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Repair as a Sustainable Business Model in a Circular Economy

Jessika Luth Richter, Associate Senior Lecturer, IIIEE, Lund University

Circular Economy

"In a circular economy, the value of products and materials is maintained for as long as possible. Waste and resource use are minimised, and when a product reaches the end of its life, it is used again to create further value."
– EU Commission

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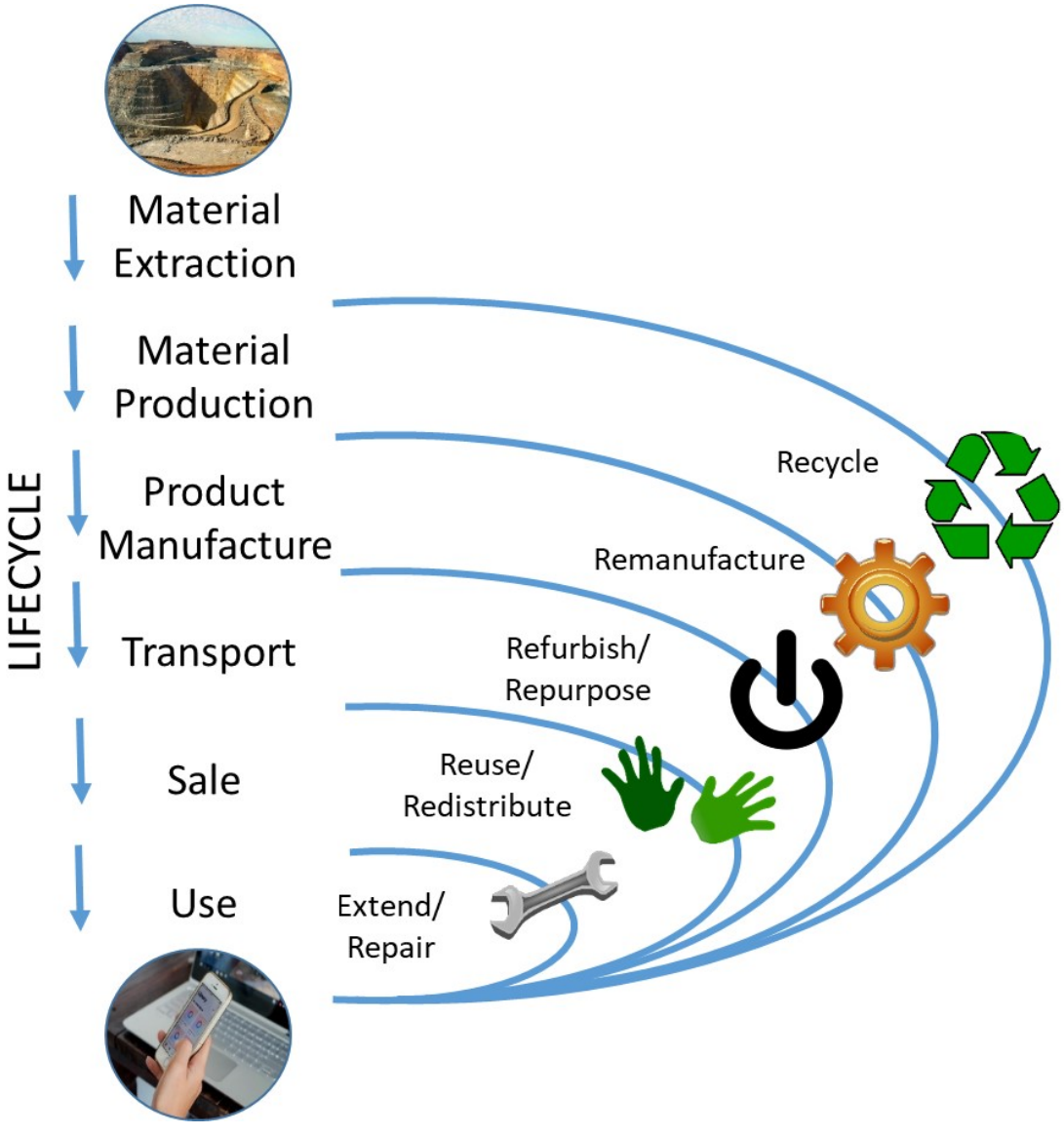

Material Extraction
Material Production
Product Manufacture
Transport
Sale
Use
LIFECYCLE
Recycle
Remanufacture
Refurbish/ Repurpose
Reuse/ Redistribute
Extend/ Repair

Value is complex

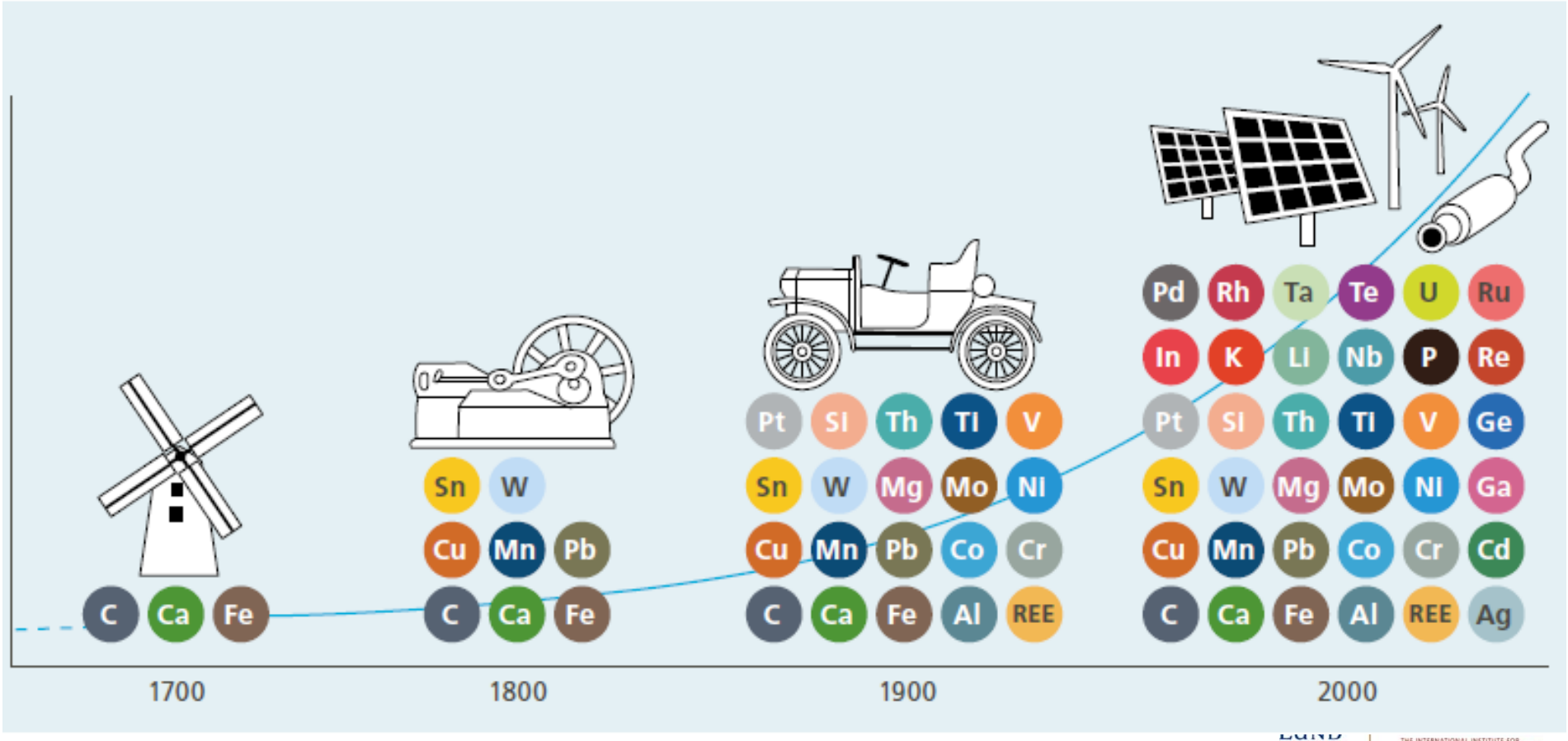
- Different dimensions

- Different perspectives

Longer product lifetimes can be environmentally beneficial…

- For passive products that do not use energy, e.g. furniture, clothing
- For energy-using products with the majority of environmental impacts in the production stage, e.g. computers, tablets, phones
- For energy-using products with slowing rates of energy-efficiency improvements, e.g. vacuum cleaners
- For energy-using products with low intensity of use, e.g. appliances in a summer house
- For energy-using products used in decarbonised energy context, e.g. Norway, Sweden

Materials in products has changed over time



Achzet, B. et al. Materials Critical to the Energy Industry: An Introduction. (BP Plc, 2014).

ELEMENTS OF A SMARTPHONE

ELEMENTS COLOUR KEY: ALKALI METAL | ALKALINE EARTH METAL | TRANSITION METAL | GROUP 13 | GROUP 14 | GROUP 15 | GROUP 16 | HALOGEN | LANTHANIDE

SCREEN

49 In Indium
8 O Oxygen
50 Sn Tin

Indium tin oxide is a mixture of indium oxide and tin oxide, used in a transparent film in the screen that conducts electricity. This allows the screen to function as a touch screen.

13 Al Aluminium
14 Si Silicon
8 O Oxygen
19 K Potassium

The glass used on the majority of smartphones is an aluminosilicate glass, composed of a mix of alumina (Al_2O_3) and silica (SiO_2). This glass also contains potassium ions, which help to strengthen it.

39 Y Yttrium
57 La Lanthanum
65 Tb Terbium
59 Pr Praseodymium
63 Eu Europium
66 Dy Dysprosium
64 Gd Gadolinium

A variety of Rare Earth Element compounds are used in small quantities to produce the colours in the smartphone's screen. Some compounds are also used to reduce UV light penetration into the phone.

ELECTRONICS

Copper is used for wiring in the phone, whilst copper, gold and silver are the major metals from which microelectrical components are fashioned. Tantalum is the major component of micro-capacitors.

29 Cu Copper
47 Ag Silver
79 Au Gold
73 Ta Tantalum

Nickel is used in the microphone as well as for other electrical connections. Alloys including the elements praseodymium, gadolinium and neodymium are used in the magnets in the speaker and microphone. Neodymium, terbium and dysprosium are used in the vibration unit.

28 Ni Nickel
66 Dy Dysprosium
59 Pr Praseodymium
65 Tb Terbium
60 Nd Neodymium
64 Gd Gadolinium

Pure silicon is used to manufacture the chip in the phone. It is oxidised to produce non-conducting regions, then other elements are added in order to allow the chip to conduct electricity.

14 Si Silicon
8 O Oxygen
51 Sb Antimony
33 As Arsenic
15 P Phosphorus
31 Ga Gallium

Tin & lead are used to solder electronics in the phone. Newer lead-free solders use a mix of tin, copper and silver.

50 Sn Tin
82 Pb Lead

BATTERY

3 Li Lithium
27 Co Cobalt
8 O Oxygen
6 C Carbon
13 Al Aluminium

The majority of phones use lithium ion batteries, which are composed of lithium cobalt oxide as a positive electrode and graphite (carbon) as the negative electrode. Some batteries use other metals, such as manganese, in place of cobalt. The battery's casing is made of aluminium.

CASING

Magnesium compounds are alloyed to make some phone cases, whilst many are made of plastics. Plastics will also include flame retardant compounds, some of which contain bromine, whilst nickel can be included to reduce electromagnetic interference.

6 C Carbon
12 Mg Magnesium
35 Br Bromine
28 Ni Nickel

RECYCLING RATES OF SMARTPHONE METALS

COLOUR KEY: < 1% RECYCLE RATE | 1–10% RECYCLE RATE | 10–25% RECYCLE RATE | 25–50% RECYCLE RATE | > 50% RECYCLE RATE | NON-METAL (OR RECYCLE RATE UNKNOWN)

SCREEN

In, O, Sn

TOUCH: INDIUM TIN OXIDE
Used in a transparent film over the phone's screen that conducts electricity. This allows the screen to function as a touch screen. This is the major use of indium.

Al, Si, O, K

GLASS: ALUMINA & SILICA
On most phones the glass is aluminosilicate glass, a mix of aluminium oxide & silicon dioxide. It also contains potassium ions which help strengthen it.

Y, La, Tb, Pr, Eu, Dy, Gd

COLOURS: RARE EARTH METALS
A variety of rare earth metal-containing compounds are used to help to produce the colours in a smartphone's screen. Some of these compounds are also used to help reduce light penetration into the phone. Many of the 'rare earths' occur commonly in the Earth's crust, but often at levels too low to be economically extracted.

ELECTRONICS

WIRING & MICROELECTRONICS
Copper is used for wiring, and for micro-electrical components along with gold and silver. Tantalum is the major component in micro-capacitors.

Cu, Ag, Au, Ta

MICROPHONES & VIBRATIONS
Nickel is used in the microphone and for electrical connections. Rare earth element alloys are used in magnets in the speaker and microphone, and the vibration unit.

Ni, Dy, Pr, Tb, Nd, Gd

THE SILICON CHIP
Pure silicon is used to manufacture the chip, which is then oxidised to produce non-conducting regions. Other elements are added to allow the chip to conduct electricity.

Si, O, Sb, As, P, Ga

CONNECTING ELECTRONICS
Tin & lead were used in older solders; newer, lead-free solders use a mix of tin, copper & silver.

Sn, Pb

BATTERY

Li, Co, O, C, Al

Most phones use lithium ion batteries, composed of lithium cobalt oxide as a positive electrode and graphite (carbon) as the negative electrode. Sometimes other metals, such as manganese, are used in place of cobalt. The battery casing is often made of aluminium.

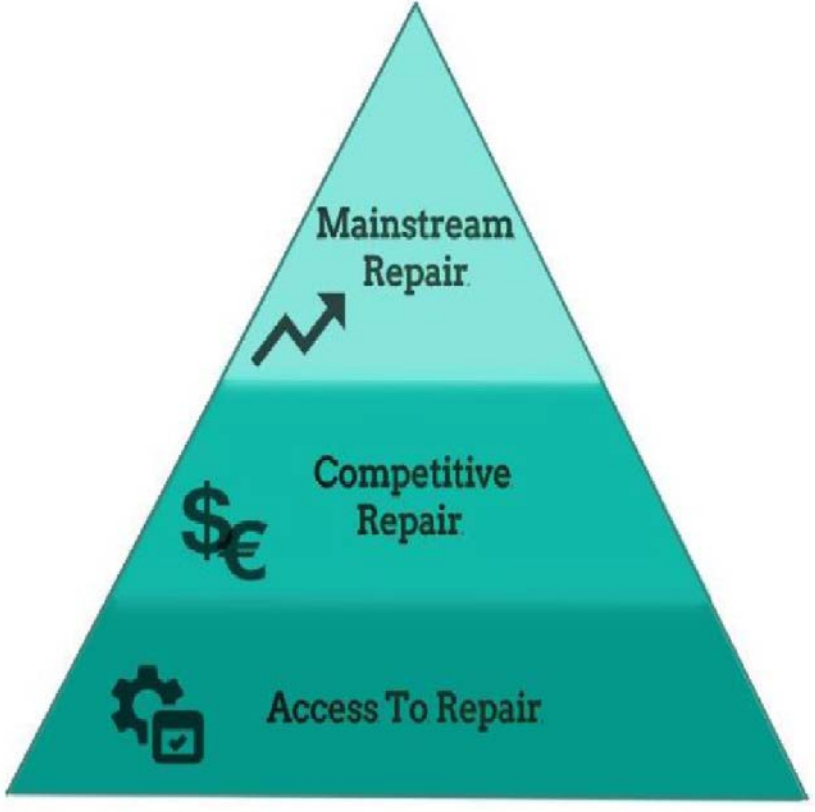
CASING

Magnesium alloy is used to make some phone cases, whilst many others are made of plastics, which are carbon-based. Plastics will also include flame retardant compounds, some of which contain bromine, whilst nickel can be included to reduce electromagnetic interference.

C, Mg, Br, Ni

Barriers to repair

1) Fundamental legal and non-legal barriers preventing accessible repair;
2) the total price of repair and other competitive factors deterring consumers from choosing repair as an economic and convenient option;
3) consumer preferences and attitudes not favoring repair.



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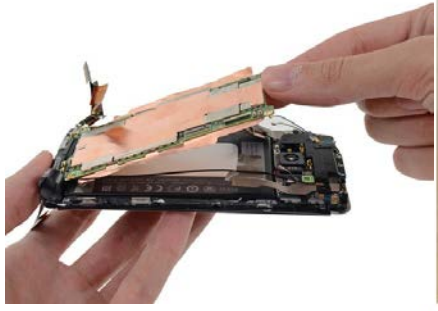
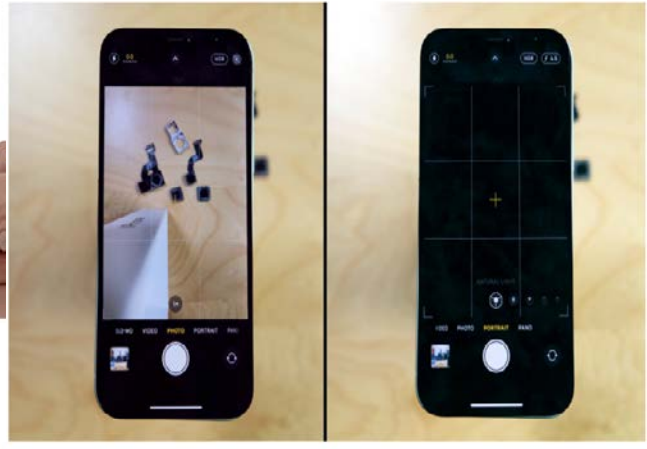
Design Barriers: examples

- Product Design
  - Premature Obsolescence
  - Adhesives, proprietary screws
  - Software doping, serialisation, etc.
- Repair system
  - Limited provision of spare parts information, diagnostics, software



Mobile phones often have designs with adhesives. Photo: iFixit, 2013



Replacing camera modules with non-OEM parts or even swapping might decrease functionality. Photo: iFixit, 2020

Jibo social robot announced in March 2019: "The servers out there that let me do what I do will be turned off soon."(Photo: Jibo)

Diagnostic software restrictions for tractors and military vehicles

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Legal Barriers: examples

Intellectual Property law preventing unauthorized repair, disassembly and/or use of non-OEM parts, enforced under:

- Patent law
- Copyright Law (manuals)
- Trademark Law (logos on parts)

DN Dagens Næringsliv

Henrik Huseby (til høyre) og advokat Per Harald Gjerstad vant saken mot Apple, hvor Apple hevdet at 63 Iphone-skjermer Huseby hadde importert som reservedeler var piratkopier. Foto: Skjalg Bøhmer Vold

Iphone-reparatør Henrik Huseby (37) vant over Apple i retten

Apple wins in 'David v Goliath' right to repair battle

By Samuel Stolton | EURACTIV.com

03-06-2020 (updated: 04-06-2020)

The Apple logo is pictured at the Apple Store in Santa Monica, California, USA. [EPA-EFE/MIKE NELSON]

Languages: Deutsch

Norway's Supreme Court has upheld a decision by the Court of Appeal, ruling in favour of US tech giant Apple and their claim that an independent smartphone repairer had breached trademark rules by using cheaper repair parts. The decision has sparked an outcry from 'right to repair' activists.

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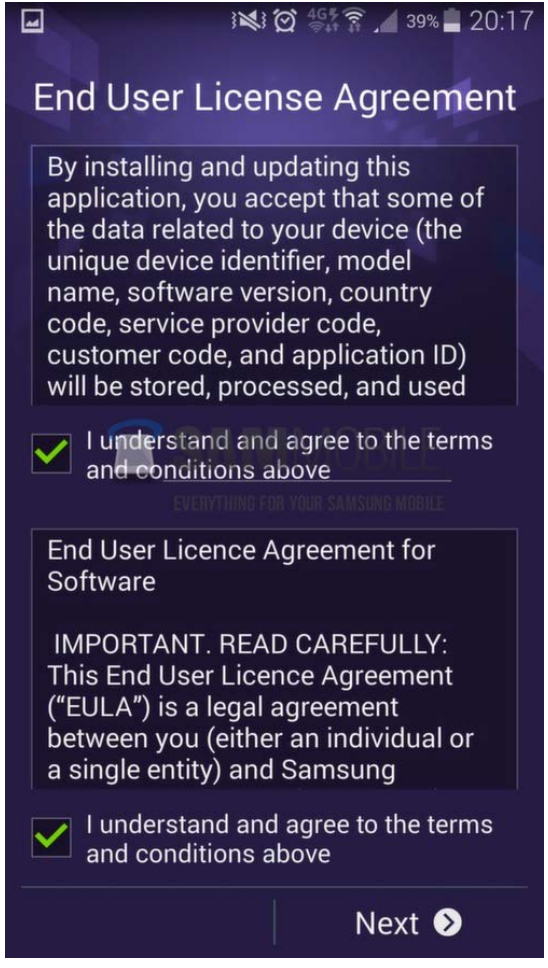
Legal barriers: examples

Contract law

- End-user license agreements with repair restrictions
- Clarity on interpretation lacking



Legal Barriers: examples

Consumer Law

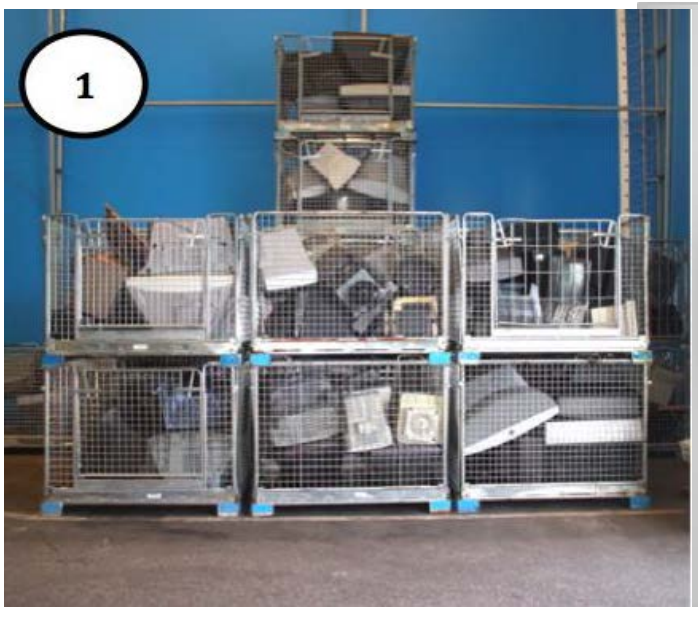
- Repair as a remedy
  - not always followed or accepted

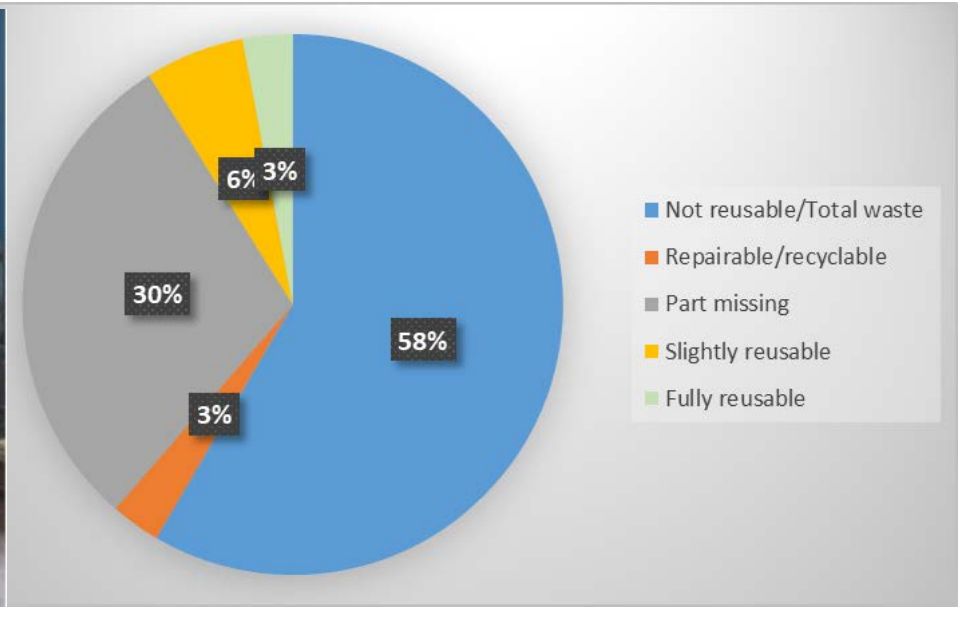
- Lack of awareness
  - Guarantee or warranty?
  - Misleading information, e.g. warranties

Other Barriers: examples

- Waste and recycling laws/systems
  - recycling targets, not reuse/repair targets
  - spare parts harvested from waste?
  - waste treatment handling

Reusable or repairable waste?





Sample WEEE from cage collection

Source for data and image: El Kretsen Functionality test 2015

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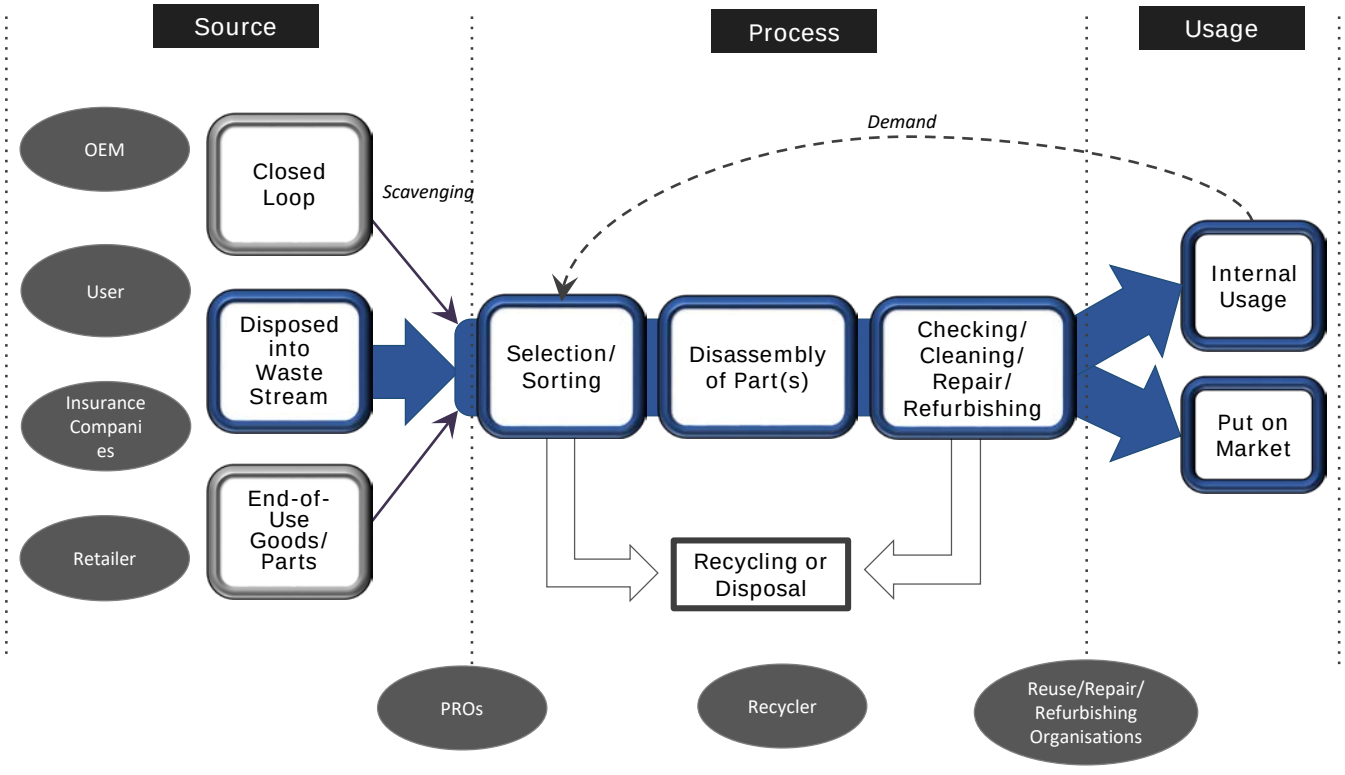

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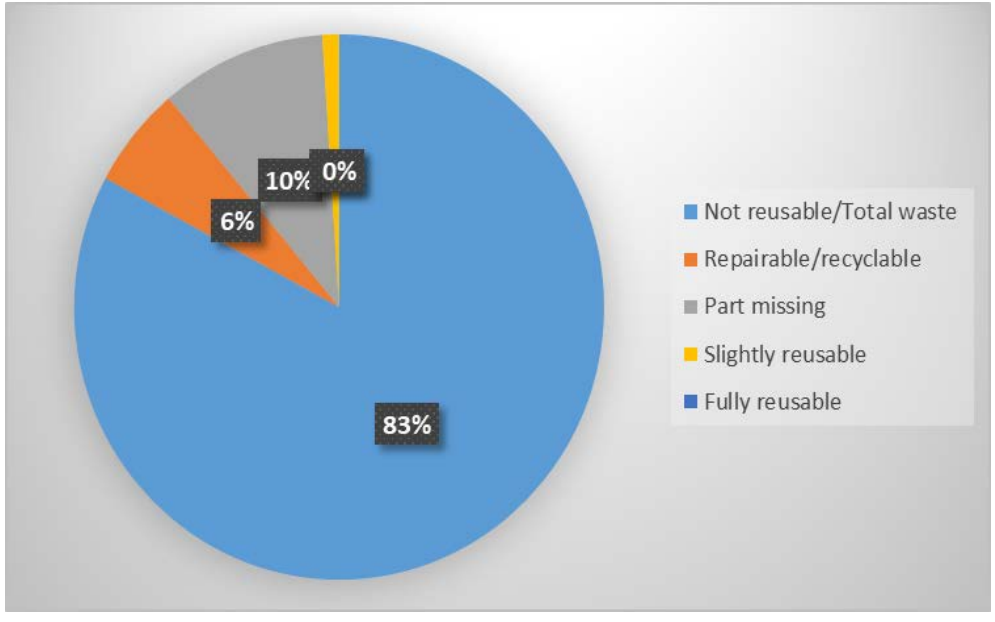
Reusable or repairable waste?



Sample of WEEE from containers

"Financially, there is no incentive to look for functioning products in the WEEE collection"

"This study demonstrated that there is no potential for preparing for re-use in the WEEE that is collected."

"The study shows that the best kind of re-use of a product is re-use which happens before the product is discarded as waste"

Source – [El Kretsen Functionality test 2015]

Home / Business / Companies / Apple

Apple's own battery blunder may be to blame for its earnings miss

A report claims that Apple CEO Tim Cook told staff the company had carried out 11 million battery replacements under the $29 program that was rolled out, compared to the 1 to 2 million that would normally be carried out in a year.

Written by **Adrian Kingsley-Hughes,** Contributing Writer
on Jan. 15, 2019

What was behind Apple's first profits warning since 2002? Was it the weakening Chinese market, in combination with pressures from the ratcheting of the US-China trade war and supply chain constraints, or did Apple bring it upon itself with the $29 iPhone battery replacement program that it had to put in place following the Batterygate scandal?

https://www.zdnet.com/article/apples-own-battery-blunder-may-be-to-blame-for-its-earnings-miss/

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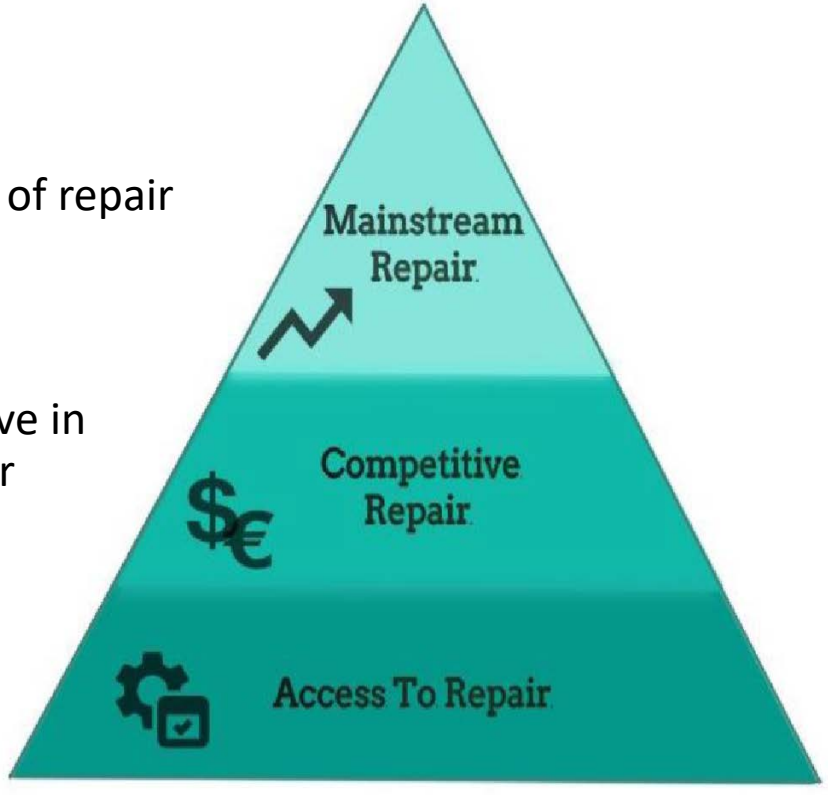
Enabling repair

Creating a culture of repair

Making repair more attractive in itself and compared to other options (i.e. buying new)

Removing fundamental legal and design barriers to ensure access to repair

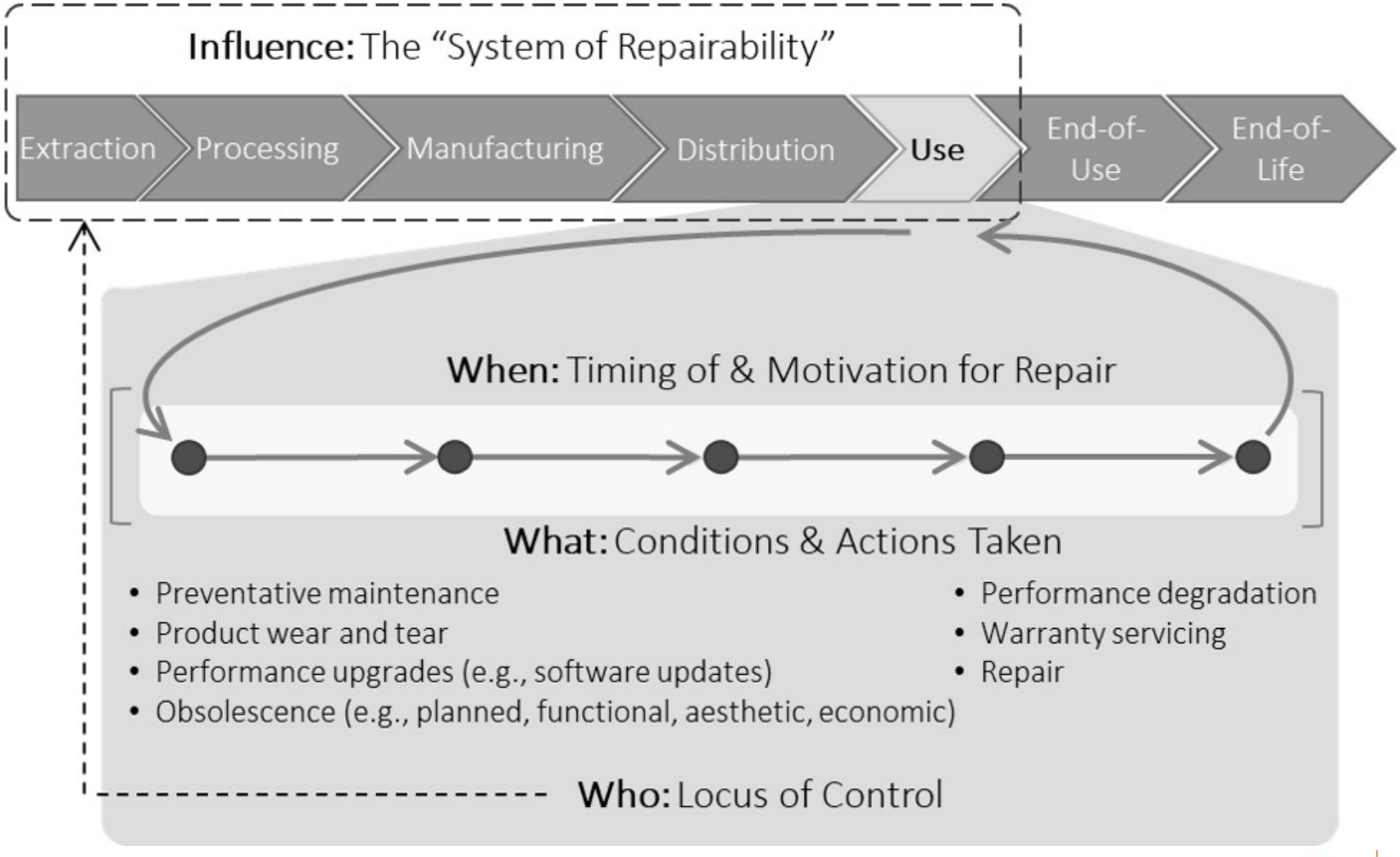


Other Barriers: examples

- Time, convenience, expense
  - Tax laws can make repair more expensive as repair is often labour intensive
  - Competing with optimized linear systems

- Consumer culture
  - fashion obsolescence
  - expectations for fast innovation cycles
  - relationship to products

Barbara Kruger, 'I Shop Therefore I am' (1990).



Russell, J. D., Svensson-Hoglund, S., Richter, J. L., & Dalhammar, C., Milios, L. (2021). A matter of timing: System requirements for repair and their temporal dimensions. 4th Plate Conference Proceedings. Product Lifetimes and the Environment, Limerick, Ireland. https://ulir.ul.ie/handle/10344/10237

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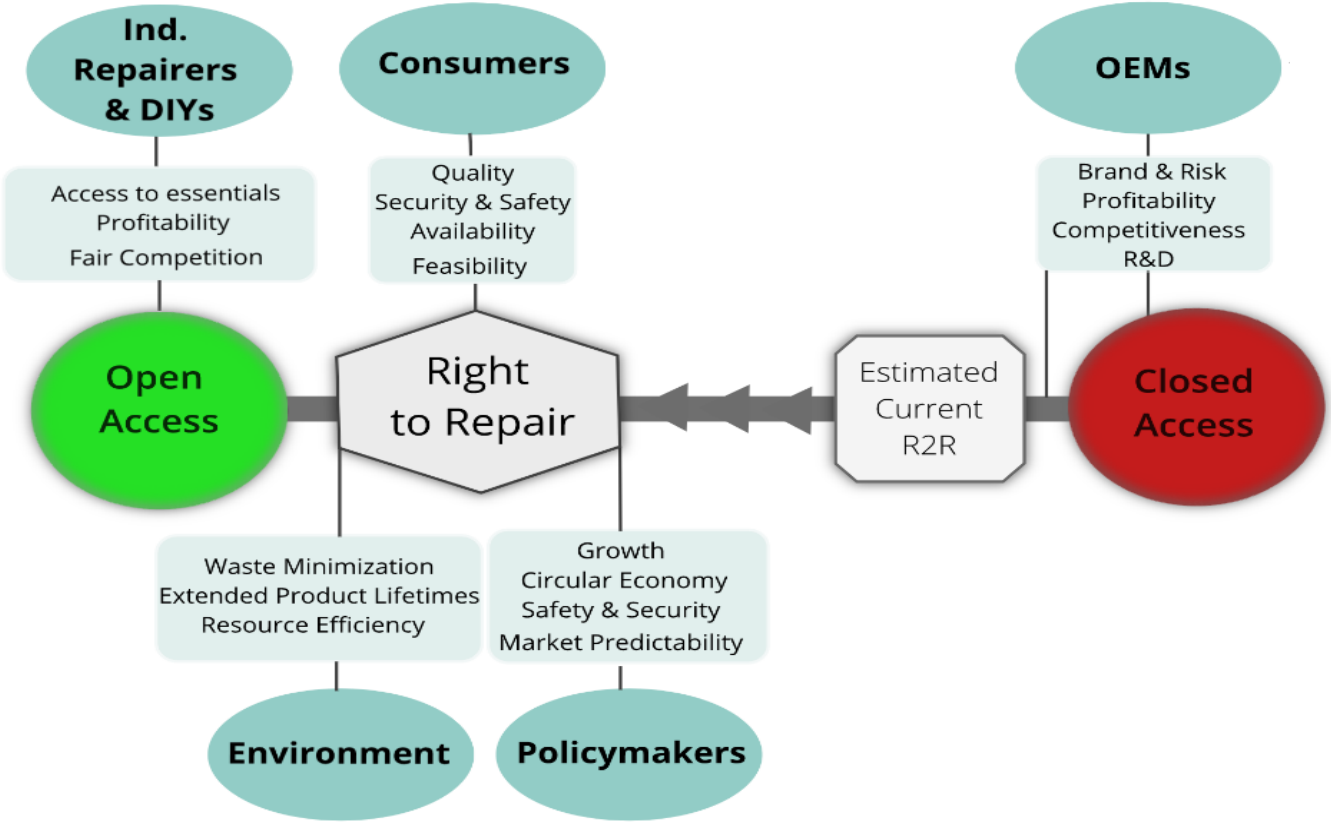
Stakeholder interests in upscaling repair



Svensson-Hoglund, S., Richter, J. L., Maitre-Ekern, E., Russell, J. D., Pihlajarinne, T., & Dalhammar, C. (2021). Barriers, enablers and market governance: A review of the policy landscape for repair of consumer electronics in the EU and the U.S. Journal of Cleaner Production, 288, 125488. https://doi.org/10.1016/j.jclepro.2020.125488

Policies enabling repair

EU:

- Ecodesign regulations
  - Availability of spare parts and manuals
  - Repairable with common tools
  - Minimum lifetimes (some products)
  - Removability/repairability of batteries?
  - Ease of disassembly?

Example: spare parts for household washing machines must be available for at least 10 years:

Available to professional repairers and end-users (at least)

- doors
- door hinges and seals
- other seals
- door locking assembly
- plastic peripherals

Available to professional repairers (at least)

- motor and motor brushes
- transmission between motor and drum
- pumps
- shock absorbers and springs
- washing drum, drum spider and ball bearings
- heaters and heating elements
- piping and related equipment
- printed circuit boards
- electronic displays
- pressure switches
- thermostats and sensors
- software and firmware including reset software

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Policies enabling repair

EU:

- Green procurement repairability criteria
  - Availability of spare parts and manuals
  - Repairable with common tools
  - Longer warranties

Member states:

- Longer Guarantees
  - Length (2 years currently)
  - Burden of proof (6 months)
- VAT reductions
- Repair funds
- Repairability scores

Policies enabling repair

USA

- Voluntary design guidelines
- More than 25 states have currently proposed R2R legislation
  - Require availability of
    - Service documentation
    - Diagnostics
    - Tools
    - Firmware
    - Service parts

    “on fair and reasonable terms” to customers and independent repairers

Hospitals Need to Be Able to Repair Their Own Medical Equipment

As the second wave of COVID-19 hits, Congress must pass a bill that would make it possible.

BY RON WYDEN AND ILIR KULLOLLI
OCT 12, 202010:09 AM

Policies enabling repair

USA

- Federal Trade Commission targeting repair restrictions that violate antitrust or consumer protection laws
  - e.g. Magnuson-Moss Warranty Act prohibits tying a consumer's product warranty to the use of a specific repair service provider or product

Policies enabling repair: municipalities

Source: Arabi et al. (2018).

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Repair Businesses

- Labour intensive
- Skilled
- Takes time, but local repair can be faster and cheaper
- Trust

EU and national policies seek to address many barriers for repair professionals

Riisgaard, H., Mosgaard, M., & Zacho, K. O. (2016). Local Circles in a Circular Economy – the Case of Smartphone Repair in Denmark. *European Journal of Sustainable Development*, *5*(1), 109–124. https://doi.org/10.14207/ejsd.2016.v5n1p109

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Repair professionals

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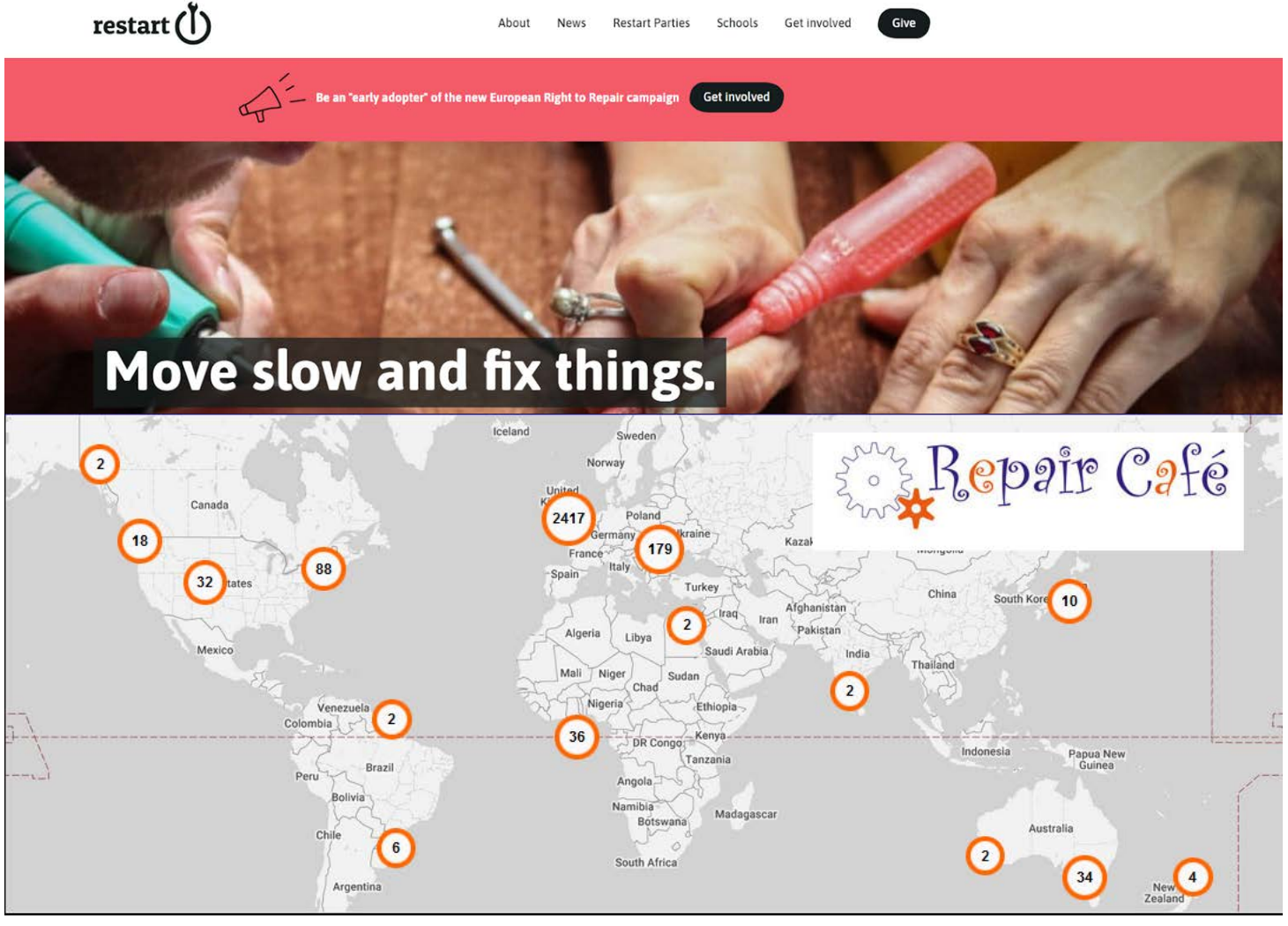
Community Repair: Repair Cafes



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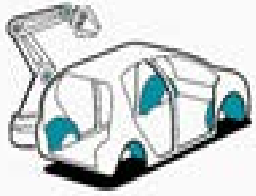
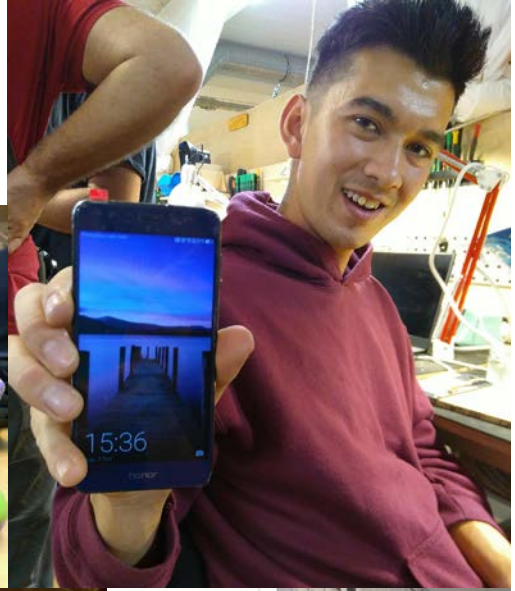
ENVIRONMENTAL IMPACT 2018

Environmental impact

Waste prevented	Equal to driving	Like manufacturing
440 kg		
CO_2 emissions prevented		
5,621 kg	46,839 km	1 car

A Culture of Repair?



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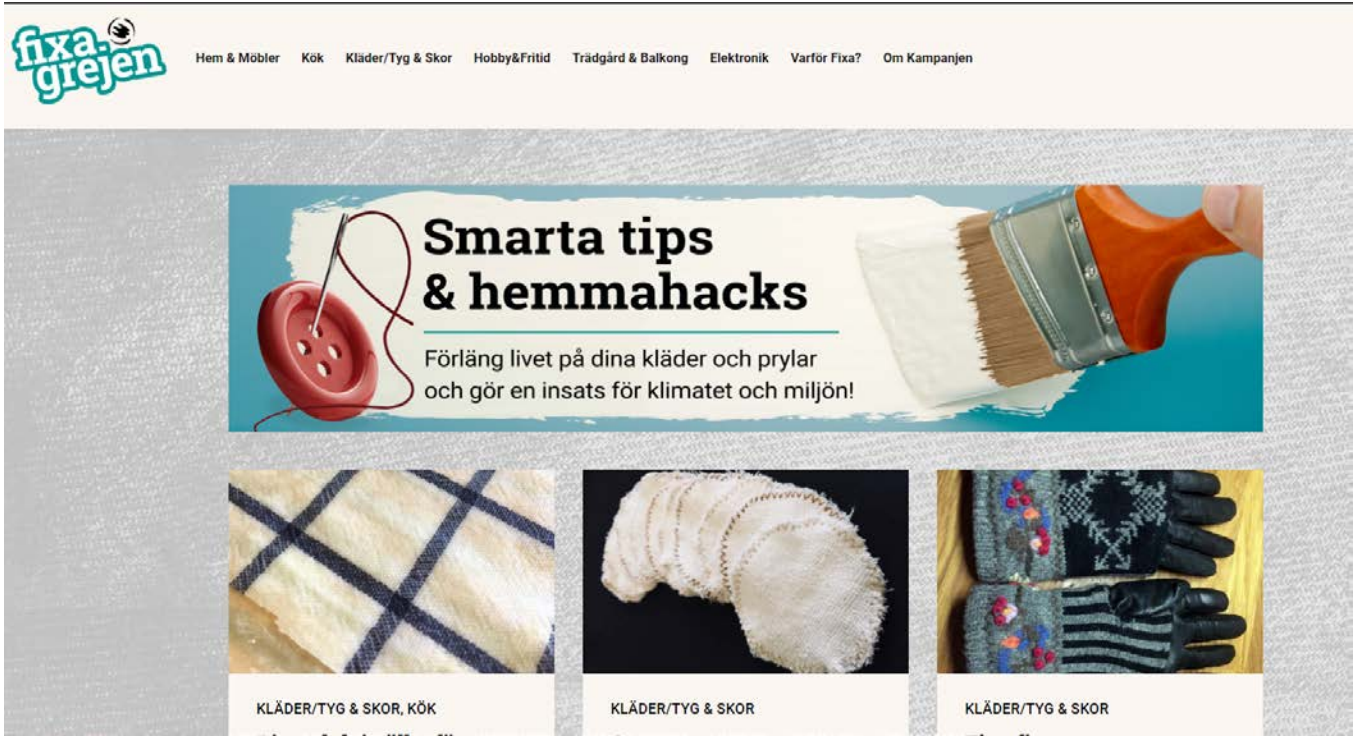
A Culture of Repair



Bradley, K., & Persson, O. (2022). Community repair in the circular economy: Fixing more than stuff. *Local Environment: The International Journal of Justice and Sustainability*, 1–17.

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Thanks!

MISTRA SUSTAINABLE CONSUMPTION
FRÅN NISCH TILL MAINSTREAM

CREACE

https://repairsociety.blogg.lu.se/

EU 1.5° LIFESTYLES

https://onepointfivelifestyles.eu/

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