Circular economy: promoting « green » engineering through policy

The electronics industry as an example

Towards a « climate-neutral digital economy »

- European Commission presented its « Green Deal »
  - EU climate-neutral by 2050
  - Digitalization of economy must accelerate the greening of society

- Can a digital economy be sustainable?
  - What are the negative effects of digitalization?
- Here: focus on consumer electronics
  - Smartphone as toy example

EU Green Deal also concerns research funding in Switzerland!

How do smartphones emit GHGs?

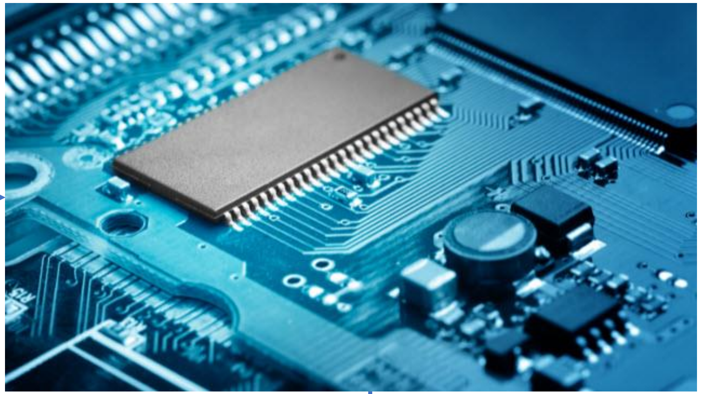
Mining & refining metals

CO_2, toxic water streams, chemical wastes

High-tech process in clean rooms

GHG F-gases (PFCs, SF_6)

Final product



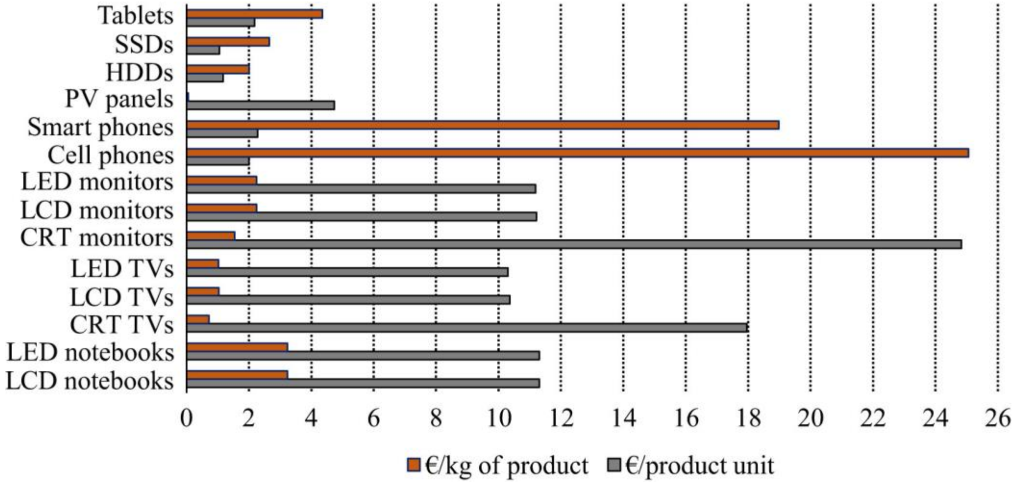
CO_2 from non-green electricity

Difficult (impossible?) to abate

Easy to abate

End-of-life treatment of electronics

- Electronic waste volumes grows 3-5% per year worldwide
    - Most goes to landfill or is burned [5,6]
- Theoric value of waste [6]:



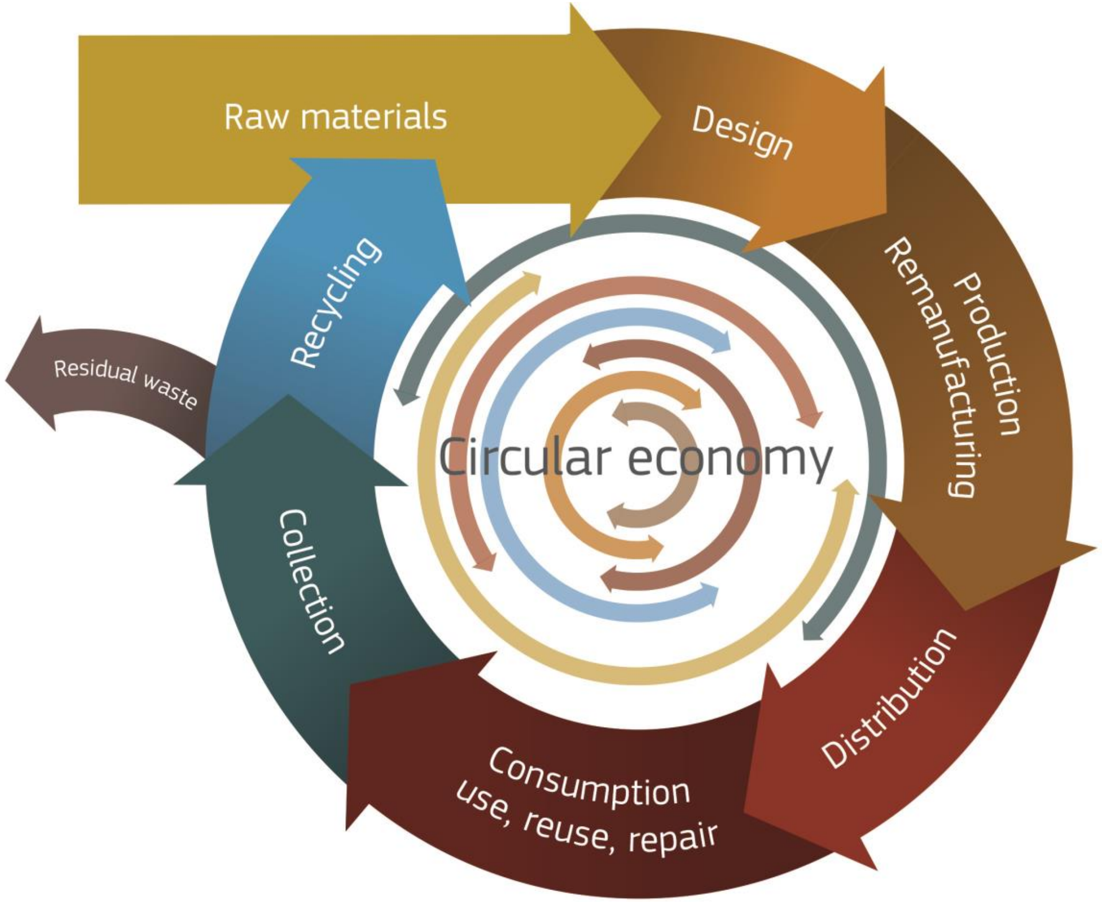
- Only PCBs from high-end products can be recycled today with profits [7]

In Ghana, illegaly exported e-waste is burned to recycle copper [4]

Circular economy as a new paradigm

- “Value of products, materials and resources is maintained for as long as possible and the generation of waste is minimized”
- Shift from the “linear economy”

- “Essential contribution to a sustainable, low carbon, resource efficient and competitive economy” (European Union, [3])
- How can it be applied to electronics?



Sustainability through green engineering [1]

1. Safer substitution materials for hazardous metals

   Simpler end-of-life treatment, reduced risk of eco-toxicity

2. New processes to digest and recover mixed materials

   Current recycling rate of critical metals is <1%

R&D subsidies
Tax on metals

3. Transparency on products to facilitate recycling

   Regulations for manufacturers to disclose metals in products

4. Eco-design for disassembly, via *modular designs*

   Facilitate reparation, recycling, upgrading, refurbishing

Regulation

A policy mix towards circular economies [2]

- A tax on all metals […] to increase material usage efficiency
- External costs are internalized through gradually expanded and increased environmental taxes

Taxation

- Eco-design directives for repairability
- Technical requirements specifying the quantity of materials that can be used in given products
  - Substitute metals where appropriate, increase material efficiency

Regulation

- Extended producer responsibility schemes
  - Producer is also responsible for the end-of-life treatment

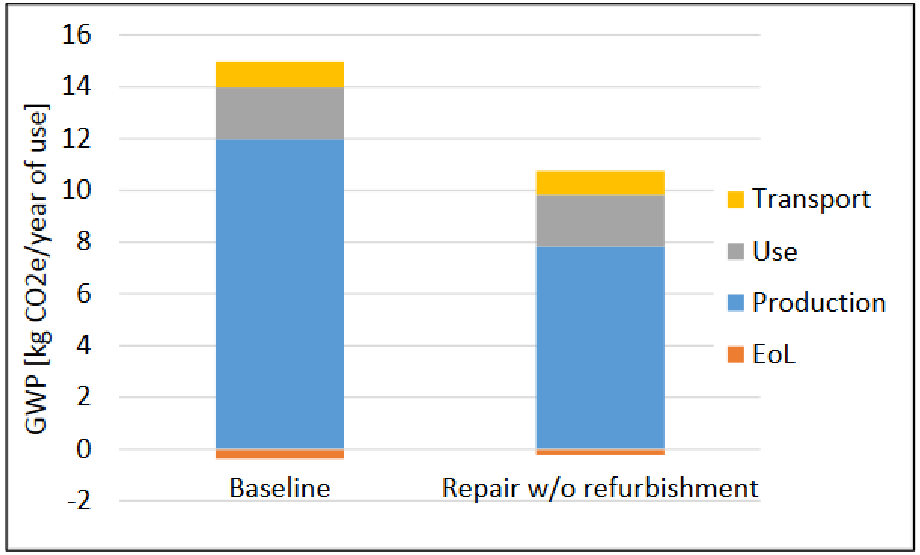
Legal

Eco-design example

- Fairphone: design of fair smartphones
  - Goal to reduce GHG emissions
  - Not 100% circular, but « state-of-the-art »

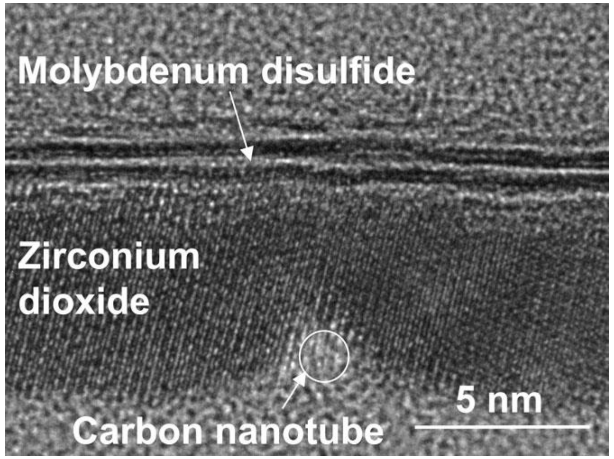
- Eco-design: all components can be disassembled & bought separately
- Transparency: life-cycles assesments studies ordered by Fairphone [11]
  - GWP dominated by fabrication
  - Extending lifetime reduces GHG/year of use

Fairphone 3: 419€



Impact of a circular economy for ICT?

Context: High-tech ICT relies on complex integrated nm-scale designs (*e.g.* smartphones)



Cross-section of 1-nm transistor [10]

- Taxing metals: recycling should be cheaper than mining
  - … however 100% recycling of electronics is impossible
  - Absence of literature, no proposals of tax levels
  - Impact on prices is not quantified

- Eco-design may brake ICT innovation & digital economy
  - Target lifetime of a « sustainable » smartphone ?
  - 5, 15, 100, … years?
  - Is a digital economy still feasible if devices cannot evolve?

Conclusion

- Electronics: many externalities are not reflected in the final price
  - GHG emissions at fabrication
  - Partial or non-existent recycling
- A more circular economy helps to reduce these externalities
- … but it won’t happen unless adapted policy is implemented!
  - Eco-design directives, transparency on products
  - Tax on metals
  - Internalizing the environmental costs (GHG, …)
- Impacts on i) prices ii) innovation iii) productivity are unknown

- Circular economy is a paradigm, it yields interesting tools
  - Joint effort in engineering and public policy

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