

Rhys Charles & Eoin Bailey



GCRA2a – Decoupling the Material-Value-
Carbon-Nexus: Retaining the Embedded
Value of Steels

GCRA1 - Materials, Resources and Energy: part 1 - Richie Hart & Louis Brimacombe

- UK Steel industry: Scene setting
- Disruptive Steel Technology for Steel Plant of 2050
 - Materials
 - Energy & Gasses
 - Zero Net Carbon
 - Zero Waste

GCRA1 - Materials, Resources and Energy: part 2 - Louis Brimacombe & Richie Hart

- Scope development
- Alignment of academics and industrialists
- Industrial Symbiosis

GCRA2a - Decoupling the material-value-carbon-nexus: Retaining the Embedded Value of Steels

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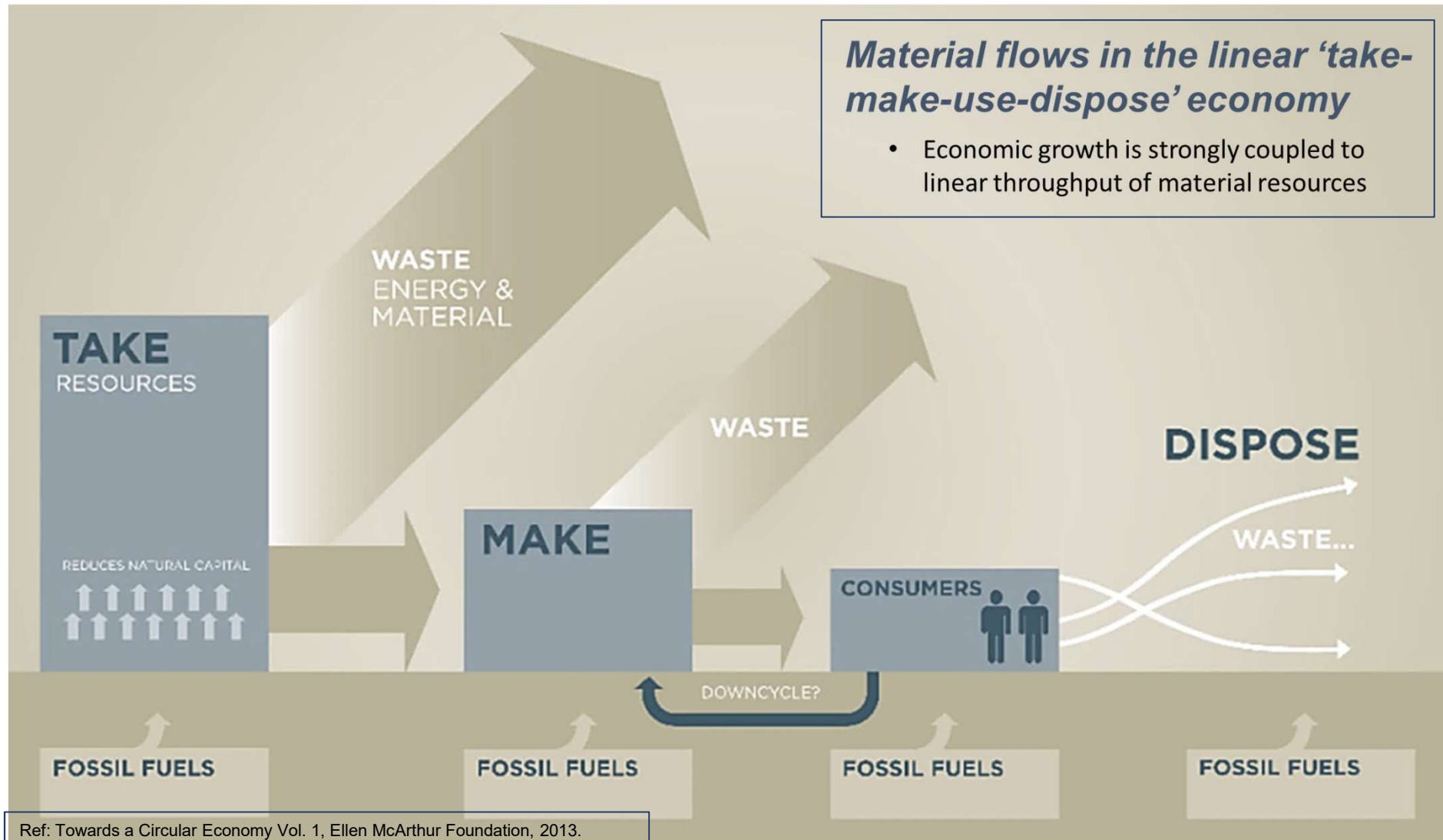
- Value creation and its link to emissions and consumption
- Maximising value retention through 'tight' circular economy loops
- Identifying barriers to 'tight' loops
- Overcoming the barriers

GCRA2b - Steel as a Service Eoin Bailey & Rhys Charles

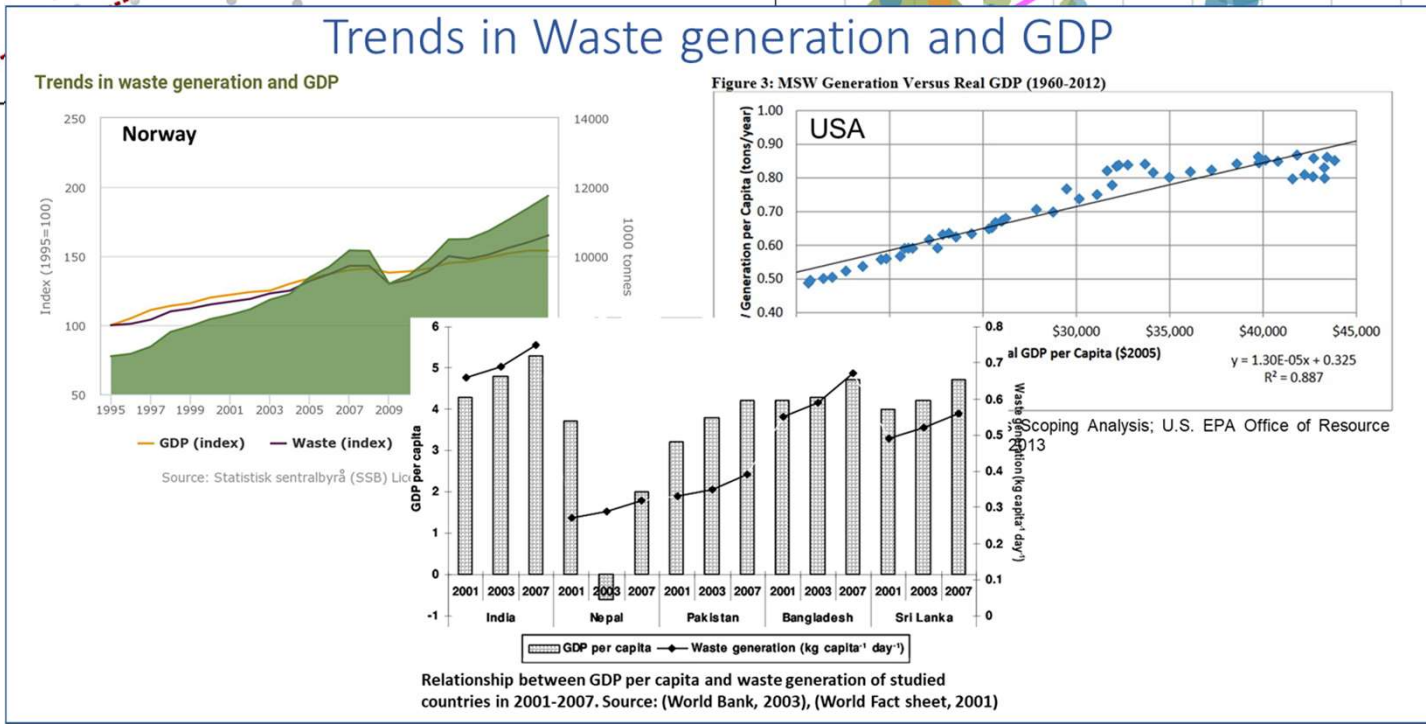
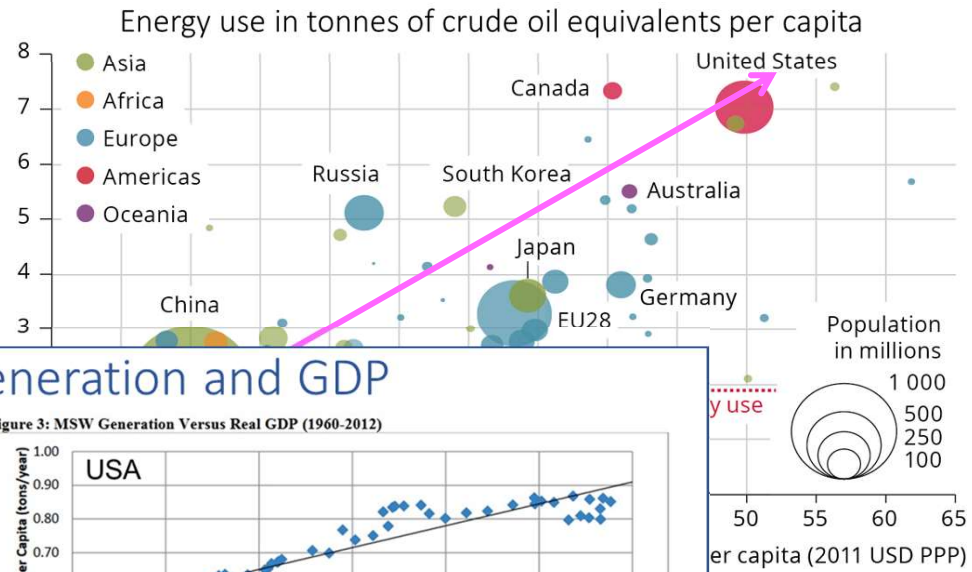
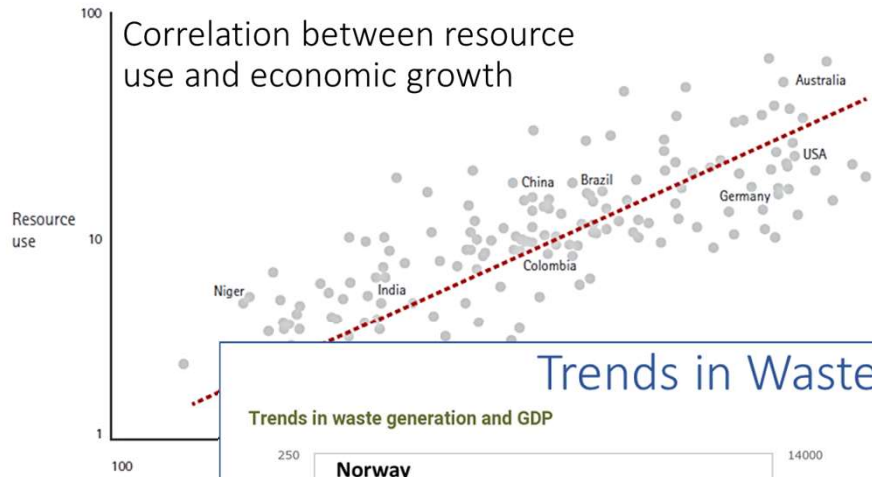
- Outward looking & sector driven
- Properties of interest
- Material tracking and identification

Material flows in the linear 'take-make-use-dispose' economy

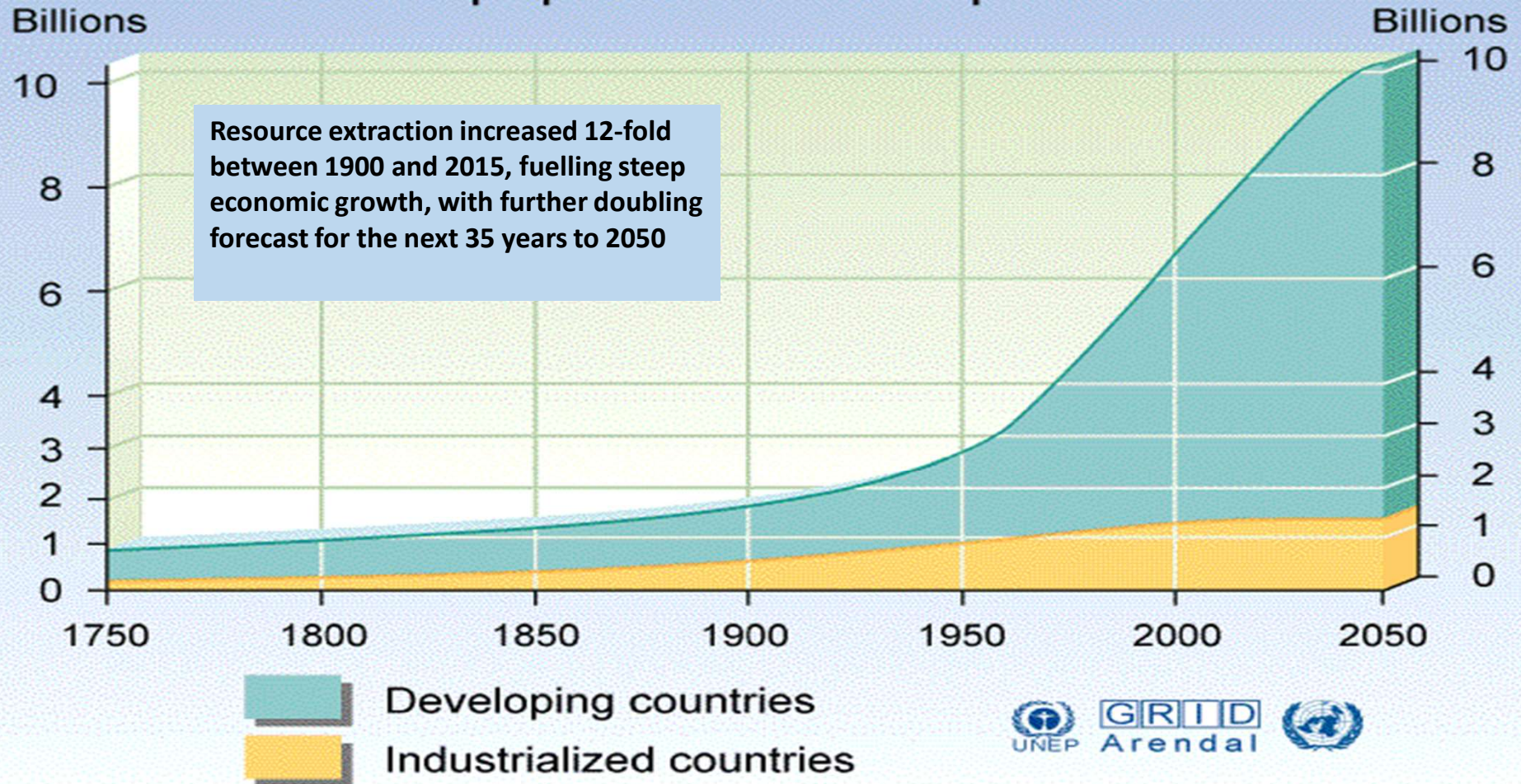
- Economic growth is strongly coupled to linear throughput of material resources



Ref: Towards a Circular Economy Vol. 1, Ellen McArthur Foundation, 2013.



World population development



Mass-value-carbon Nexus

Development for material extraction (Mass), financial value creation (Value), and GHG emissions (Carbon) from 1900 to 2017 and projected to 2050.

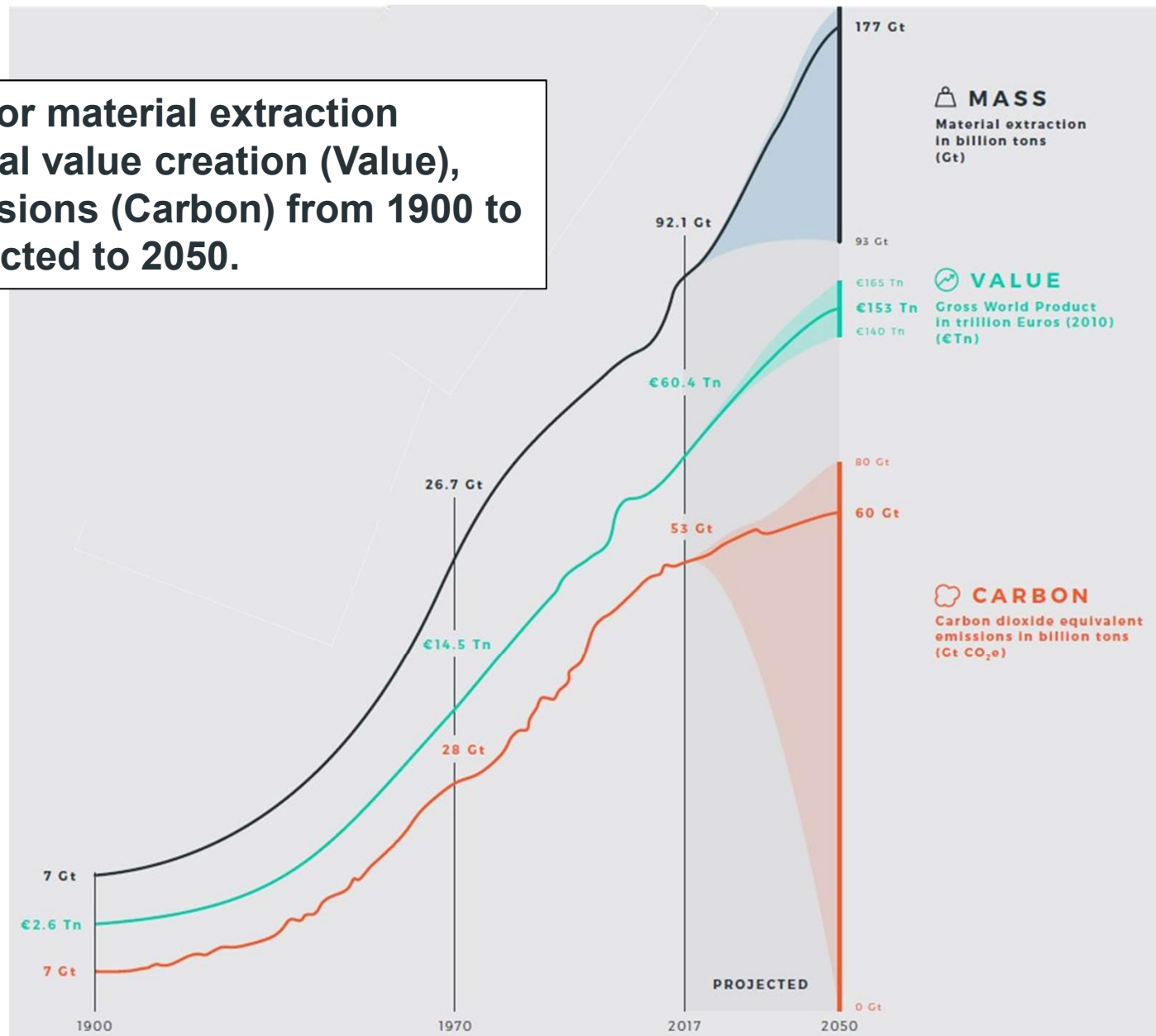
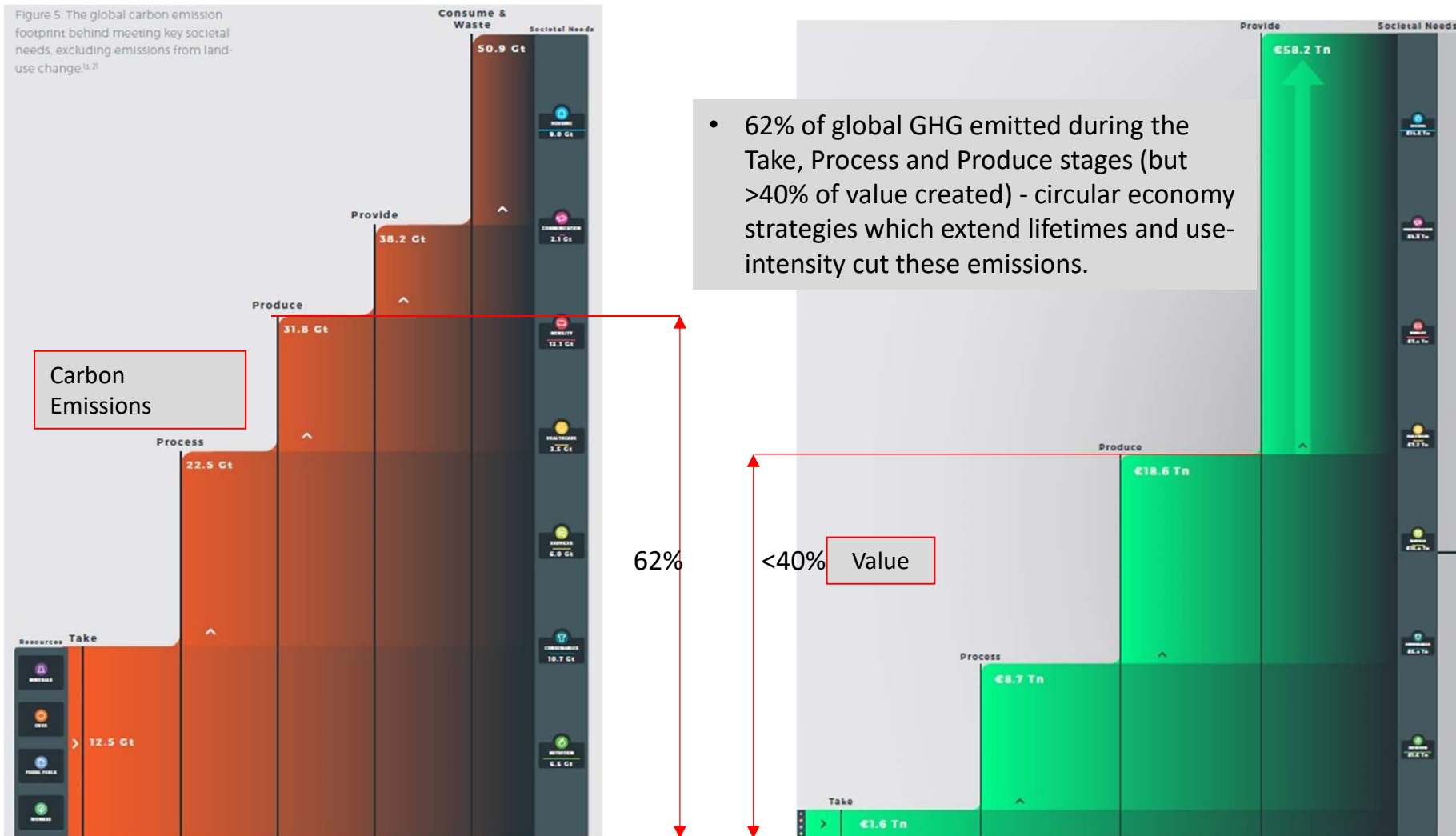
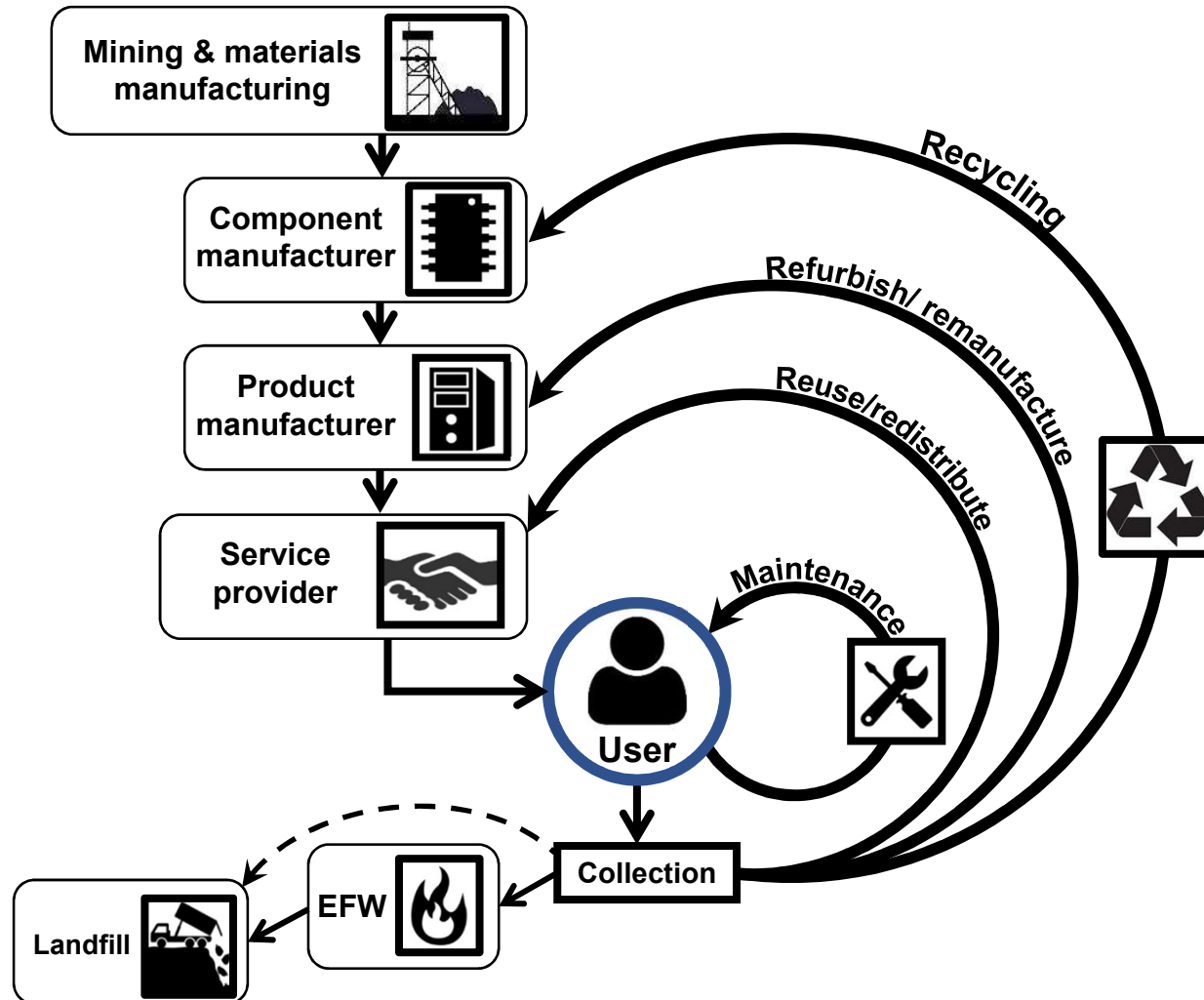
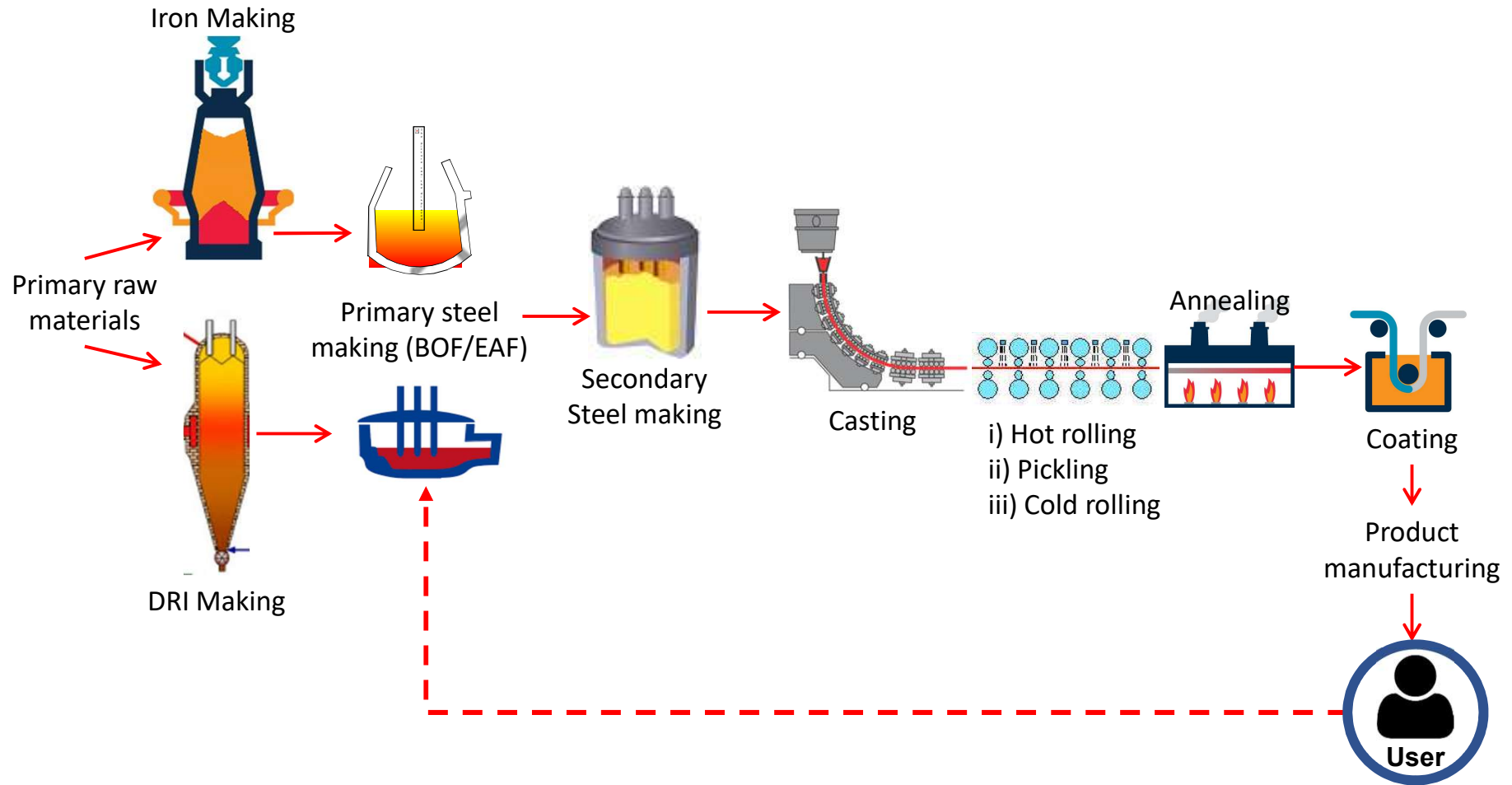


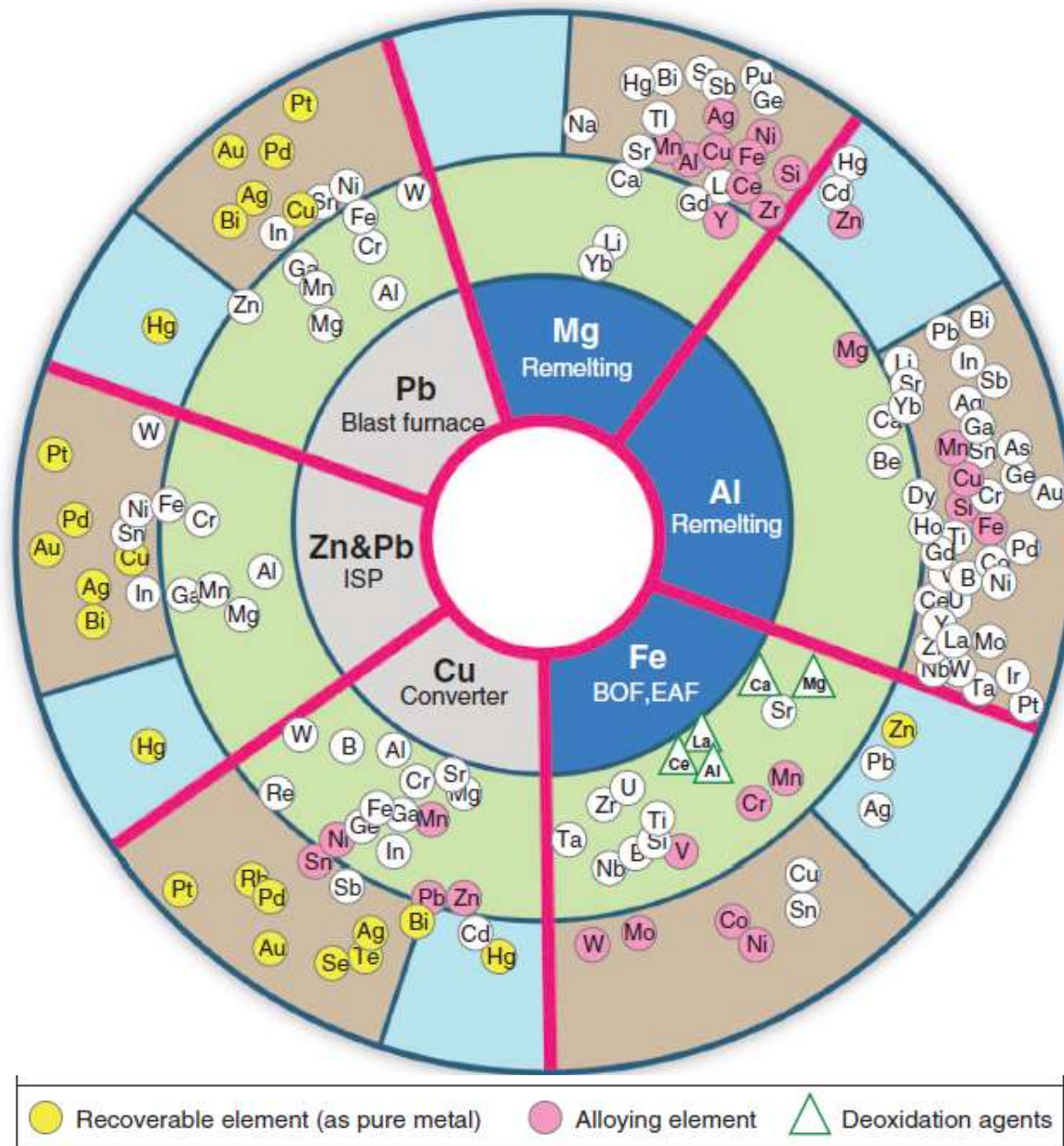
Figure 5. The global carbon emission footprint behind meeting key societal needs, excluding emissions from land-use change.^{15, 27}



Material Flows in a Circular Economy







To metal phase
Elements that have distributed among the metal phase as a solid or liquid metal

To slag phase
Elements that have distributed among the slag phase as oxide

To gas phase
Elements that have evaporated and distributed among the gas phase

Fig. 4. An element radar chart showing the distribution of alloying elements among metal, slag, and gas phases during thermochemical reprocessing (54). BOF, basic oxygen furnace; EAF, electric arc furnace; ISP, imperial smelting process.

What adds the value?



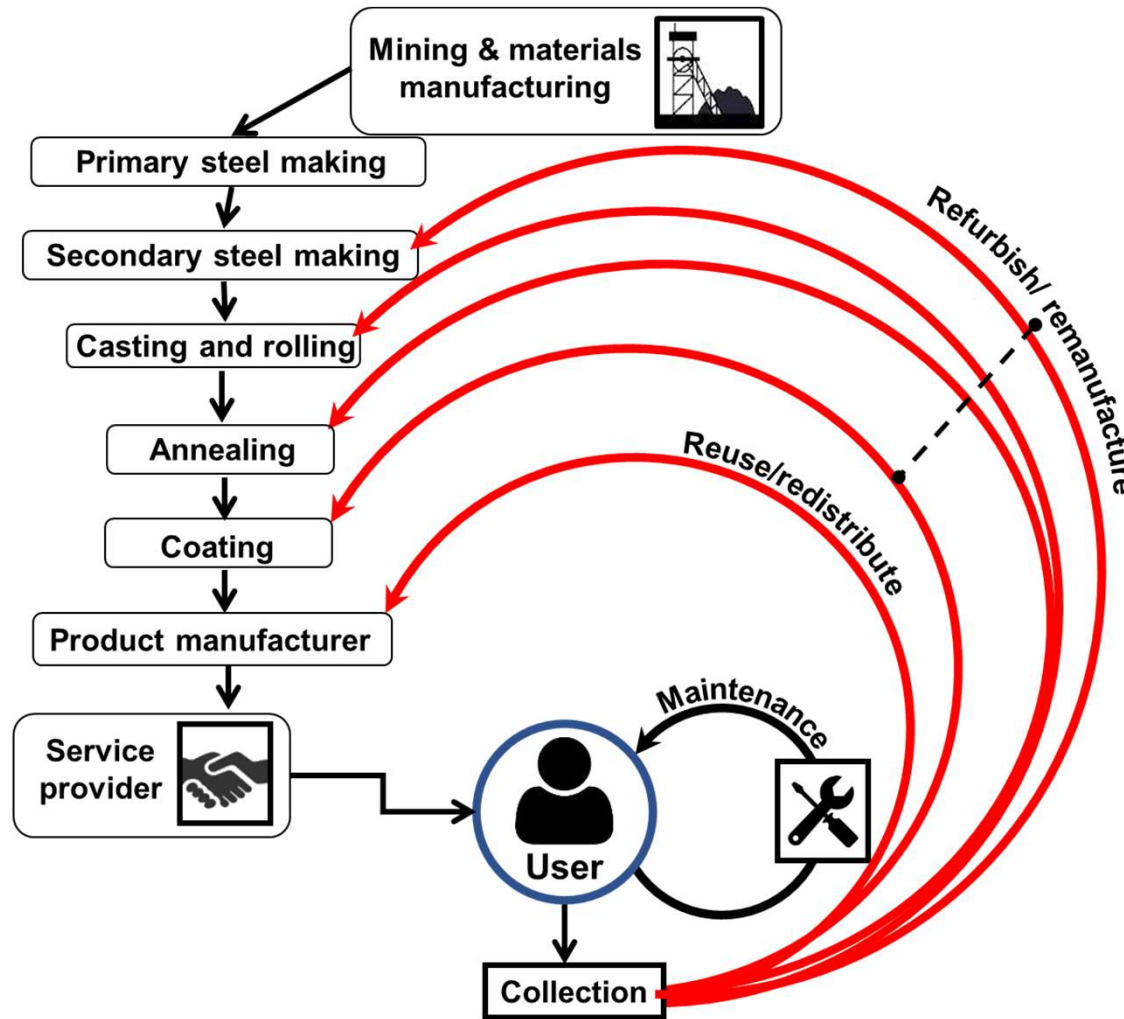
Where is value Created

- Secondary steel making to modify chemistry, consumes critical raw materials (CRMs)
- Rolling and annealing to refine microstructure and mechanical properties
- Coating to improve corrosion resistance, aesthetics and sometimes functionalise.

Where is value destroyed?

- By recycling steel in BOF/EAF
 - Coatings lost
 - Microstructure lost
 - Critical raw materials (CRMs) lost! Steel recycling is a global sink for CRMs!

Material Flows in a Circular Economy



Please split into 6 groups, and attempt to identify:

- 1) What technical barriers are there to retaining steels in these tighter loops?
- 2) What is required (tech, people, expertise etc.) to enable utilisation of steel within these tighter loops of the circular economy?