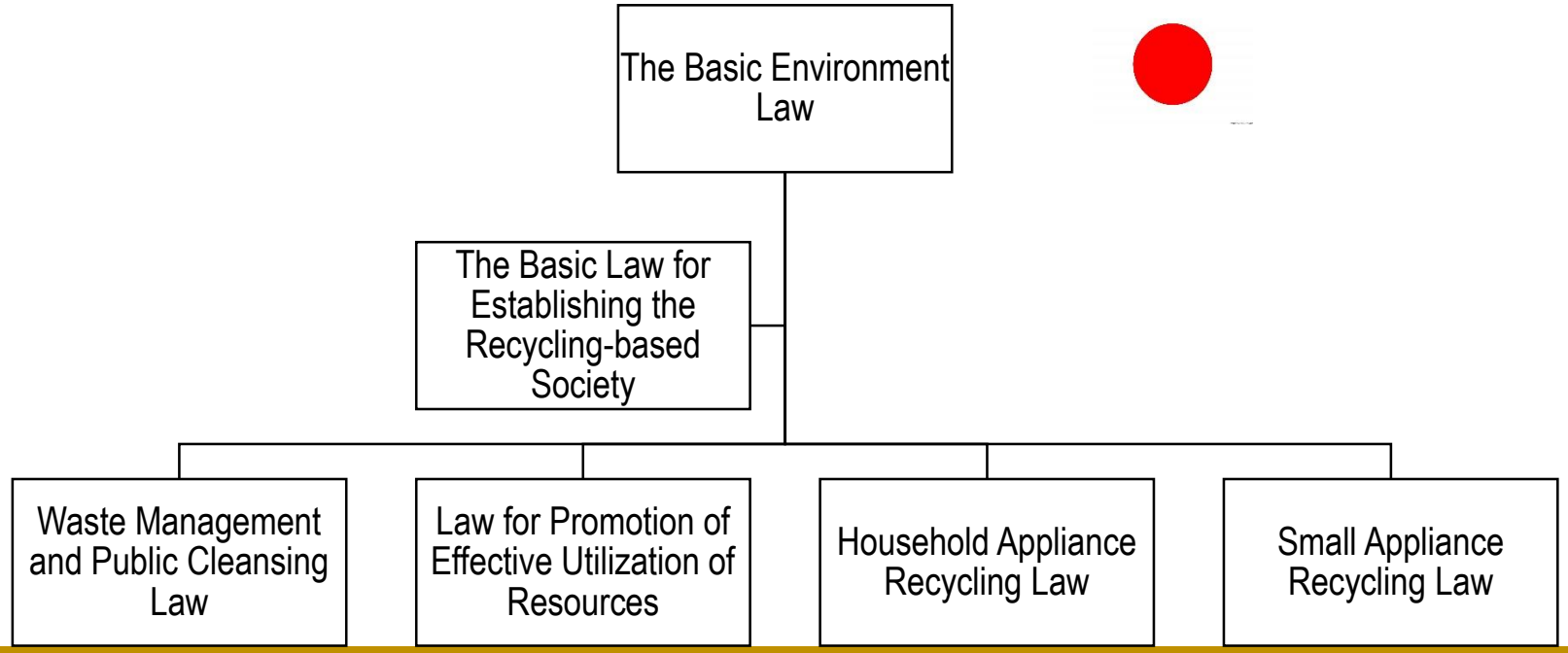


Li et al., 2015; Urban Mine Platform; Zeng et al., 2016

1. Regulation




RoHS directive
ErP directive
REACH directive
WEEE directive
Switzerland
Germany
Belgium
Netherlands
.....


The Basic Environment Law
The Basic Law for Establishing the Recycling-based Society
Waste Management and Public Cleansing Law
Law for Promotion of Effective Utilization of Resources
Household Appliance Recycling Law
Small Appliance Recycling Law

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2000 Feb.

1. Notification on Importation of the Seventh Category Waste (MEP)

- *Ban the import of e-waste*

2006 Apr.

2. The Technical Policy on Pollution Prevention and Control of WEEE (MEP No.115)

- *Set principles of '3R' and 'polluter pays principle';*
- *Stipulates eco-design;*
- *Provisions for the environmental collection, reuse, recycling and disposal of WEEE*

2007 Mar.

3. The Ordinance on Management of Prevention and Control of Pollution from Electronic and Information Products (MIIT)

- *Requirements for product eco-design;*
- *Restrictions on the use of hazardous substances;*
- *Requirements for producers to provide information about their products*

2008 Feb.

4. Administrative Measures on Pollution Prevention of WEEE; Technical Specifications of Pollution Control for Processing WEEE (MEP)

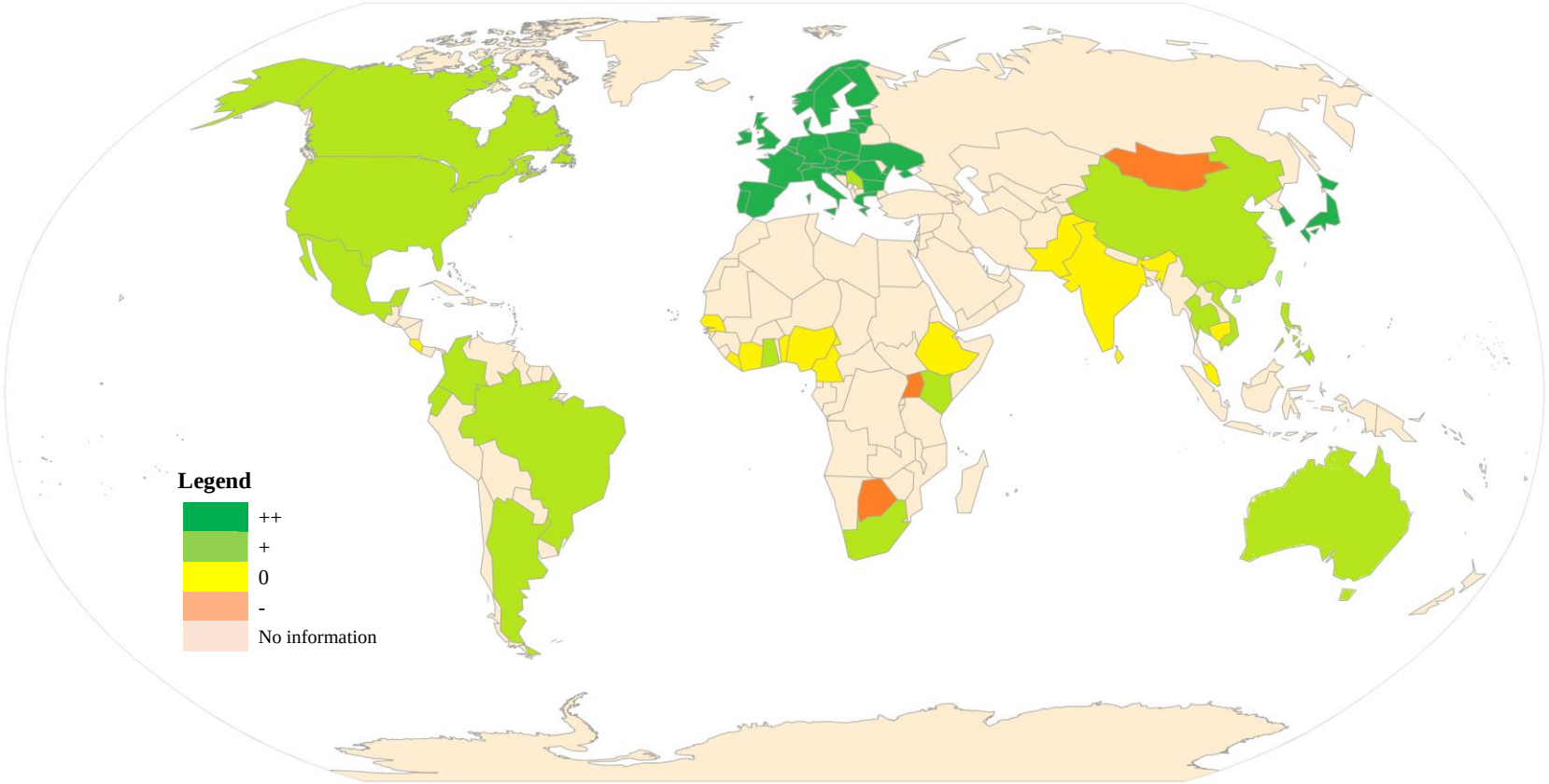
- *Prevent the pollution caused by the disassembly, recycling and disposal of e-waste;*
- *License scheme for managing e-waste recycling companies*

2011 Jan.

5. Regulation on Management of the Recycling and Disposal of Waste Electrical and Electronic Equipment (NDRC; NPC, MEP; MIIT)

- *Mandatory recycling of e-waste*
- *Implementation of Extended Producer Responsibility;*
- *Establish of a special fund to subsidize e-waste recycling;*
- *Certification for second hand appliances, and recycling companies*

Status for global e-waste management in terms of legislation



Although 66% of the world's population is covered by e-waste legislation, more efforts must be made to enforce, implement, and encourage more countries to develop e-waste policies.

Note: ++ : implemented controls, + : new command and control regulations, 0 : control regulations under development, and - : no regulations.

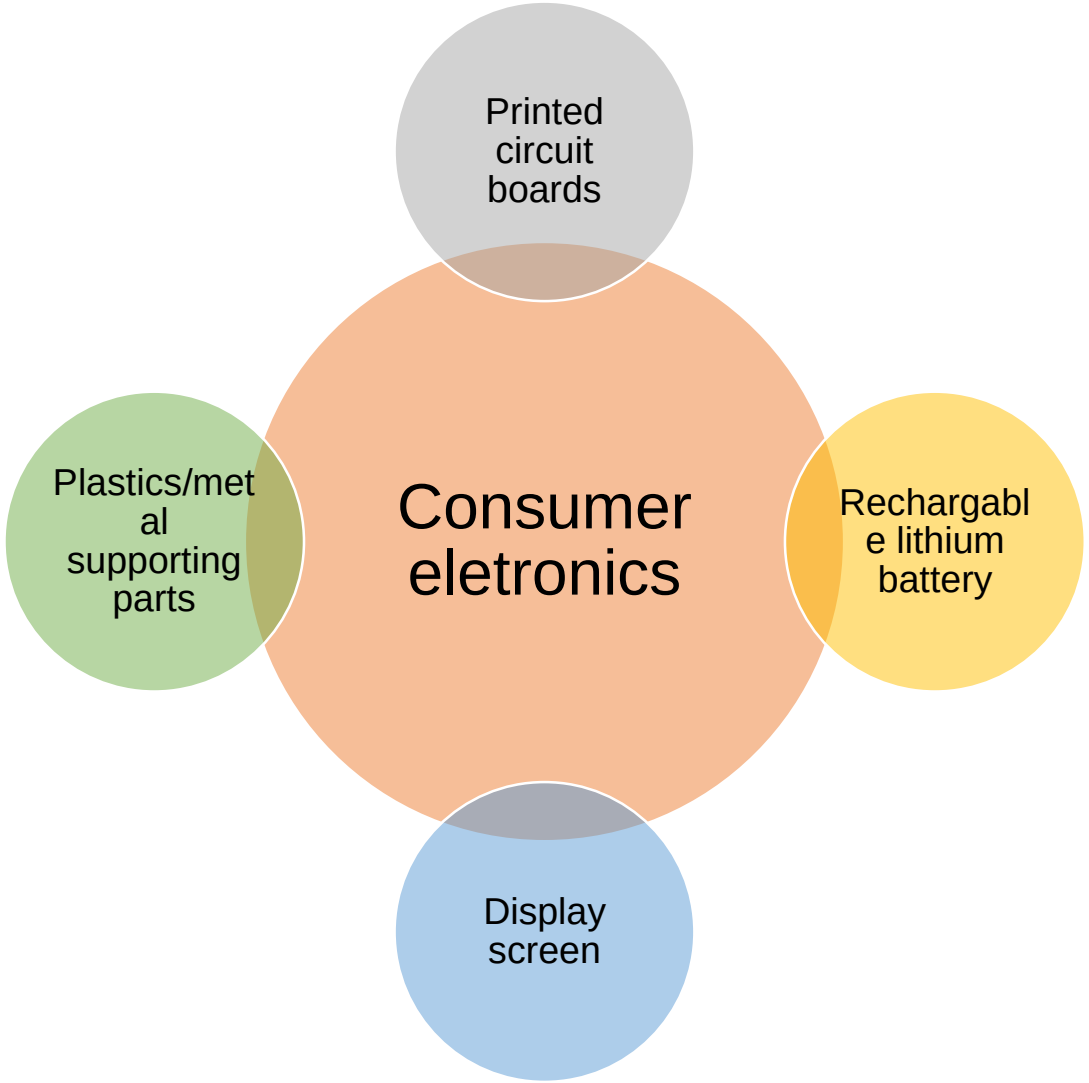
- ❖ E-waste legislation in force in over 90 jurisdictions, planned in 20+
- ❖ 2,000+ pieces of legislation affecting e-waste management

Collection experience: EPR

Countries	Registration of appliances	PROs	Financing of collection	Financing of recycling	Municipal recycling activities	Control of results
Germany	EAR on behalf of the Federal Env. Agency	Only lightcycle for CG4	Municipalities	Producer/importers	Complete CGs can be recycled/sold	Federal Env. Agency
Switzerland	None	SWICO, SENS, SLRS and INOBAT	Producers/importers	Producers/importers	None	Experts reporting to the Swiss Env. Agency
Denmark	DPA on behalf of the Danish Env. Authority	PROs: Elretur, RENE, ERP with the exception of CG4	Municipalities (partial refunding)	Producers/importers	None	Miljostyrelsen (Umweltbehörde)
Sweden	Naturvårdsverket (Env. Agency)	PROs: El-Kretsen, EAR	Producers/importers	Producers/importers	None	Naturvårdsverket

Note: CG: collection group; DPA: Dansk Producentansvarssystem; EAR: 'Stiftung ear'; PRO: producer responsibility organization.

2. Recycling technology




Printed circuit boards


Rechargable lithium battery


Display screen


Plastics/metal supporting parts

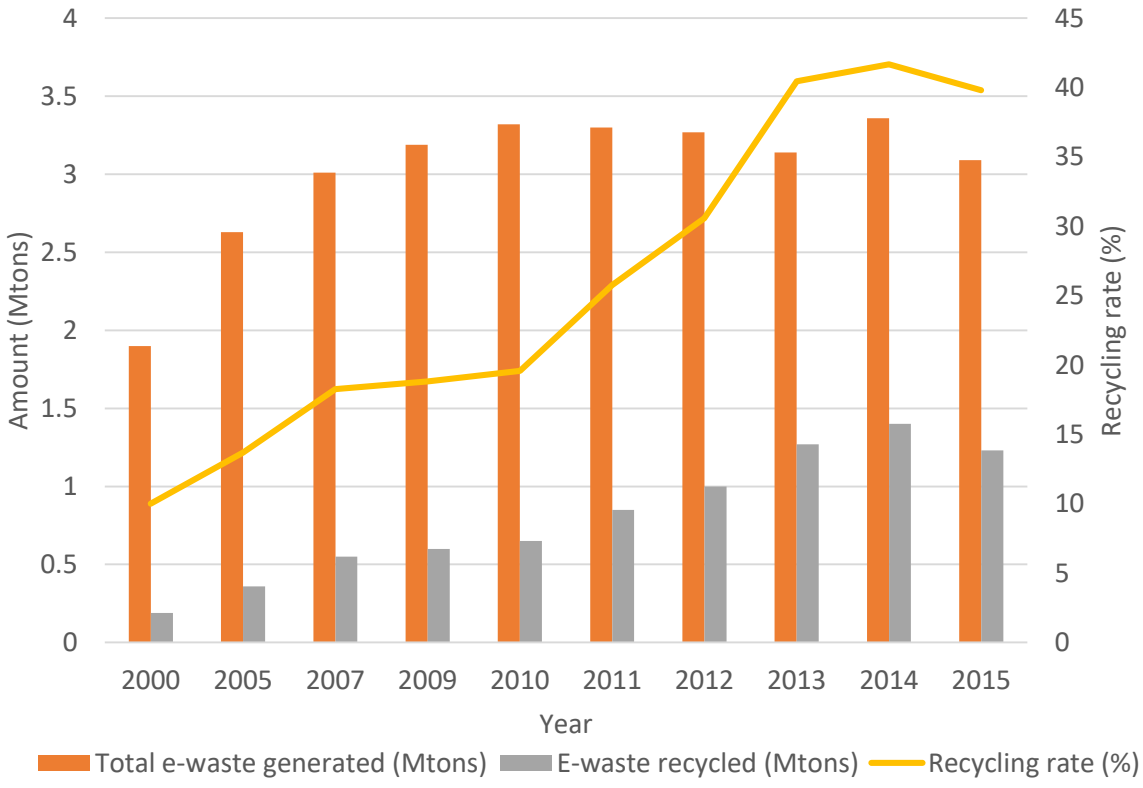
E-waste recycling facilities

(a)

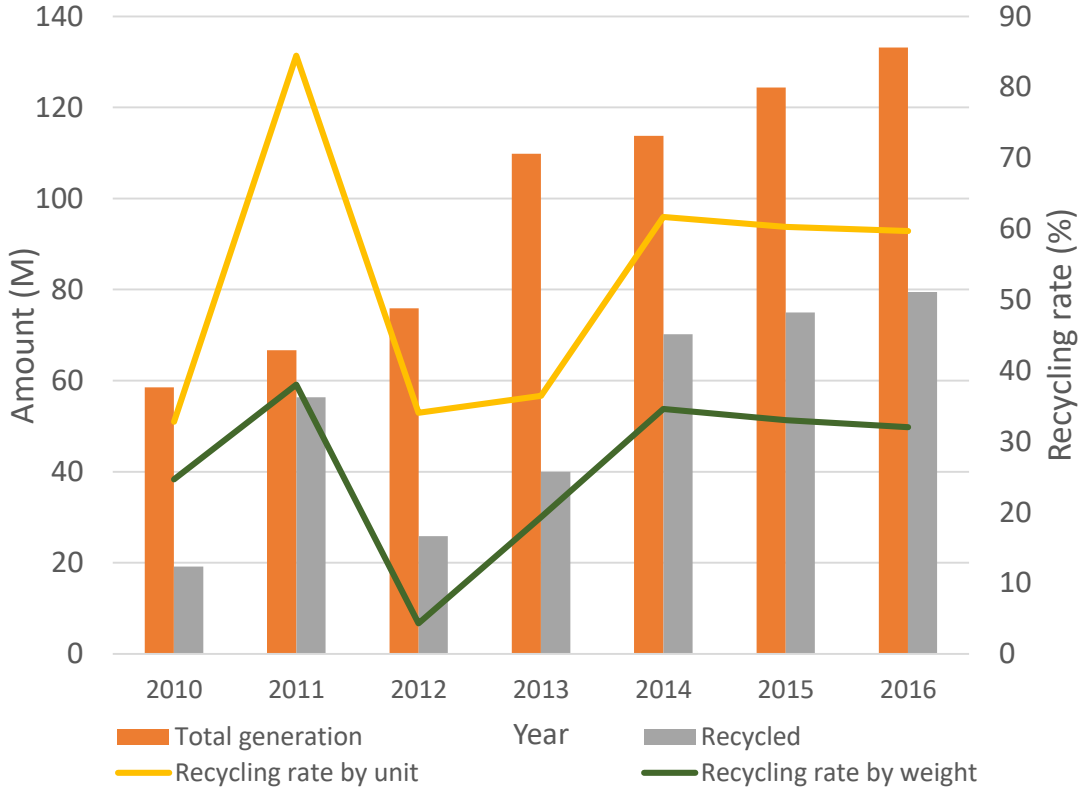
(b)

E-waste Recycling Practice

USA



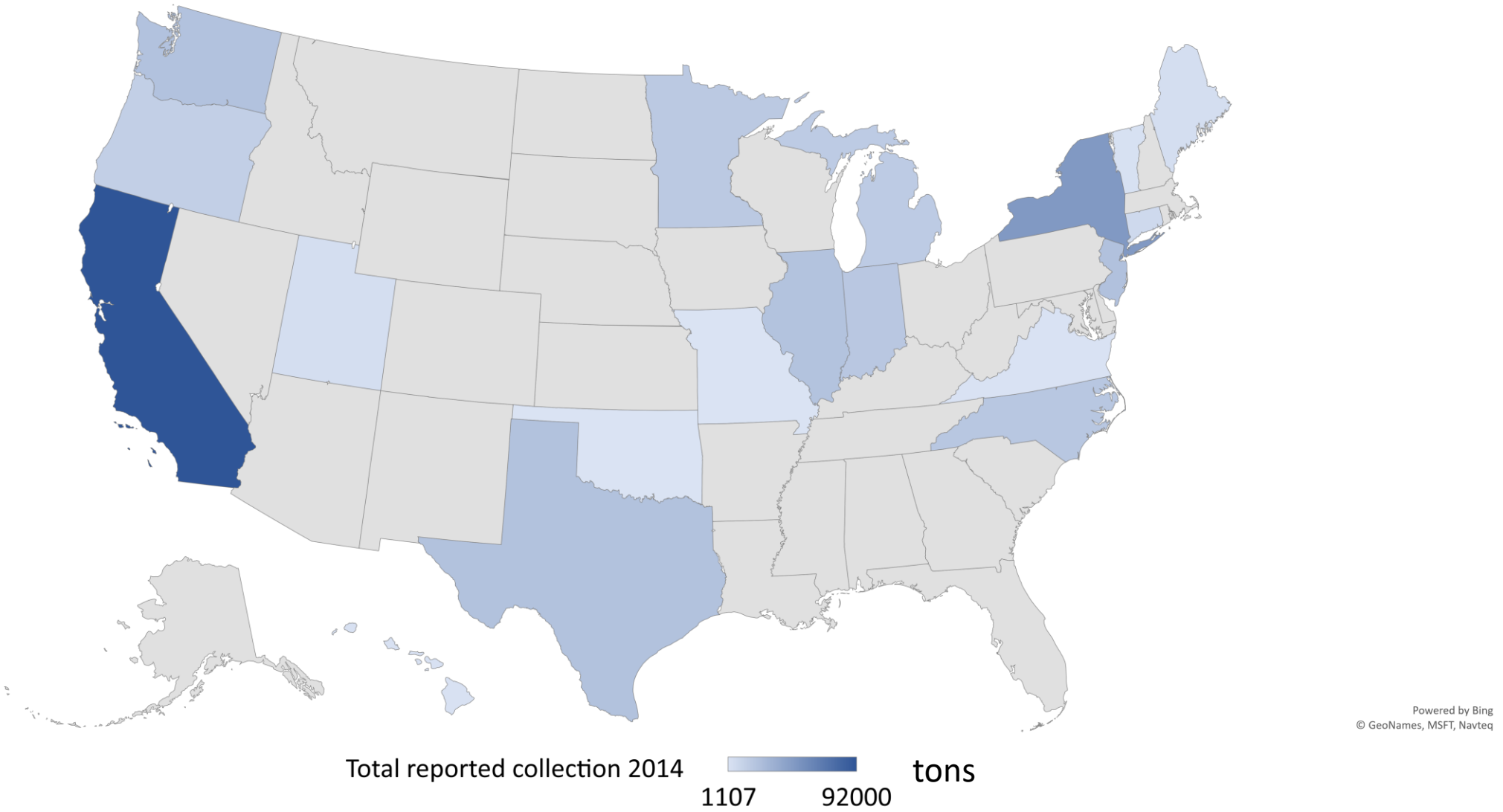
China



Globally, only 20% was recycled through appropriate channels.

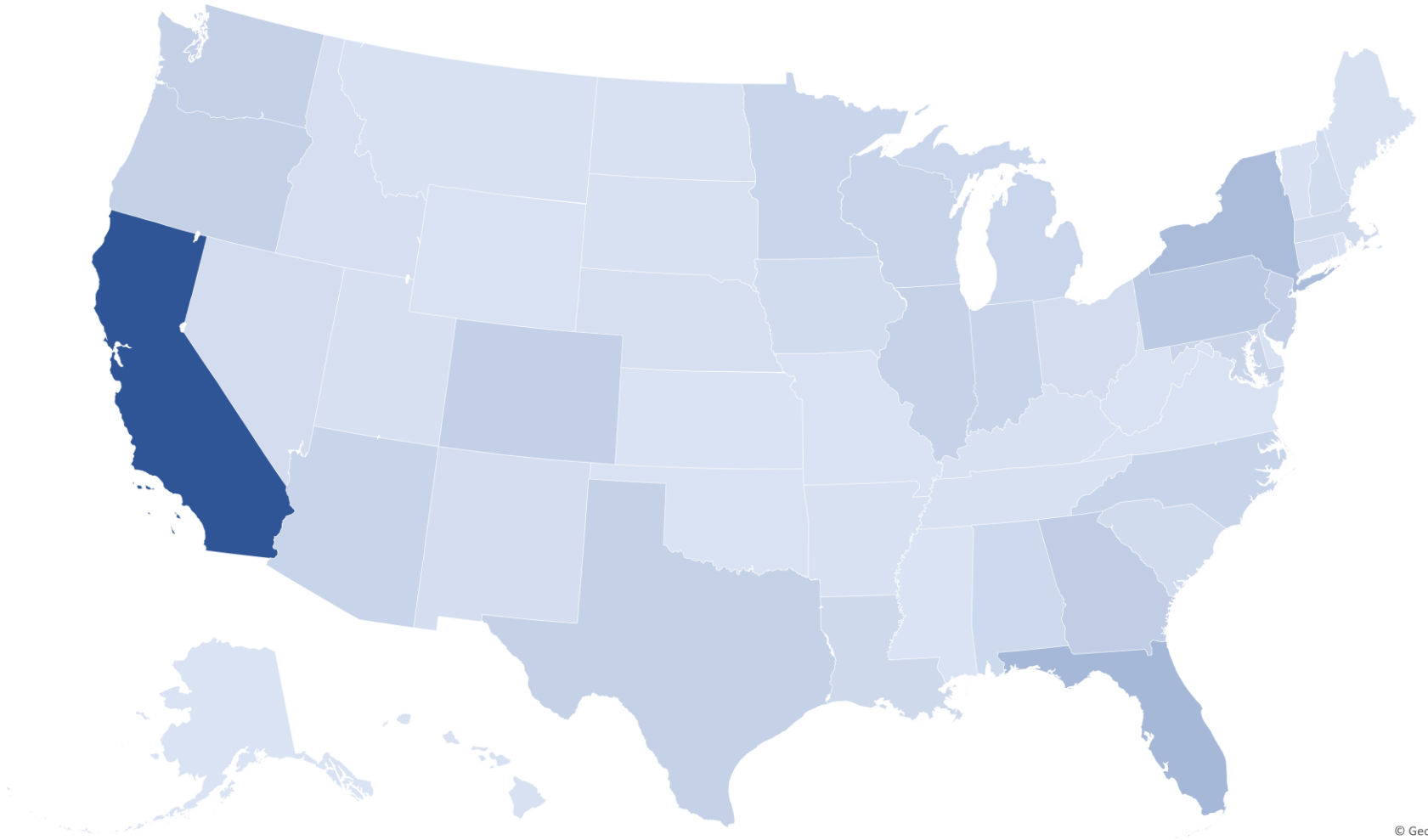
Zeng et al., 2018

E-waste Collection In the USA (2014)



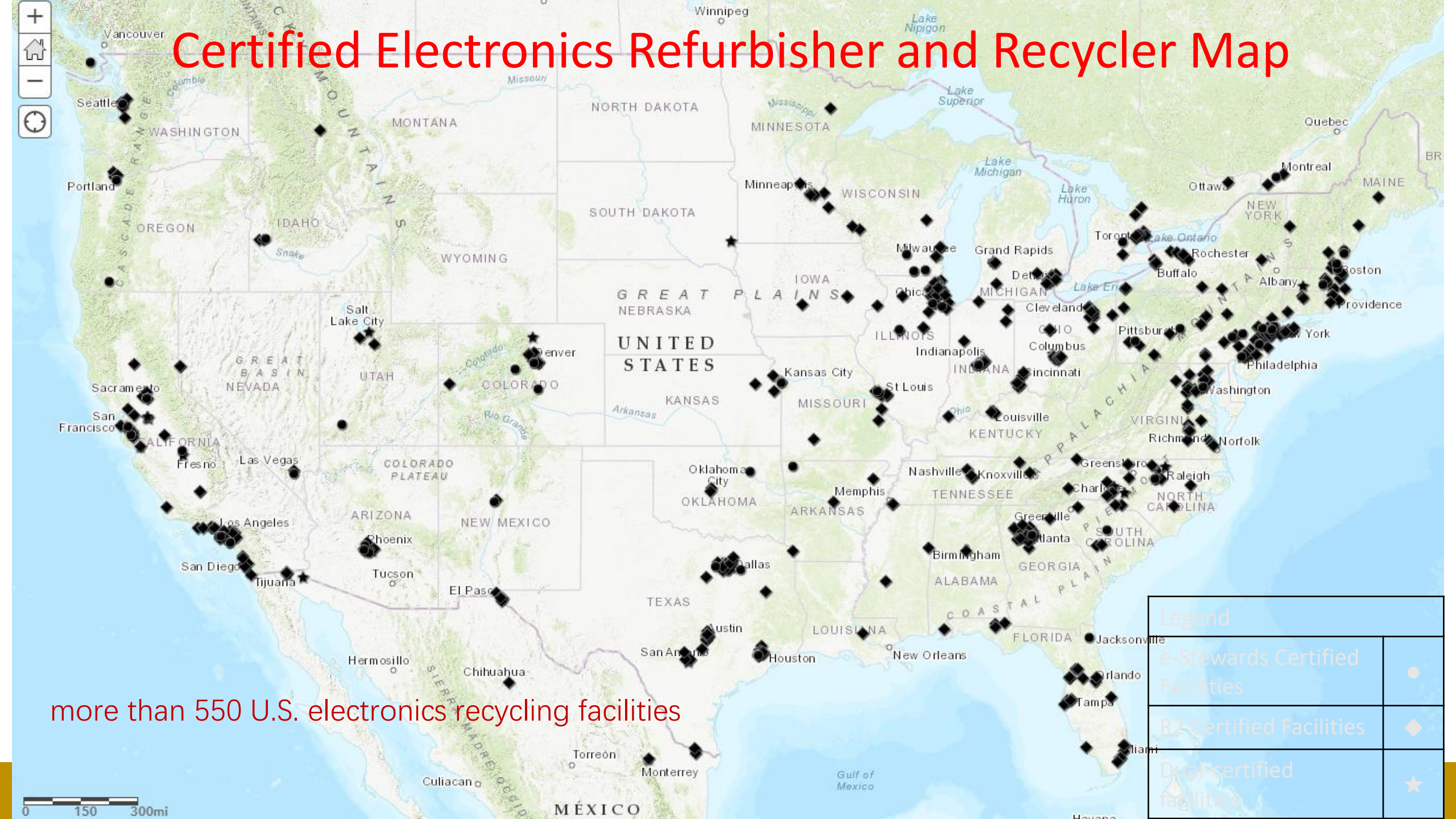
Data source from USEPA (2016)

E-waste Recycling in the US (2013/2014)

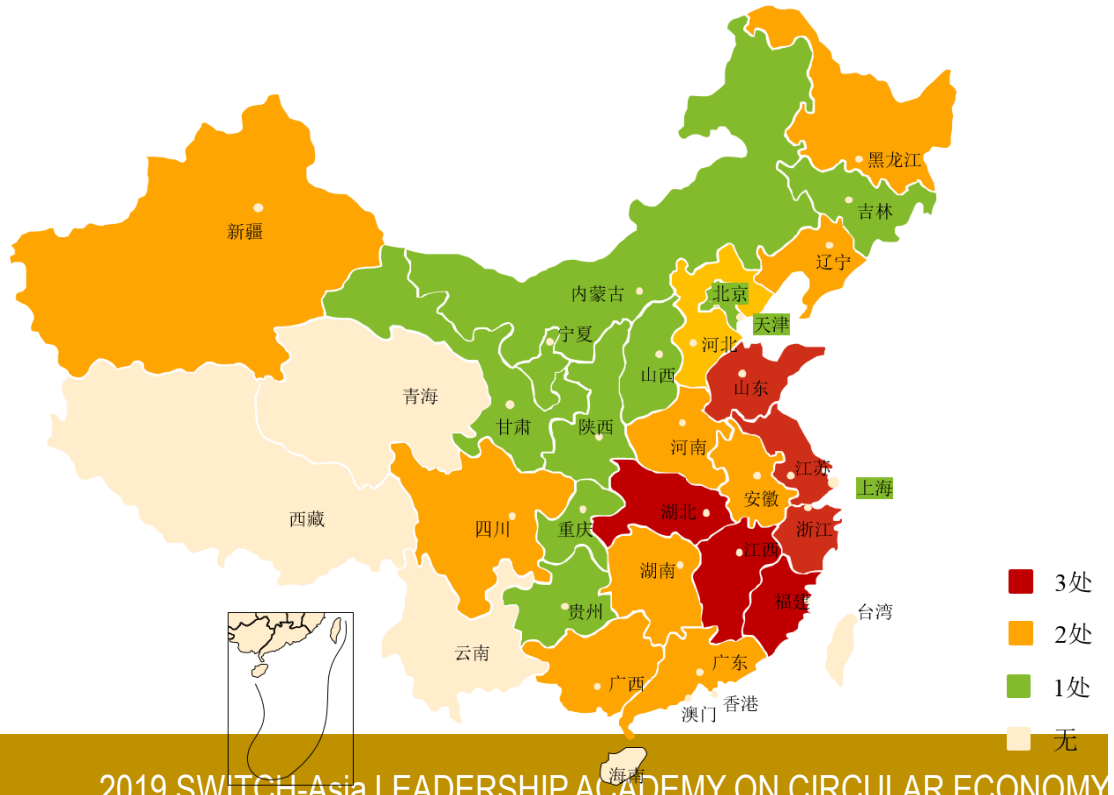


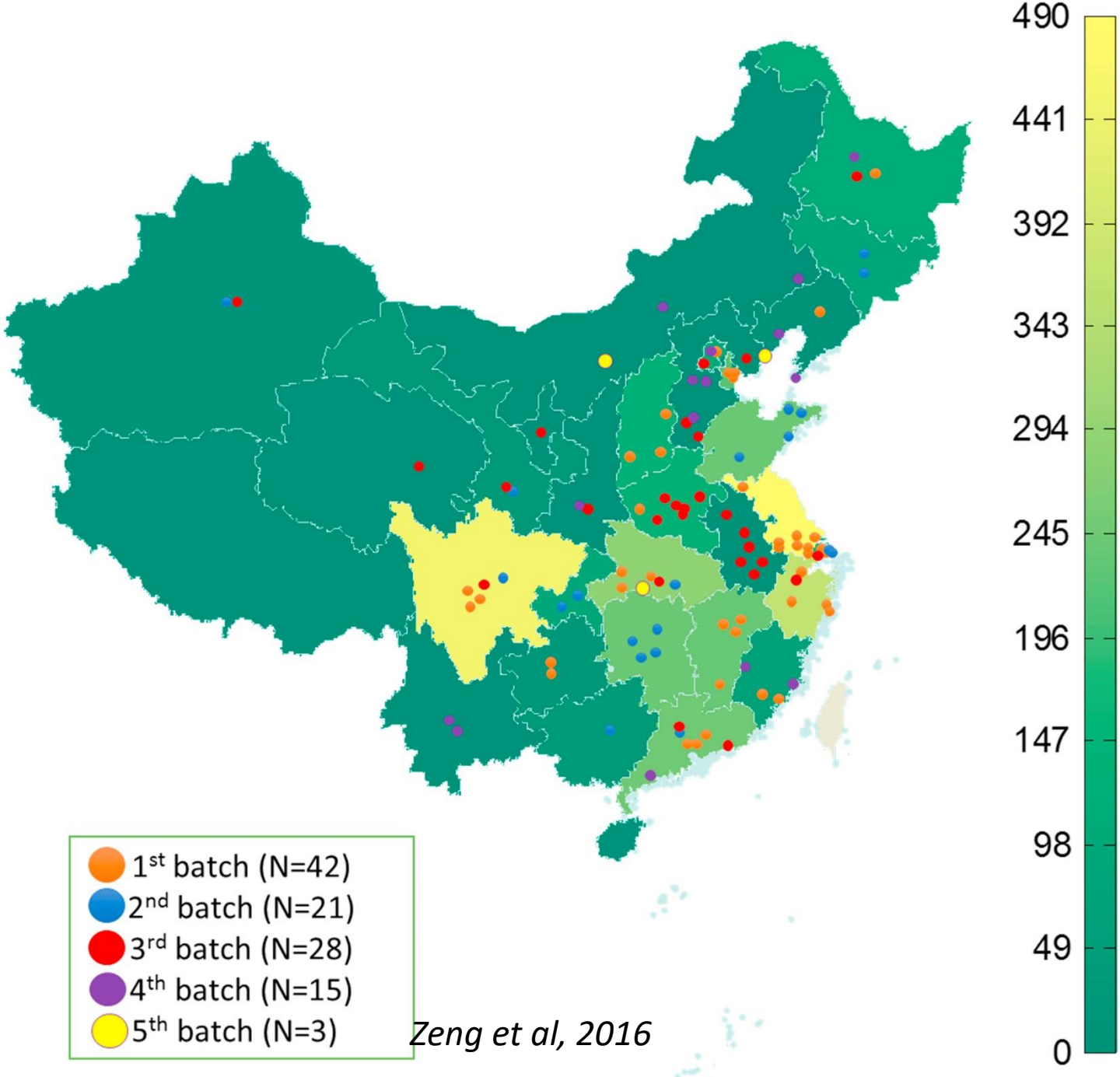
Data source from USEPA (2016)

Certified Electronics Refurbisher and Recycler Map



Licensed e-waste recycling companies & urban mining bases

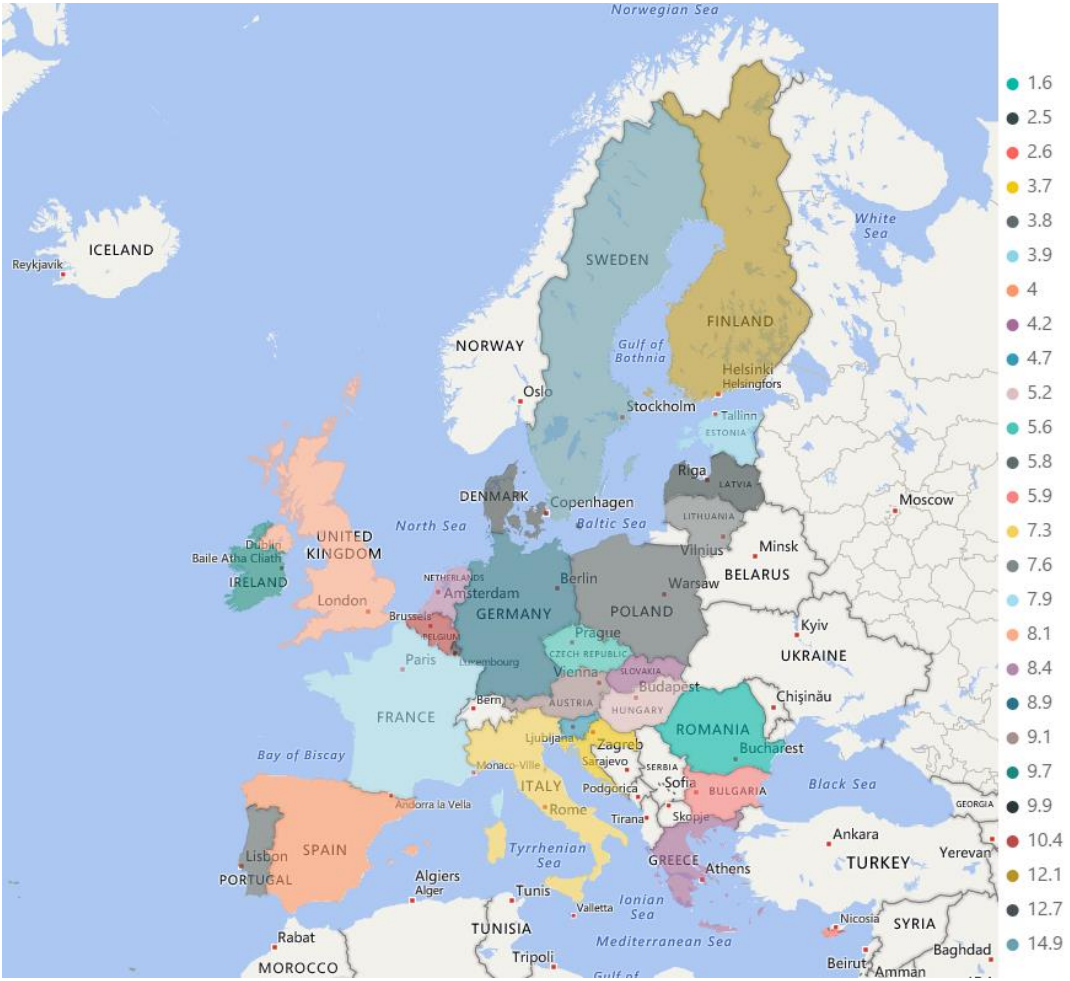


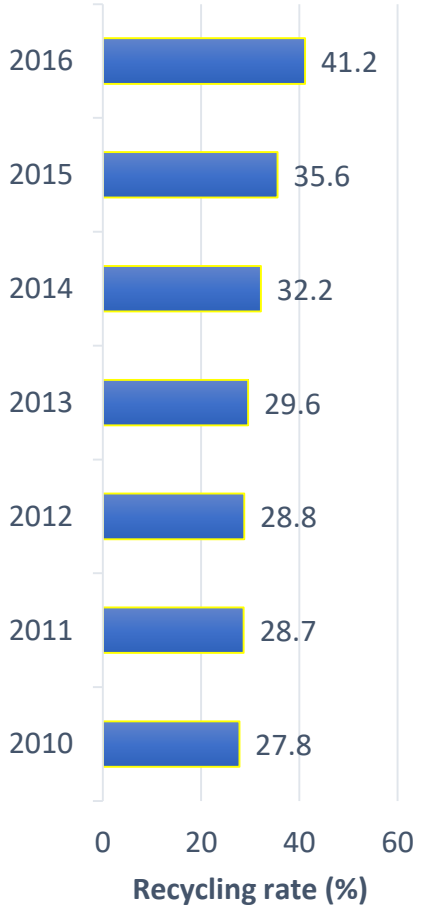


Zeng et al, 2016

E-waste collection and recycling in the EU

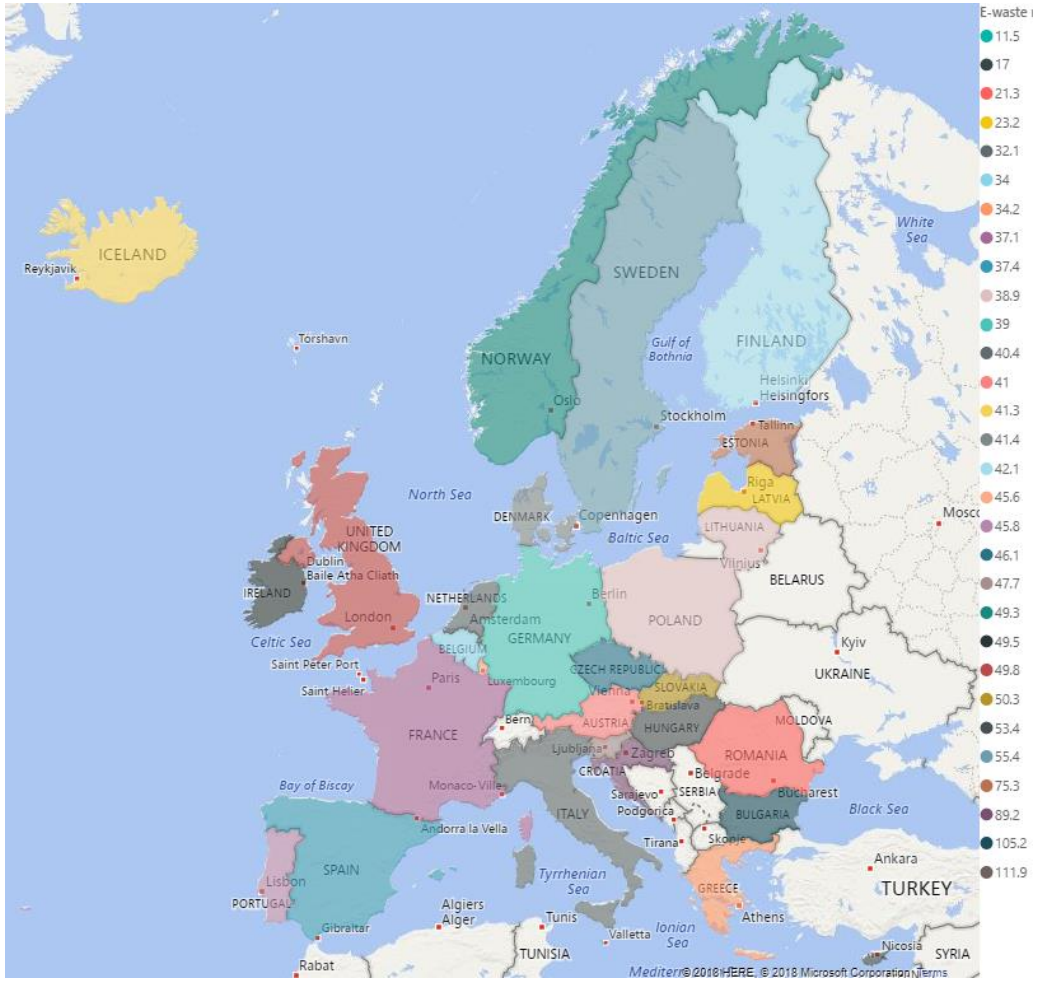
Collection per capita (kg/capita)





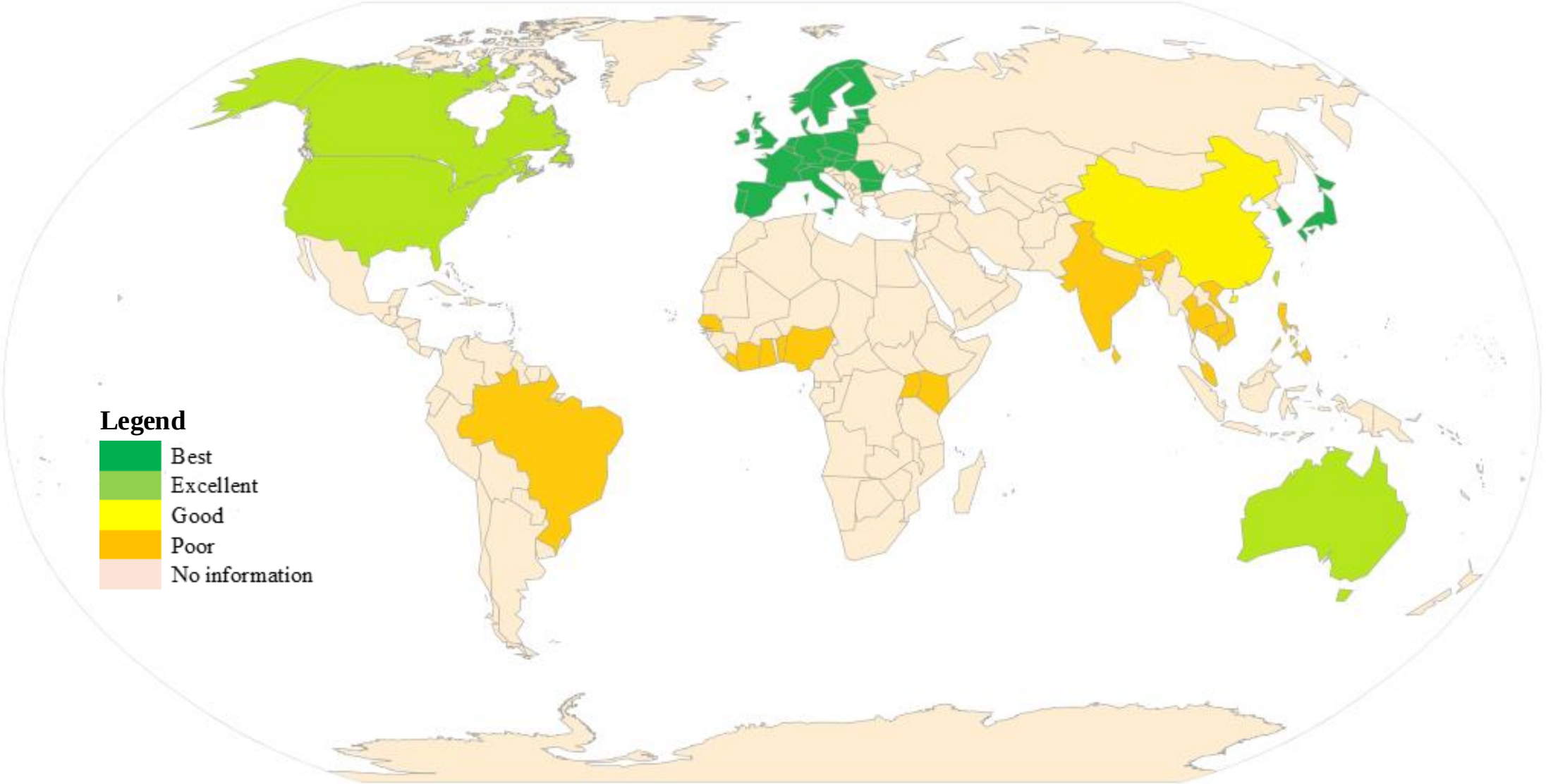
Awasthi et al., 2018

Recycling rate in 2016 (%)

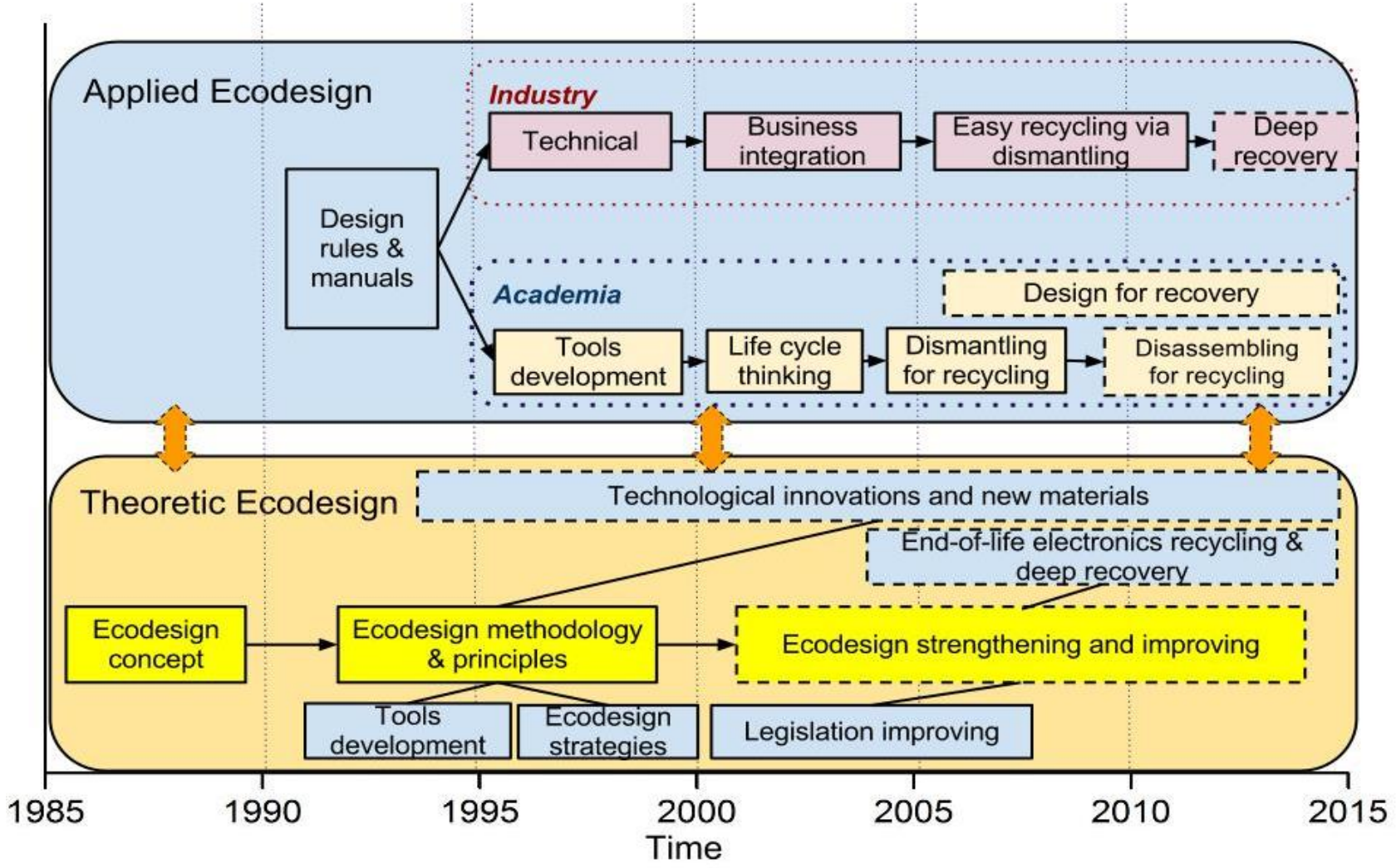


Data source: Eurostat, 2018

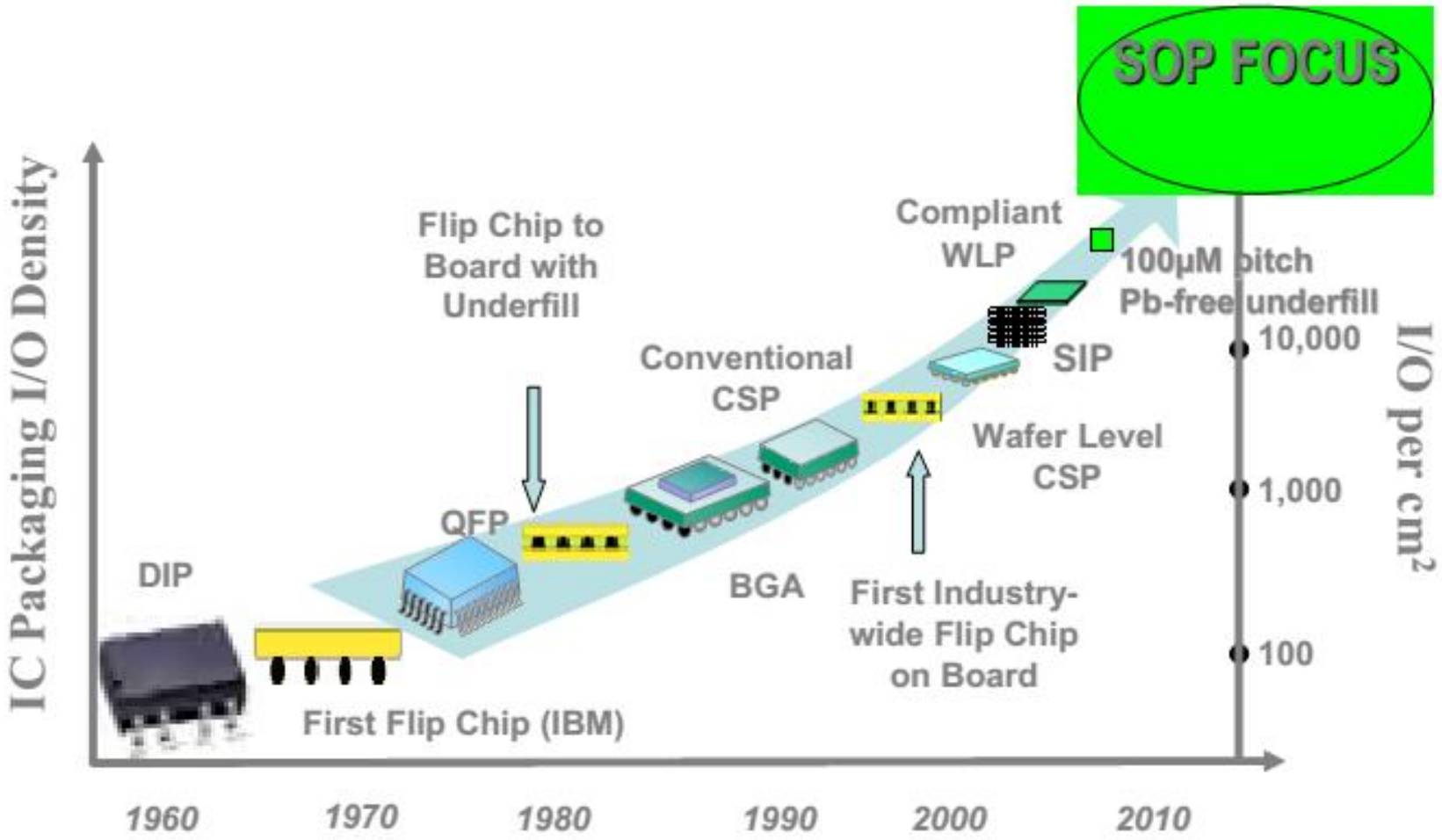
Environmental performance of e-waste recycling



3. Detoxification and eco-design



Electronic packaging evolution



Source: R. R. Tummala, in *Electronic Packaging Technology, 2005 6th International Conference on*. (IEEE, 2005), pp. 3-7.

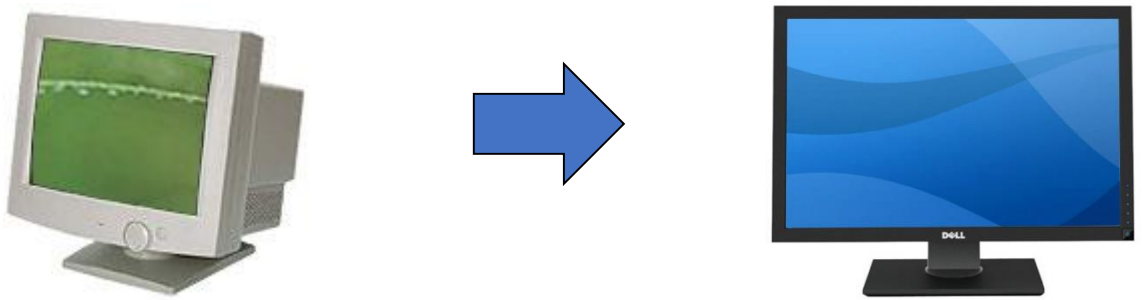
Material substitution

Pb-Sn solder

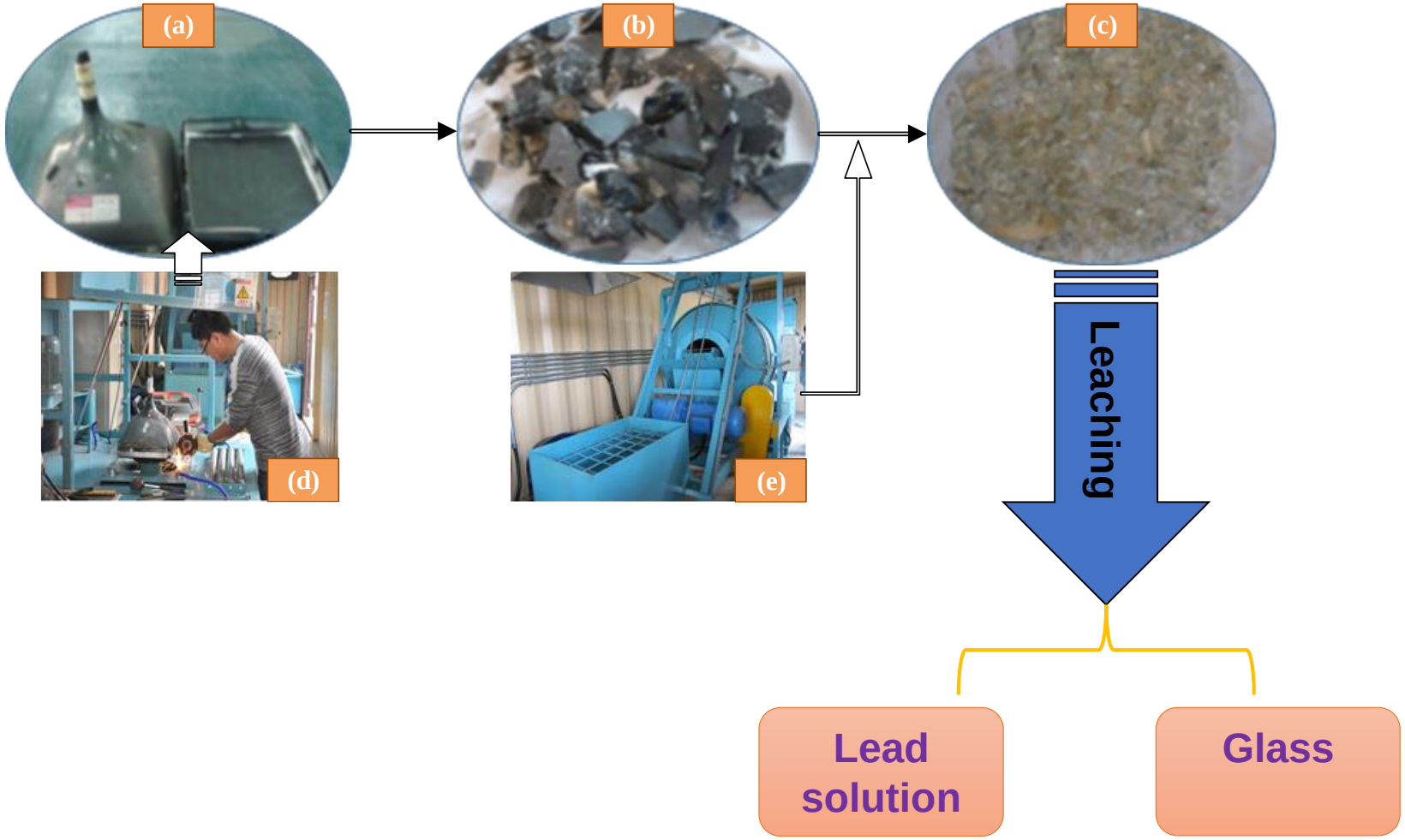
Lead-free solder

Carbon

Product updating



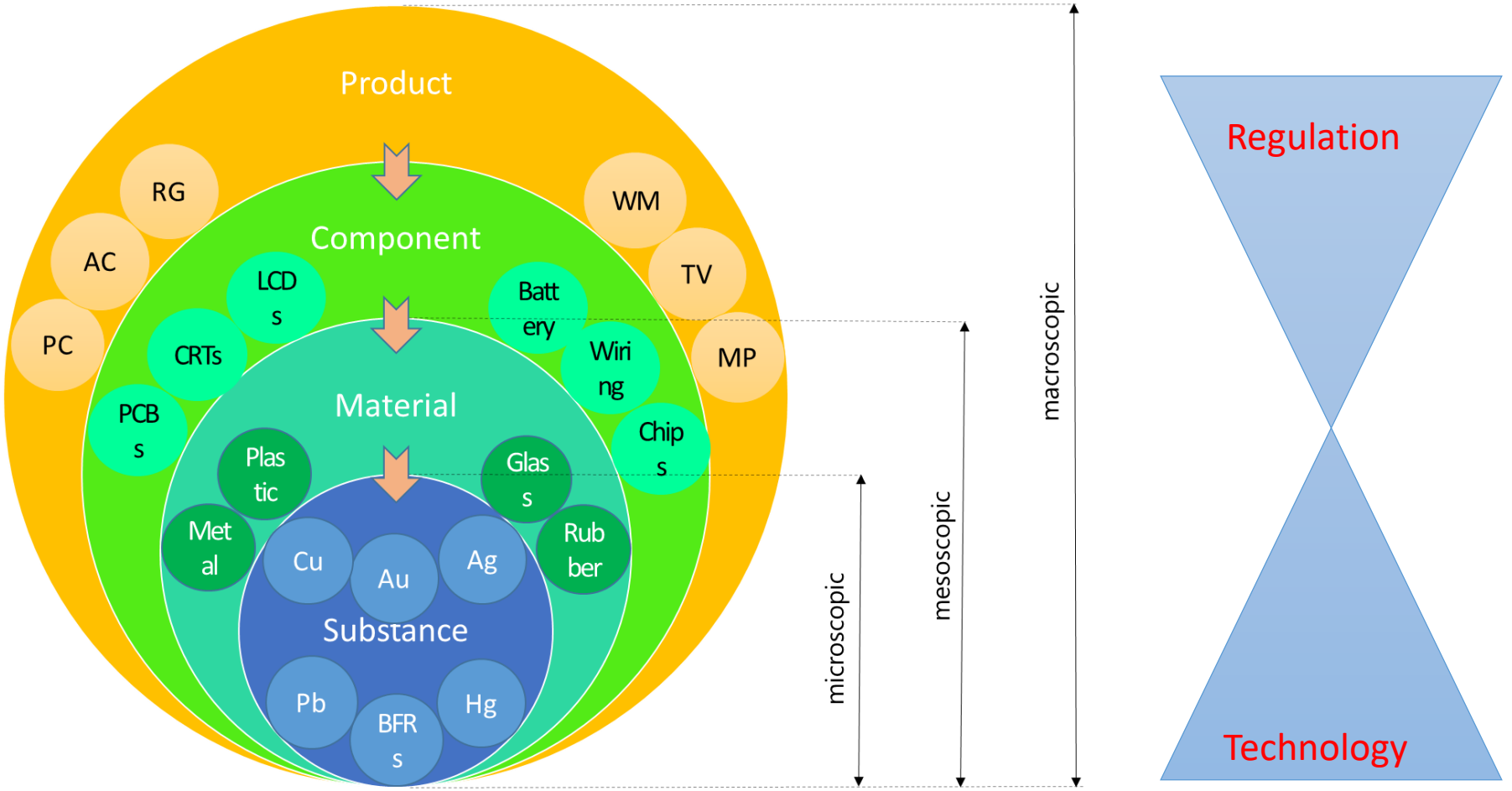
Detoxification of e-waste: case of CRT



4. Summarization for gaps and lessons

- Basic knowledge to recognize e-waste is not adequate
- Lack of systemic legislation system and unclear responsibility of stakeholders
- Fundamental facilities have been established, but high-valuable utilization and industrial distribution are not smooth
- Eco-design should be improved
- Detoxification of e-waste remains at the start

Four levels of product, component, material, and substance for e-waste management



New solution

Four patterns of the way forward

- ✓Most developed countries: technologies innovation and facilities expansion of e-waste recycling
- ✓Most developing countries: legislation improving and collection channel strengthening
- ✓Small countries or regions: mobile plant
- ✓Some countries with little e-waste generation: synergic recycling

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