



Circular economy: time for quality

Visions, ideas, perceptions, value, assessment, optimisation

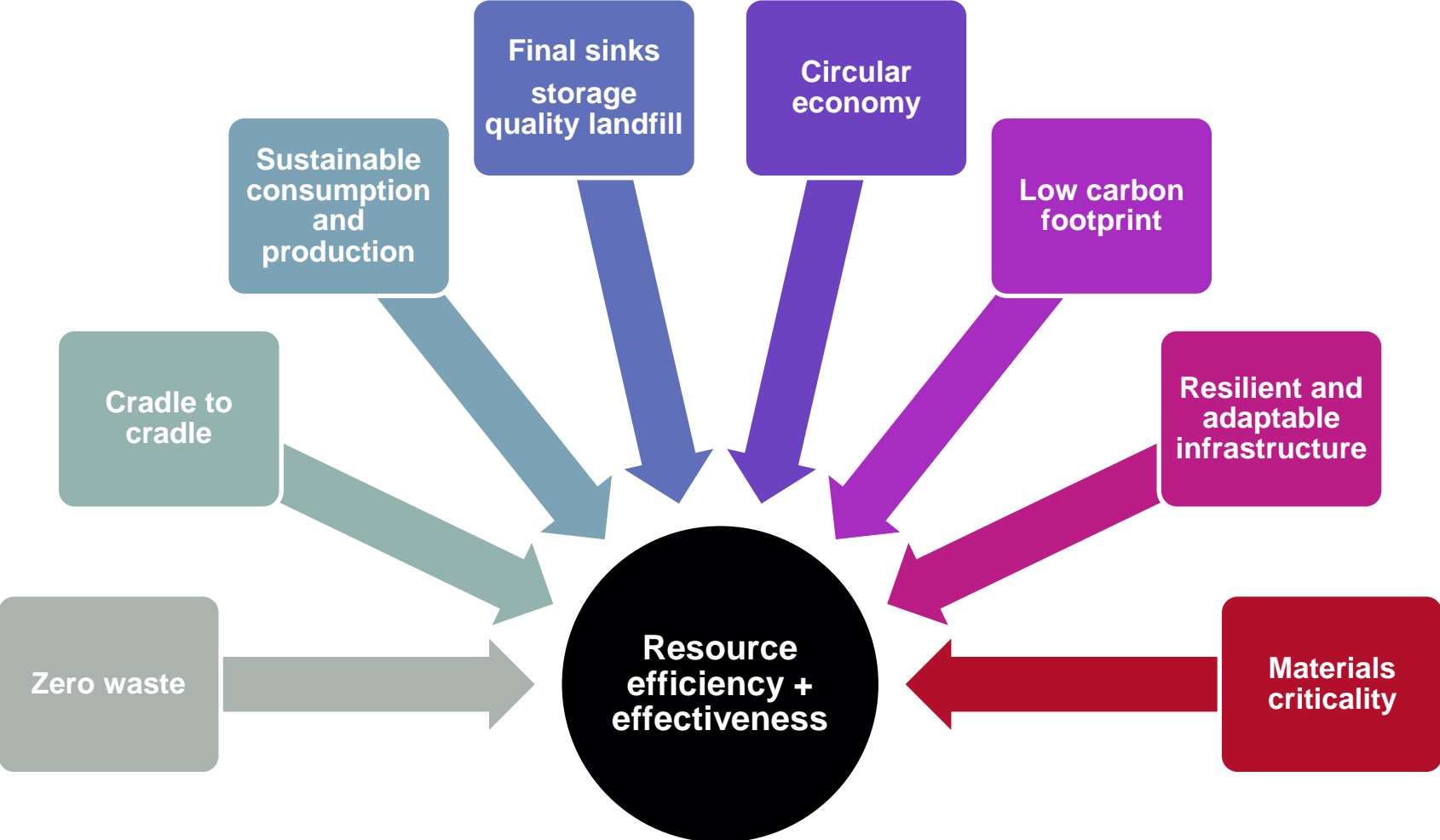
Dr Costas Velis



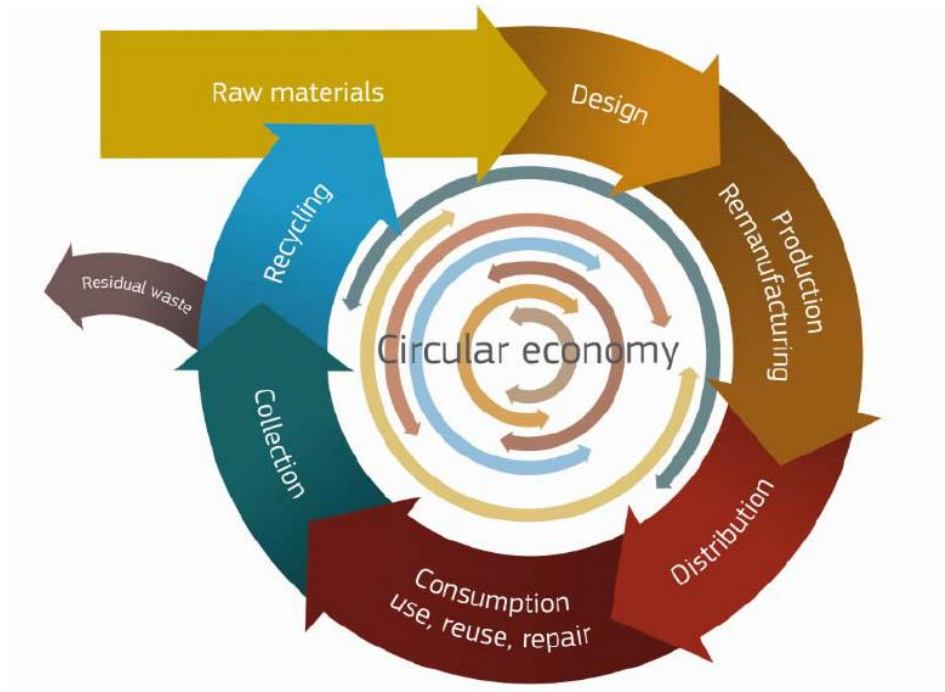
Local Energy from Local Waste
CEWEP Congress

Brussels, 24-25 September 2014

Resource management – which vision?



Who cares about waste hierarchy? (40 years old concept...)



‘Towards a **circular economy**:
A **zero waste** programme for Europe’

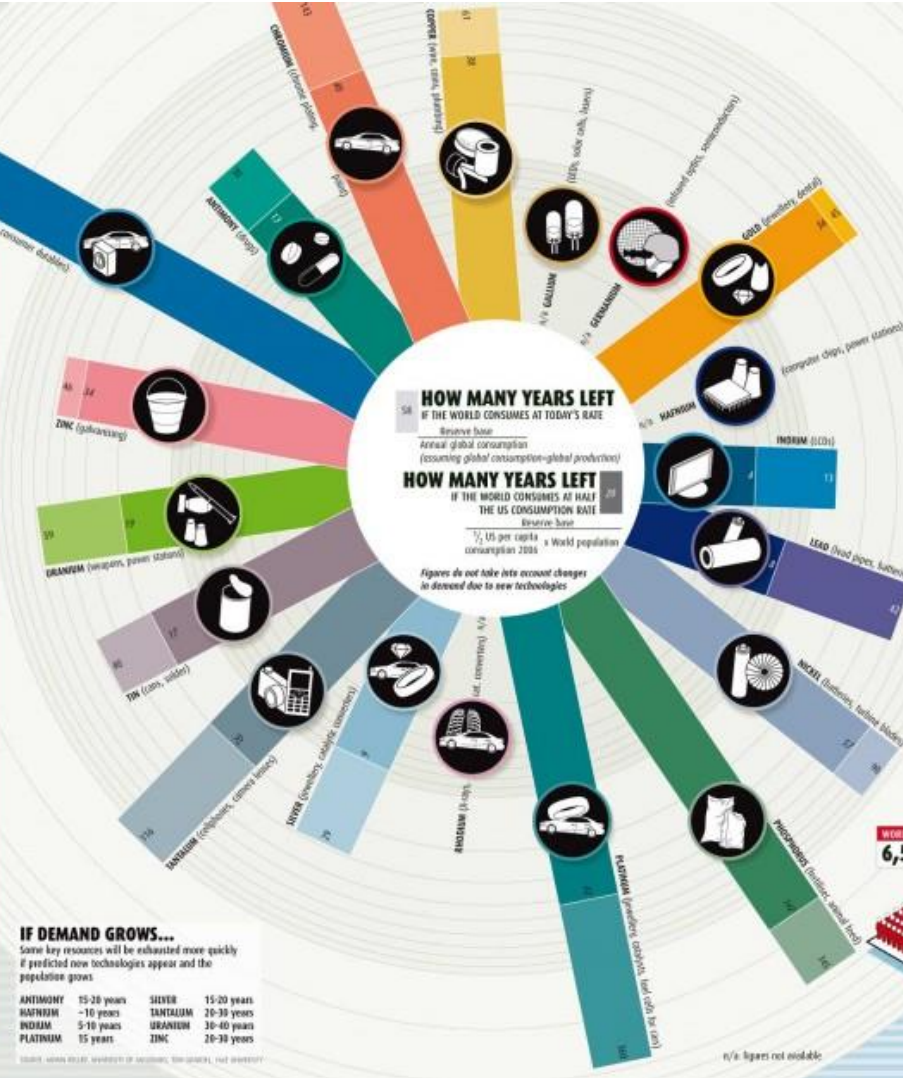
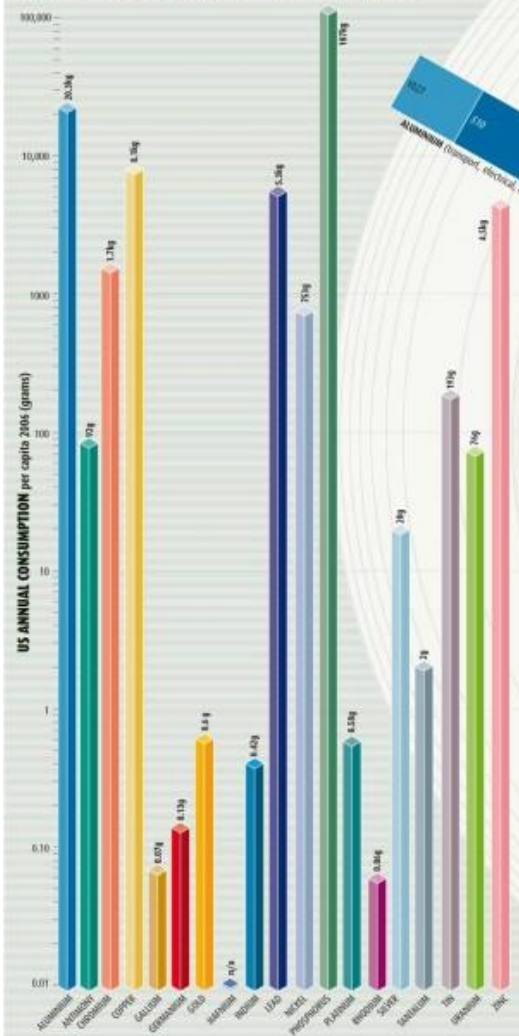
Product Longevity and minerals consumption

Infographic by Armin Reller of the University of Augsburg and Tom Graedel of Yale University

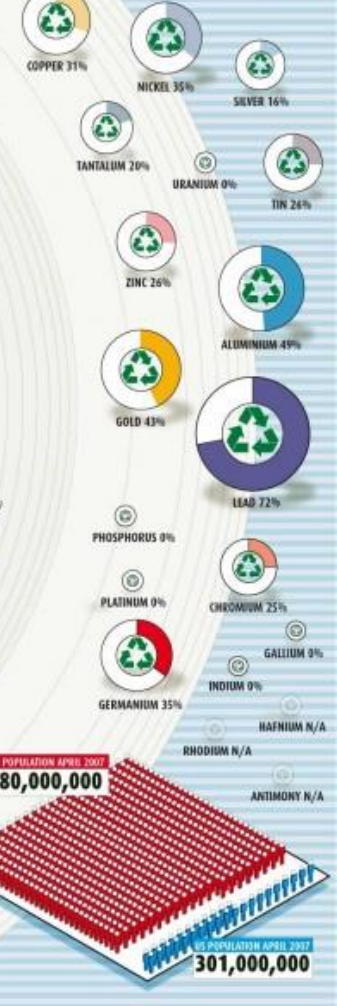


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HOW LONG WILL IT LAST?



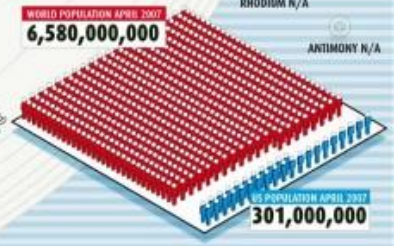
PROPORTION OF CONSUMPTION MET BY RECYCLED MATERIALS (%)



IF DEMAND GROWS...
Some key resources will be exhausted more quickly if predicted new technologies appear and the population grows.

ANTHONY	15-20 years	SILVER	15-20 years
HAFNIUM	~10 years	TANTALUM	20-30 years
INDIUM	5-10 years	URANIUM	30-40 years
PLATINUM	15 years	ZINC	20-30 years

SOURCE: ARMIN RELLER, UNIVERSITY OF AUGSBURG, BUNDESBANK, THE UNIVERSITY OF LEEDS

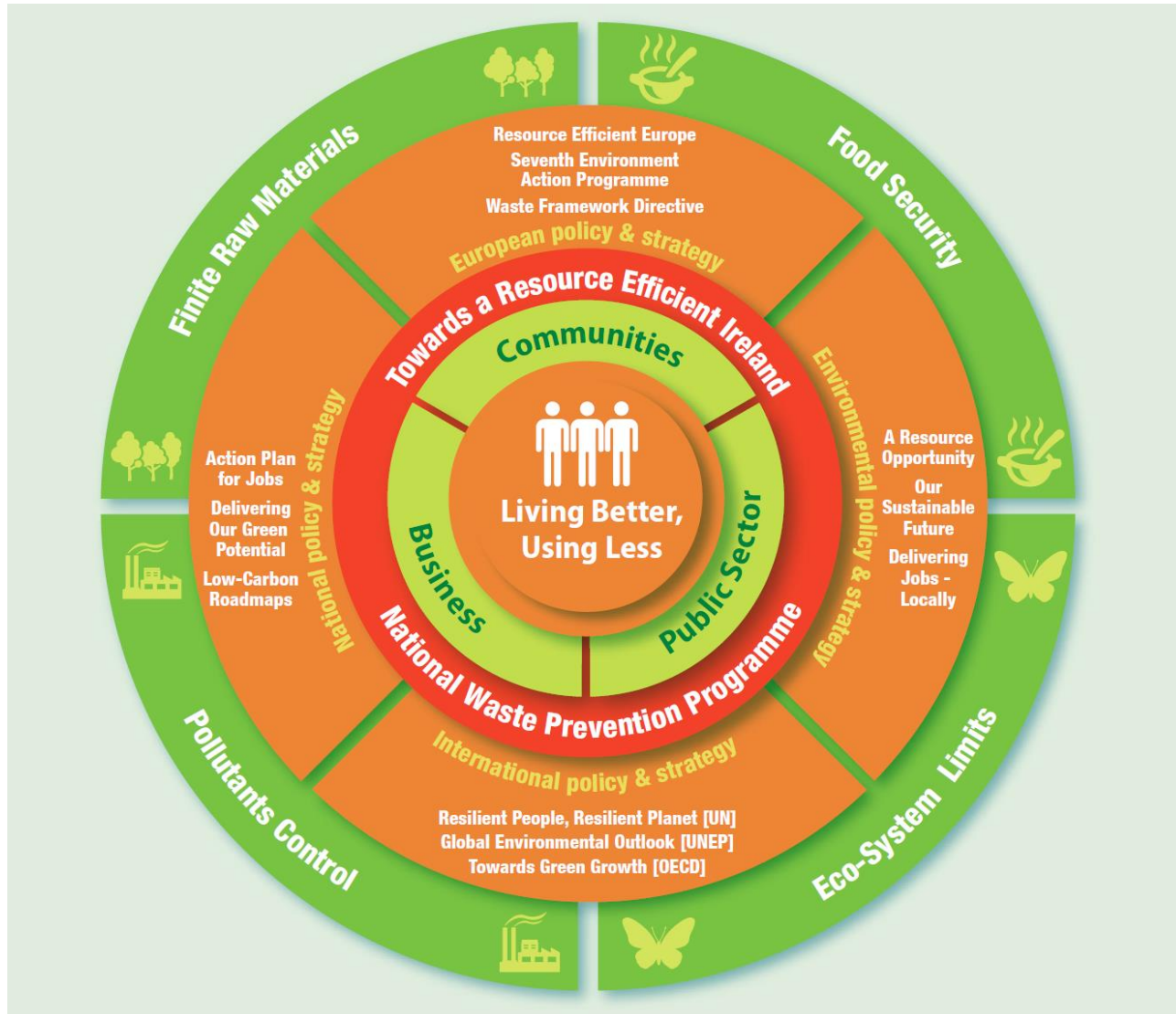


n/a: figures not available

“Towards a resource efficient Ireland”



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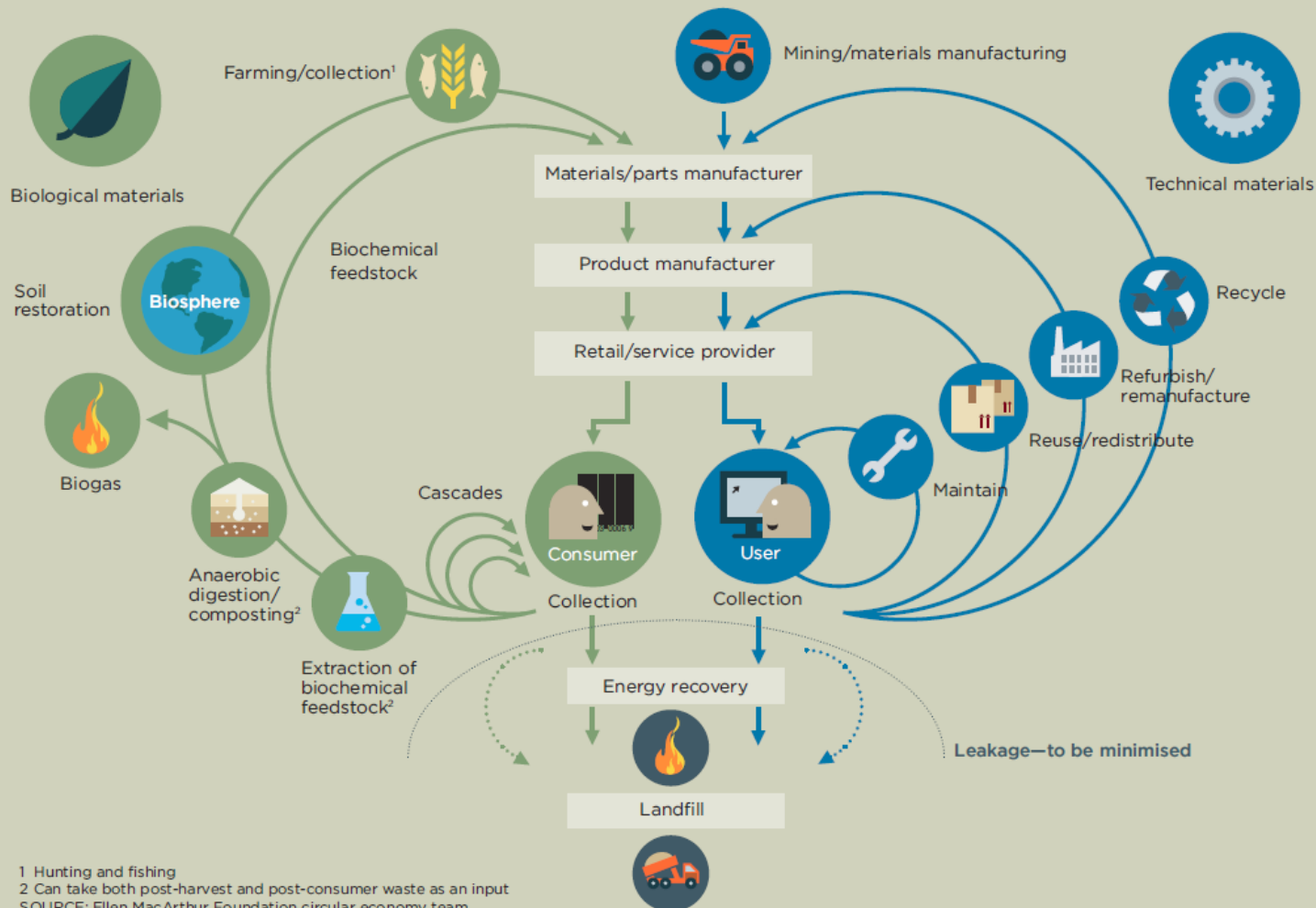


Ellen MacArthur Foundation vision of circular economy



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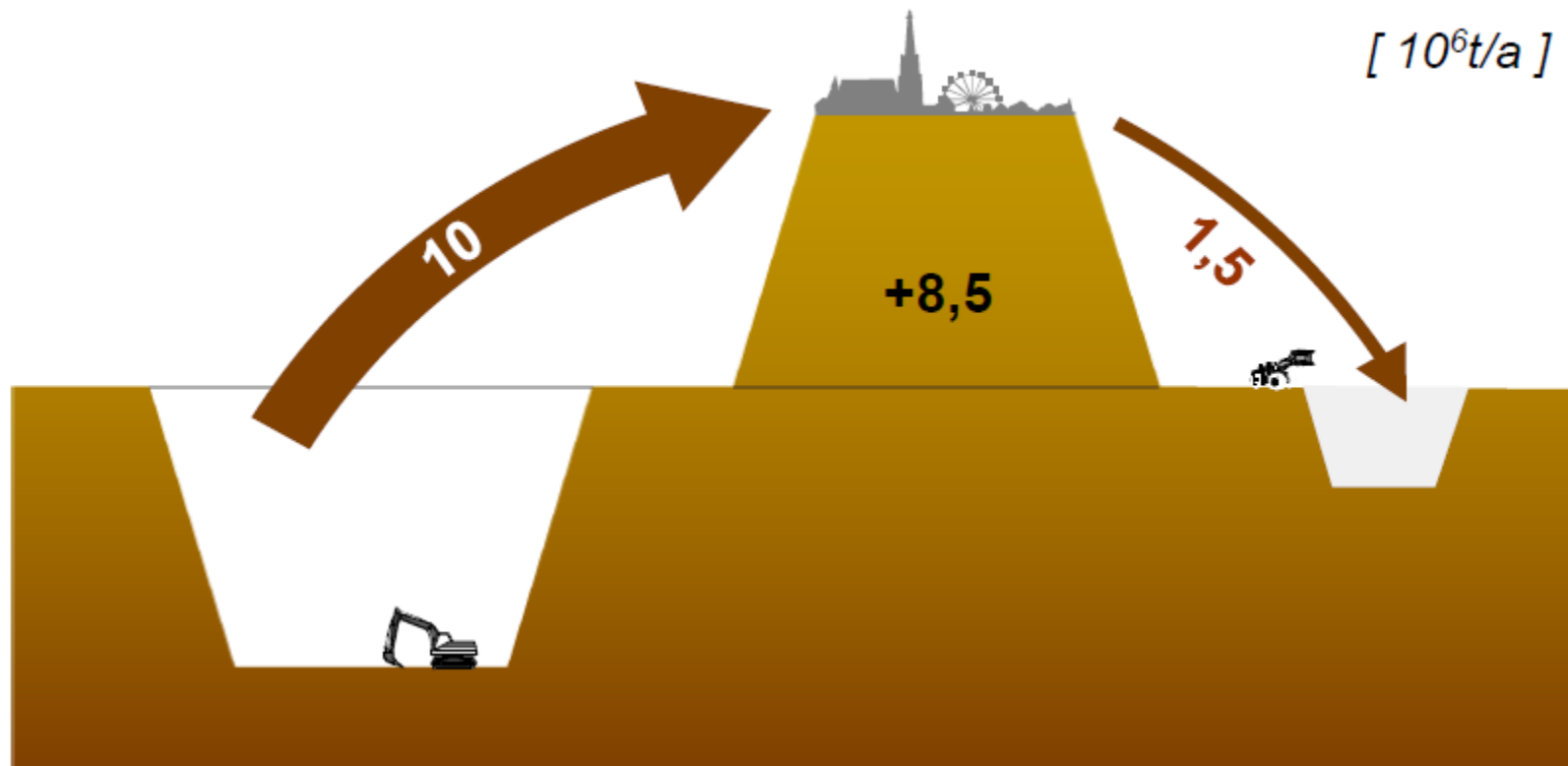
FIGURE 4 The circular economy—an industrial system that is restorative by design



Material flows in anthropo- or techno-sphere (cities)



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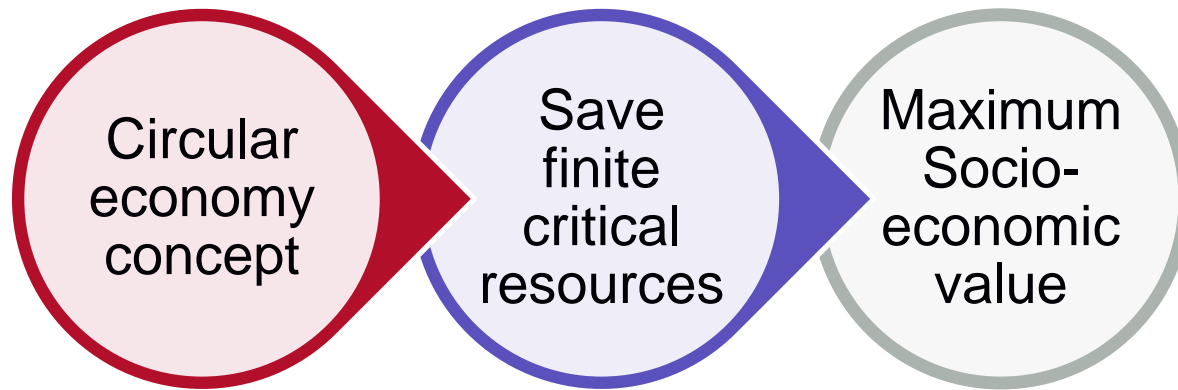
Graph source: TU Vienna
Prof Paul Bruner



Circular economy = (closed)-loop economy?



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Better society – how?



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Start

High level goals

- Set the right ones
- Societal agreement?
- Inertia?
- Technical elites?
- Influential groups?
- Comitology legacy?
- Co-creation?



Stop to reflect

Evidence base

- Track record
- History
- Predictions



New coherent policy

Action

- Targets?
- Main goal
- Side effects

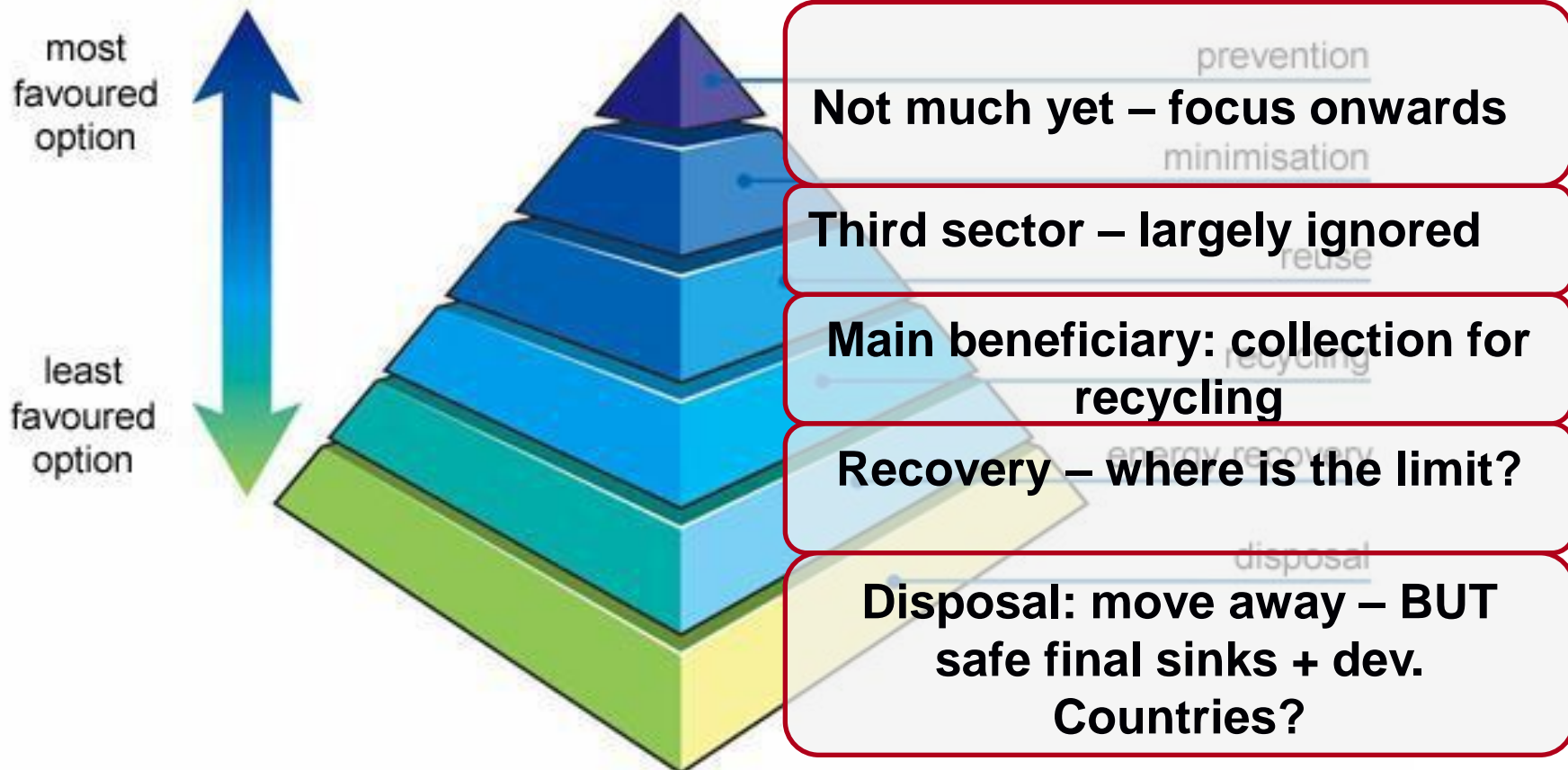


- **1990: poor recycling levels for EU 12 MSs:** municipal waste recycling
 - Ranged from **1 to 20% wt.**
 - Half of 12 MSs between <1 – 6% (Source: Environmental Resources Limited:1992)
- **Today:** High recycling rates (**40% or more**) achieved – targets set
 - Benefits of technical and bio-based (green) materials recycling / recovery rediscovered
 - Invested heavily in physical infrastructure and communication strategies
- **A resource efficiency motivation?**
 - **Not primarily driven by commodity value of recovered materials**
 - Recycling market as a competitive ‘sink’ - alternative to increasingly expensive landfill disposal and EfW

Waste hierarchy according to revised WFD: 2008/98/EC Directive (Art. 4)



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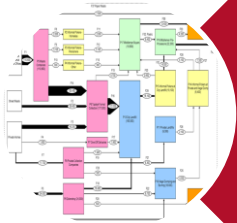
Source: <http://www.ehsgs.com/company-ethos.html>

At best: just a static “environmental” hierarchy of waste processing options: simplistic >> simple?

Is waste hierarchy outdated in a globalised recycling system?



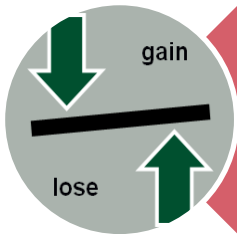
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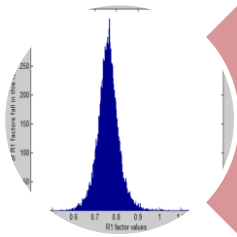
No systems - boundaries



No multiple aspects of value



No trade-offs

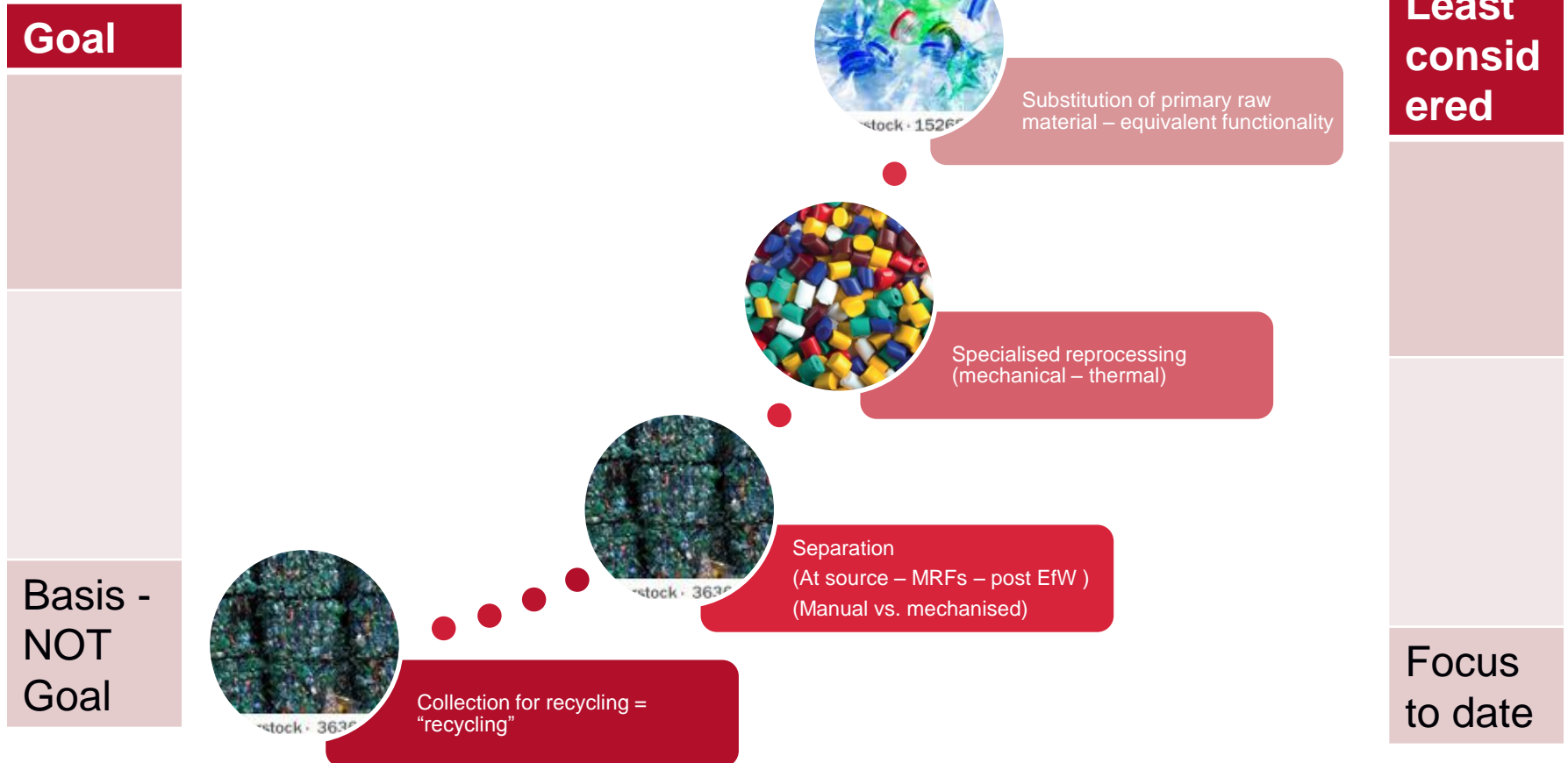


No optimisation

Meaning / role of “recycling”



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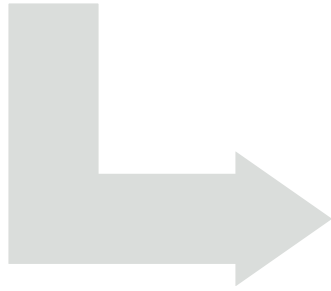
Quality in secondary material cycles



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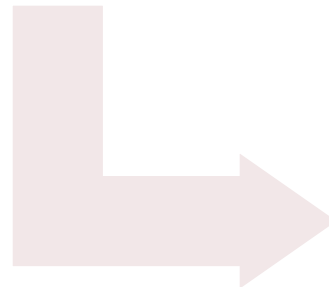
Quality

- Technical specifications
- Average
- Variation
- Steady in time
- Contamination
- Value over effort



Capture
(Collect)

- Sufficient quantity
- Meeting technical specs
- Minimise reject flows
- Optimise emissions + sustainable sinks
- Document flows



Reprocess

- To technical specs
- Using less resources (energy, water)
- Minimise emissions + sustainable sinks

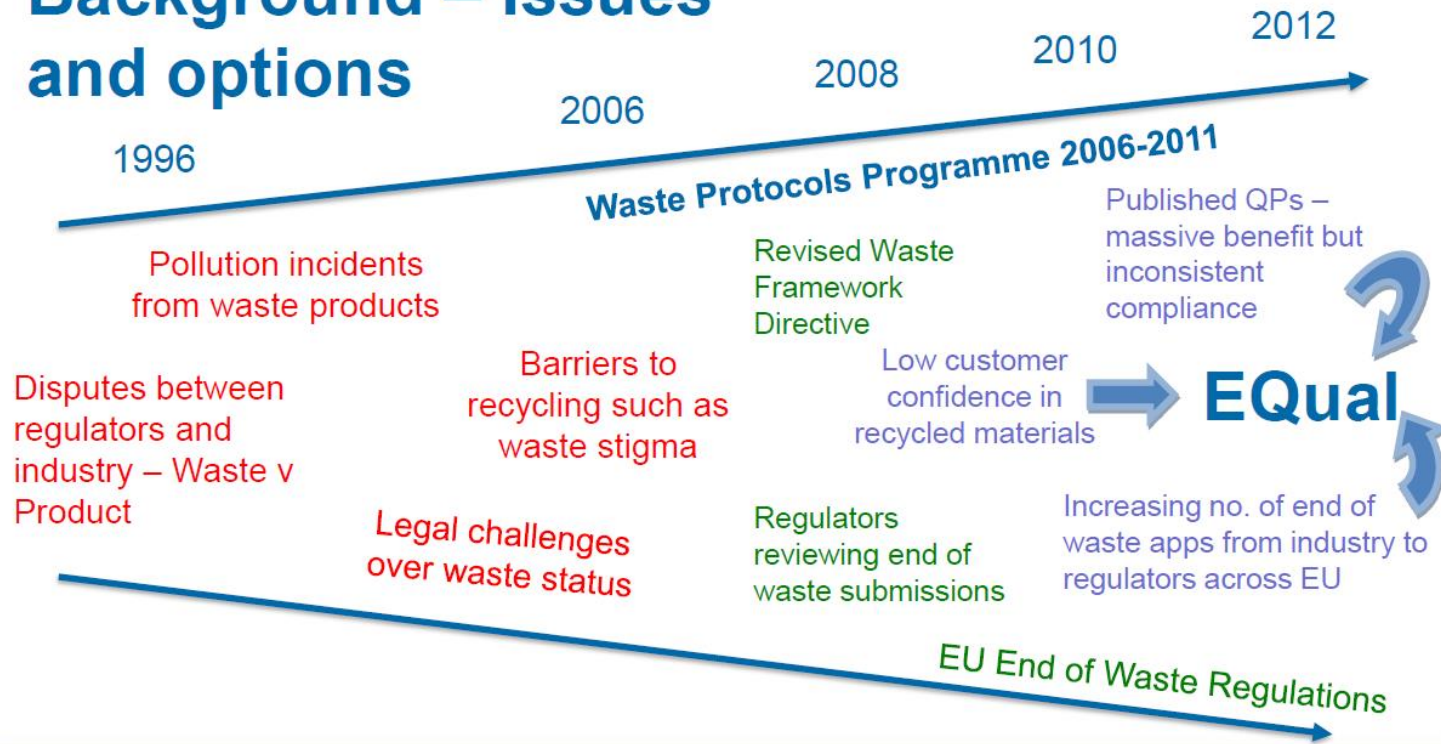
End of Waste – UK implementation



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Background – Issues and options



Source: <http://www.environment-agency.gov.uk/aboutus/wfo/134219.aspx>

REACH after EoW???



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If **End of Waste** status is achieved:

the product (possibly) becomes subject to the **REACH regulation**

(Registration, Evaluation, Authorisation and Restriction of Chemicals)

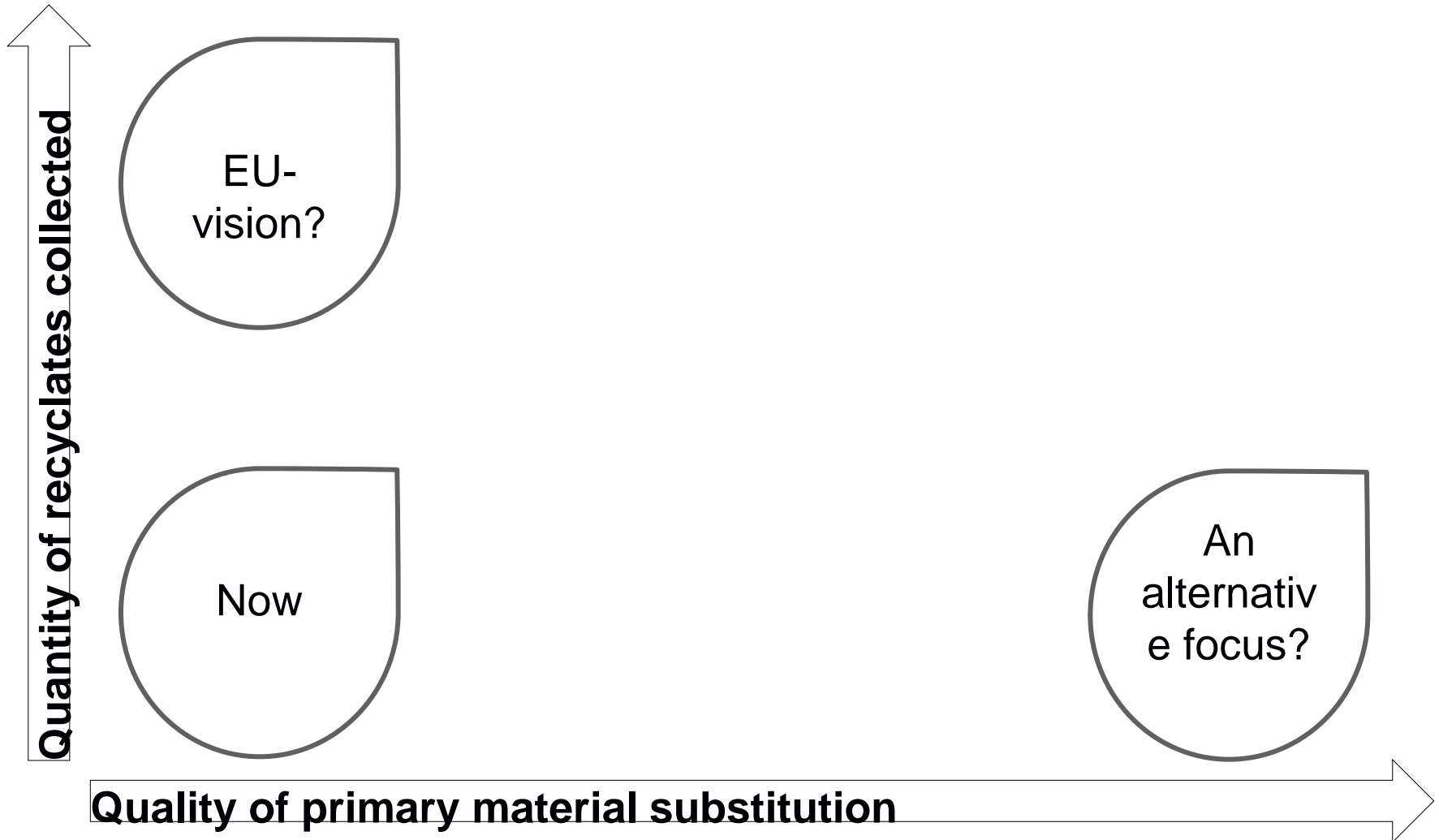
<http://www.hse.gov.uk/reach/>



High quality single material streams vs. Quantities of everything?



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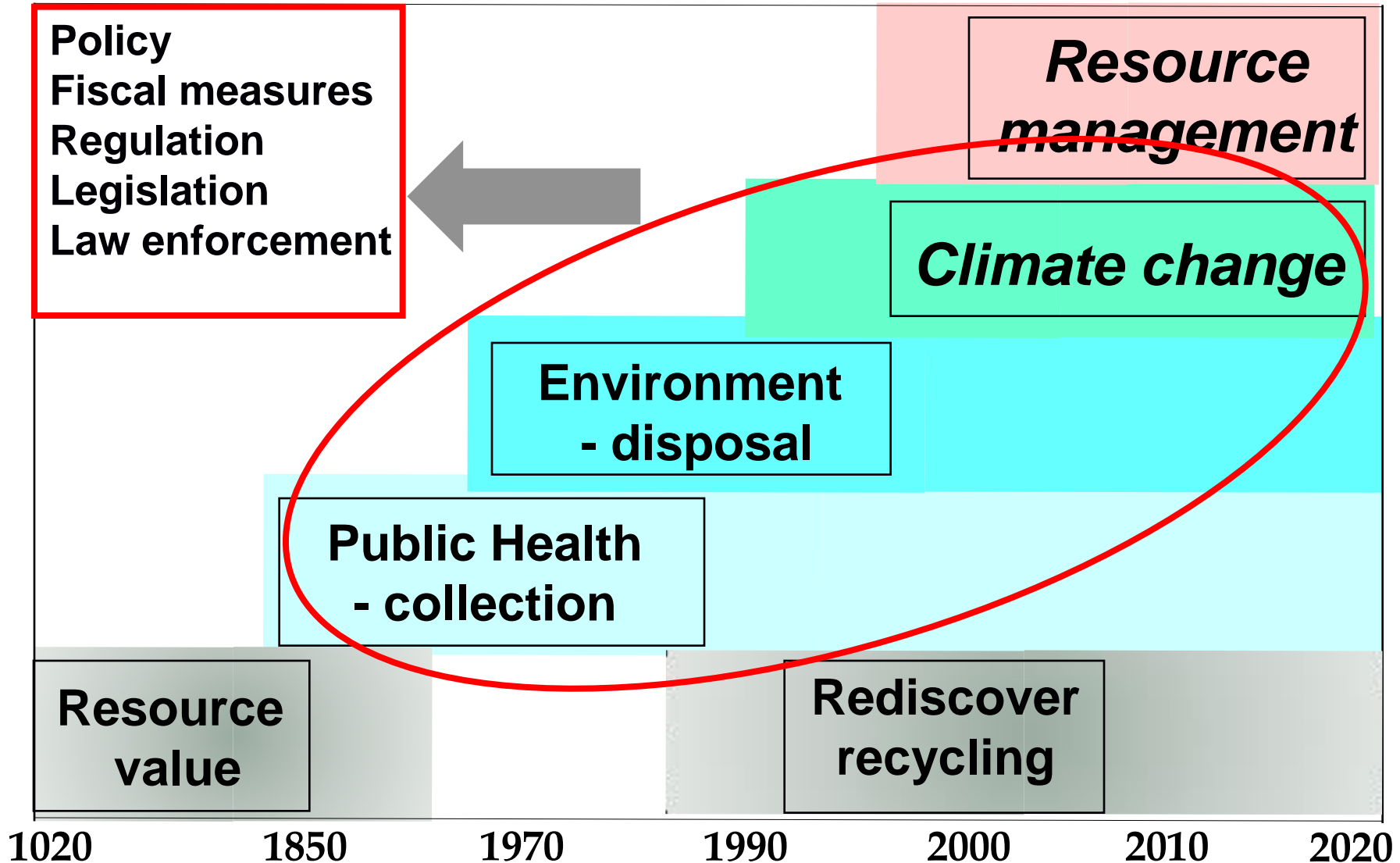


Drivers for waste and resource management



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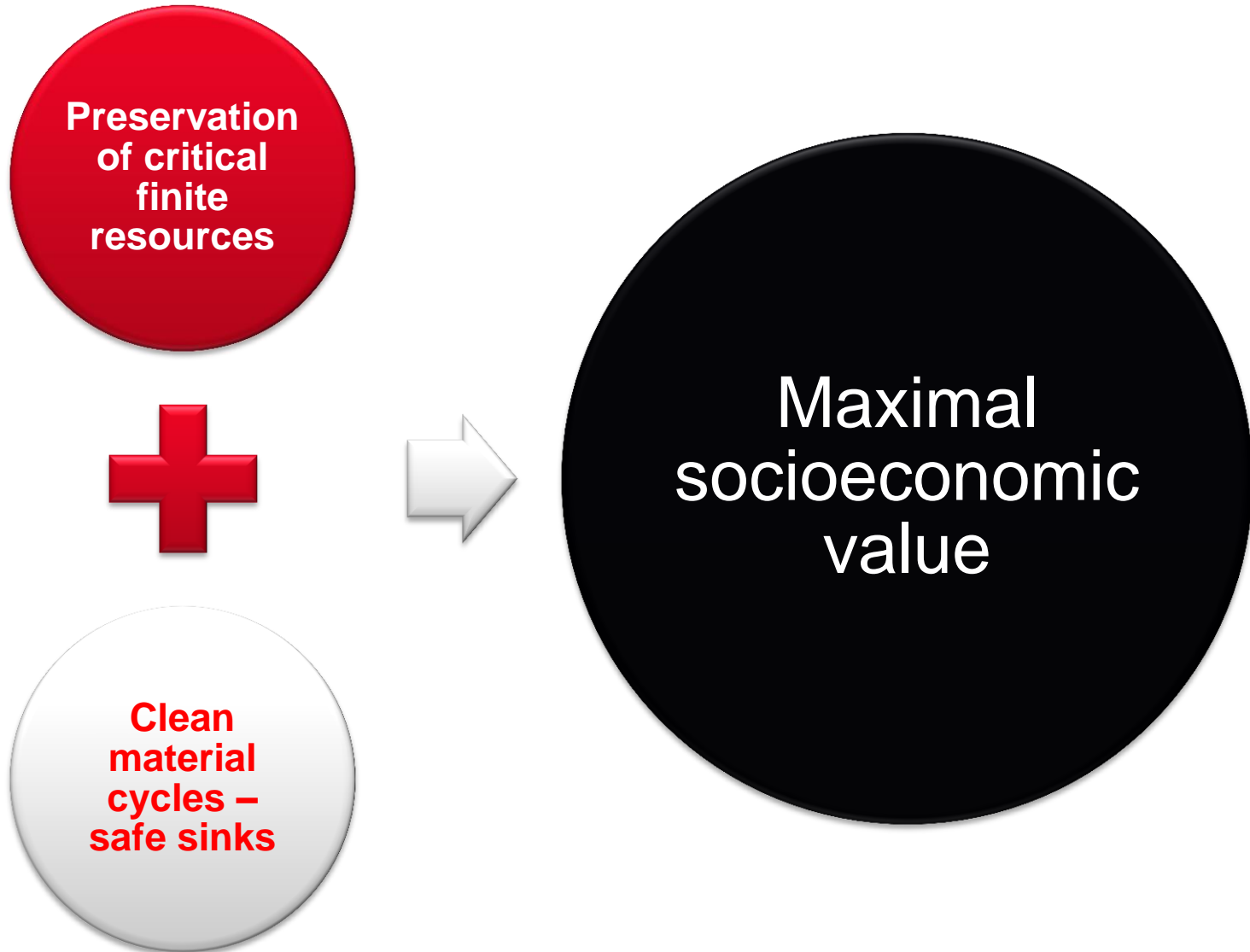
Slide copyright: © DCW - adapted



Circular + green economy? Any dilemmas?



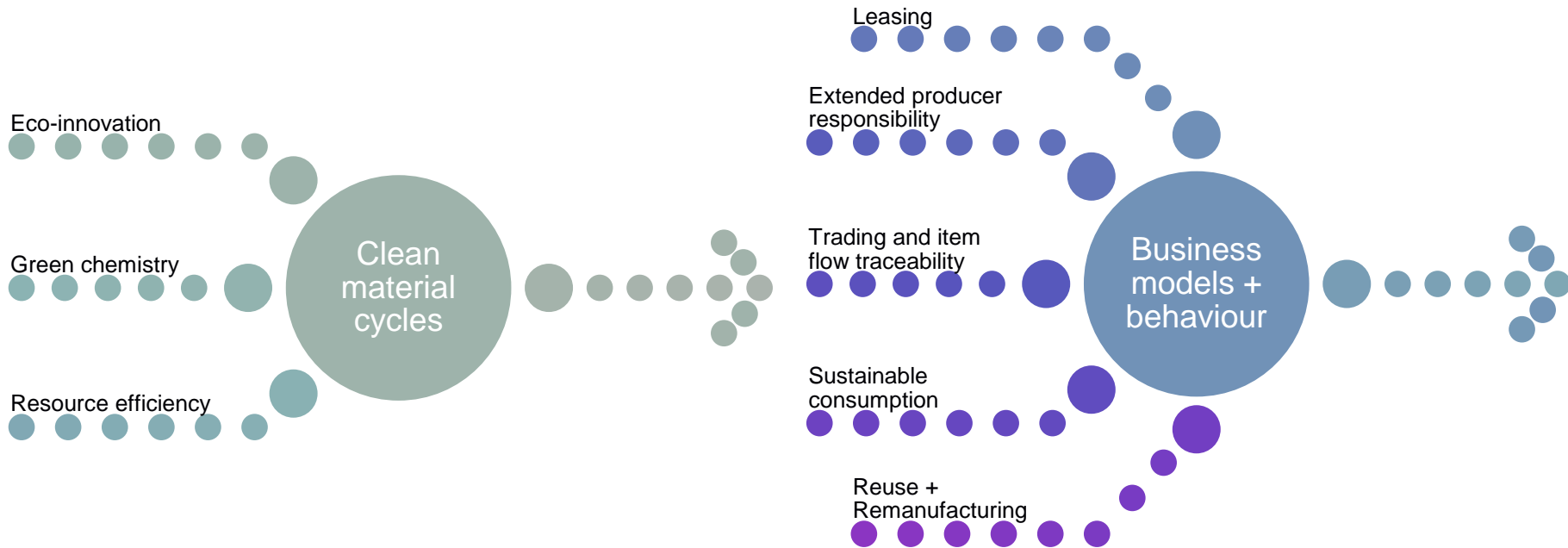
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Circular economy can only be part of a chain...



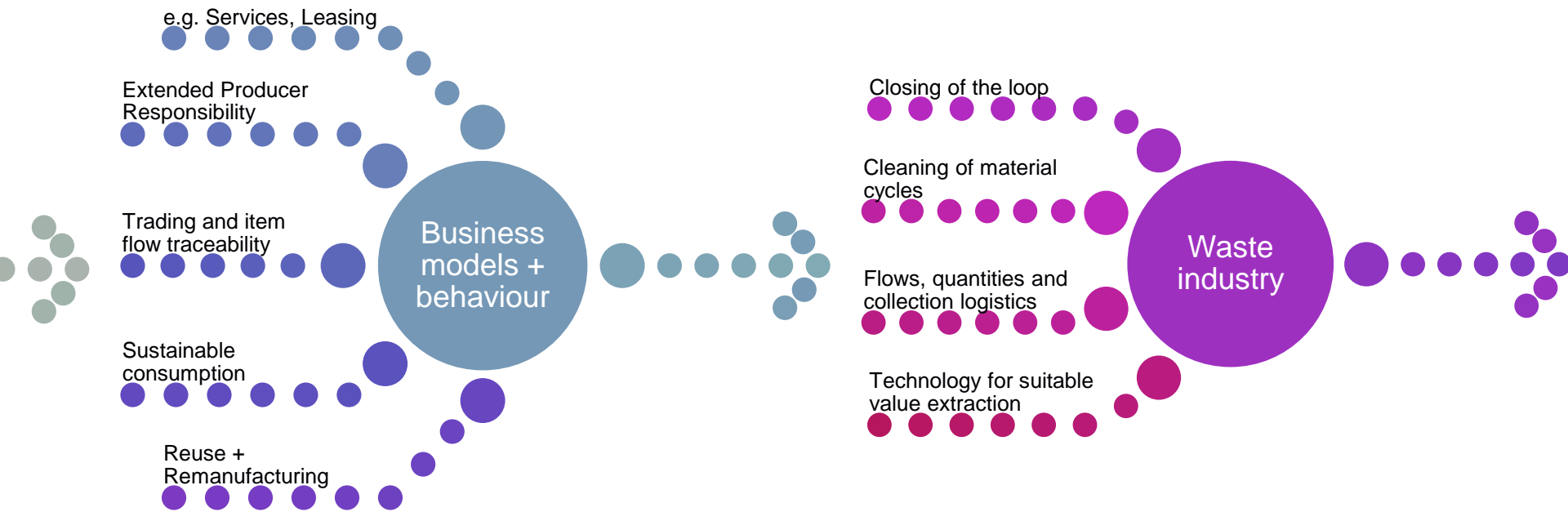
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Business models and consumer behaviour change



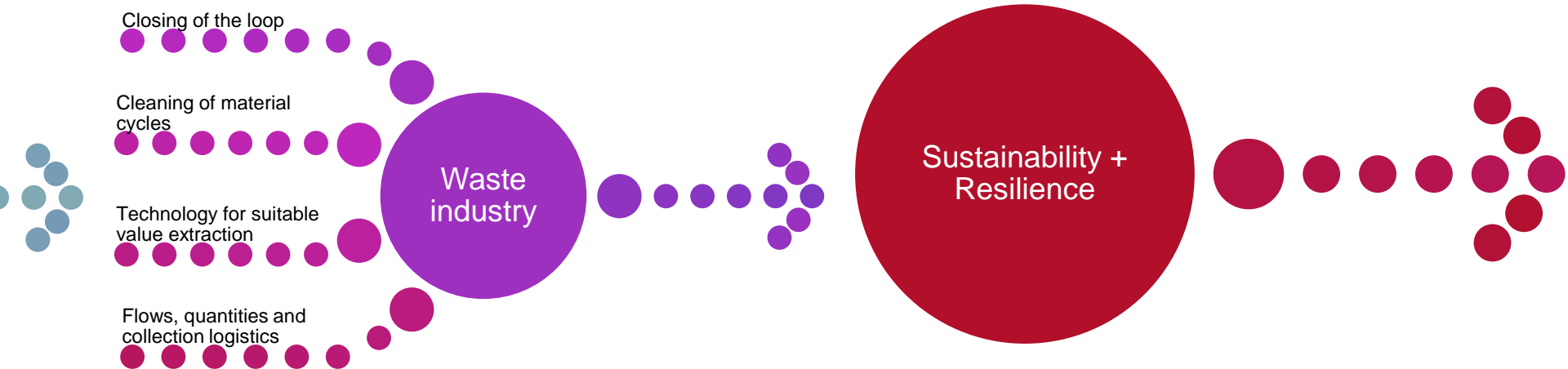
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Circular economy vs. double decoupling



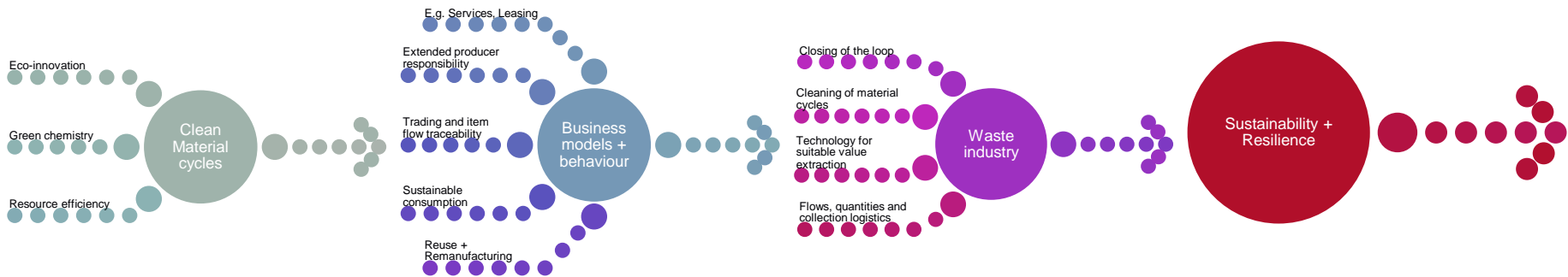
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A long chain – how to maintain throughout clean material flows and environment?



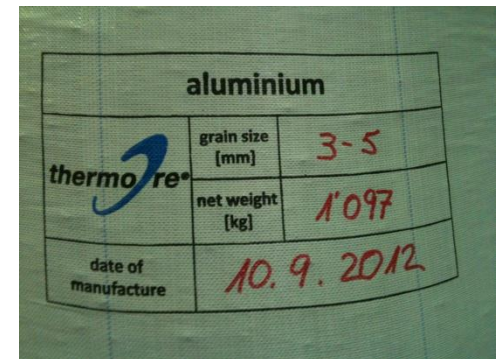
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Recycling metals (Au, Cu, Al) via EfW: Full liberation of contraries



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aluminium		
thermo re	grain size (mm)	3-5
	net weight (kg)	1'097
date of manufacture	10.9.2012	

R1 EfW formula: quantification enables to drive up value to society

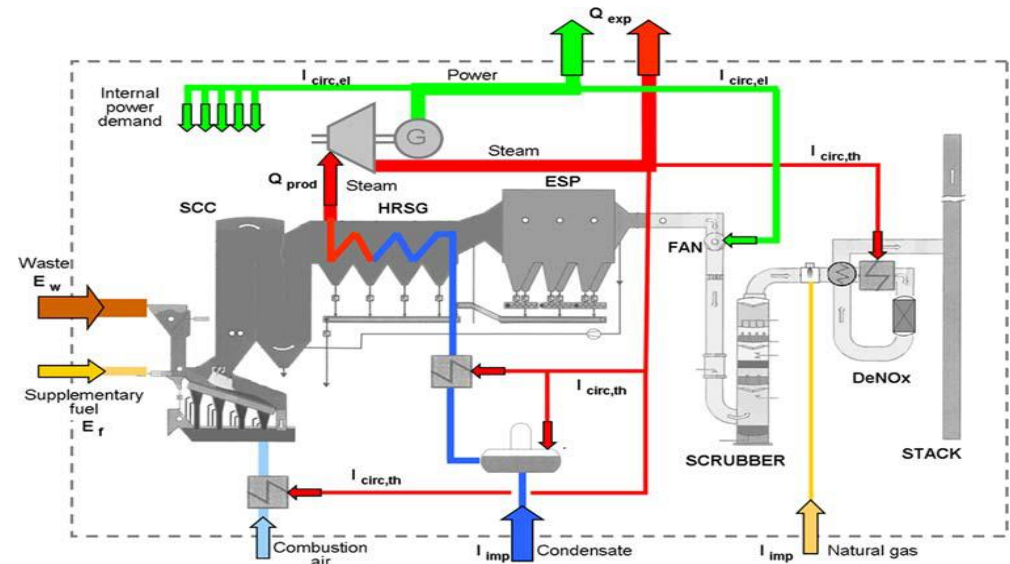


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$$R1 = \frac{E_P - (E_f + E_i)}{0.97 * (E_w + E_f)}$$

- WFD 2008/98/EC: allows efficient EfW facilities to be classified as **'energy recovery'** operations
- **Single most important development**
- **Systems and measurable outcome** focused approach

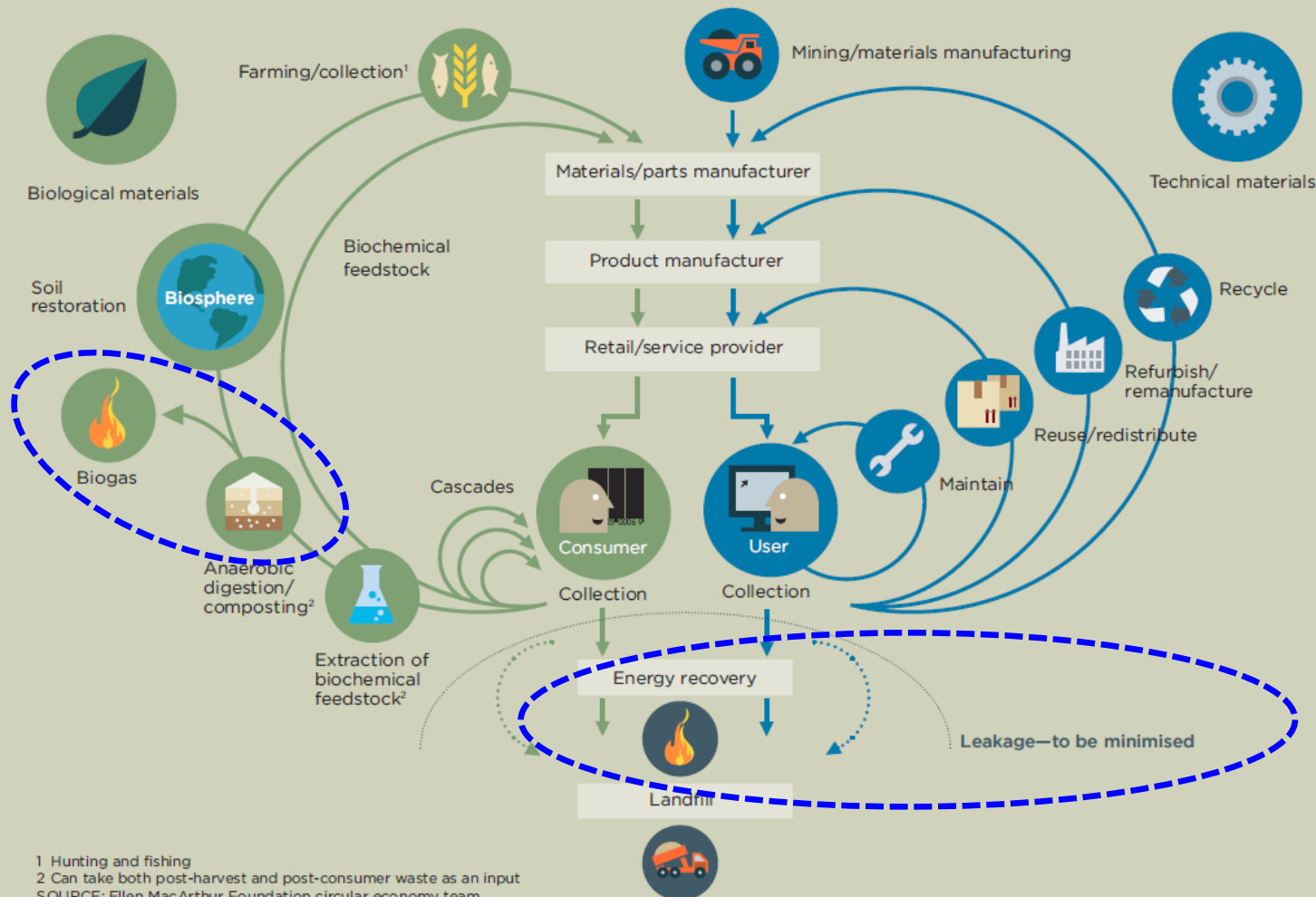


Ellen MacArthur Foundation vision of circular economy



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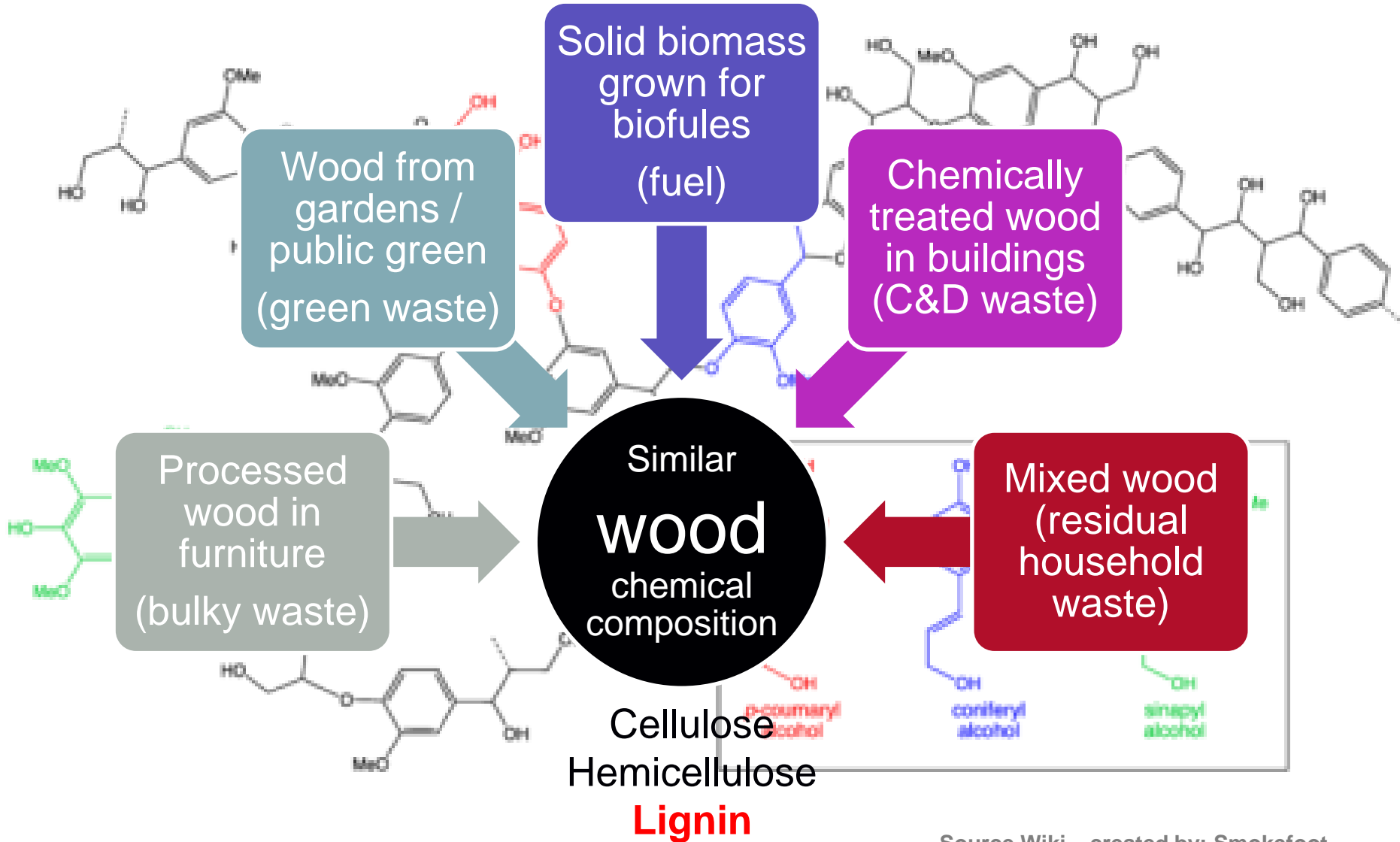
FIGURE 4 The circular economy—an industrial system that is restorative by design



Waste categories: place of arising + physical macro features vs. chemical composition



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Would you collect for recycling if it was not locally sustainable?

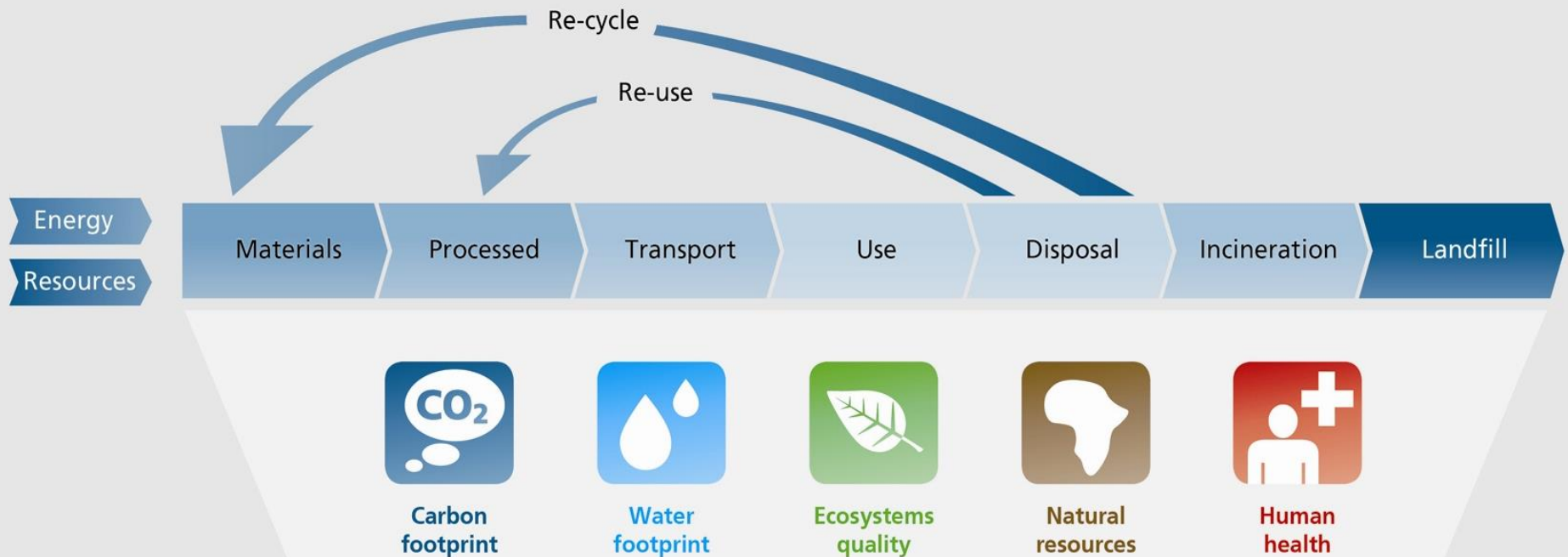
Would you collect for recycling if it was not globally sustainable?

What options are we left with for avoiding pollution dispersion?

Life cycle assessment: some challenging outcomes



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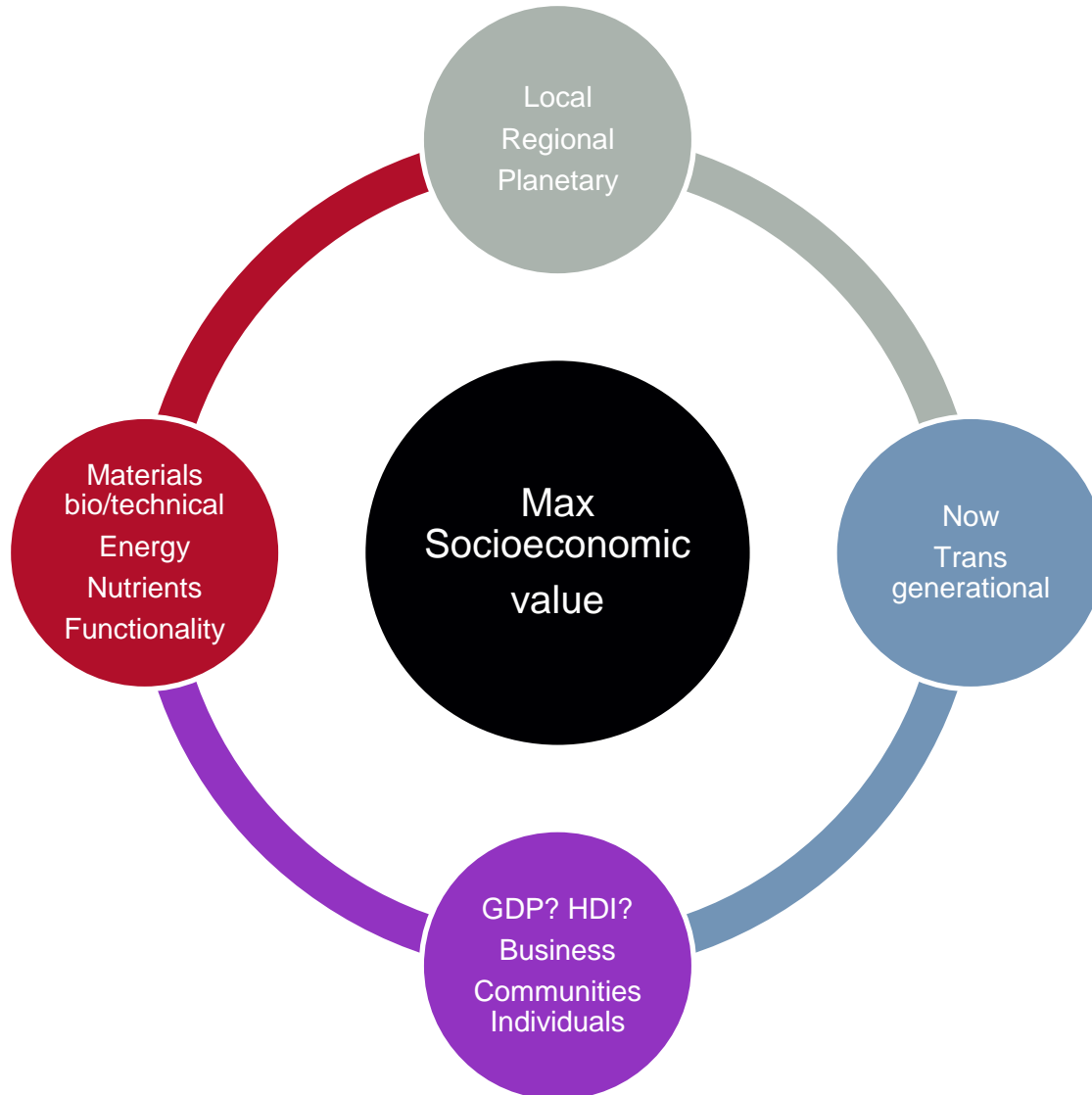


LCA evidence that certain plastics recycling overperforming EfW
only if virgin polymer is replaced above 70-80%
(Rajendran, Hodzic et al., 2013)

What is value? Value to whom?



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New report on global recycling markets for Waste plastics



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Global recycling markets: plastic waste

A story for one player – China



A report from the ISWA Task Force on Globalisation and
Waste Management

Author : Costas Velis

Download from:

<http://www.iswa.org/iswa/isw-a-groups/task-forces/>

European waste plastics 'value recovery'



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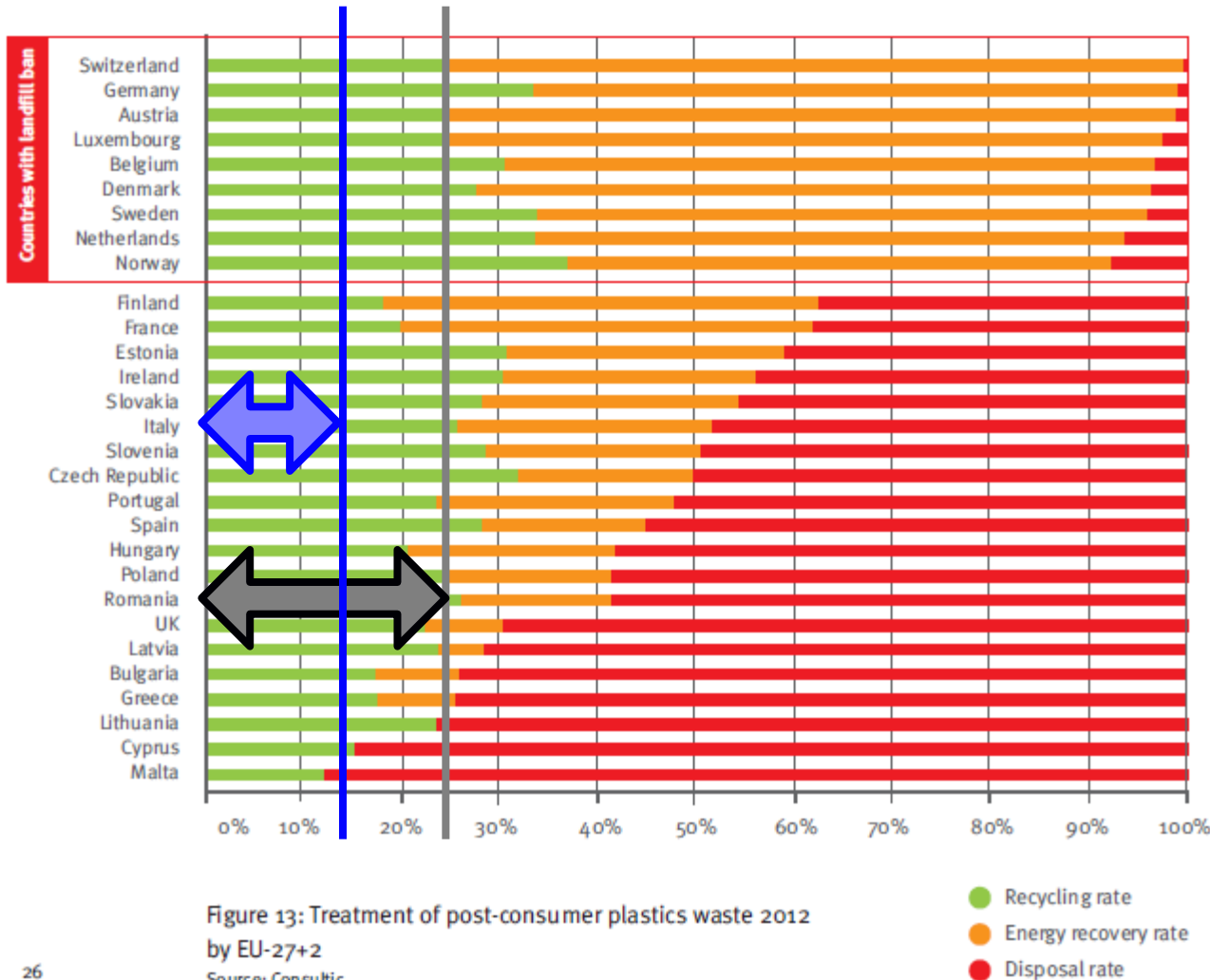


Figure 13: Treatment of post-consumer plastics waste 2012 by EU-27+2
Source: Consultic

EU-27 exports

46% wt.

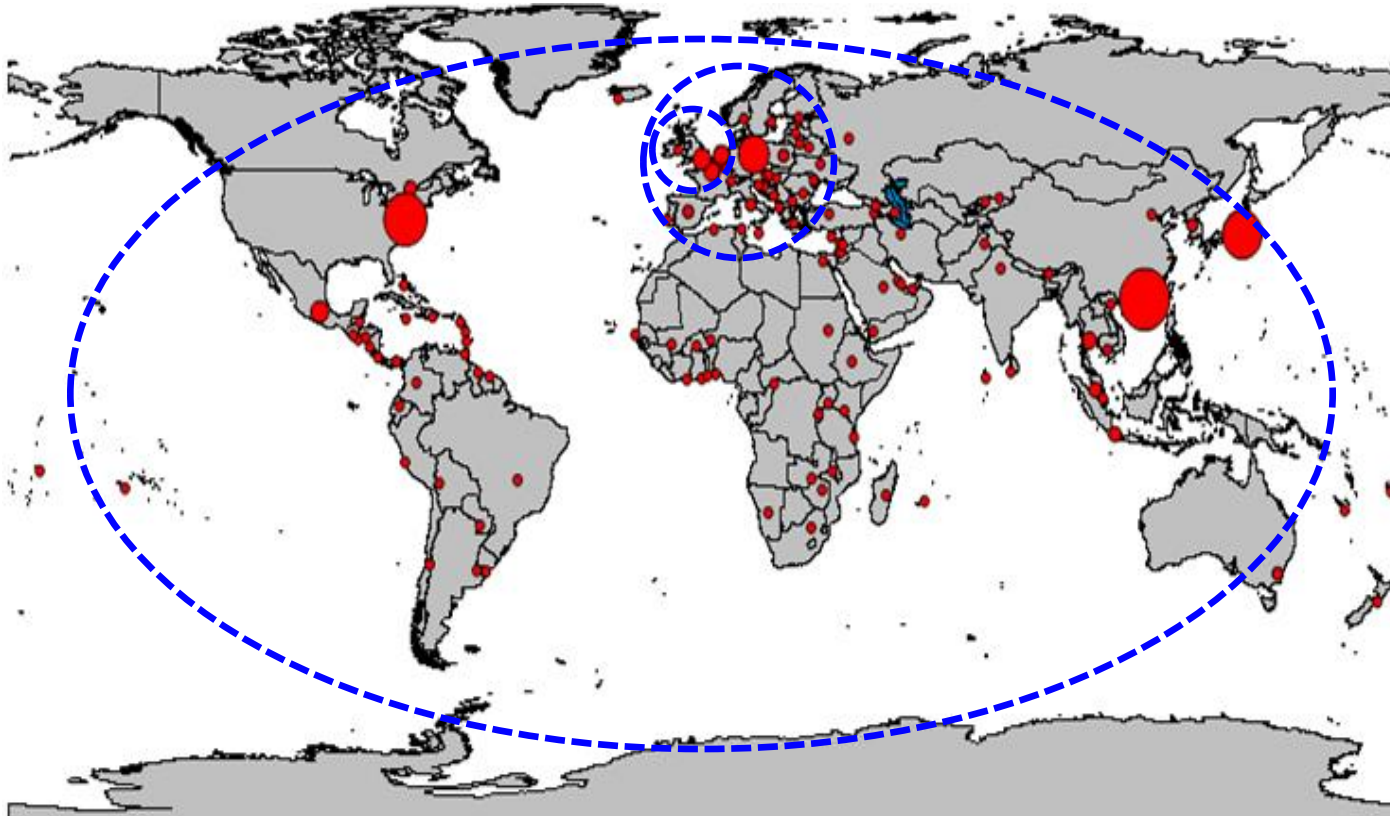
of the post-consumer plastics that collects for recycling

Adopted from: Consultic, as cited by PlasticsEurope, 2013

Waste plastic exports transactions: is your sustainability global?



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Code 3915:
“waste, pairings
and scraps of
plastics”

Data source:
UN Comtrade - 2011

Hazardous properties: Exporting risk?

Equivalent treatment capacity?



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Code	Hazardous properties
H1	Explosive (E)
H2	Oxidising (O)
H3-A	Flammable (F)
H3-B	Highly flammable (F+)
H4	Irritant (Xi)
H5	Harmful (Xn)
H6	Toxic (T) / Highly toxic (T+)
H7	Carcinogenic



H1



H6



H3-A



H4



H2



H5



H3-B

Recycling and dispersion



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Over 80,000
man-made
chemicals

- Innovation
- Functionality
- Toxicity?
- Bisphenol A, PBDEs,

Recycling
mean
recirculation
and
dispersion?

- Is there a de-pollution stage?
- Exporting also the risks of responsible handling

Role of
waste
industry as
ceaning
safeguuard

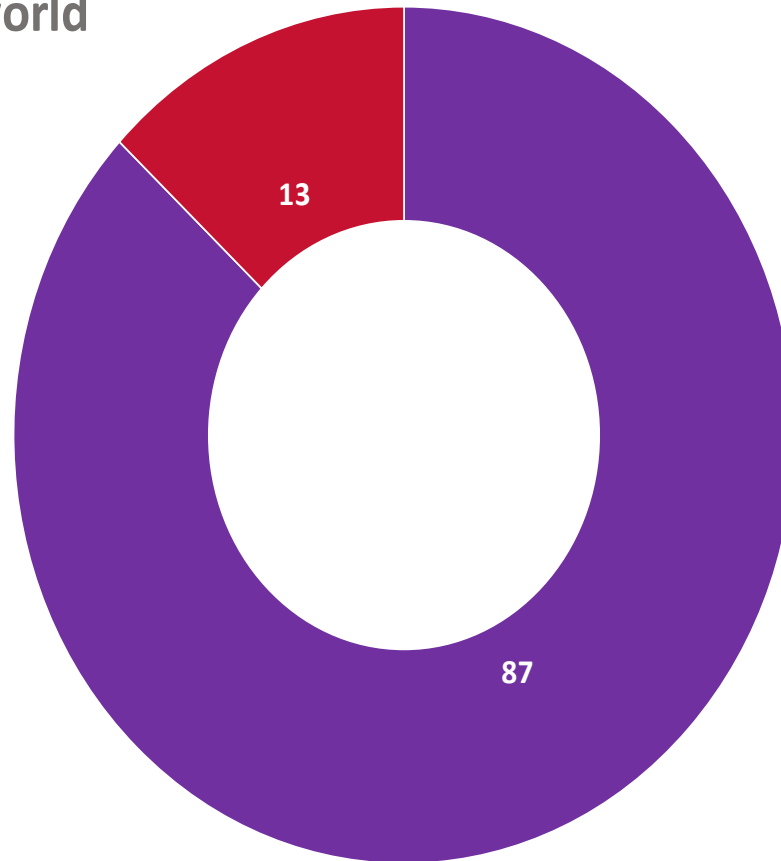
- EfW APC systems as concentration sinks
- Destruction of POPs

Europe's recycling depends on exporting waste plastics to China



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Rest of world



China and Hong Kong SAR

By weight – 2012 data

3 possible destinations within China



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The diagram consists of three white circles arranged vertically on the left side, connected by a red line. Each circle is connected to a horizontal bar of a different color (grey, blue, and red) that contains text. The text in the grey bar is in red, while the text in the blue and red bars is in white.

“3-non enterprises”: no rules for operation
– no quality standards – no inspection

Big centralised reprocessing facilities

Incineration / energy from waste

Documentary on reprocessing plastic scrap imports “Deadly waste in China”



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See at ZDF: <http://www.zdf.de/ZDFmediathek#/beitrag/video/1993090/Die-Doku:-Tödlicher-Müll-in-China>

A least environmental standards pathway?



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- ▶ **Least environmental standards / resistance path is often followed**
 - Applies to waste trafficking (e.g. WEEE)
 - Same for global waste and secondary raw materials trans-shipment?
 - Support for hypothesis: (1) Hong Kong and China (2) role of ASEAN countries (3) reaction to Green Fence Operation

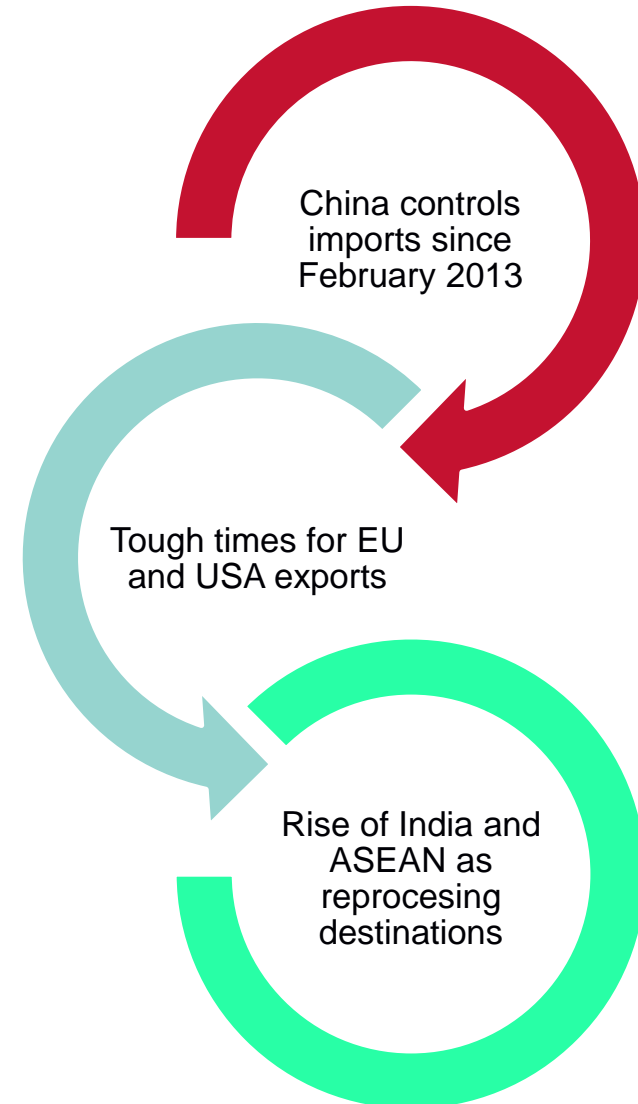
- ▶ **? A direct link between:**
 - Western consumption patterns and
 - Small-scale low-tech reprocessing enterprises in South Asia?
 - Negative correlation between **amount of exported waste and wages in importing countries** (D'Amato, Lozzi et al., 2012)

Green Fence Operation and the way ahead...

The least resistance path in action



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Desired outcome of more EU & recylates?

Issues with plastics recycling via exports



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A complex and potentially vulnerable market

China oligospony – huge EU dependence if recycling targets are to be met

Poor environmental control and H&S, and sub-optimal manufacturing practices in China

General pathway of least environmental performance – risk transfer

Dispersion of PoPs vs. destruction in EfW?

Do environmental / health recycling aspired benefits materialise?

Opportunities for high value closed-loop recycling value recovery and local green growth and energy generation under optimal conditions

Africa – EU research collaboration



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Quality of recycling: real sustainability benefits



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- **Need to ask the right questions to inform the way forward**
- Focus on truly sustainable and high value (e.g. PET close loop)
- Transparency – traceability – quality controls before exports
- Establish a maximum acceptable (environmental) cost for recycling
- Focus on clean material cycles and prevention of pollution dispersion
- Higher ambitious intangible generic recycling targets will increase the materials collected: **are we creating a hot potato and for whom?**
- Should we move out of **inertia** and use “**priming**” in this debate?
- Why not measure much more **downstream**?
- Quality quality quality?
- **Quantify quantify quantify**

Recycling operation modes: focusing on actual material substitution - quality?



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Recycling
'business as
more than usual'

**High
unverifiable
numbers**

Collected for recycling-
exported for???

No metrics – poor data
– low confidence

No End of Waste –
quality management

Multiple closed loop and
down-cycling equal

Systems holistic
approach – scientific +
policy metrics as R1
EfW

Clear quantification of
contribution to resource
recovery

Meaningful waste
hierarchy level
distinctions

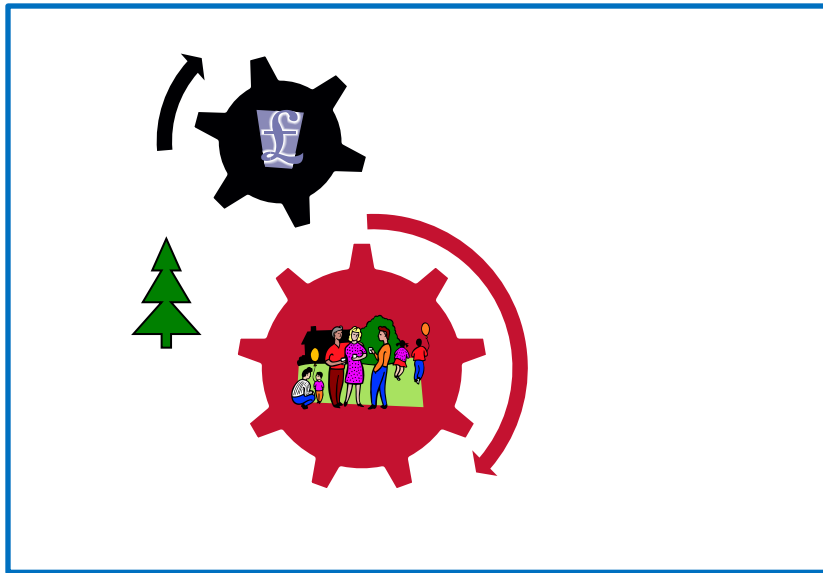
Lower recycling
numbers – more
tangible benefits

Recycling for
resource
recovery

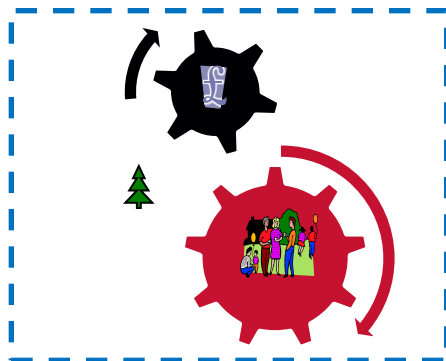
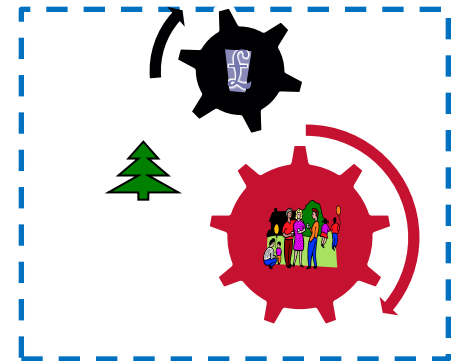
**Quality and
impact
orientated**

**Systems
optimisation**

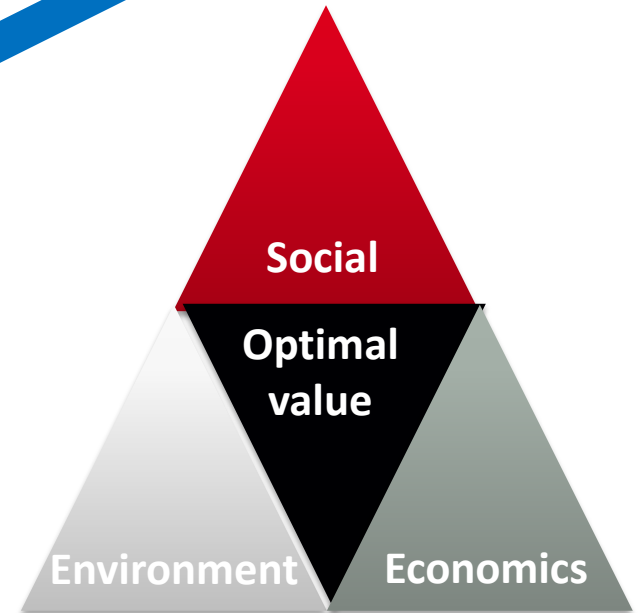
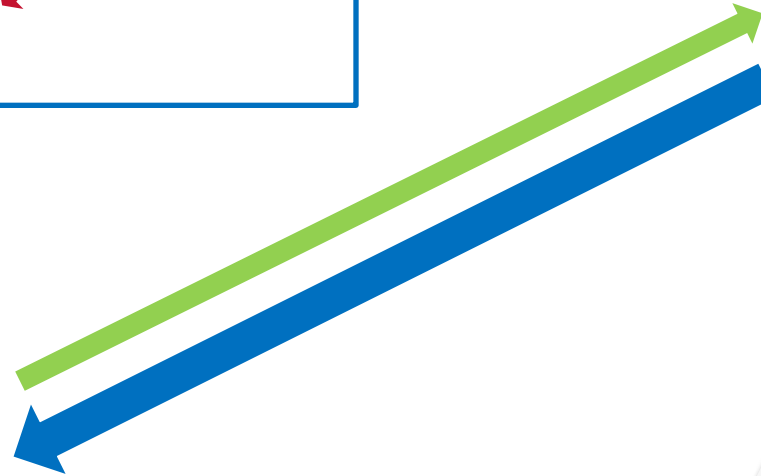
System A



System B



System C



“If you cannot measure it, you cannot manage it”

C-VORR at University of Leeds:

**novel framework and tool
for optimizing resource efficiency beyond just
solid waste management**

- Make trade offs explicit – eliminate partial accounting
- Extend to comprehensive environmental and social valuation
- Do not lose transparency by unnecessary aggregation
- Separate objective measurement from value judgment
 - Explicitly design your system boundaries
 - Include all ‘values’ that could be of relevance
 - Sophisticated multi-objective optimisation
- Inform the urge to circular and green economy with real
comprehensive evidence**

Complex Value Optimisation of Resource Recovery



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“If you cannot measure it, you cannot manage it”

C-VORR at University of Leeds:

Please join our efforts

for an evidence-based

circular and green economy

Thank you!
Merci beaucoup!



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Editorial in *Waste Management & Research*:

[Recycling and resource efficiency: it is time for a change from quantity to quality](#)

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