On the Way to Circular Economy – Intention and Reality

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1. Motivation of Circular Economy

- promoting the circular economy to conserve resources
- relief of ecosystem earth:
  - supply function (reduction of scarcity)
  - carrying function (reduction of environmental contamination)
- intergenerational justice (availability of resources & environmental quality for future generations)
- closing of (anthropogenic) mass- and energy-flows
- reduction of entropy / postponing the process of increasing entropy
- emissions reduction & climate protection
- re-use & recycling as „backstop-technologies“ in view of actual scarcity of resources and unavailability of substitutes
- security of supply in conjunction with geopolitical risks

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2. Finiteness ≠ „Scarcity“: Example Oil Prices

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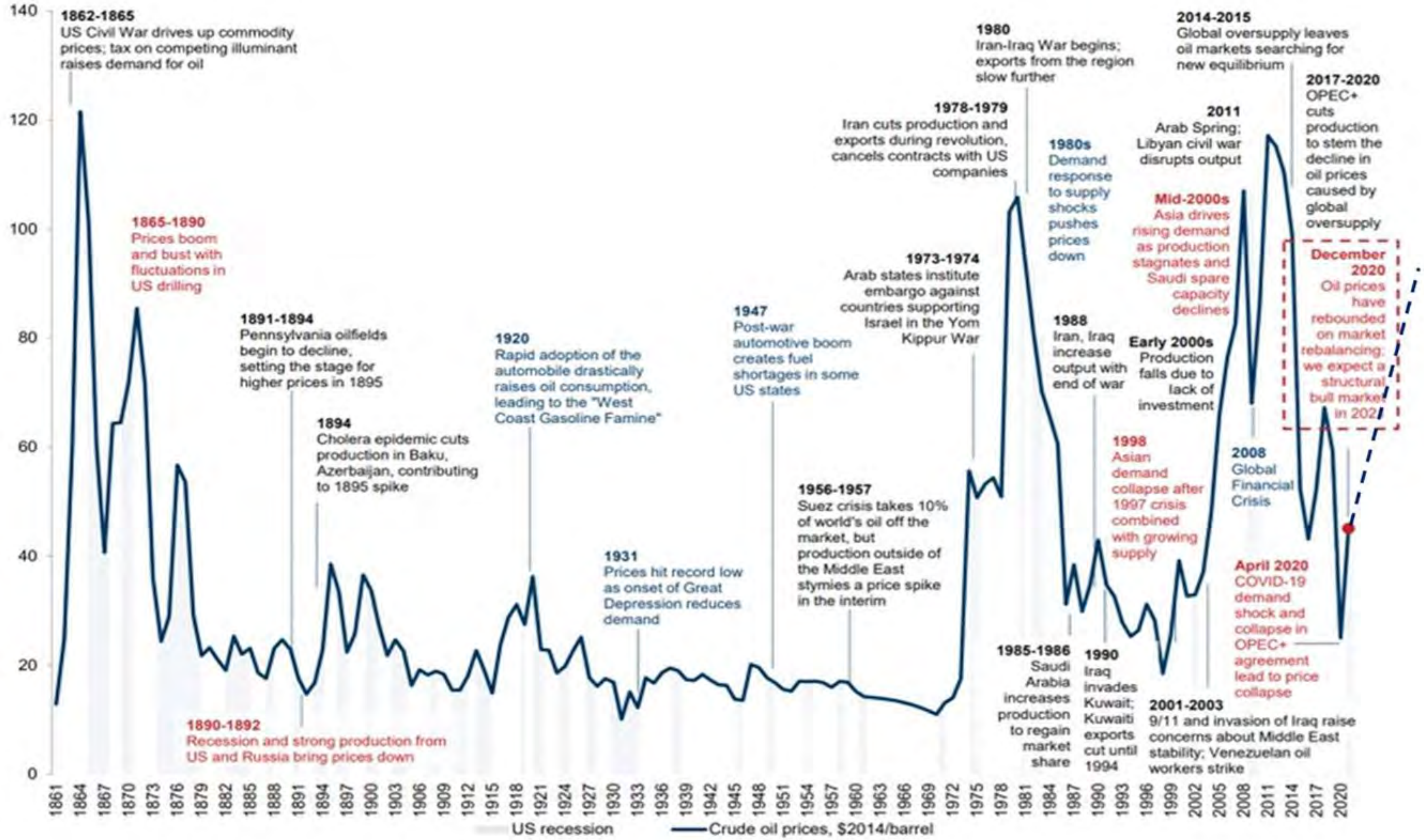
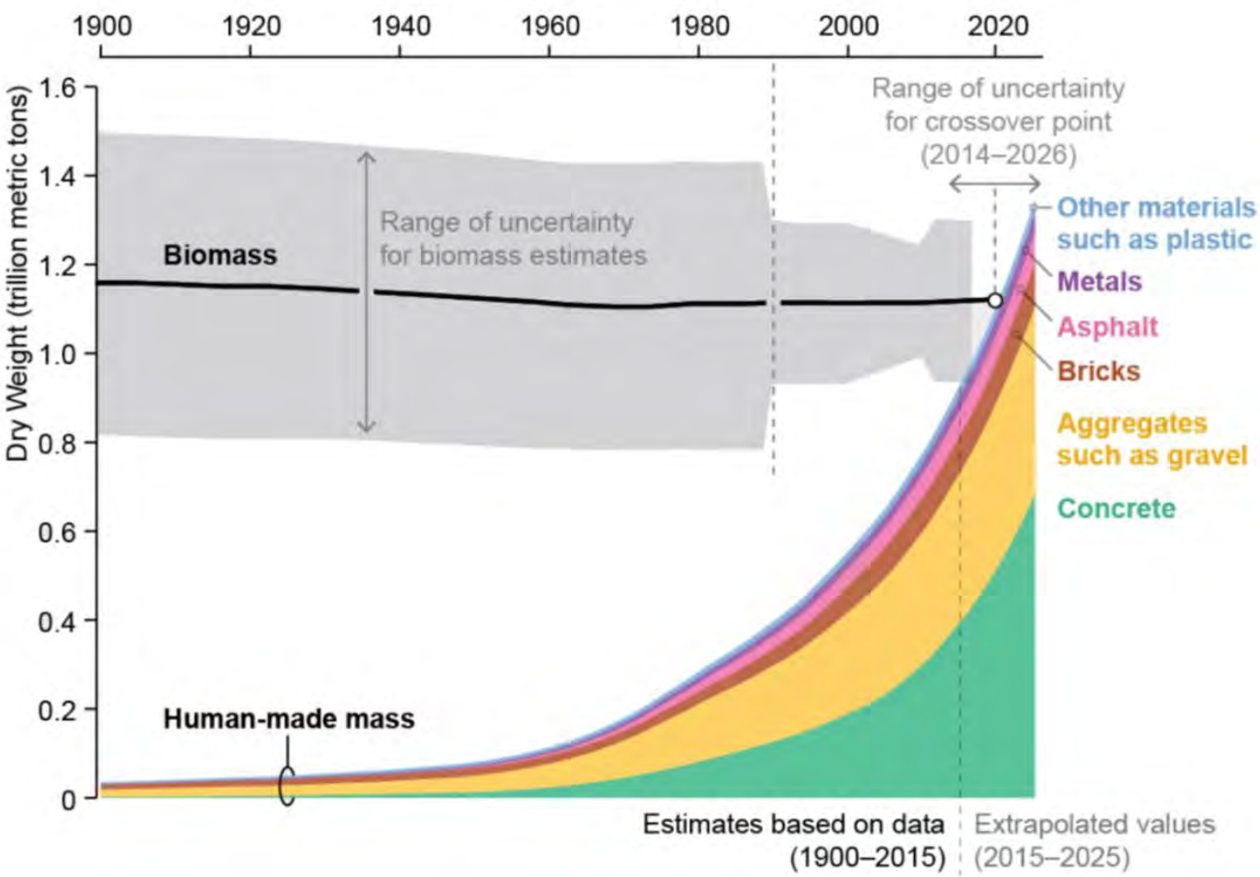


Source for data: BP, NBER/Federal Reserve Bank of St. Louis, Haver Analytics.
Source for annotations: ©James Hamilton, "Historical Oil Shocks," University of California, San Diego, February 2011; various news sources; Goldman Sachs Global Investment Research.

2. Anthropogenic Material Stock

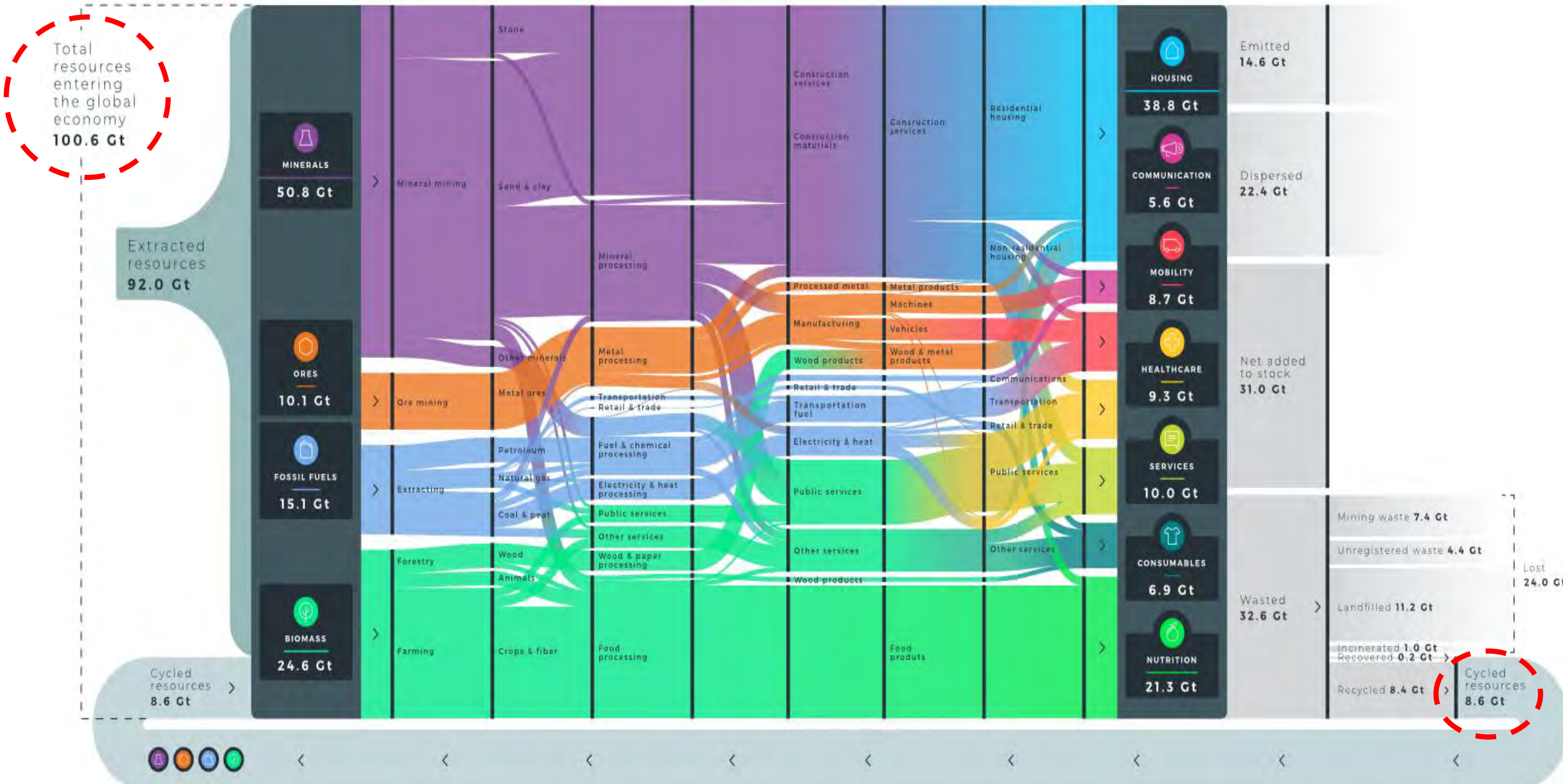
- Human made "**anthropogenic mass"** (streets, buildings, machinery, plastics etc) is currently **growing by more than 30 gigatons per year** – rising trend.



- **Human race** consuming **100 billion tonnes** of materials **per year**. **Projection 2050: > 170 billion tons**
- In 2020, the mass of the **anthropogenic material stock** has **exceeded** the **mass of all living biomass** on the planet. (**> 1,1 teratonnes**).
- Mass of all animals not even half the mass of plastics produced within the last 75 years (> 8 billion tons).

Source: Elhacham, E. et al. (2020), "Global Human-Made Mass Exceeds All Living Biomass", Nature online, Dec. 9, 2020.

2. Global Resource Footprint & Circularity Gap

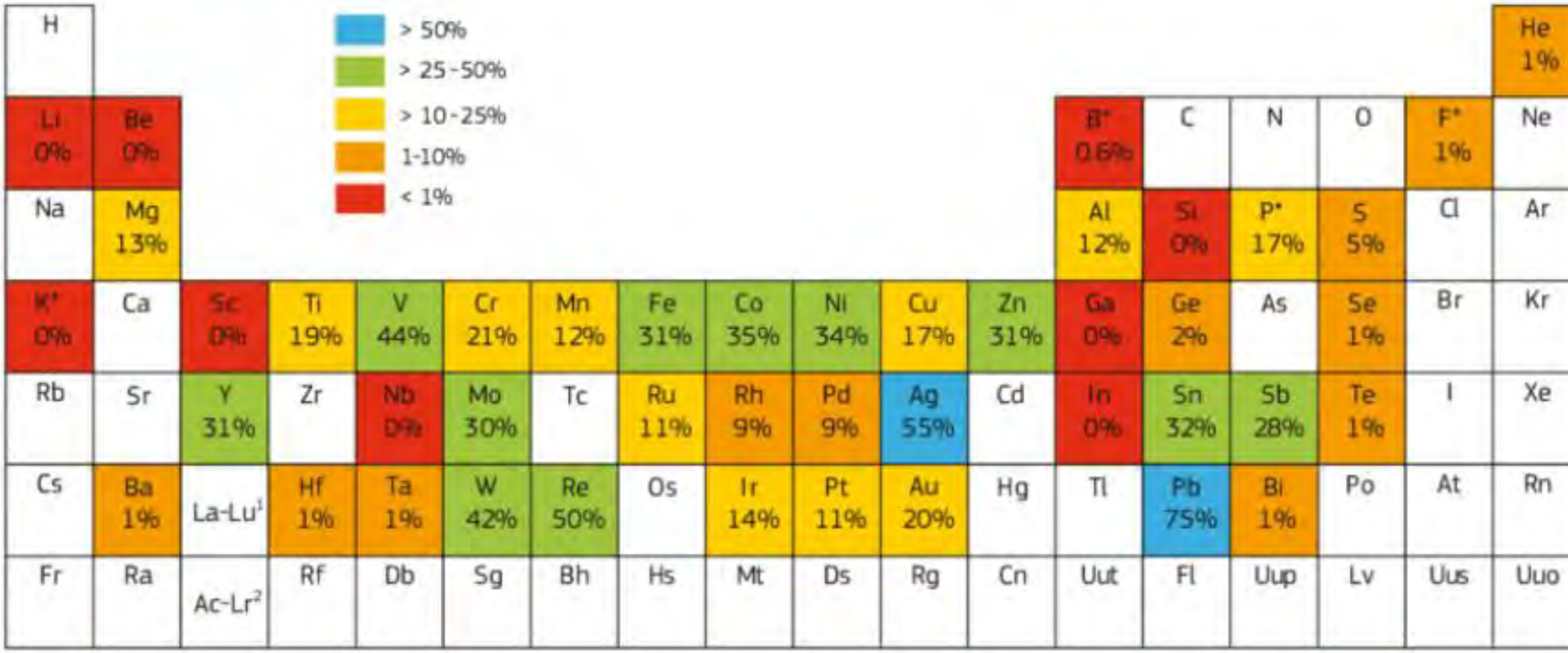


Source: The Circularity Gap Report 2022

- **Not even 10 percent** of the global economy can be referred to be **"circular"**
- **Current Global Circularity Gap > 90%** (has even risen during the last 5 years)

End-of-Life Recycling Input Rate European Union (2017)

(EOL-RIR = ratio of recycled / secondary material among total supply of raw matter)



Source: Talens Peiró, L. et al. (2018):Towards Recycling Indicators based on EU Flows and Raw Materials System Analysis Data

It is not matter as such that is scarce in the narrower sense but „useful“ matter…

…vulgo: matter with a sufficiently low entropy level = “feasible” matter !

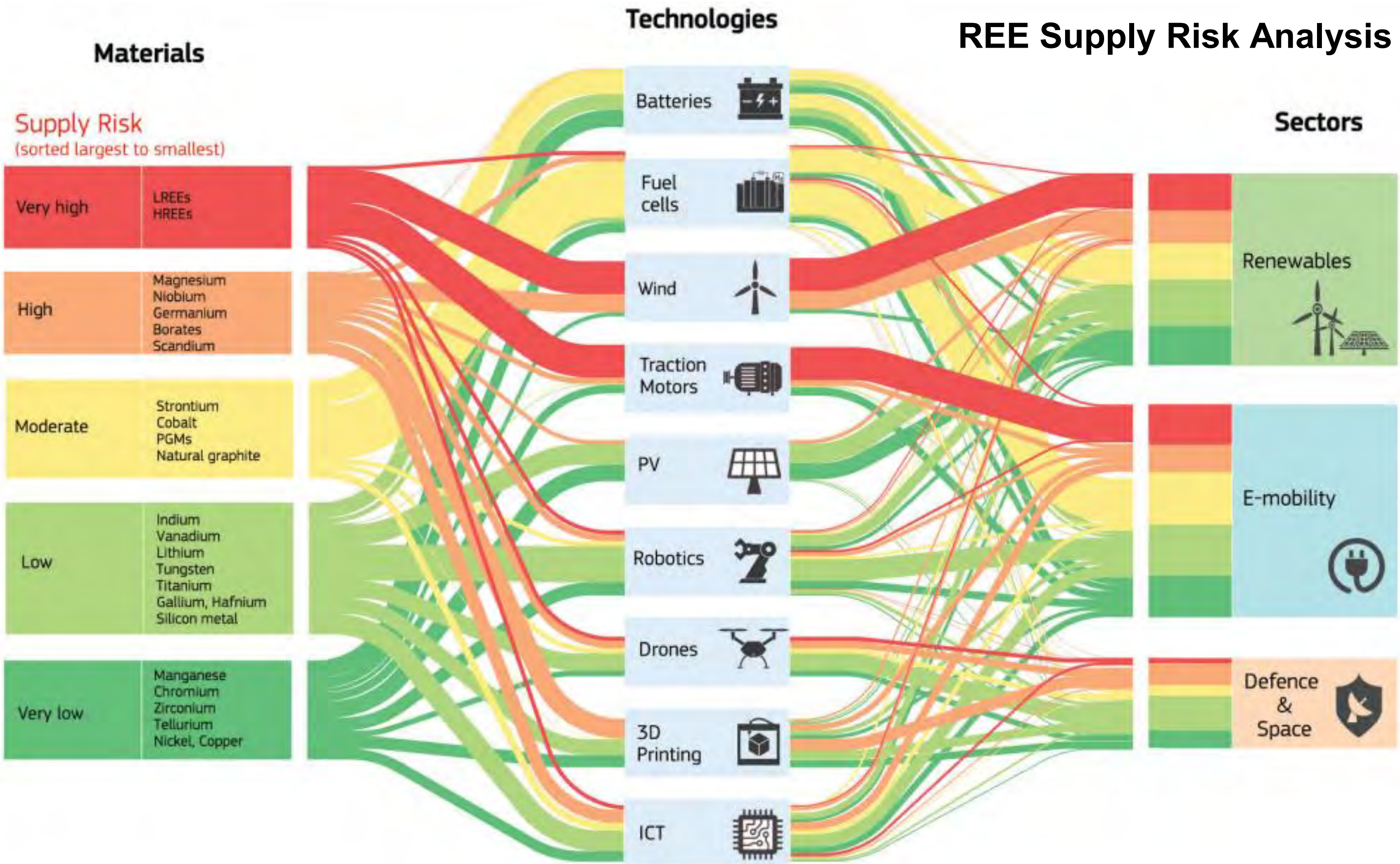
2. The case of Rare Earth Elements (REE)

Sc	Y	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
21	39	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71

- rare earth elements (REE) actually not that “rare”
  ⇨ economic rather than physical scarcity
- global market for rare earth metals increases at annual rates of 10 percent and is supposed to reach more than US$ 7.3 billion by 2025
  ⇨ huge and growing market potential
- essential input in the production of future technologies (solar cells, wind turbines, electric vehicles, smartphones etc)
  ⇨ essential commodities of high strategic importance
- extraction is energy- and chemically intensive
  ⇨ high economic and environmental cost
- price volatility ⇨ business risk & cost of risk management
- about 90 percent of the world’s supply currently originates in China
  ⇨ vulnerable to geopolitical tensions

2. The case of Rare Earth Elements (REE)

REE Supply Risk Analysis



Source: Bobba, S et al. (2020) “Critical Raw Materials for Strategic Technologies and Sectors in the EU – A Foresight Study”, European Commission

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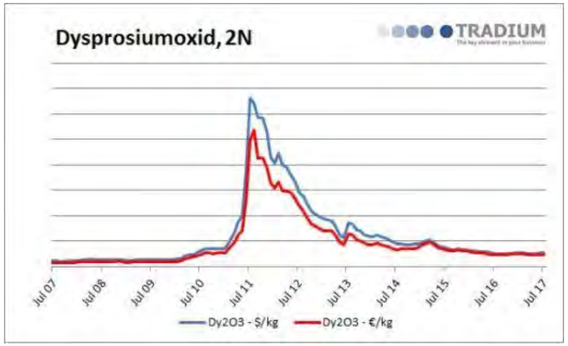
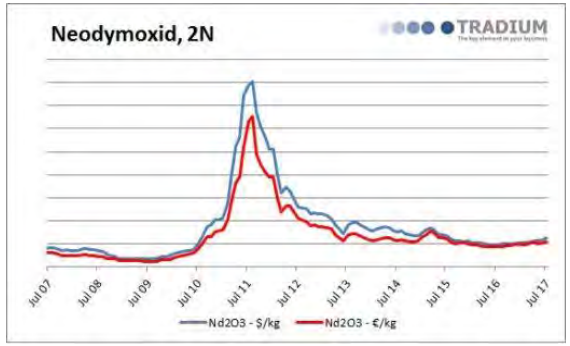
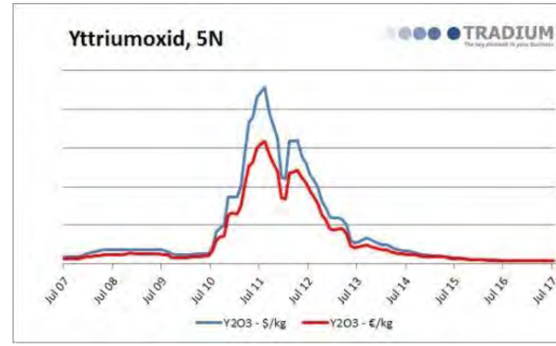
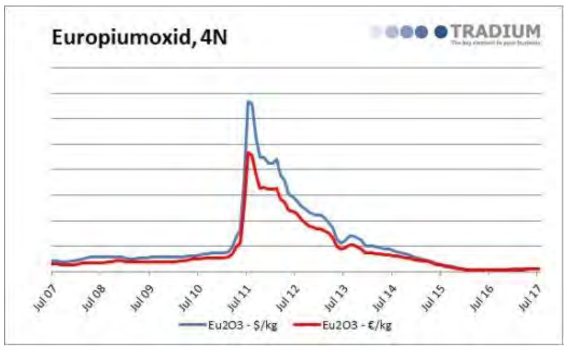
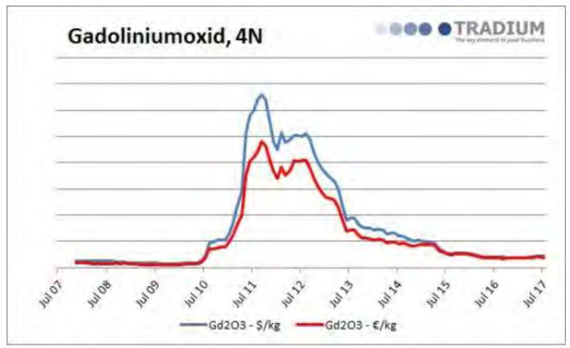
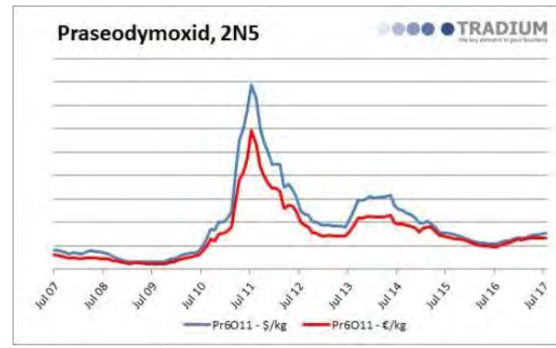












- 2011-2012 huge increase in REE prices due to (perceived) temporarily supply shortage (China announced export duties and restrictions in late 2010)
- Even in the face of these soaring prices of REE recycling rates did not significantly increase because of the (technical but mainly economic) constraints.
- It was / is just not profitable to invest in appropriate recycling technologies from a rather short term return-on-investment-perspective.

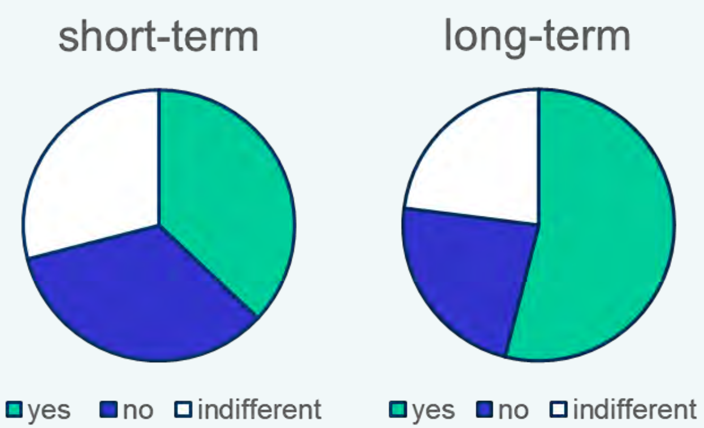
RARE EARTH ELEMENTS: A PERFECT CASE FOR CIRCULAR ECONOMY … BUT…

- REE with the lowest recycling rates of the 60 metals examined by the UNEP
  ⇨ only about 1 to 5 percent of the world's rare earth metals get recycled
- many products simply not designed for recyclability and are – from a short term business perspective – not meant to be reused or recycled
  ⇨ regulatory challenge?
- amount of REE in a typical mobile device add up to fractions of a gram
  ⇨ massive technical obstacles for (economically) feasible & efficient recycling
- consumers not aware of (convenient) recycling possibilities
  ⇨ challenges of collecting = "social" obstacle
- huge potentials for technical solutions especially regarding the rather "low hanging fruits" such as wind turbines, batteries, cars etc
  ⇨ higher collection rates of batteries, magnets and effective recycling strategies for larger units could raise REE recycling from 1-5 percent up to 30 percent
- However, even at much higher recycling rates (> 25 percent), recycling would produce not even five percent of global mine production.

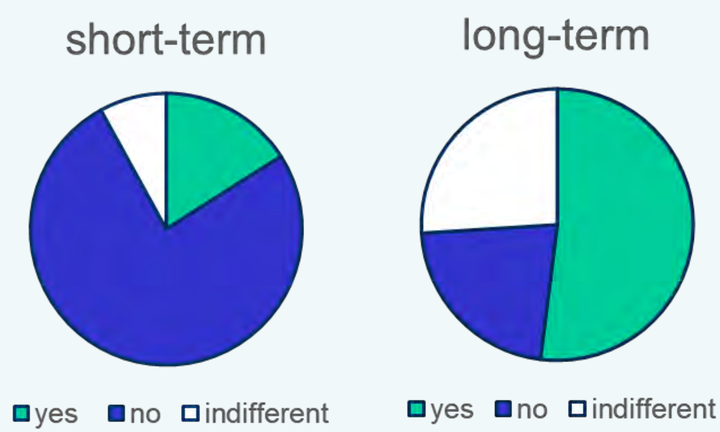
Selected results of a company survey from 2018

- 600 biggest industrial companies in the area of Chamber of Industry and Commerce Bavarian Swabia
- response rate: 9 - 12 % (depending on the question)

Q: Is a circular-based business model applicable to create and secure competitive advantages in general?



Q: Do you expect a shortage of raw materials?

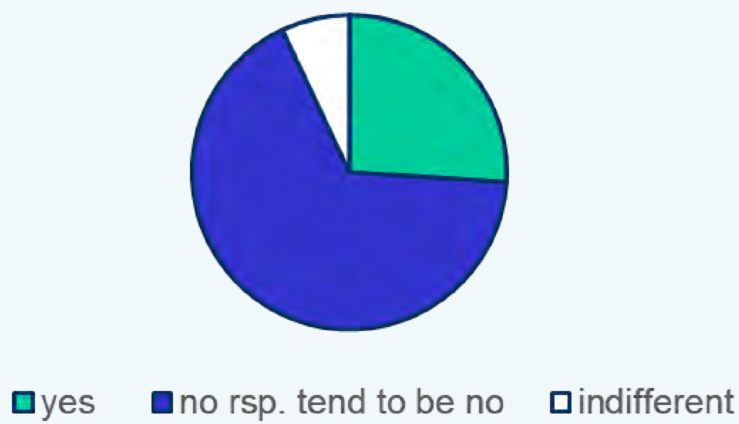


Source: Baum, H.-G. (2018): Unternehmensbefragung zum Grad der Übernahme kreislaufwirtschaftlicher Elemente in die betriebliche Praxis, Schriftenreihe des Fachbereichs Lebensmitteltechnologie, Hochschule Fulda 2018.

3.1 Opinions of Business Managers

Q: Does your company endorse an obligatory minimum input quota of secondary raw materials?

Q: Are producers or distributers to be obliged to give dismantling instructions to increase recyclability?



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General results:

- Company managers are well aware of (negative) effects and risks of current production and consumption patterns.
- However, they usually do not consider circular-based business models or even certain obligations as a suitable remedy for the problems at hand.

RessProKA

“Closing of resource efficient product cycles in the construction sector with new business models”

Part of the BMBF (German Federal Ministry of Education and Research) integrated project „ReziProk“ (Resource efficient circular economy – innovative product cycles)

BIFAS
Betriebswirtschaftliches Institut für Abfall- & Umweltstudien

Lindner

IWARU Institut für Infrastruktur · Wasser · Ressourcen · Umwelt
Arbeitsgruppe Ressourcen

Active Partners:

- University of Applied Sciences Münster, Institute for Infrastructure, Water, Resources & Environment
- Lindner Group KG
- Economic Institute for Waste and Environmental Studies (BIFAS)

3.2 Practical example of a circular-based business model

current business model:

„sell & forget“

usage phase

LOOP prime™

- Cradle to Cradle Certified®
- significant reduction of REA-gypsum
- 70 % CO_2-reduction
- > 90 % natural gas reduction
- 10 % price advantage

new business model:

„right or obligation to return“

return of the component

(–)

(exit option)

Lindner

simplified: details on mandatory return contract not shown

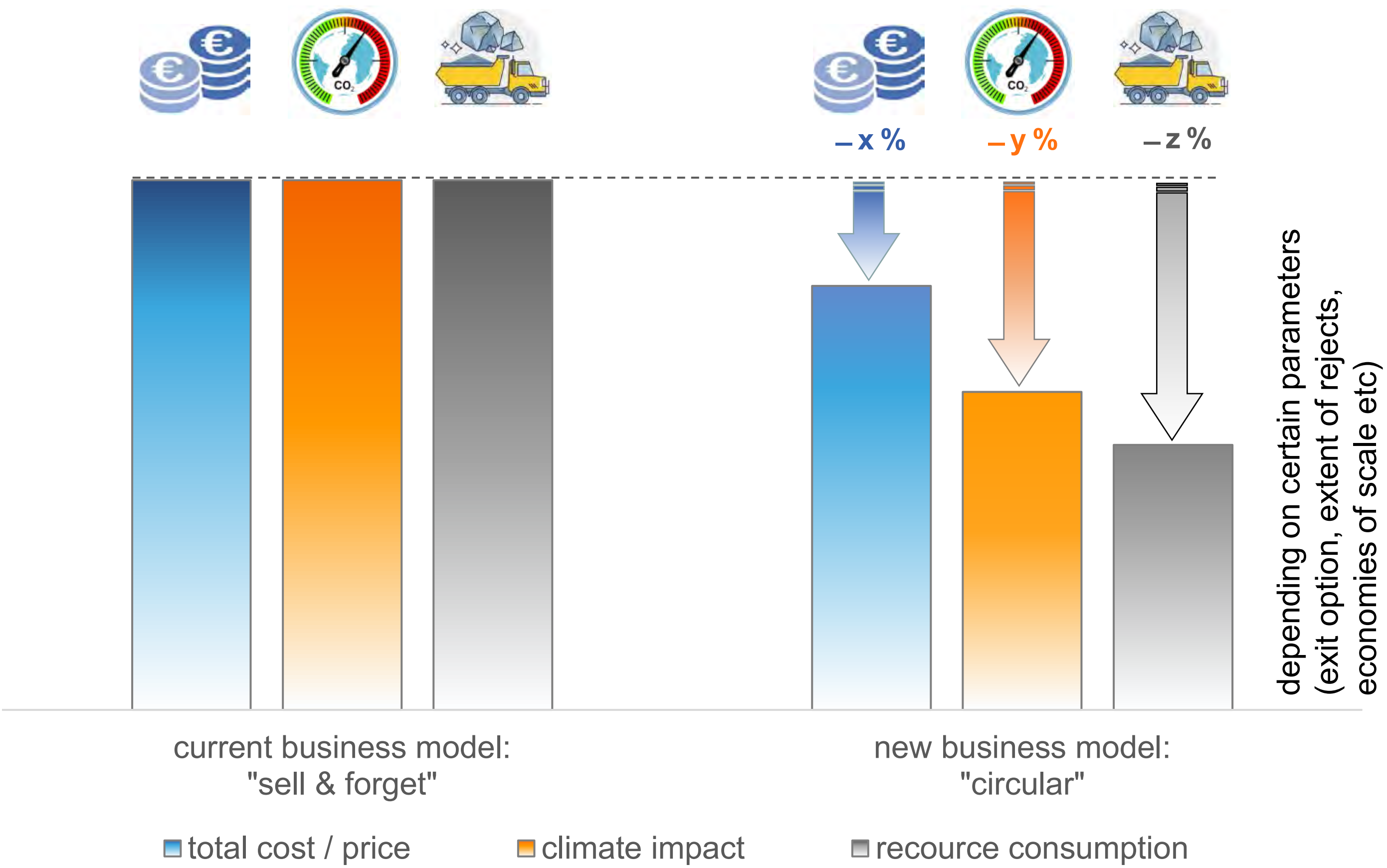
3.2 Practical example of a circular-based business model

current business model:

„sell & forget“

new business model:

„circular“



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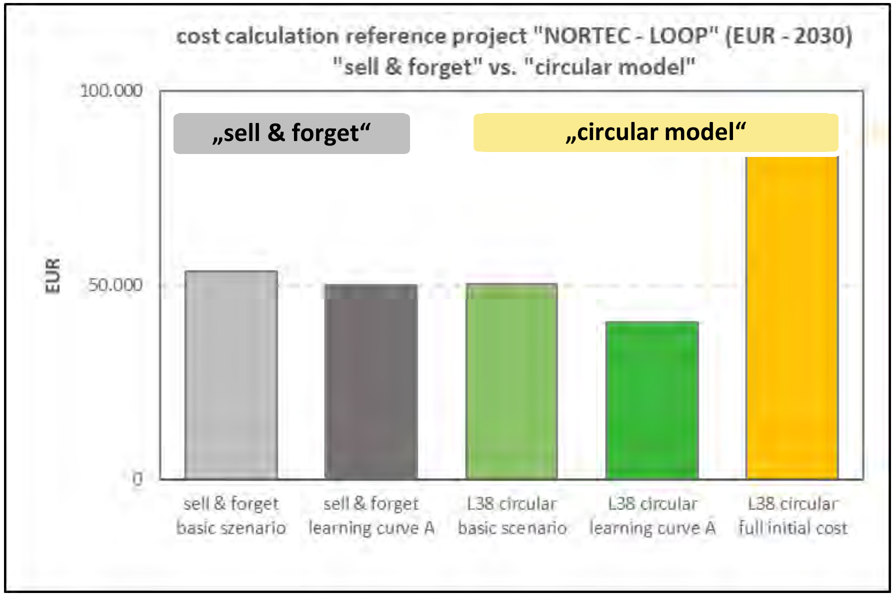

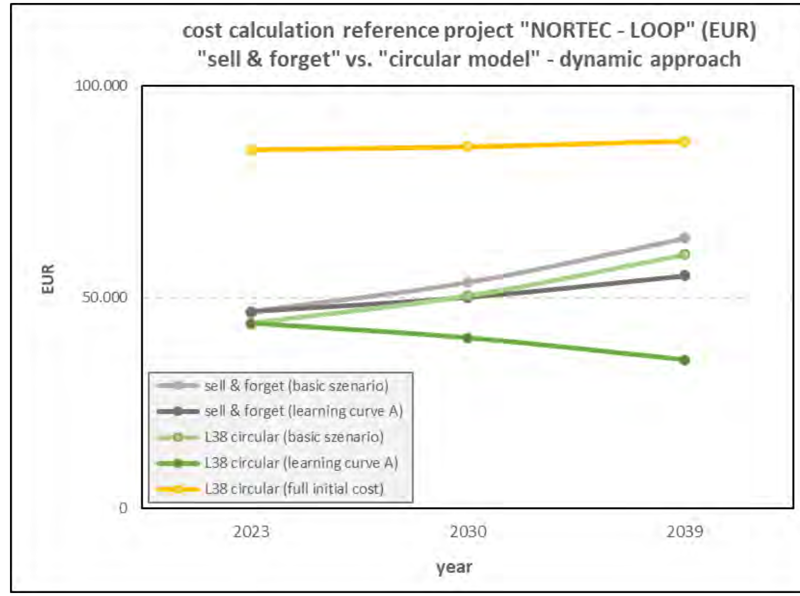

- Basically, this circular business model is already competitive.
- Once learning curve effects (e.g. economies of scale) occur over time, the advantages of the circular model will by far surpass the existing model “sell & forget”.
- But: If full (expected) deconstruction cost (today: “end of life deconstruction cost”) are internalized in the circular model contract (“circular model – full initial cost”) the price would exceed the (perceived) cost of the status quo (“sell & forget”).
- Therefore, costumer must be aware of the “end of life cost” in either model from the very beginning (long term approach rather than short term cost minimization)
  OR: certain (financial) incentives have to be provided during the start-up phase.

4. Conclusion

- There is a broad consensus on the existence of harmful (external) effects of our "way of living" (production & consumption patterns).
- Basically, a significant and increasing social and political will to reinforce the development towards circular economy can be observed.
- Unfortunately, reality clearly lacks behind this desire for a more circular-based economy (significant and growing "latent demand" vs. insufficient "willingness to pay")
- …mainly because of economic constraints and the absence of functioning business models!
- Wide agreement on huge (economic and ecological) potential for circular economy
- Well designed circular-based business models can be successful already today.
- However, stumbling blocks (e.g. regulatory and tax issues, technical constraints, relatively high initial cost of implementation etc) still exist.
- These obstacles need to be overcome, external cost of the extraction of primary resources should be internalized on a global scale and support during the start-up phase of new circular-based business models (e.g. contract for difference – CFD) might be necessary.

It's the economics, smart!

Thank you for your attention

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