

New wave of Green materials and Technology for Sustainability

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- The wave of material technology for sustainable society has started since early 1990s as Ecomaterial. In those days, ecomaterial is explained as “Environmental conscious material”. Now, “conscious” is insufficient. Measure and infrastructure of solution is the role of Ecomaterial. In the presentation, the development of ecomaterial is reviewed with using the six directions of ecomaterials called ecostar. Going into 21st century, we face new and serious situation for sustainability. Issue of climate change has had to be solved in this century. Demand of resource will overshoot the natural resource in this century. “Resource efficiency” is become important keyword. Material technology should be changed from how to use materials with environmental friendly into how to form sustainable society with efficient material use. In Europe, “Circular Economy” actions have started. It should be developed “Global Multi-value Circulation System”, in which retained value of material and products will efficiently leveraged.





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SPORTS NEWS | Wed Feb 1, 2017 | 5:28am EST

Tokyo Olympic medals to be made from recycled donated metal



FILE PHOTO: A woman is silhouetted against a monitor showing Tokyo 2020 Olympics and Paralympics emblems during the Olympic and Paralympic flag-raising ceremony at Tokyo Metropolitan Government Building in Tokyo, Japan, September 21, 2016. REUTERS/Toru Hanai/File Photo

	Vancouver 2010	London 2012	Rio 2016
gold	Recycled content (1.11%)	Obtained from sustainable mining	extracted without the use of mercury
silver	Recycled content (0.12%)	Not mentioned	Recycled content 30%
broze	Recycled content (1.52%)	Zinc in bronze was partially recycled	Recycled content 30%





Olympic Charter (-2000)

BYE-LAW TO RULE 70

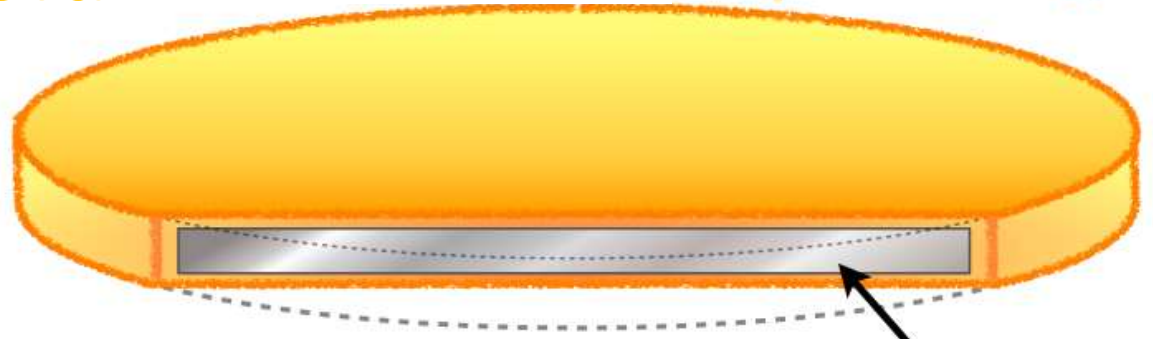
2- Medals and Diplomas

2.2 the medals shall be at least 60mm in diameter and 3mm thick. The medals for first and second places shall be of silver of at least 925-1000 grade; the medal for first place shall be gilded with at least 6g of pure gold.

Weight
95 ~ 500g

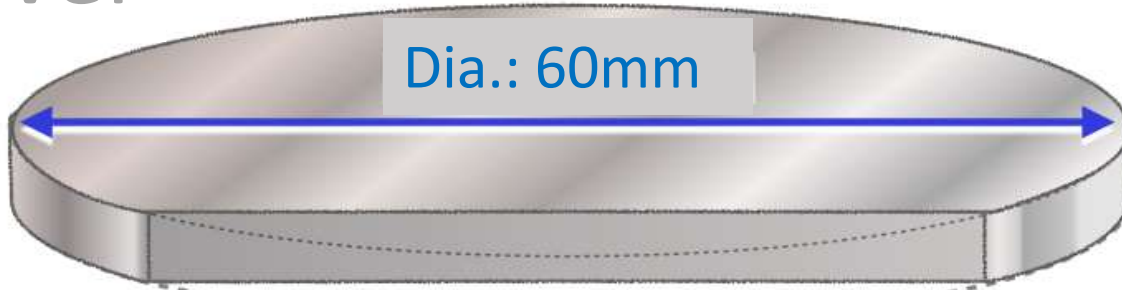
gold

Gold plated 50 μ m 6 g



Base consists of Silver

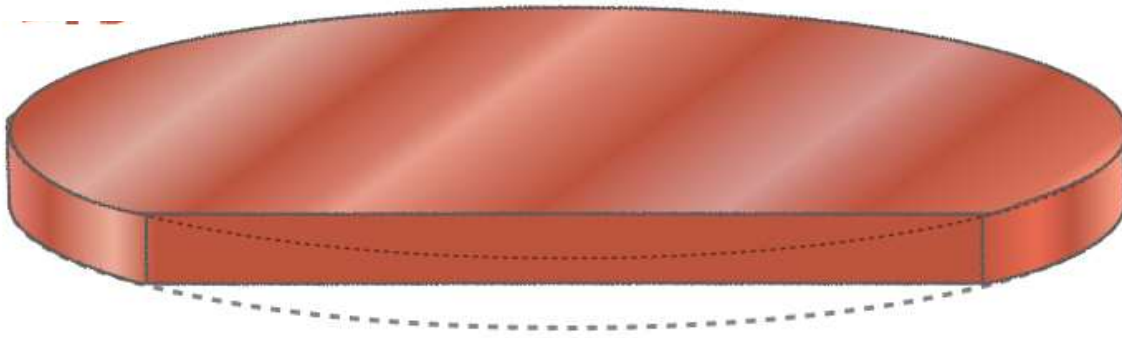
silver



Dia.: 60mm

3mm thick

bronze



How much metals are required for Olympic medals

	London 2012		Olympic Charter 2000				
	Olympic	Paralympic	Au	Ag	Cu	Zn	Sn
Gold	659	675	6	379	25	0	0
Silver	649	670	0	381	29	0	0
Bronze	702	687	0	0	368.5	9.5	2
Total	2010	2032	9.6kg	1,210kg	700kg		

Recycled raw material percentage in Japan

	2014			2015		
	Recycled (t)	produced (t)	recycled %	Recycled (t)	produced (t)	recycled %
Au	29.2	106.8	27.3%	31.7	113.8	27.8%
Ag	731	1803	40.5%	817	1967	41.5%
Cu	254000	1538000	16.5%	253000	1509000	16.8%
Pb	114000	200000	57.0%			
Zn	125000	589000	21.2%			

Data from Japan Mining Association

西園さそり

小型家電リサイクル法が始まります

小型家電
このロゴが目印!

小型家電を処分するときは、市町村のごみ分別ルールに従って出しましょう

※小売店が回収に協力している場合もあります。

小型家電リサイクルの対象品目

小型家電はレアメタル等の有用金属を含む一方、鉛などの有害物質を含むものもあることから、法律に基づく適切なリサイクルが必要です。

※ご家庭の電気でおくものが幅広く制度の対象になりますが、市町村ごとに回収品目や回収の開始時期が異なります。
※大型の家電4品目（テレビ・エアコン、冷蔵庫・冷凍庫、洗濯機・衣類乾燥機）については処分方法が異なります。詳しくは家電小売店又は市町村へお問い合わせください。

小型家電リサイクル

Recycling law for small size electric appliances starts from April 2013.



【小型電気電子機器の例】

2013.4.1



<http://www.universe-corp.jp/article/14864904.html>

Electric households contain a great amount of metals

	BD player	Cell phone	PC laptop	PC disctop
Per equipment	3.6kg	0.1kg	2.1kg	8.2kg
Discarded at 2011	60,000	40,000,000	6,700,000	5,000,000
Annual amount	211t	5600t	1400t	4000t
gols	3kg	1,900kg	2,000kg	2,500kg
silver	16kg	10,000kg	5.600kg	15,000kg
copper	4800t	510,000t	550t	2,200t

Amount of recycled metal by the law of small size electric households rcycling

	2013	2014	2015	Requisite for Olympic medals
Au	46kg	143kg	214kg	9.8kg
Ag	446kg	1566kg	2563kg	1210kg
Cu	381ton	1,112ton	1469ton	700kg

Recovery of Gold from Urban mine



コンピュータなどの電子基板です

2020 Tokyo Olympic is
in preparation



Dream Island just after Tokyo Olympic 1964.

Deposit site of waste from mass consumption



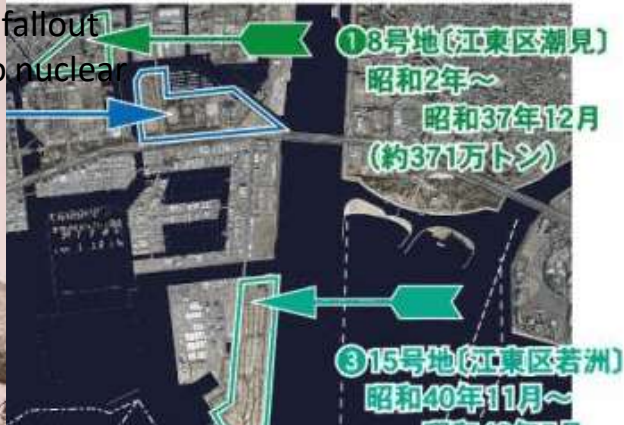
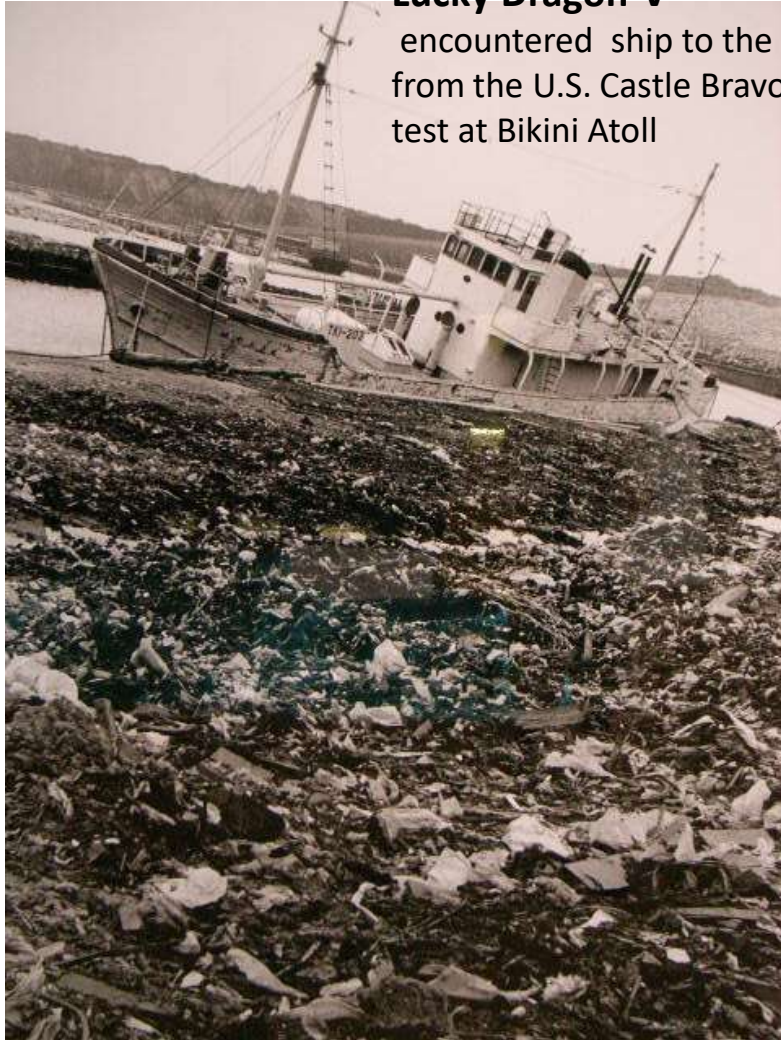
We fought against
fly.



Waste landfill area of Tokyo in late 20th century.

Lucky Dragon-V

encountered ship to the fallout from the U.S. Castle Bravo nuclear test at Bikini Atoll



(資料提供: 東京都港灣局)

We construct Olympic stadiums
in this area.



Olympic becomes a symbol
from

Economic growth 成長
to

Mature society 成熟

**Global material management
should change to be
from Economic growth
to mature society of sustainability**



SUSTAINABLE DEVELOPMENT GOALS

17 GOALS TO TRANSFORM OUR WORLD

1 NO POVERTY

2 ZERO HUNGER

3 GOOD HEALTH AND WELL-BEING

4 QUALITY EDUCATION

5 GENDER EQUALITY

6 CLEAN WATER AND SANITATION

7 AFFORDABLE AND CLEAN ENERGY

8 DECENT WORK AND ECONOMIC GROWTH

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

10 REDUCED INEQUALITIES

11 SUSTAINABLE CITIES AND COMMUNITIES

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

13 CLIMATE ACTION

14 LIFE BELOW WATER

15 LIFE ON LAND

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

17 PARTNERSHIPS FOR THE GOALS

SUSTAINABLE DEVELOPMENT GOALS

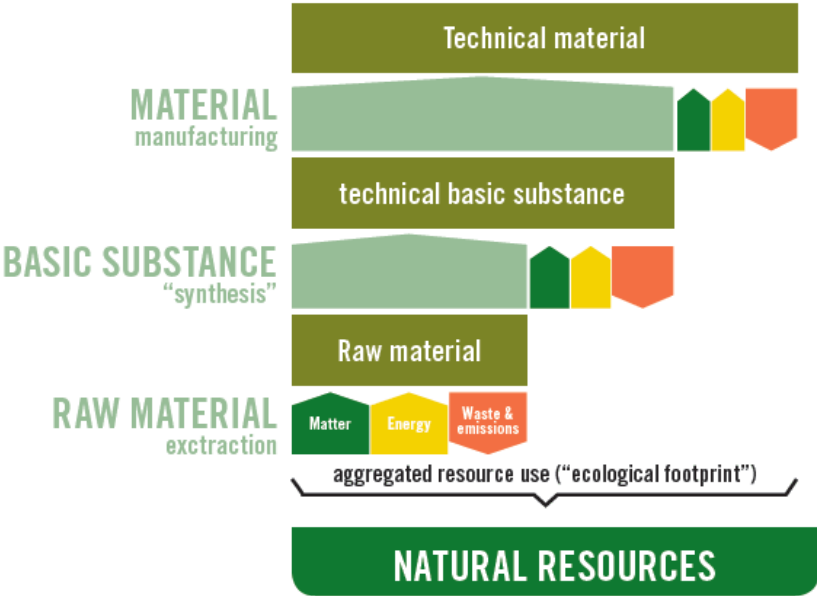
Resource efficiency

How can we make our economy circular and resource efficient?

Currently, we are using more resources than our planet can produce in a given time. We need to reduce the amount of waste we generate and the amount of materials we extract.



Figure 4: Aggregated resource use for technical materials



 **12.4**

tonnes of materials per capita were **extracted** in the EU.

 **3.2**

tonnes of materials per capita were **imported** to the EU.

1.3 

tonnes of material per capita were **exported** from the EU.



Consumers' view
weight

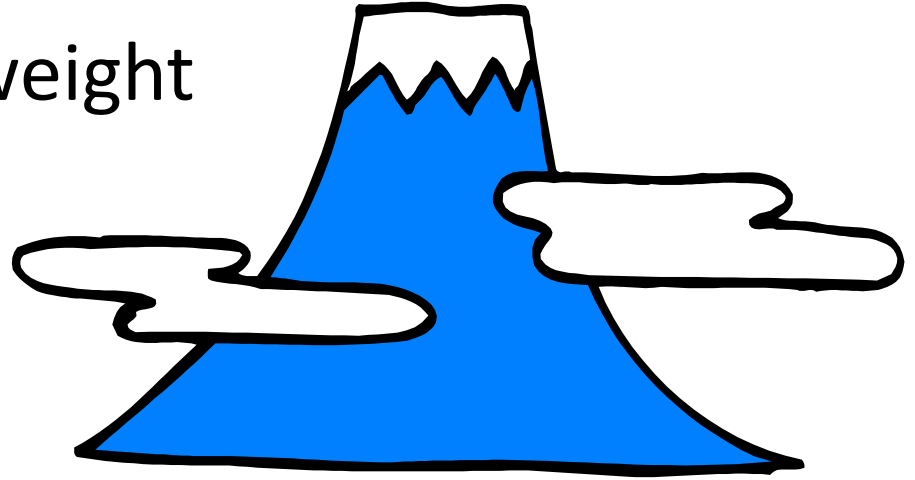


Total volume of gold which
Human has been used is only
Three pools of Olympic

Au



Resources' view
weight



One Mt. Fuji

100,000,000,000ton

100G ton

The natinal resource
which was diged for the
three pools of gold.



Important materials have great deal of Eco-Ruecksuck

In Japanese sense,
Every material has each a great number of guardian spirits,
and frequently you waste them.



A view of an artisanal gold mine, seen from a hill just outside the eastern Congolese town of Kamituga, a mining town 180 km (112 miles) south west of Bukavu, January 18, 2006.

資源端重量が大きいと、インフォーマルな採取による環境破壊も起きやすい

<https://www.hrw.org/ja/news/2015/09/30/281785>



http://www.nimd.go.jp/kenkyu/review/h14/h14_mercury_analysis_review.html



<http://www.circleofblue.org/2012/world/global-gold-rush-the-price-of-mining-pursuits-on-water-supply/>





SUSTAINABLE DEVELOPMENT GOALS

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SUSTAINABLE DEVELOPMENT GOALS

E-waste (Electric waste)



Eco-ruecksuck of mining



47.8ton

Eco-rucksuck for Hearing E-waste



95.1g



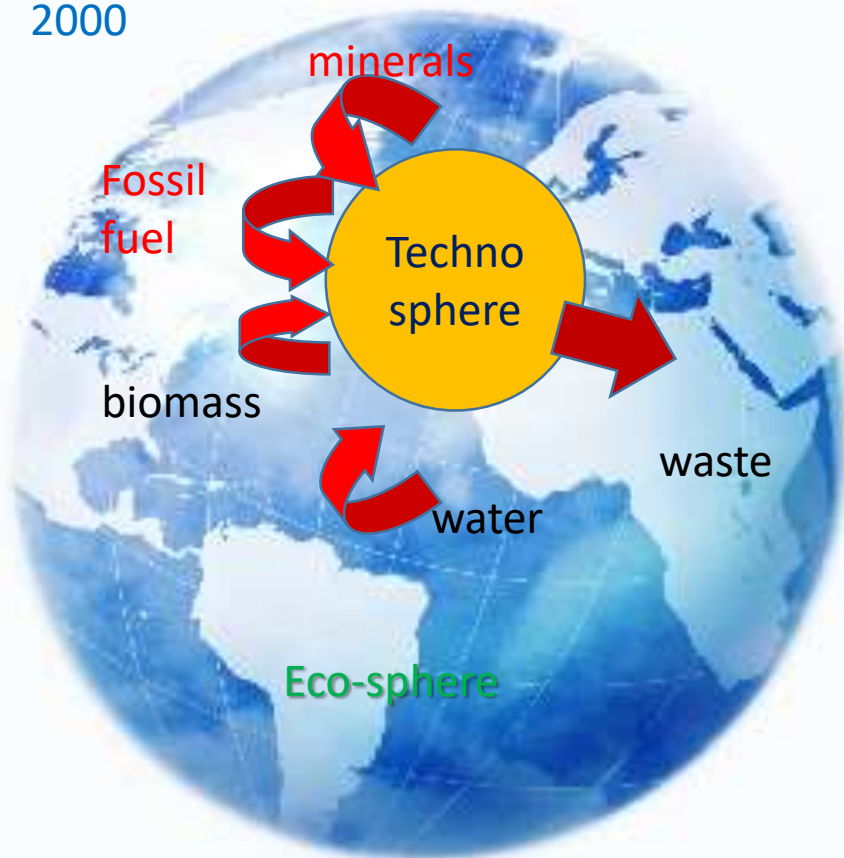
1600ton

One recycled medal improve the resource efficiency.

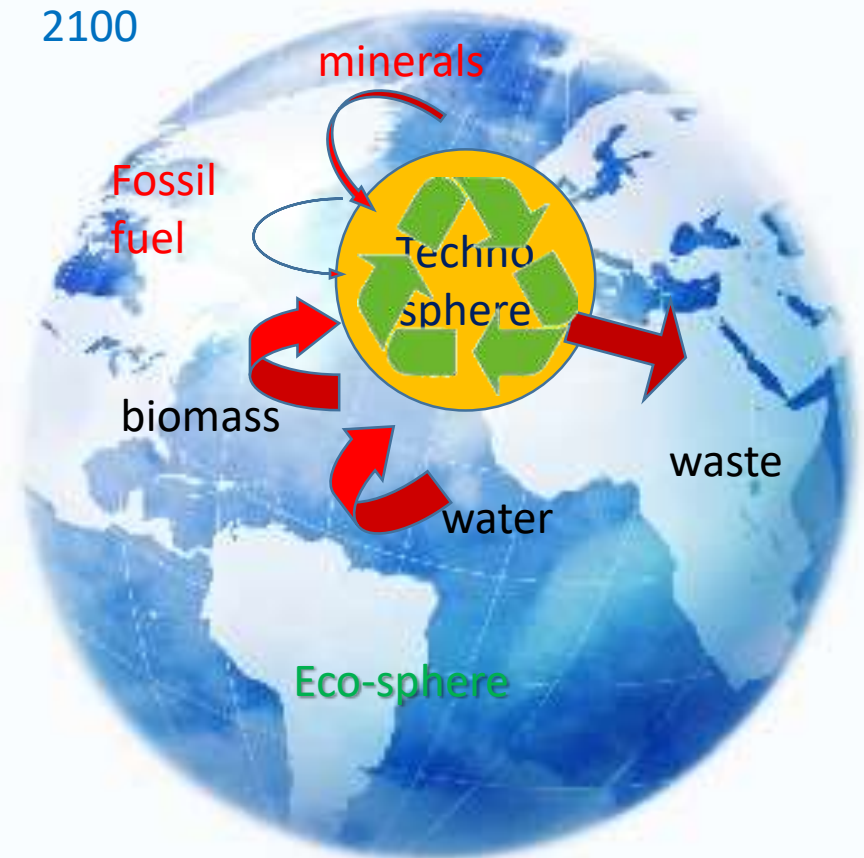
The world at 2100

- The minerals and fossil fuels from natural resource is nearly zero.

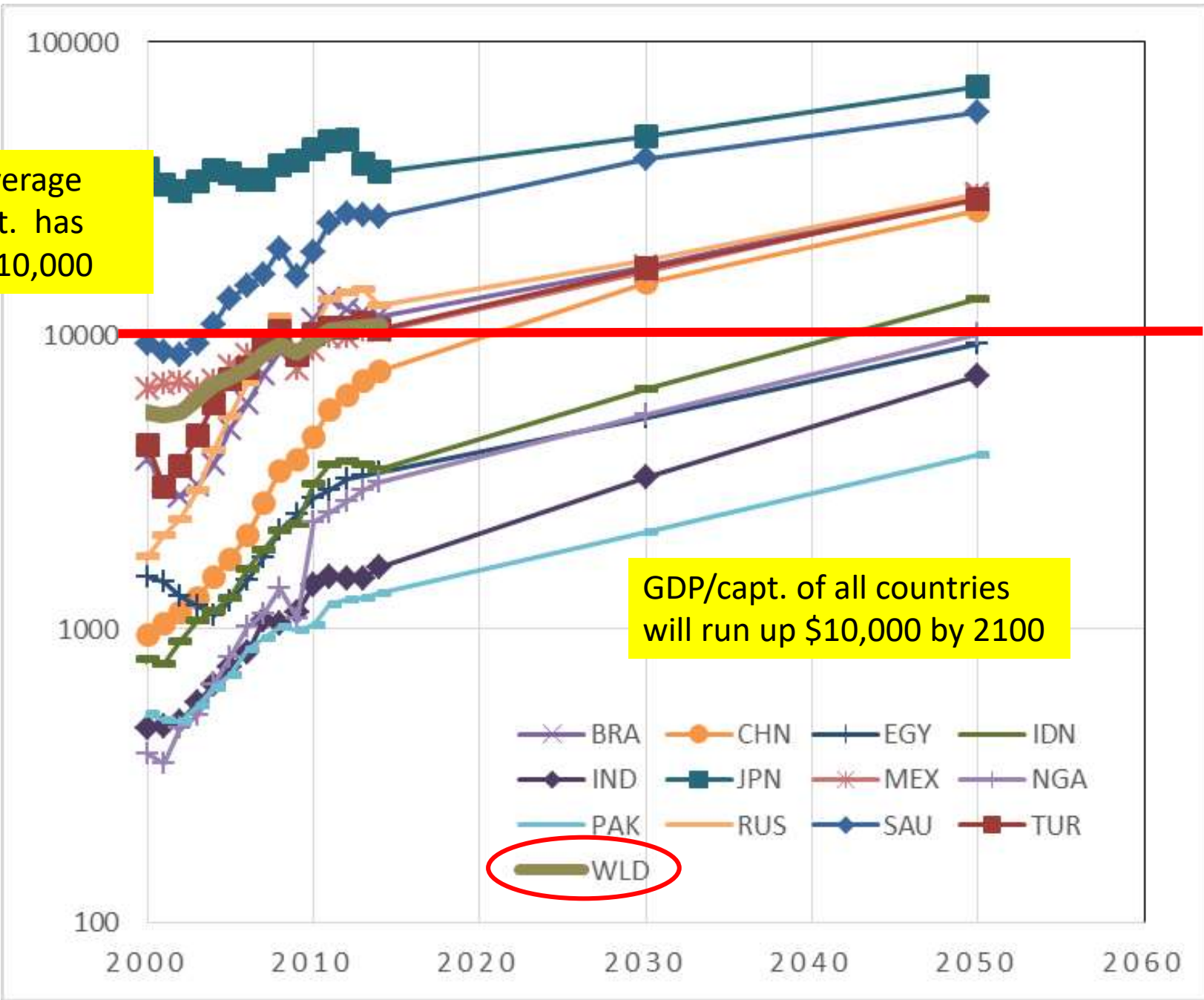
2000



2100



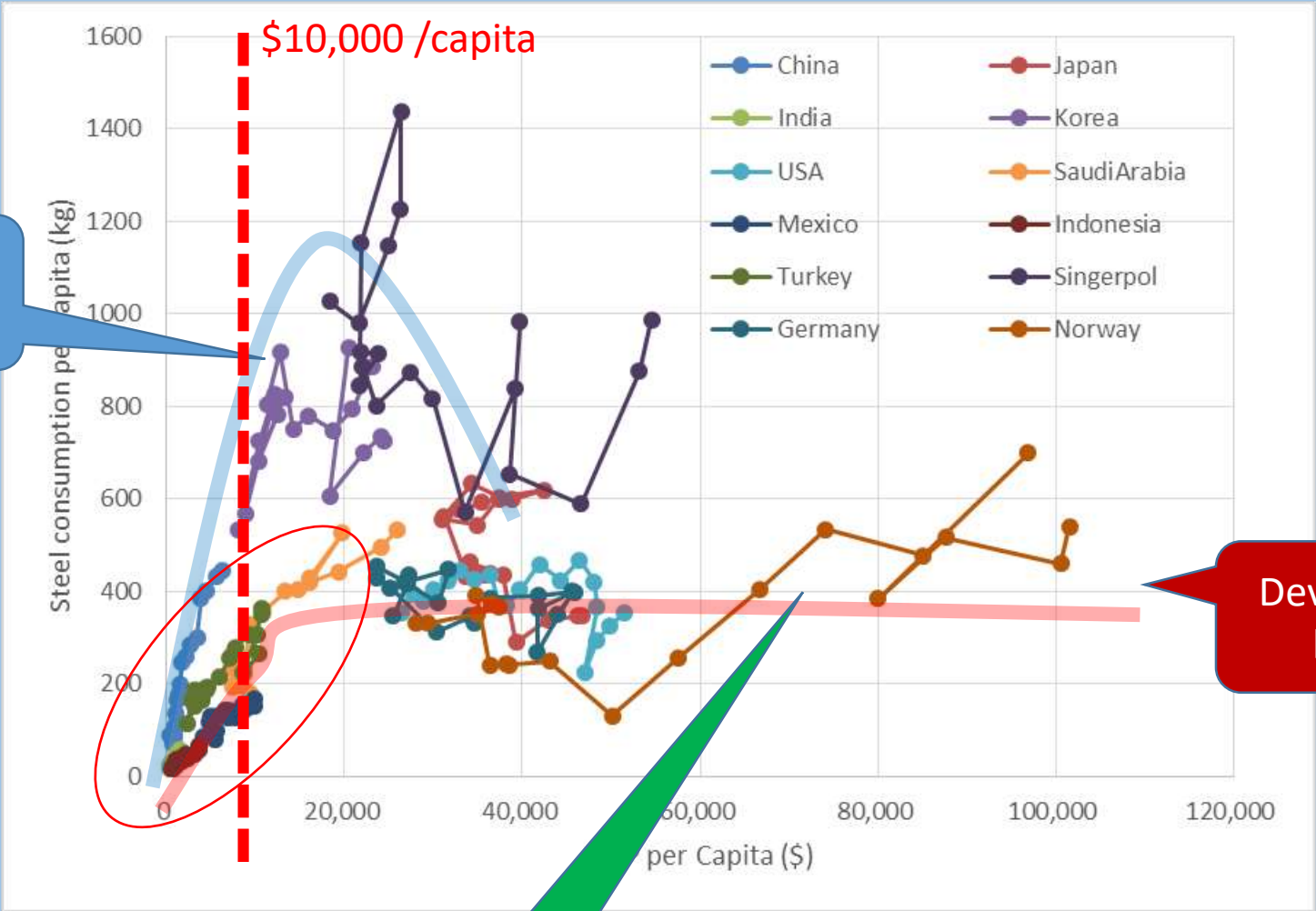
World average
GDP/capt. has
run up \$10,000



GDP/capt. of all countries
will run up \$10,000 by 2100

Consumption/capt. reaches developed level when GDP capt. reaches \$10,000

Fe consumption / capita v.s. GDP/ capita from 1994 to 2014



Exporting countries

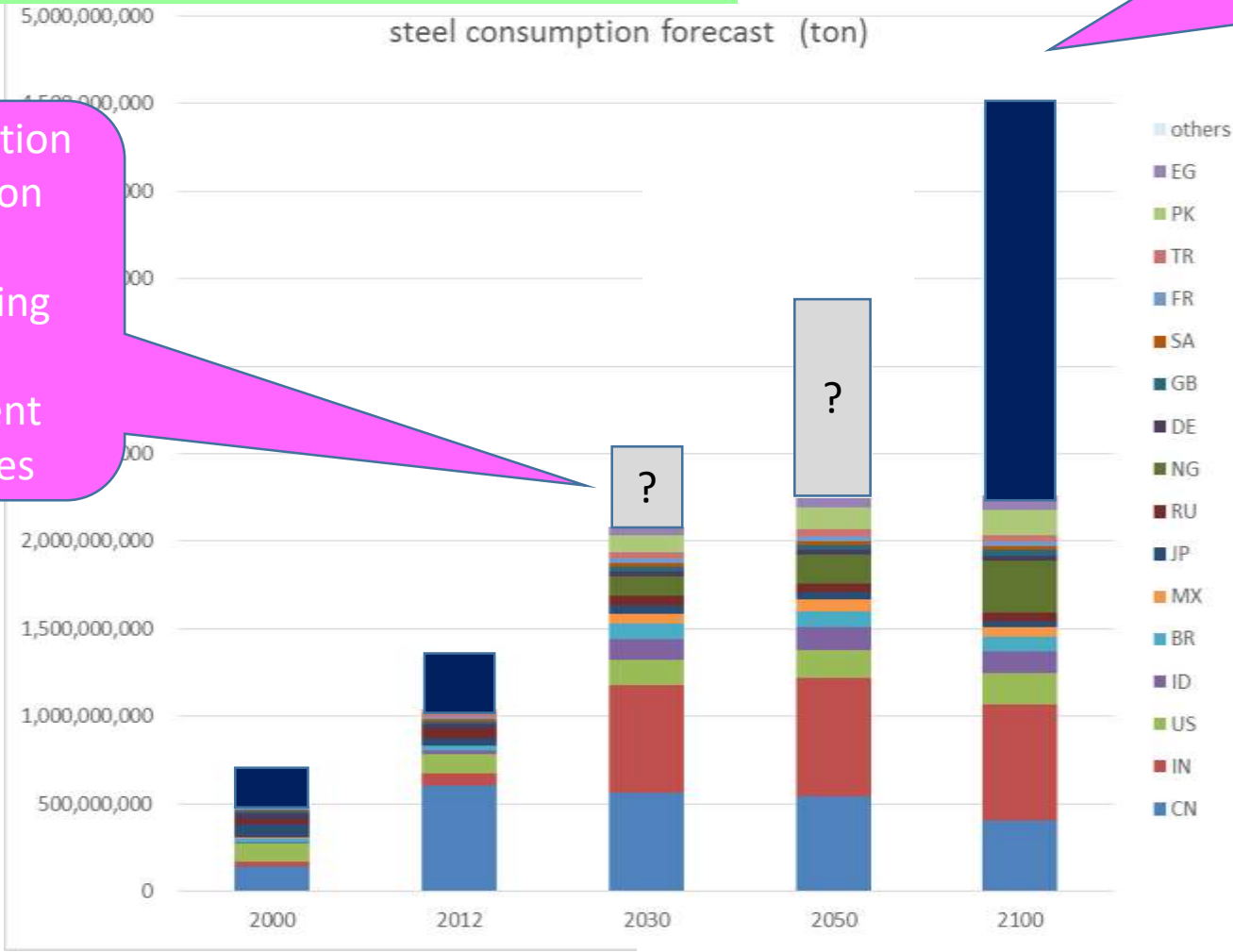
Developed level

Consuming countries

Rough forecast gets to be simpler,
 (population) x (developed consumption level)

Every country reaches developed level of consumption per capita

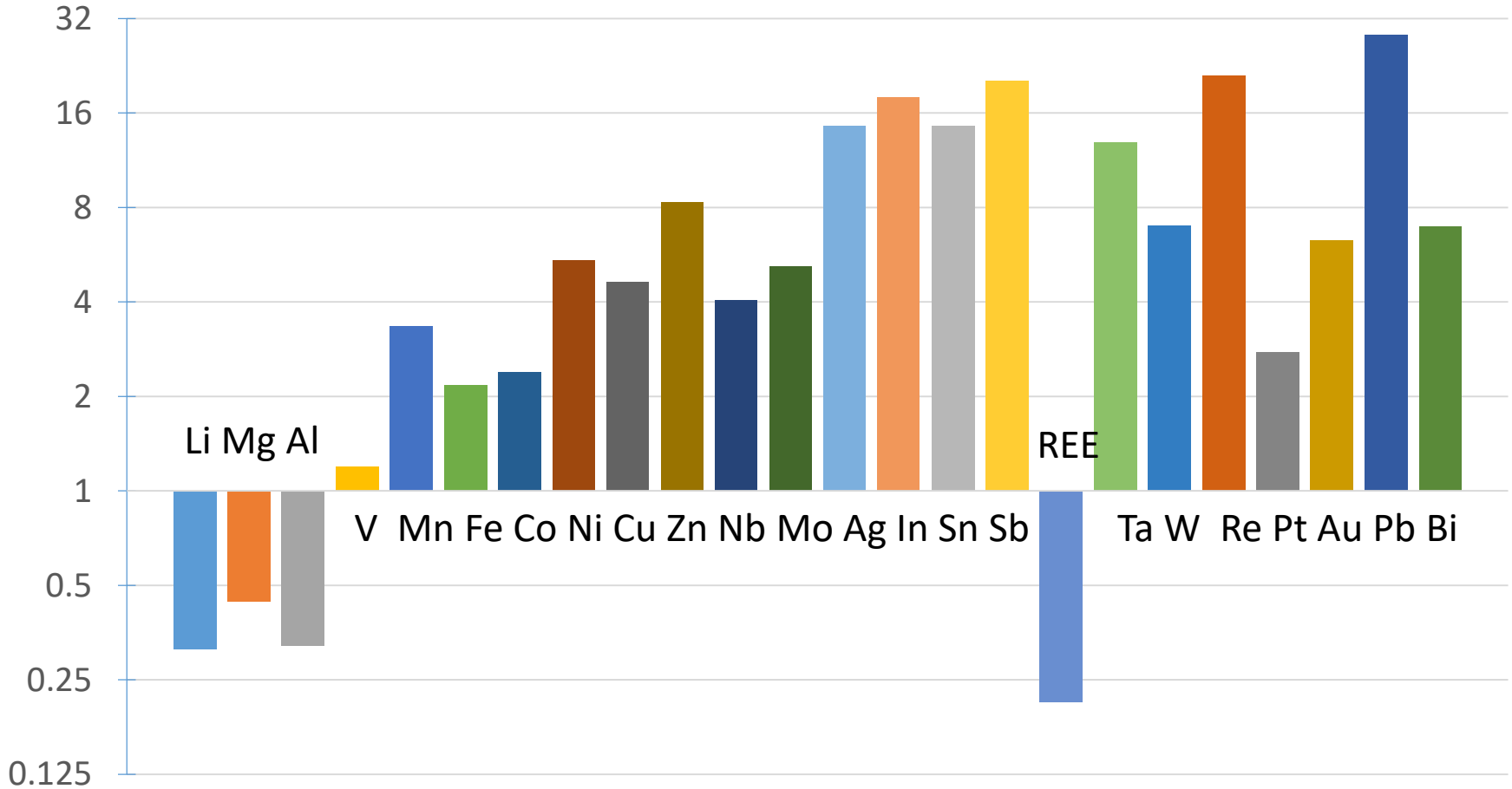
Consumption prediction with concerning only prepotent countries



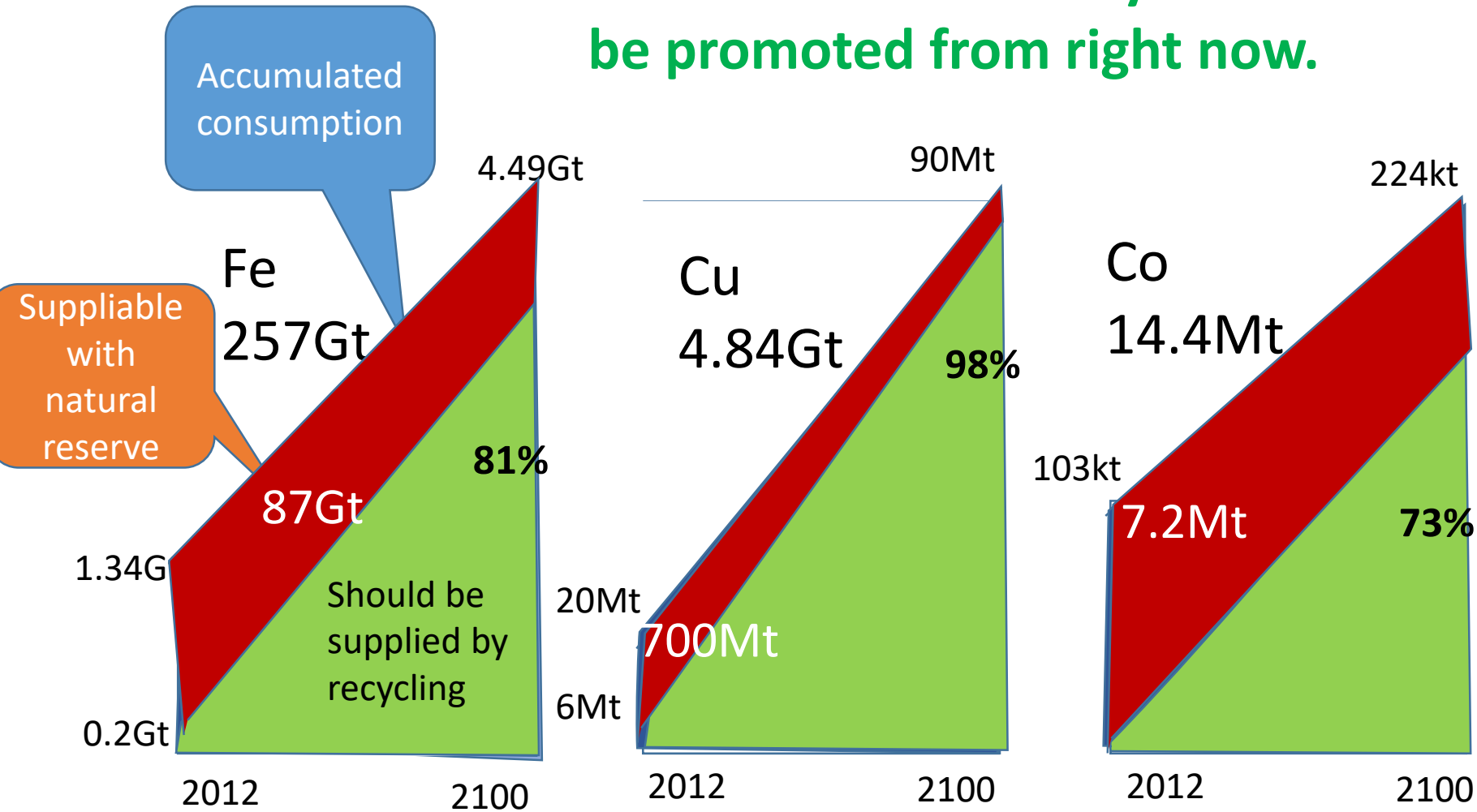
metal	Fe
Consumption/year at 10Gperson world	4.5Gton/year
Reserve	87Gton

Much more times of resources will be required by 2100.

Estimated demand up to 2100 v.s. current reserve amount



The circulation society must be promoted from right now.



Estimated accumulated consumptions till 2100 with simple assumption of linear growth

Accumulated consumption

Suppliable with natural reserve

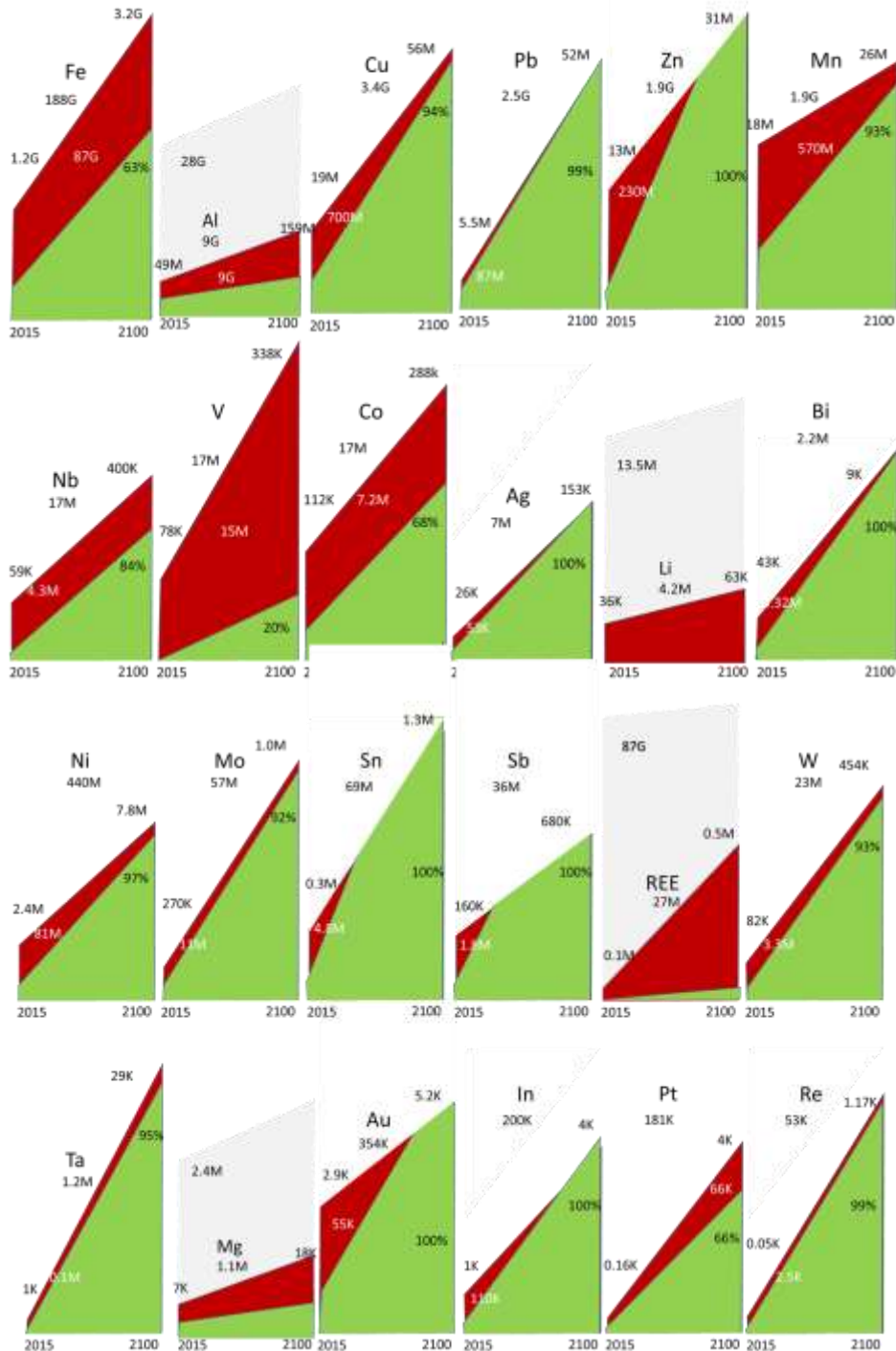
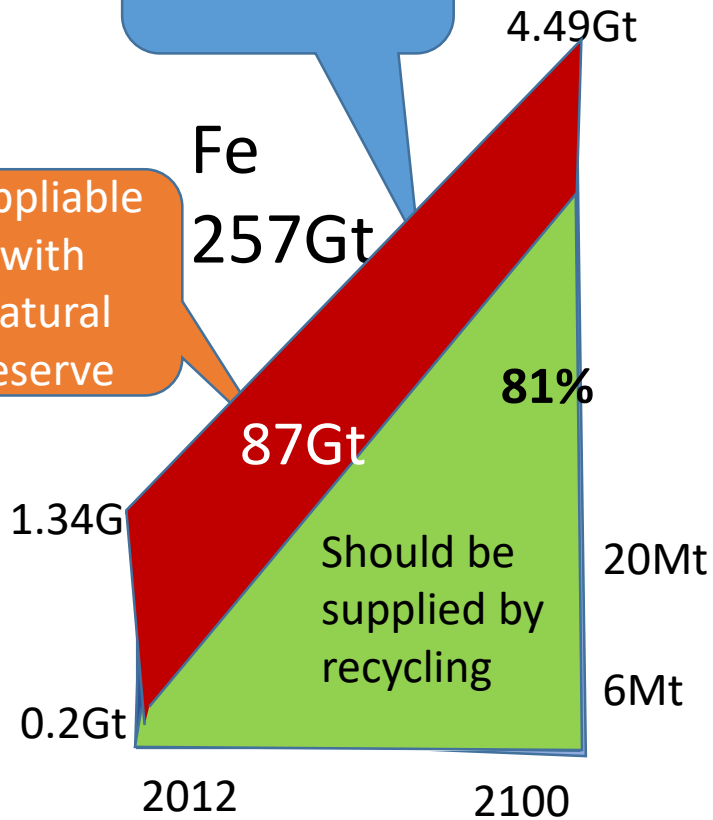
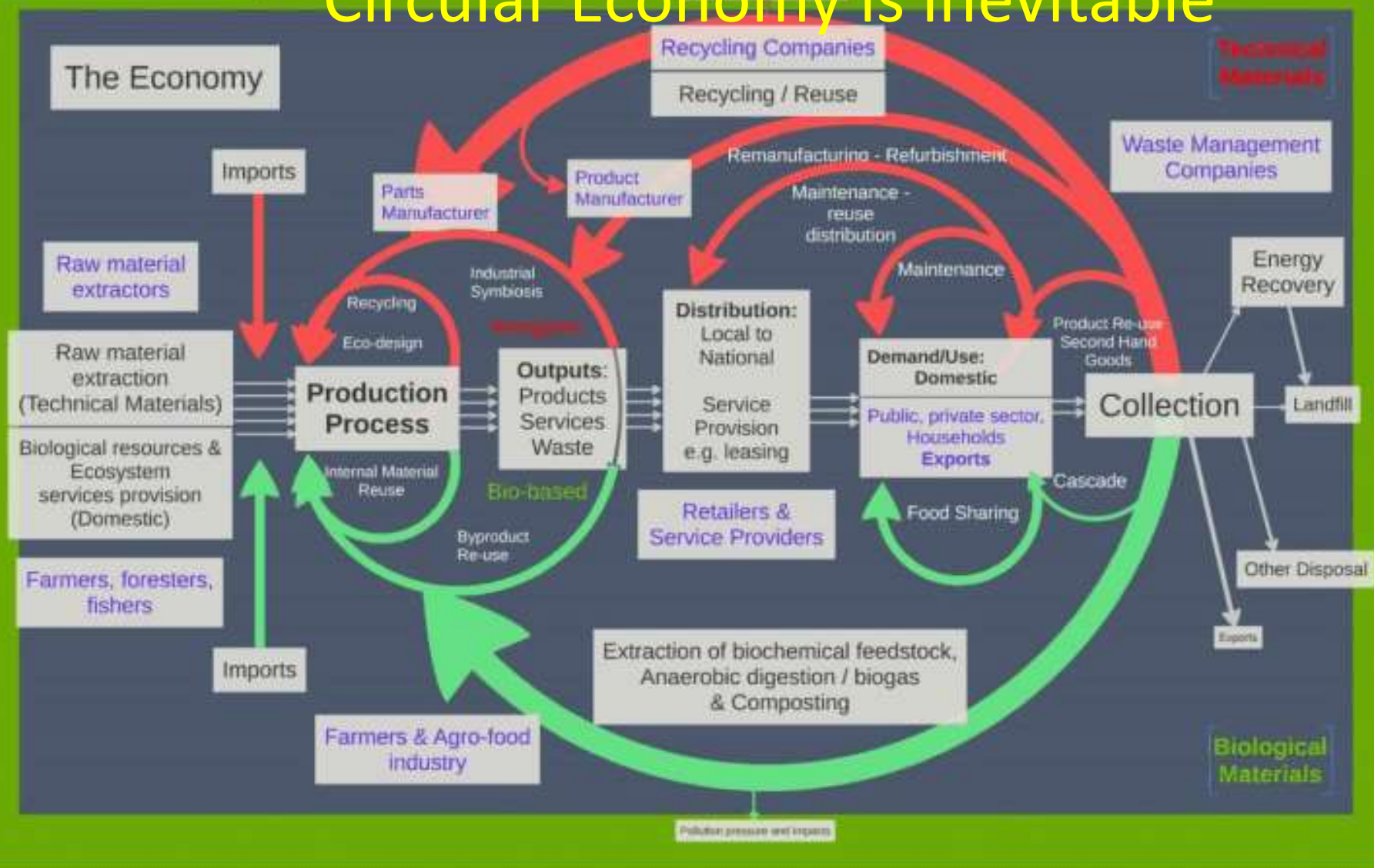


Figure E2: Simplified illustration of a circular economy

Circular Economy is inevitable

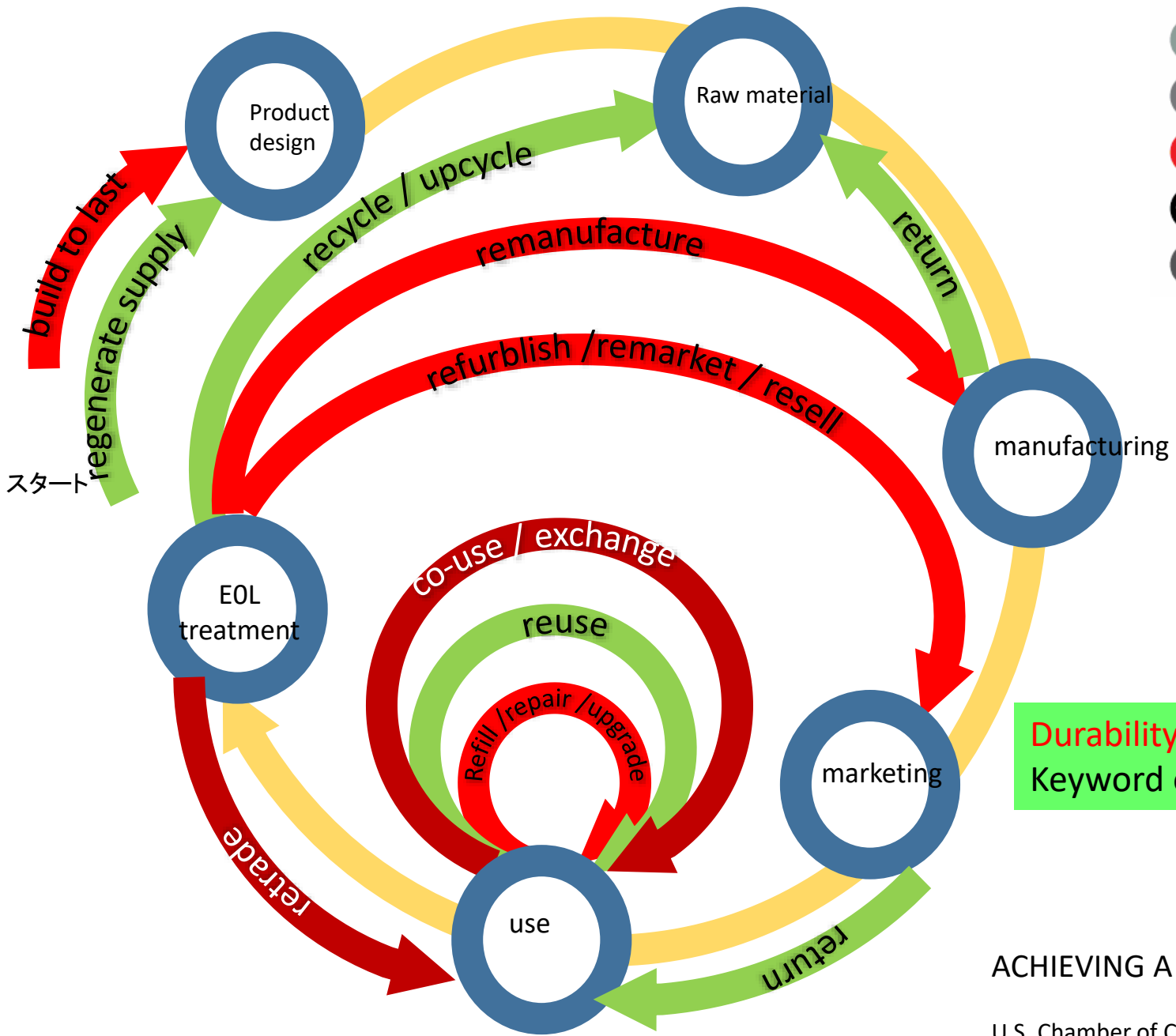


Source: Own representation, P ten Brink, P Razzini, S. Withana and E. van Dijk (IEEP), 2014

Circulation like the capillary blood.

BUSINESS MODELS

-  CIRCULAR SUPPLY-CHAIN
-  RECOVERY & RECYCLING
-  PRODUCT LIFE-EXTENSION
-  SHARING PLATFORM
-  PRODUCT AS A SERVICE



Durability becomes the greatest Keyword of Ecodesign

ACHIEVING A CIRCULAR ECONOMY

U.S. Chamber of Commerce Foundation,
Supported by CCC's Circular Economy Network

	Function & value	process	certification	Notice
remanufacturing	Same as primary	Dismount and Reconstruct to same performance	Same quality	
Refurbish (re-bild)	According to primary	Dismount and Reconstruct to similar performance		“Re-bild” in automobile
repair	Revive deteriorated parts	Repair and exchange of deteriorated parts	Check the function	Include parts for refurbish
direct reuse	Second hand value	Cleansing level	Simple checking	
recycle	Resource value	extraction of substance	As raw material	

Difference of Circular Economy(CE) from conventional circulation society(3R)

	3R	CE
	Results oriented	Concepts oriented
aim	Reduction of final disposal	Improvement of Resource Efficiency
benefit	Reduction of extra economic burden of the society	Creation fo new business different from mas consumption
measure	Recovery of secondary raw material	Multiple utilization of EoF products
EoF products	Subjects to be recycled as raw material	Subjects to be used again.
Economic entity	Recyclers, mining company	Service suppliers, SME producers
motivation	Social responsibility	Add-value toward sustainability

勿体無い

essence of material

loss

cut blocks with a razor

Ms Wangari Muta Maathai insisted

mottainai

- ① blaspheme against God and Ancestors
- ② awful to overmuch hospitality
- ③ spare material over-consumption

物の本体を失する意

神仏などに対して不都合である。
過分のことで畏れ多い。

そのものの値打ちが生かされず
無駄になるのが惜しい。

Don't waste the sprit of material which is given by God !

Mottainai Society

Communication value

Behavior value

Utility value

Value as Function unit

Value as Parts

Value as Material

Value as Resource

Shared space

IoE

ICT



Co-use

repair

Service share

???

direct Reuse



Repair

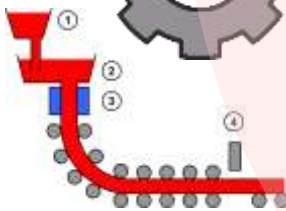
Parts

Re-manufacturing

Elements

Reuse/refurbish

Substance-recycle



Drag out the retained value of a product throughly

Personal space

Entity-centered to Behavior-

Mono モノ 物

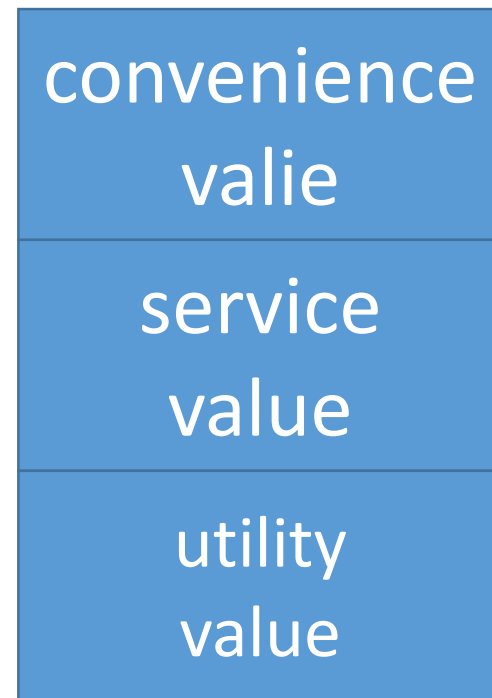
Koto コト 事



Mass production



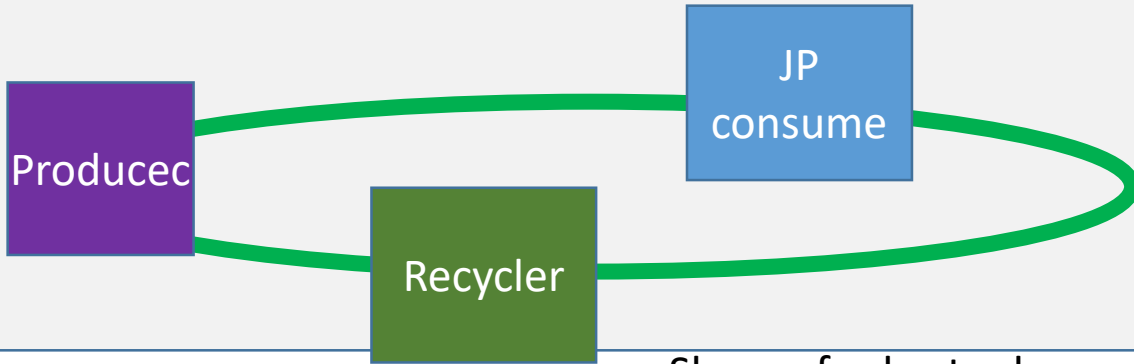
IoE: internet of everything
ICT information communication
technology



RRRDR

Different circulation society of EU from JP

Japanese circulation society

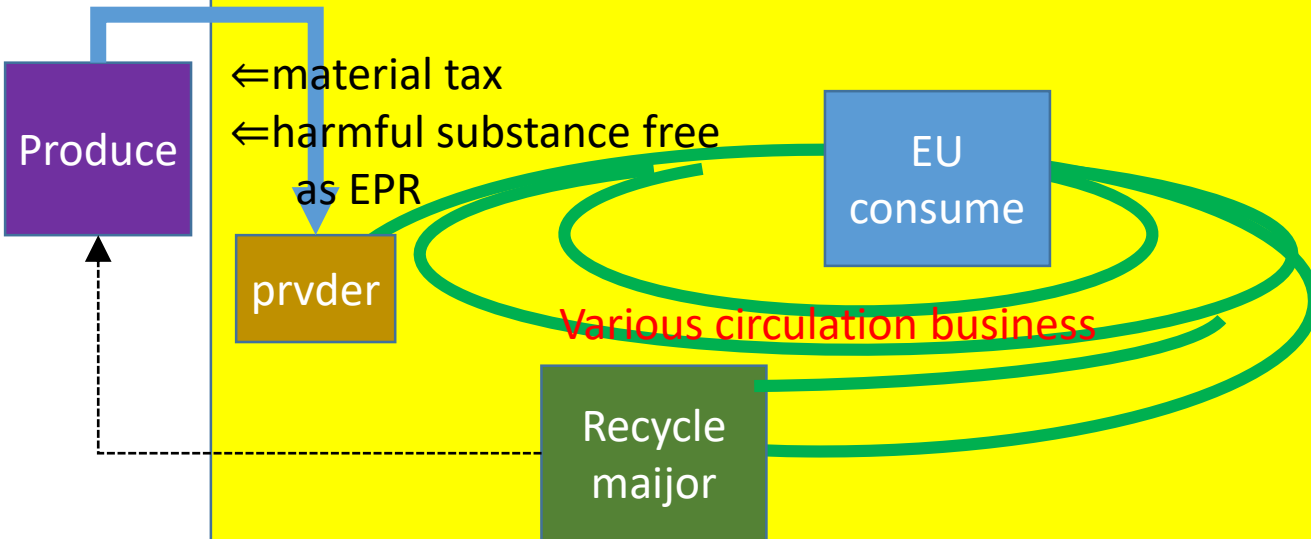


Arrange the outer ward of material circulation In the society

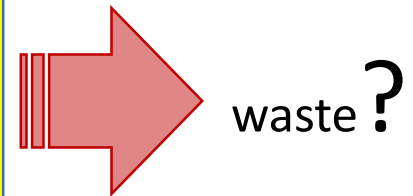
Zero emission
or
Low waste

Share of roles to decrease waste

EU's Circular Economy



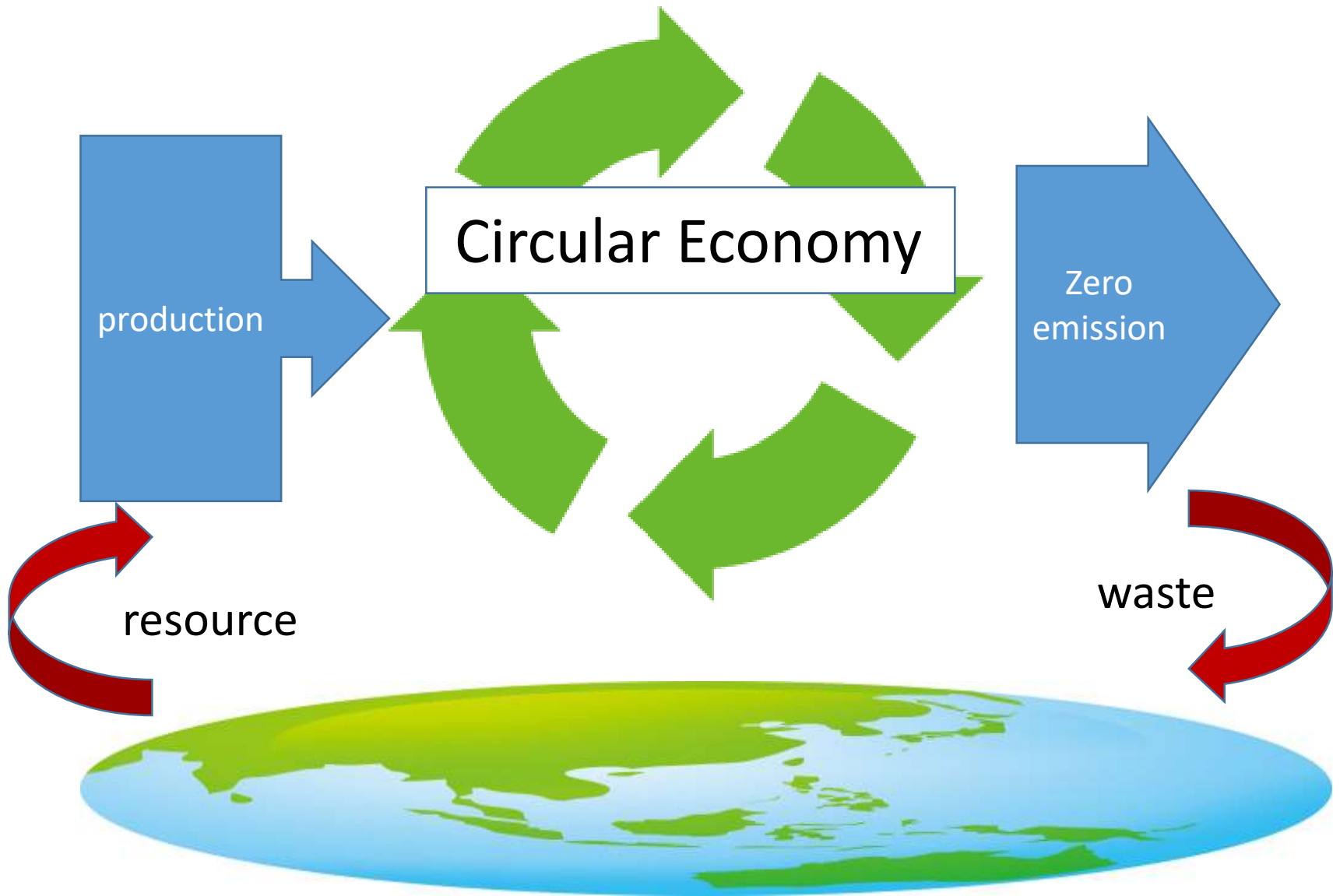
Create multiple inner route of goods circulation In the society



waste ?

Business chance in circulation from view point of sustainable consumption

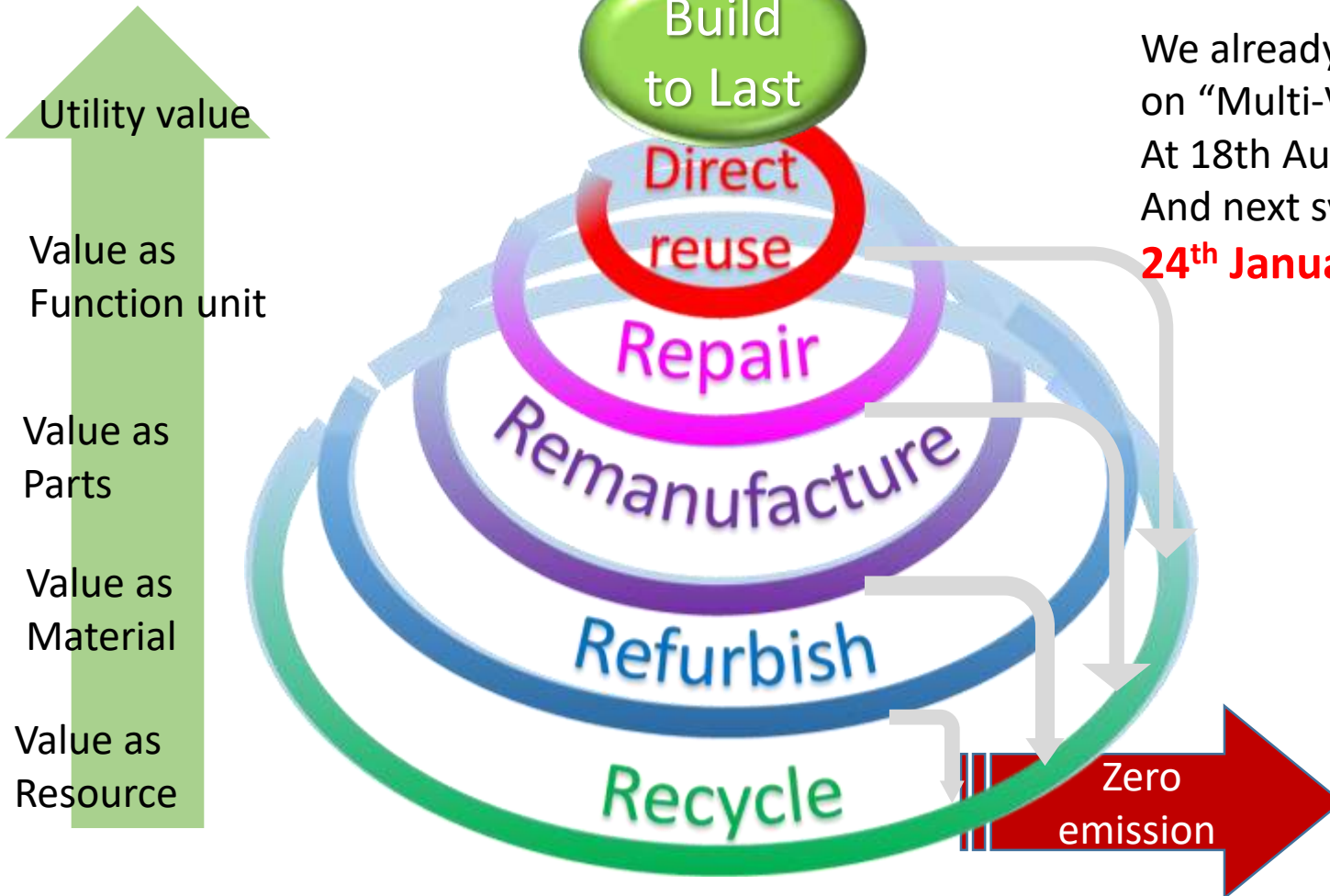
Total Life-cycle management is required for the improvement of Resource Efficiency



Multi-value Circulation

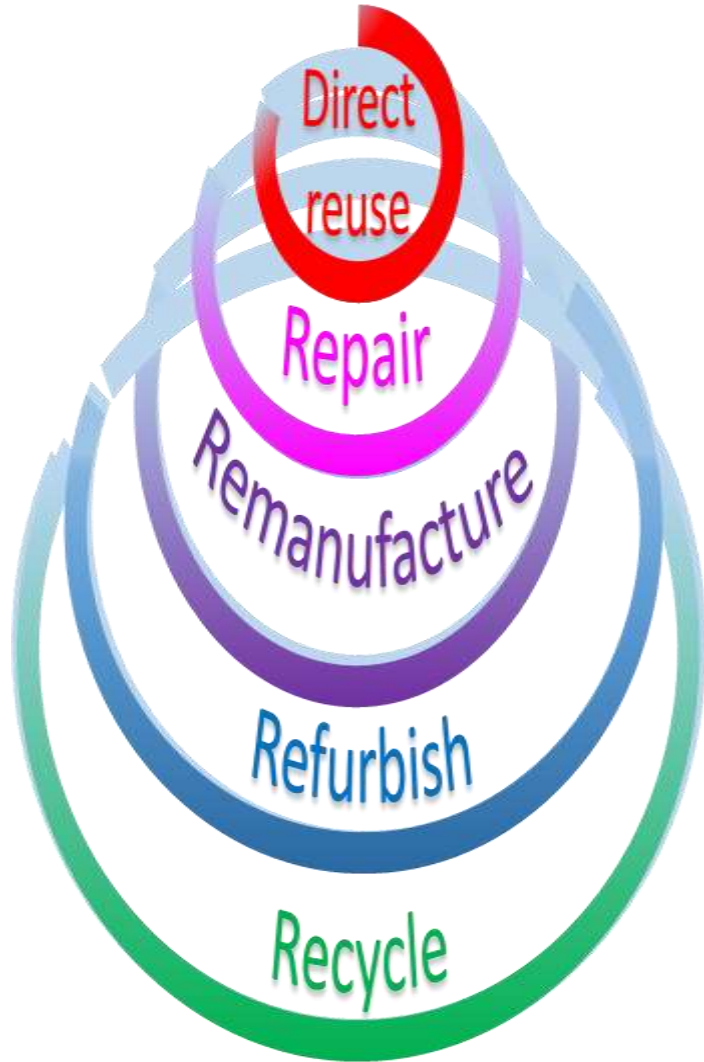


We already had a symposium on “Multi-Value Circulation At 18th August”
And next symposium will be held **24th January** 2019.



Requisite for materialization on Multi-Value Circulation

Monozukuri



Long life

Renewalizing technology

degration detectation

Multi material design

Technical Barriers o remanufacturing

プロセス技術

Deterioration of material

Fracture



Fatigue



Wear



Corrosion



Surface treatment & Mending



Welding



Cold Spray



Submerged Arc
Welding



Plasma
Transferred Wire
Arc

出典：M.Haselkorn, RIT

Requisite for material in the multi-value circulation society

- Long-life several times longer than goods
- Higher and visible reliability indispensable for RRRDR
- Repairable : detachmentable
- Repairable : material hearing
- Repairable : localized mending
- Easy Cleansing, refreshing : dry cleansing technology etc.
- In-situ Customizing processing such as localized additive manufacturing

Structural material for sustainable society

strong, tender and dependable material for the social system of sustainability

Strong as
elder brother



哥哥的強
gē gē de qiáng

Expand the human's activity frontier toward new environment, such as space, marine and underearth.
strong, tough, anticorrosion, heat resistant, light-weight, multi-function

Tender as
mother



母的和
Mǔ de hé

Multi-Function structural materials which provide well-being in the nature-harmonized living space of the future.

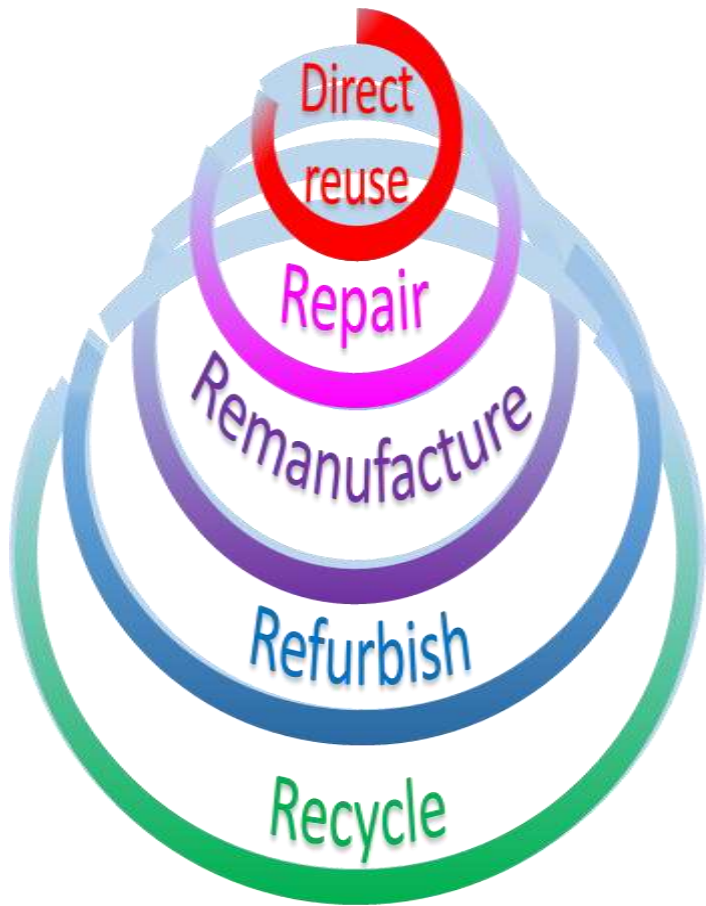
視sight : diversified design
聽aural: selective insulation
觸touch: organic-touch inorganics
膚skin: moisture control etc.

Dependable as
father 父的壯
Fù de zhuàng

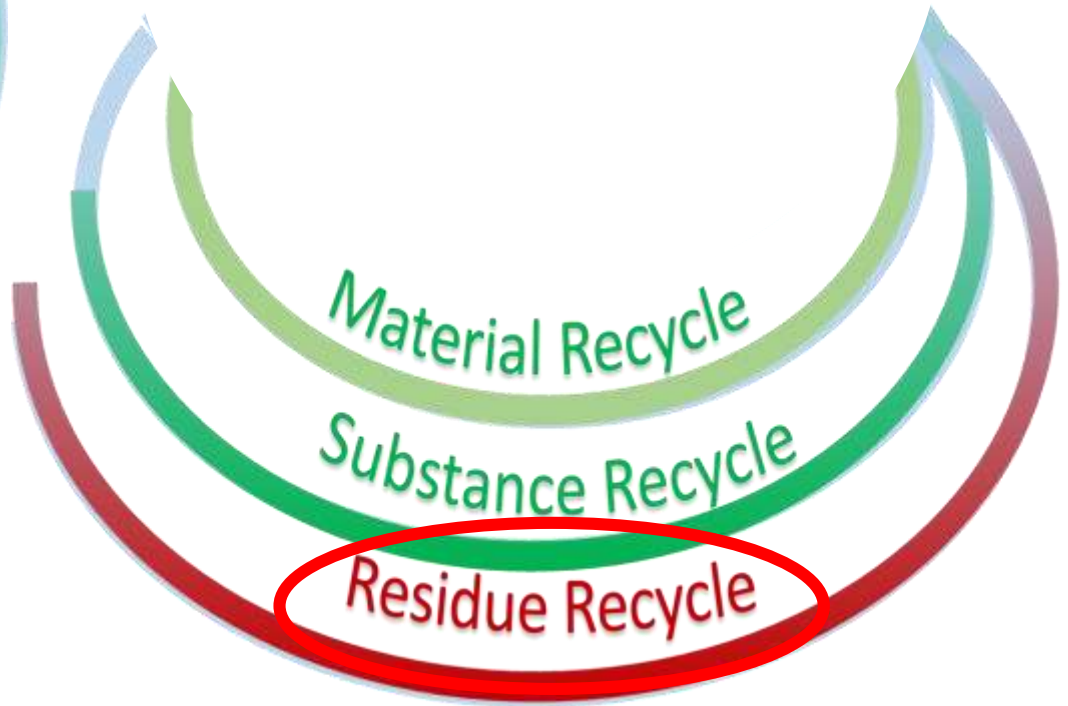


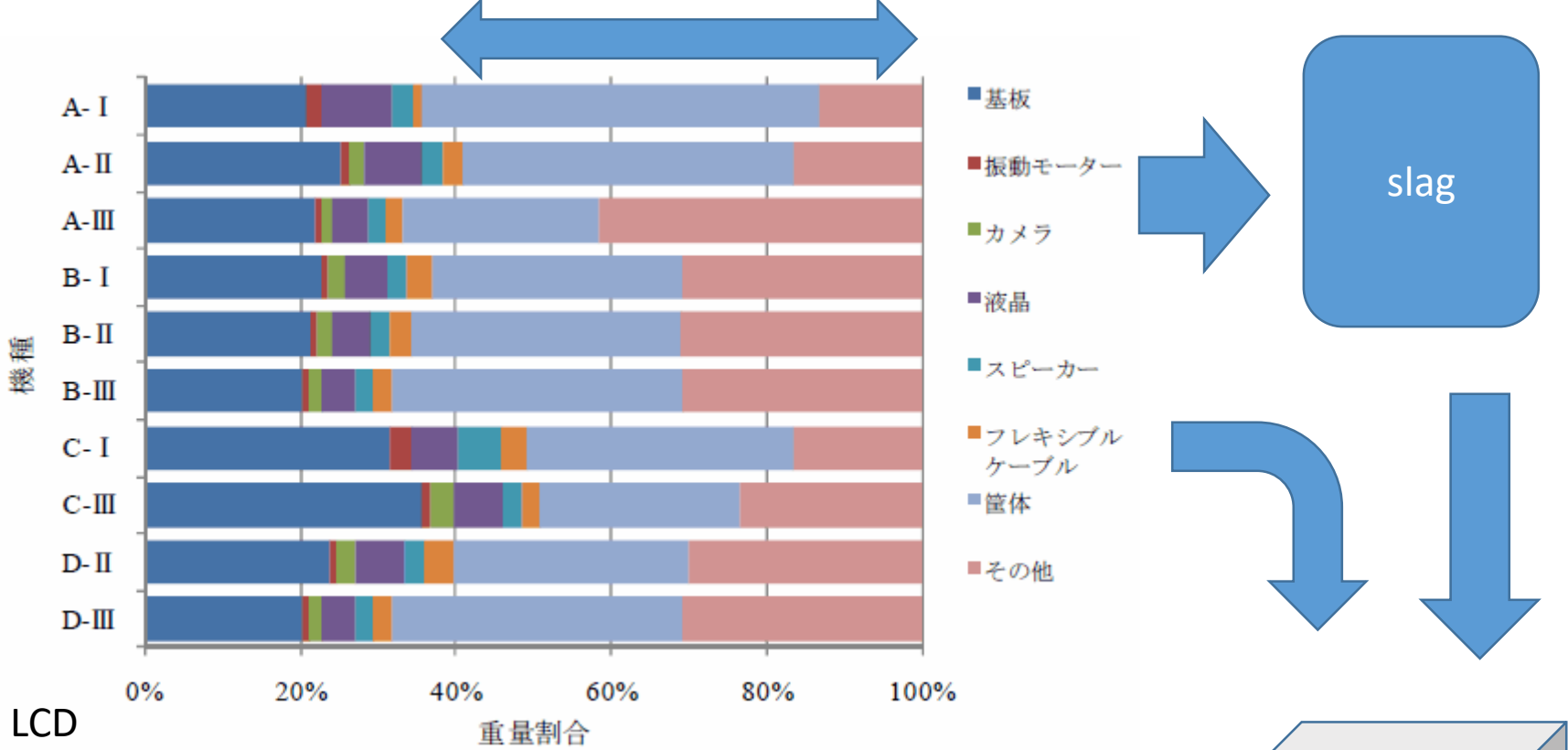
Dependable materials which have reliability of endurance for sever stress and its rapid fluctuation. Intelligent materials which predict , diagnose and respond to deterioration.

Halada: Sept. 2013 at Beijin



Recycle has three roles



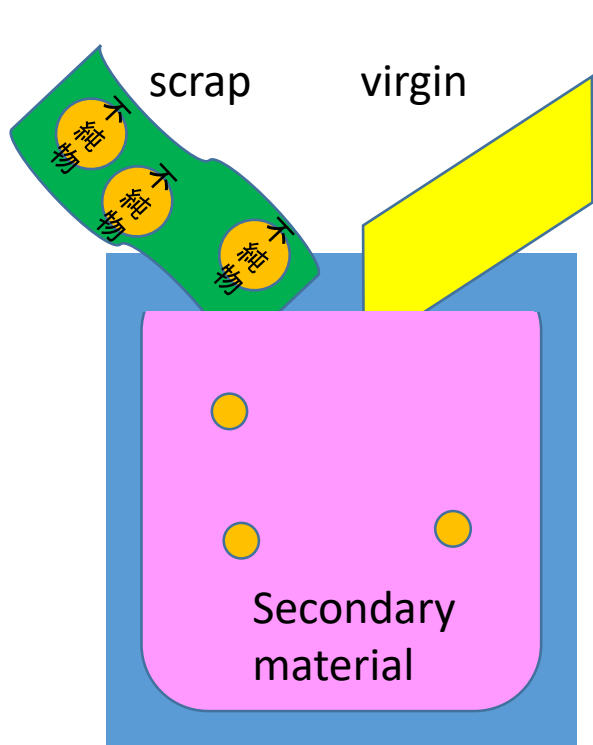


元素	2000-2002年
Ag	A-I
Al	1~5
As	
Au	
B	1~5
Ba	0.5~3
Ca	0.5~3
Cr	
Cu	0.01~0.1
Fe	
In	0.01~0.1
Mg	0.1~1
Mn	
Mo	
Ni	
Sb	
Si	10~30
Sr	
Ti	0.005~0.05
W	
Zn	

基板	A-I
元素	2000-2002年
Ag	0.262
Au	0.113
Co	0.031
Cu	25.7
Dy	0.014
In	0.008
Nd	0.112
Pd	0.012
Sm	<0.01
Ta	0.180
W	0.132

Ag 0.05%
Au 0.02%
Co 0.06%
Cu 5%
Dy 0.003%
In 0.0015%
Nd 0.02%
Ta 0.04%
W 0.025%

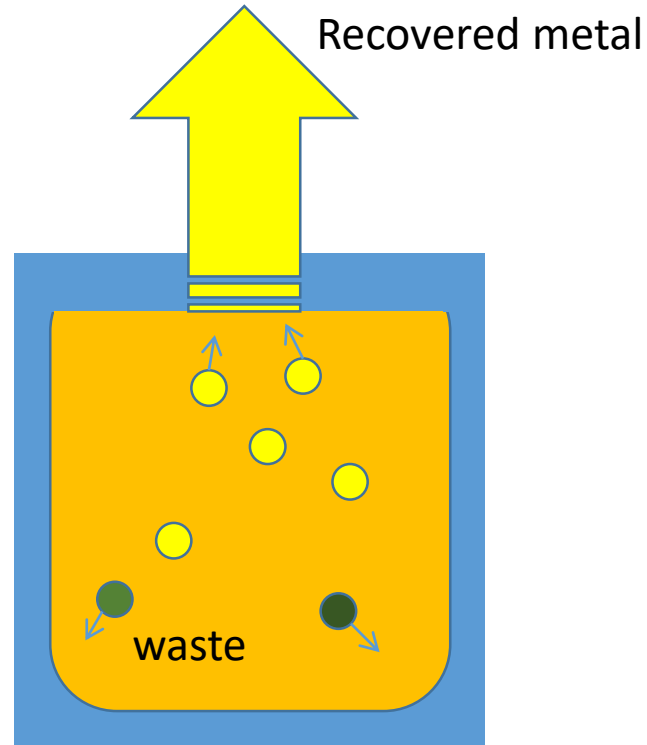
Two different types of recycling



Dilution-type

: Fe, Al, plastic, paper, glass

De-grading of material

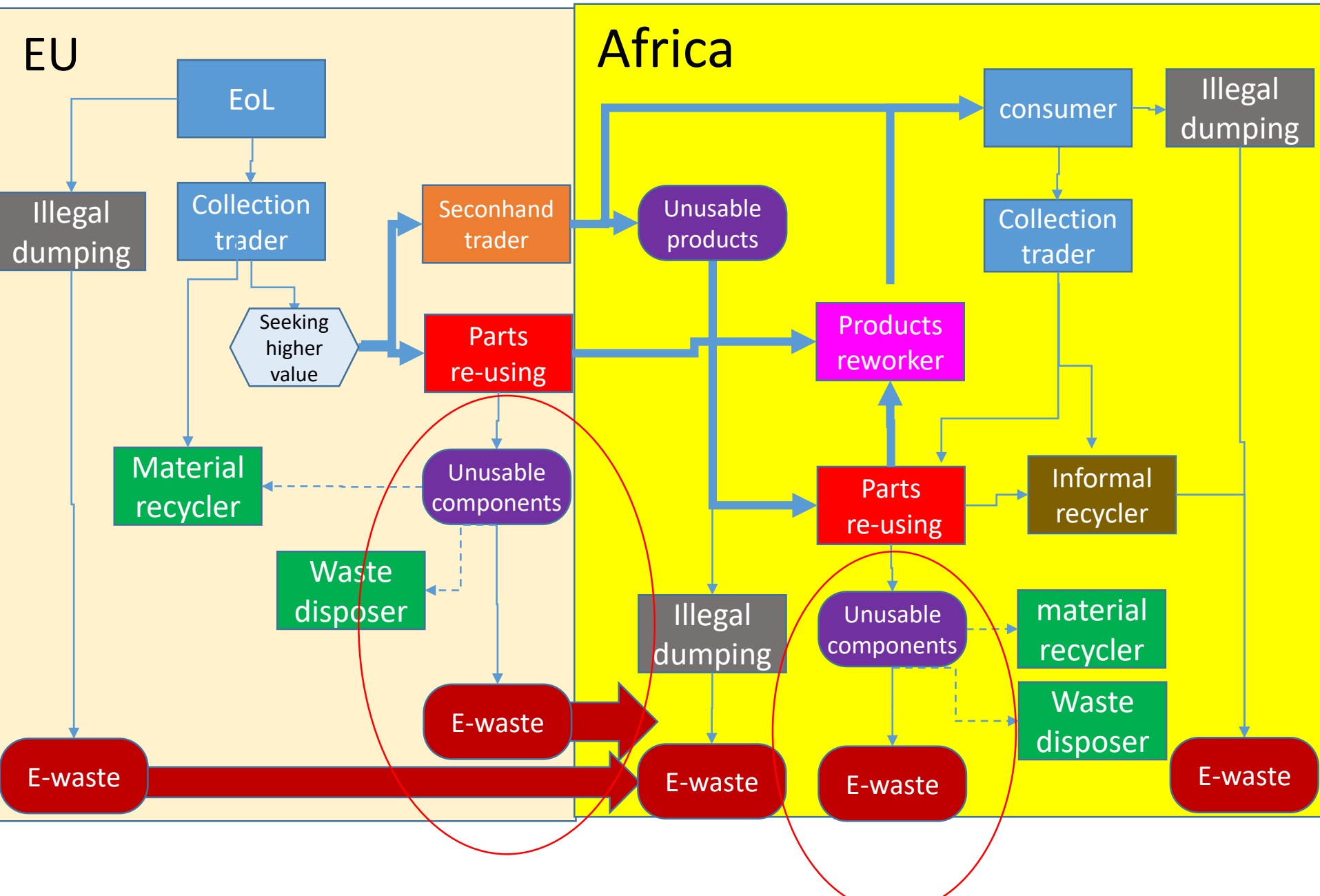


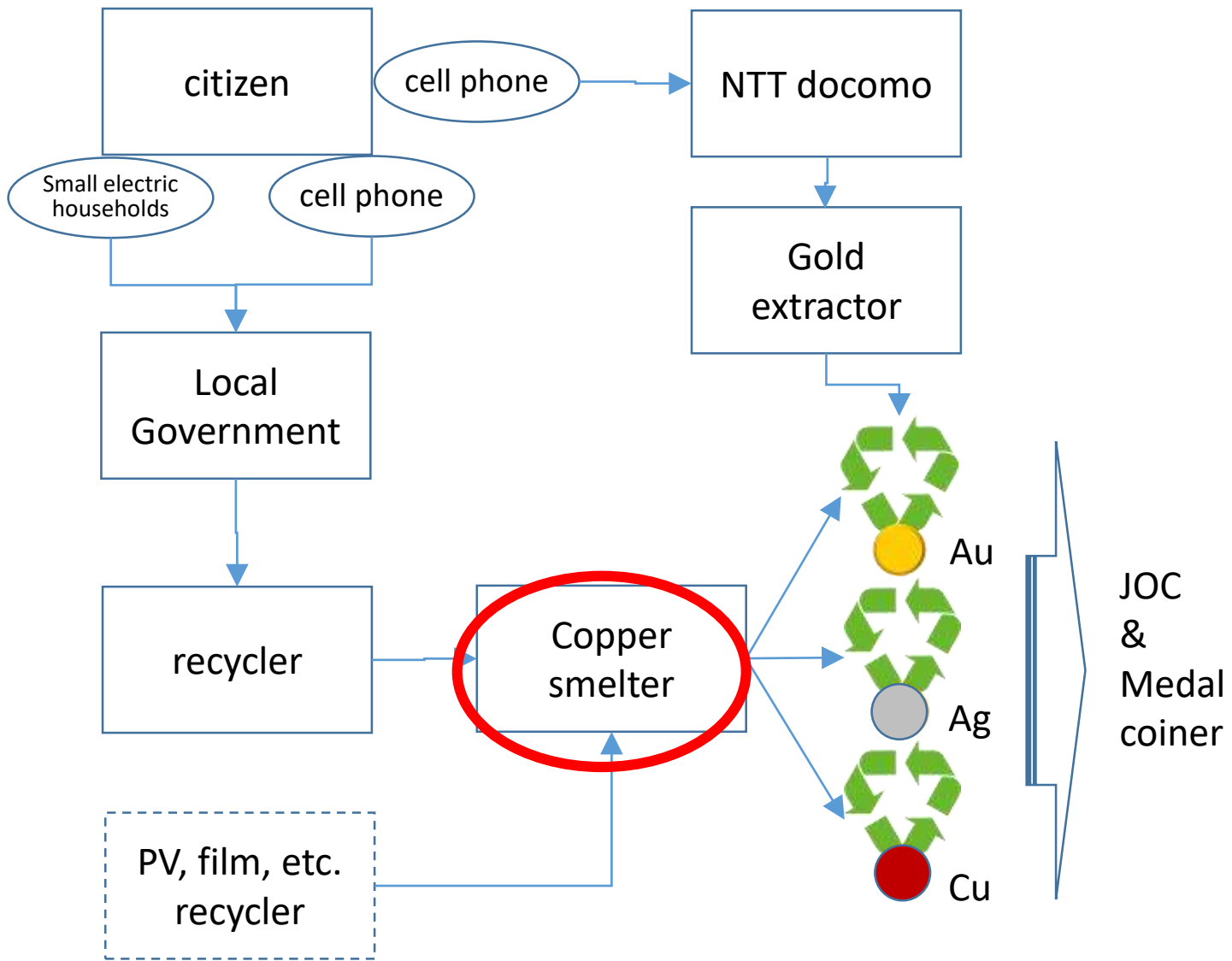
Extraction-type

Rare metals, precious metals

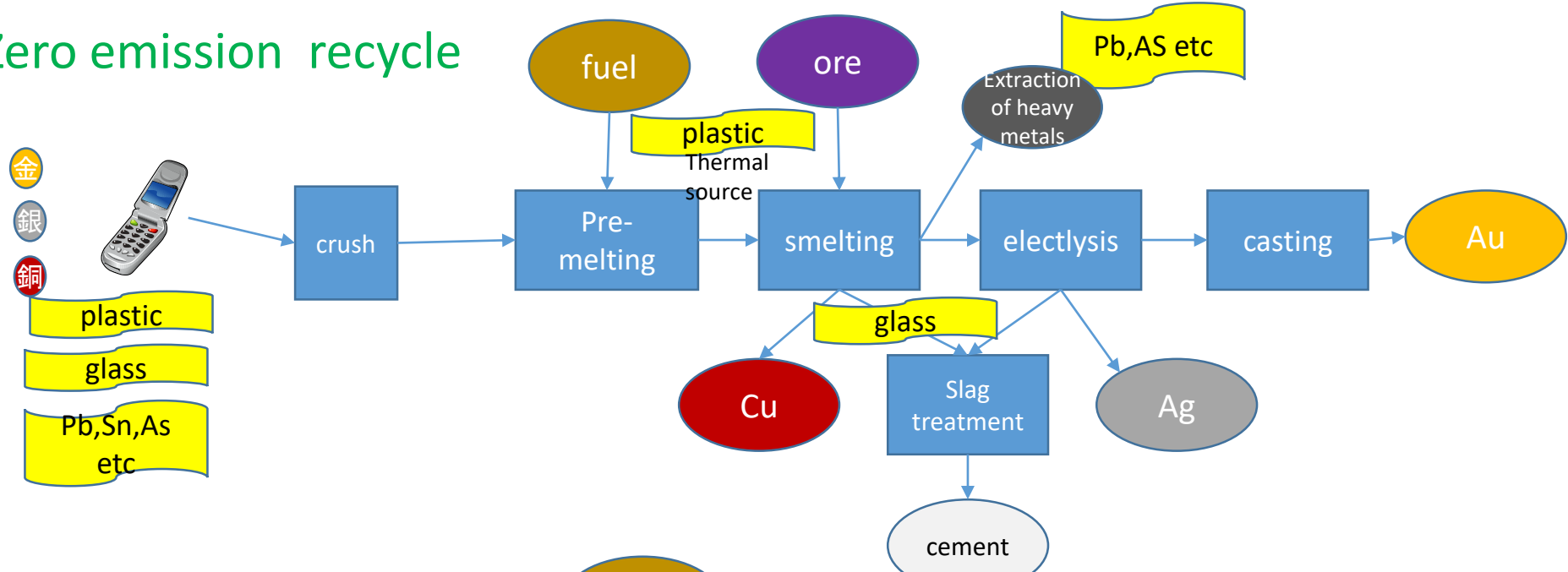
much waste than obtained

Structure of the issue of E-waste

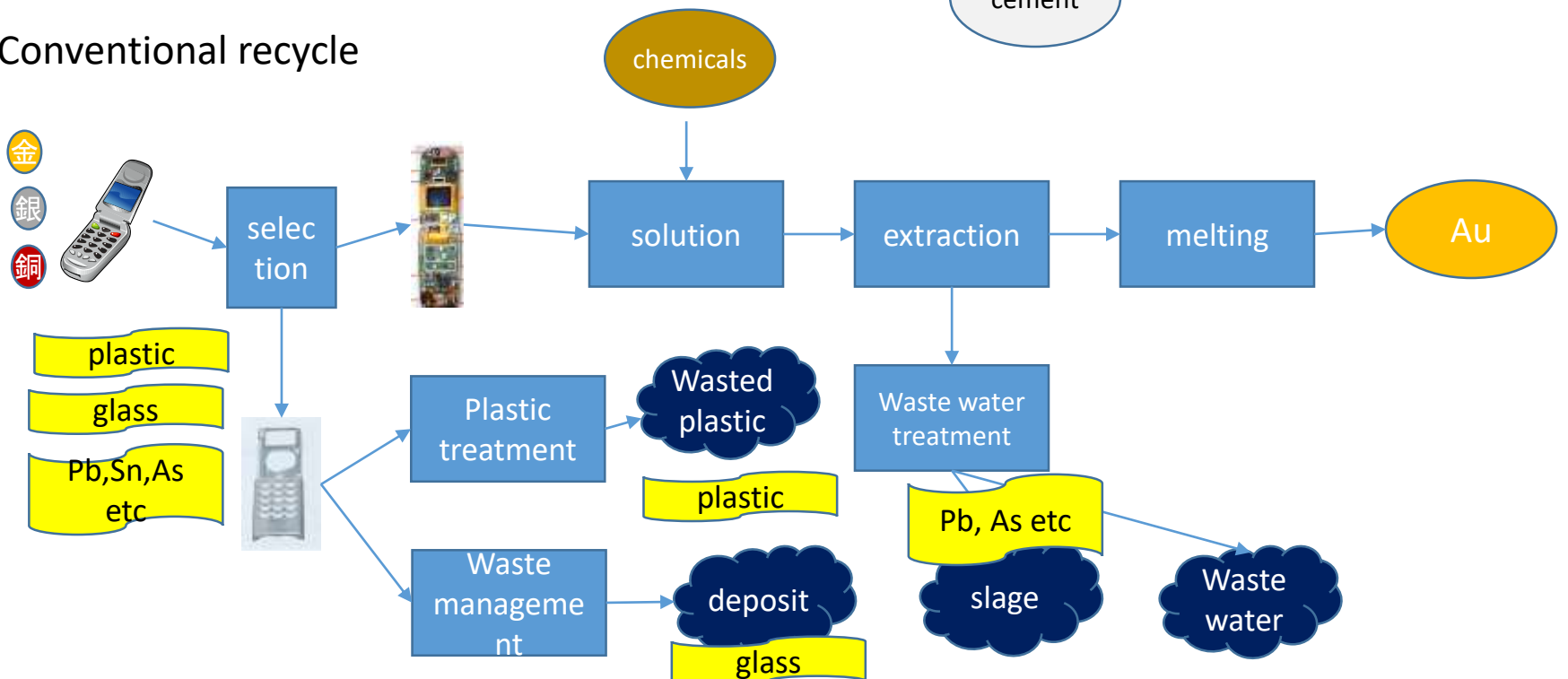


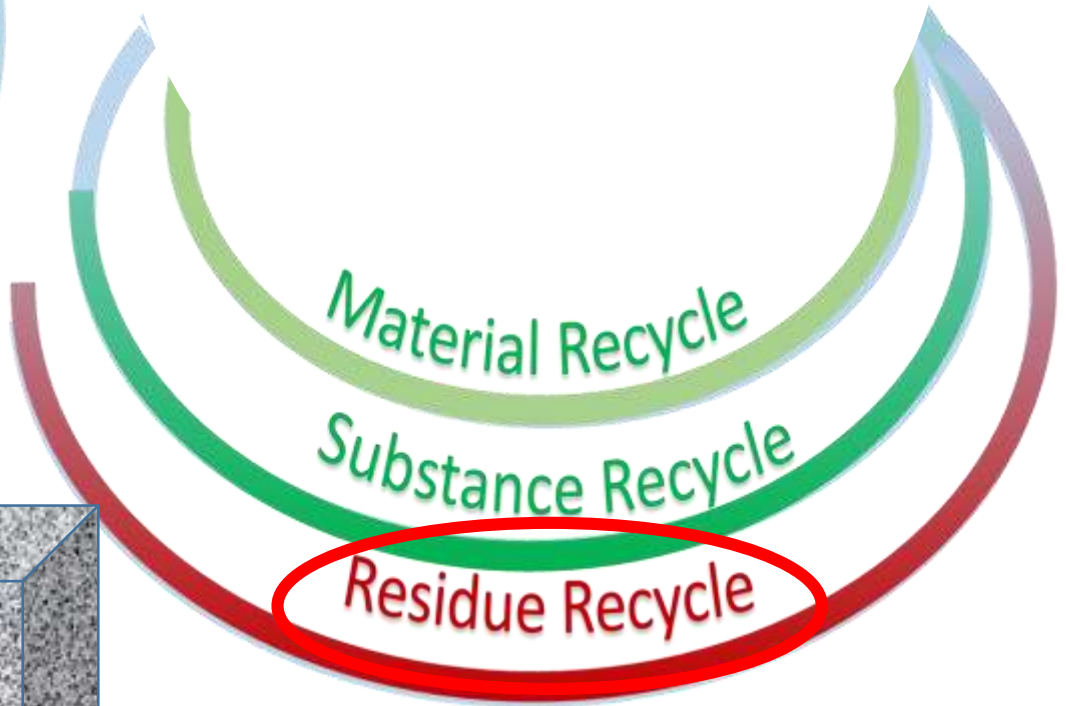
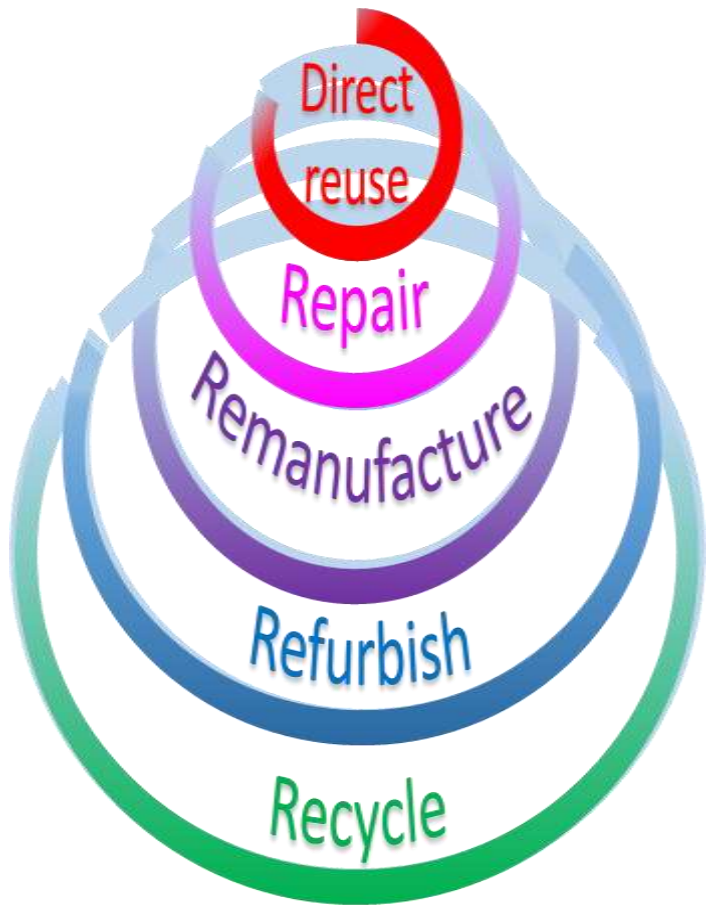


Zero emission recycle

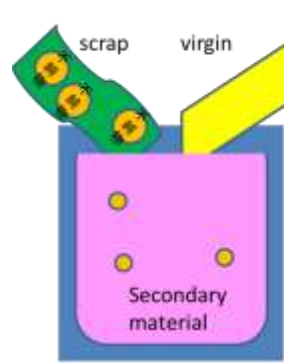
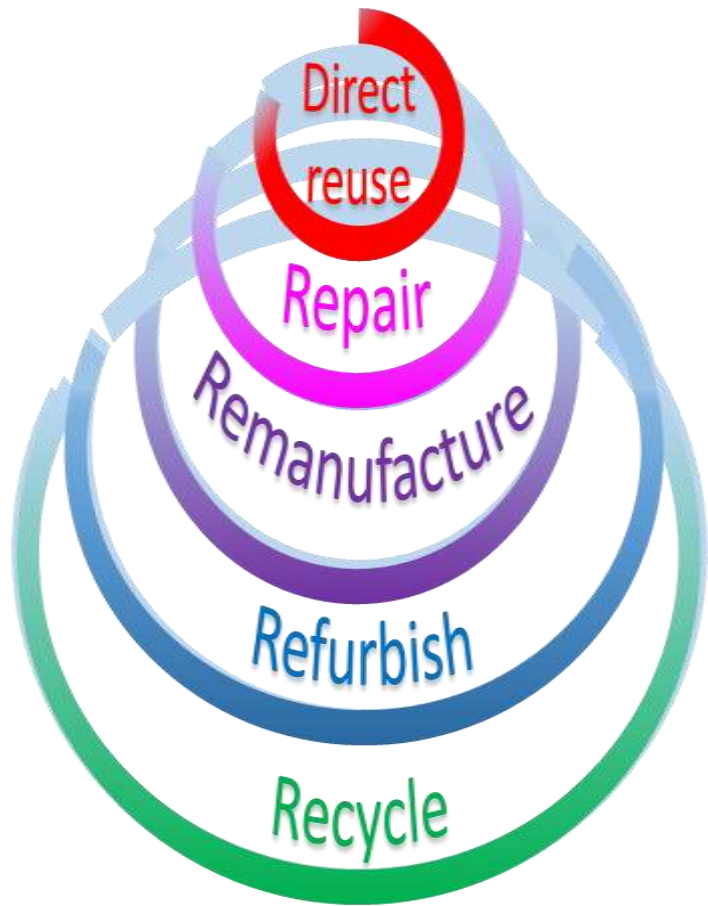


Conventional recycle

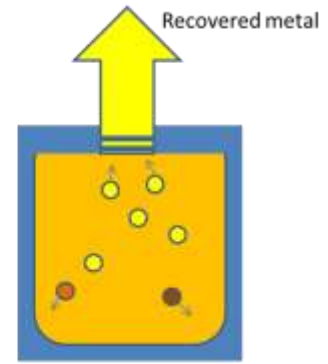




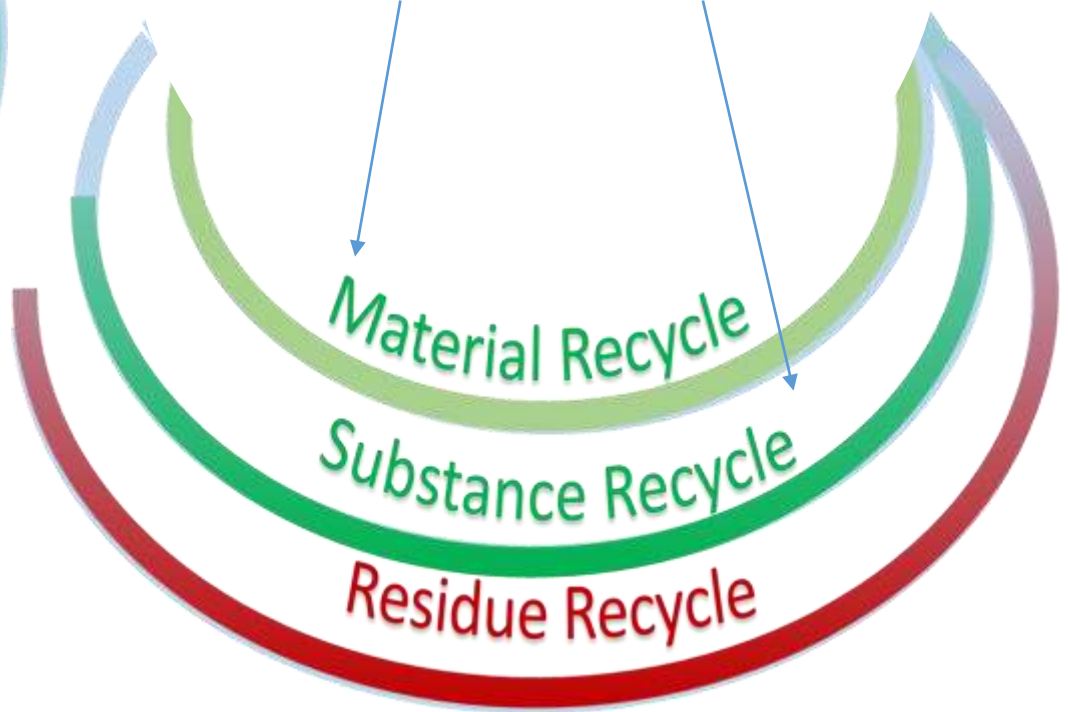
Slag, Ash, Mud to
Social infrastructure



Dilution-type
: Fe, Al, plastic, paper, glass
De-grading of material



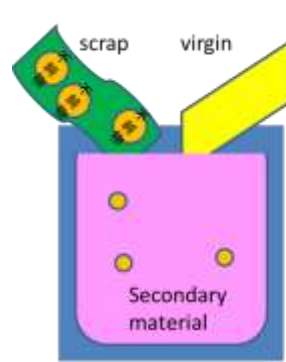
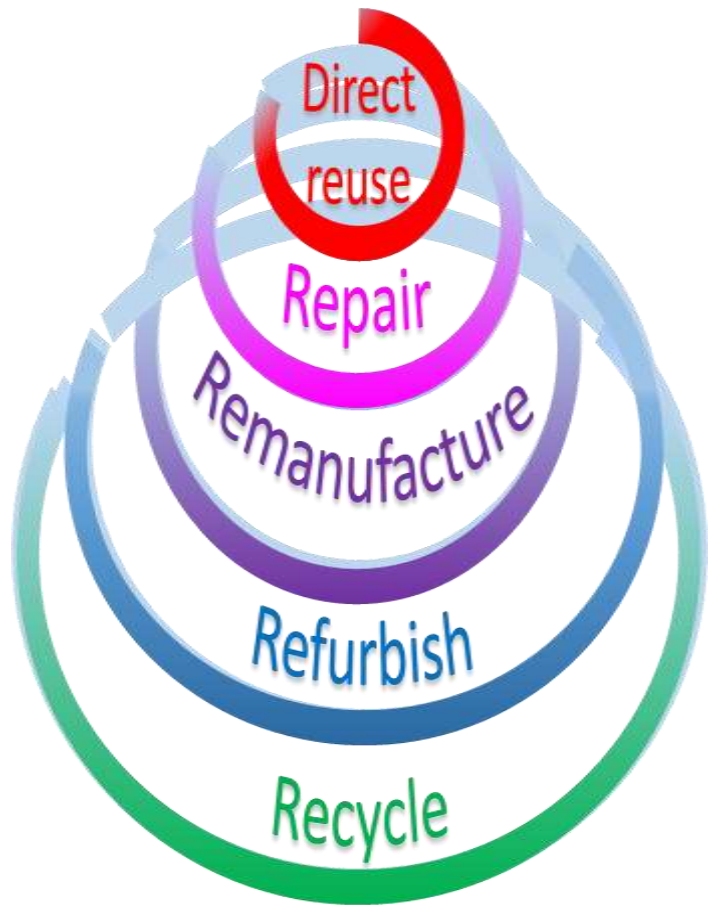
Extraction-type
Rare metals, precious metals
much waste than obtained



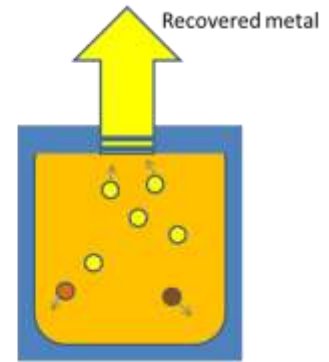
Technology for horizontal recycling

- Metal : control by structure not by composition ○
- Plastic : science of strength of polymer and additives
- ceramic : healing technology of damage

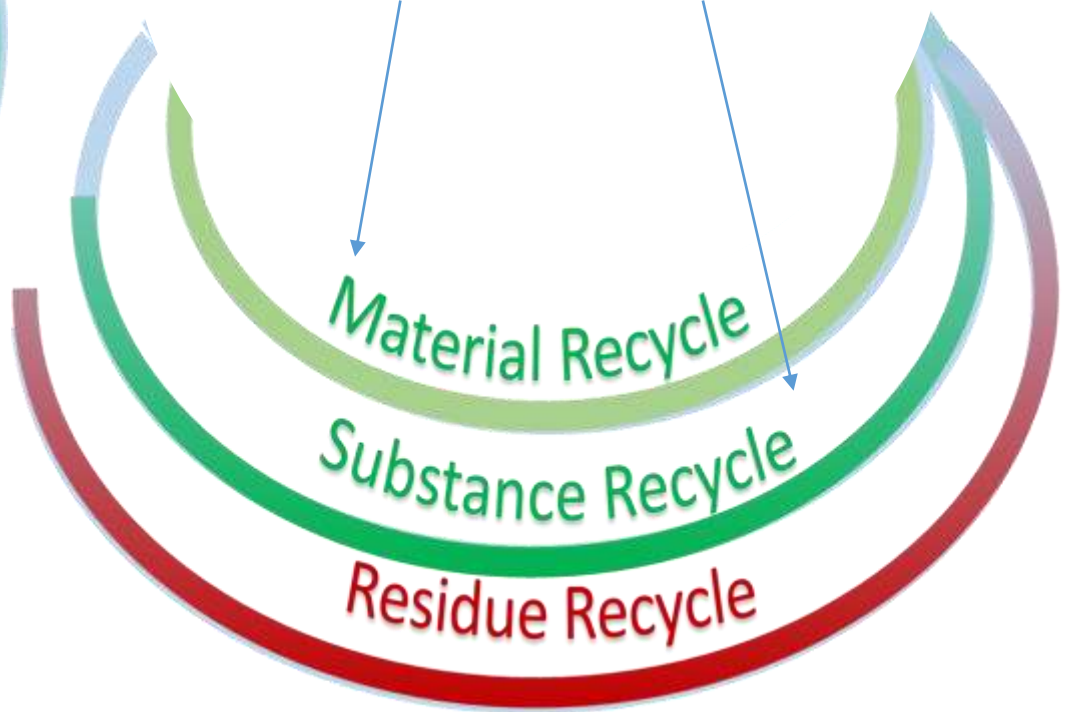




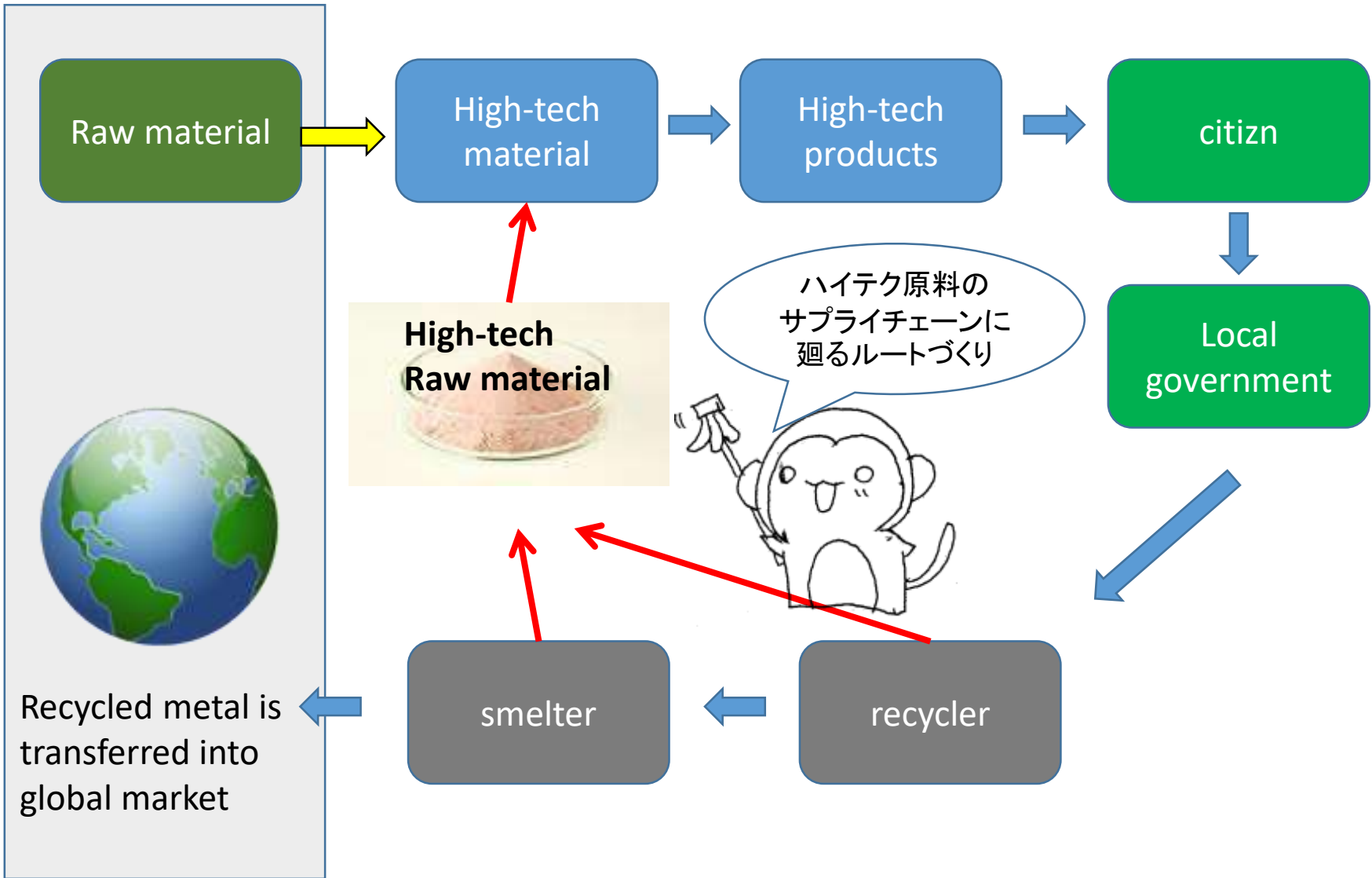
Dilution-type
: Fe, Al, plastic, paper, glass
De-grading of material



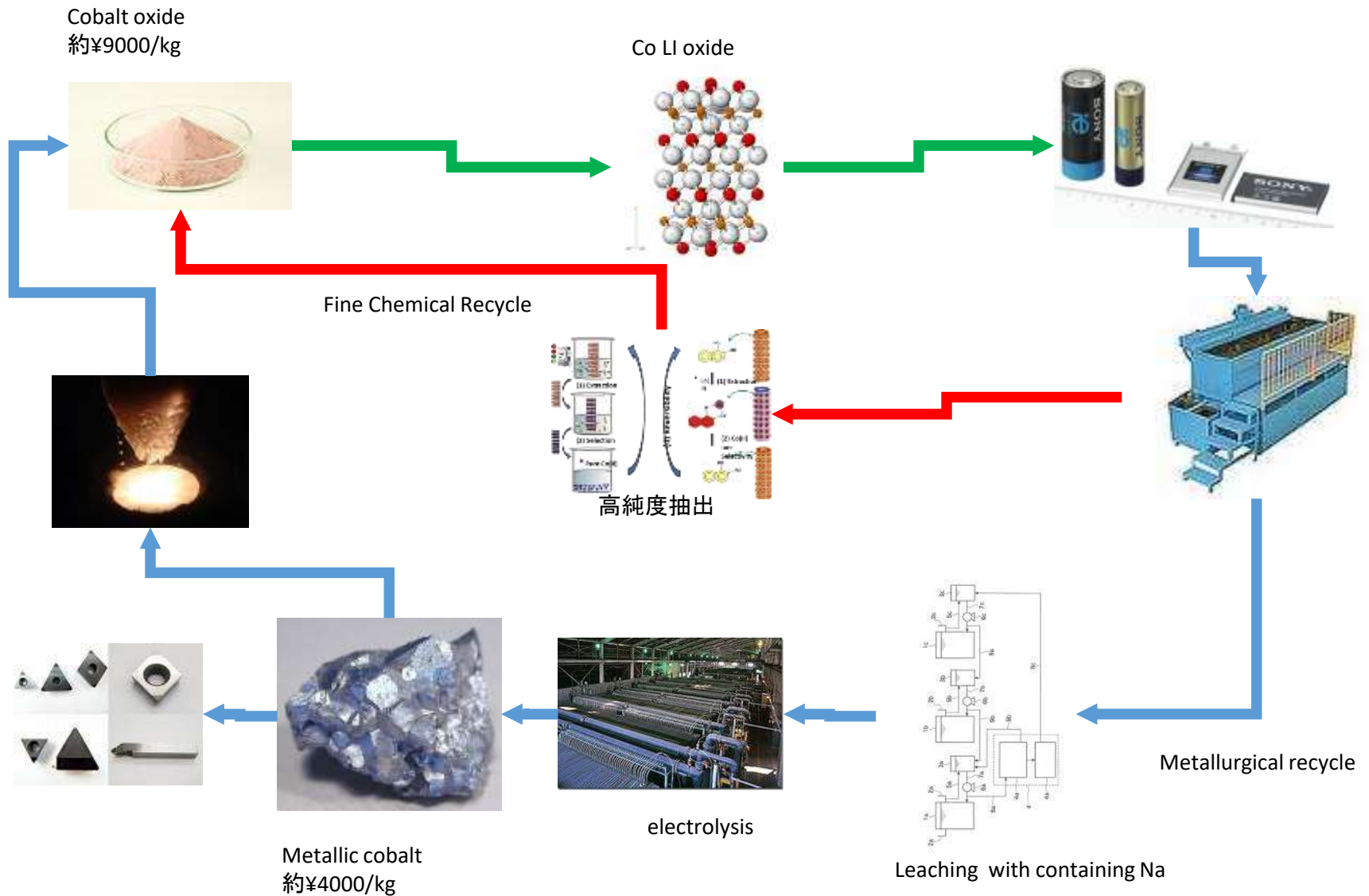
Extraction-type
Rare metals, precious metals
much waste than obtained



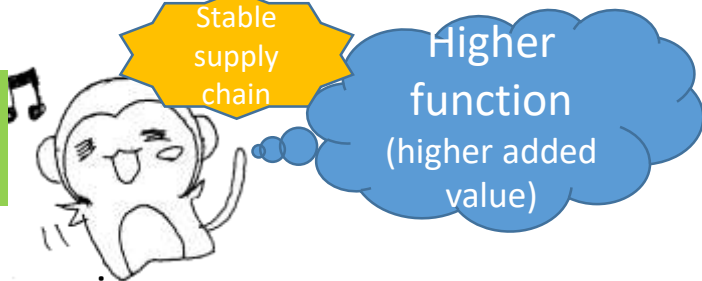
Recycling goes back to supply chain



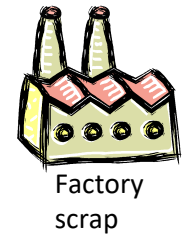
Fine chemical recycle of Co from LiB



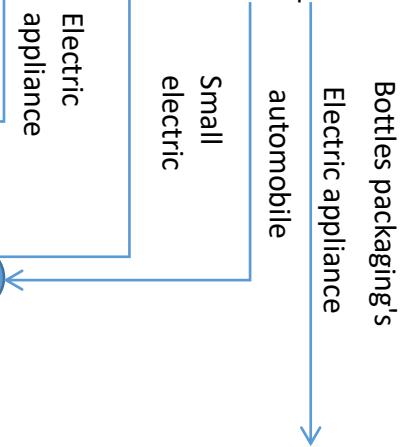
Raw material acquisition



Requisites raw is
Acquired by recycle



New wave



High grade
Less impurity



File chemical

Mass produces

reduction



Find value
Make value
Into **Goods**

Valuables
are converted

Generalize



General material

environ
ment

Waste lay off
recycling

Burden share

Robustness,
stability

Bads is
salvaged and defused



Construction



Fabricator generates high value secondary resources



But they have no facility To refine them.



Fine chemical refining factory

Transported as half-finished raw material

Preliminary Mobile recycle comes to generation site

Let us make the Mottainai World!

Wide-area Multi-value Circulation

Circular Economy of productive Asia

