Circular Economy and the Sustainable Development Goals

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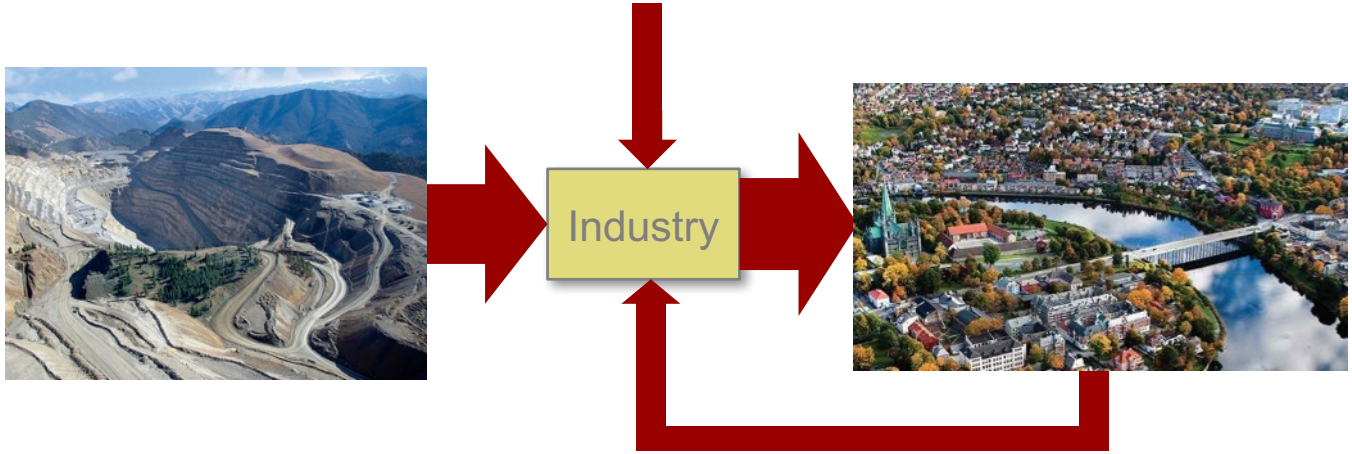
1. Motivation
2. Challenges for a circular economy
3. Example for aluminium
4. Conclusions / hypotheses



Three key drivers for global material cycles

1. Population growth and urbanization / industrialization

→ Moves materials from the ground into use

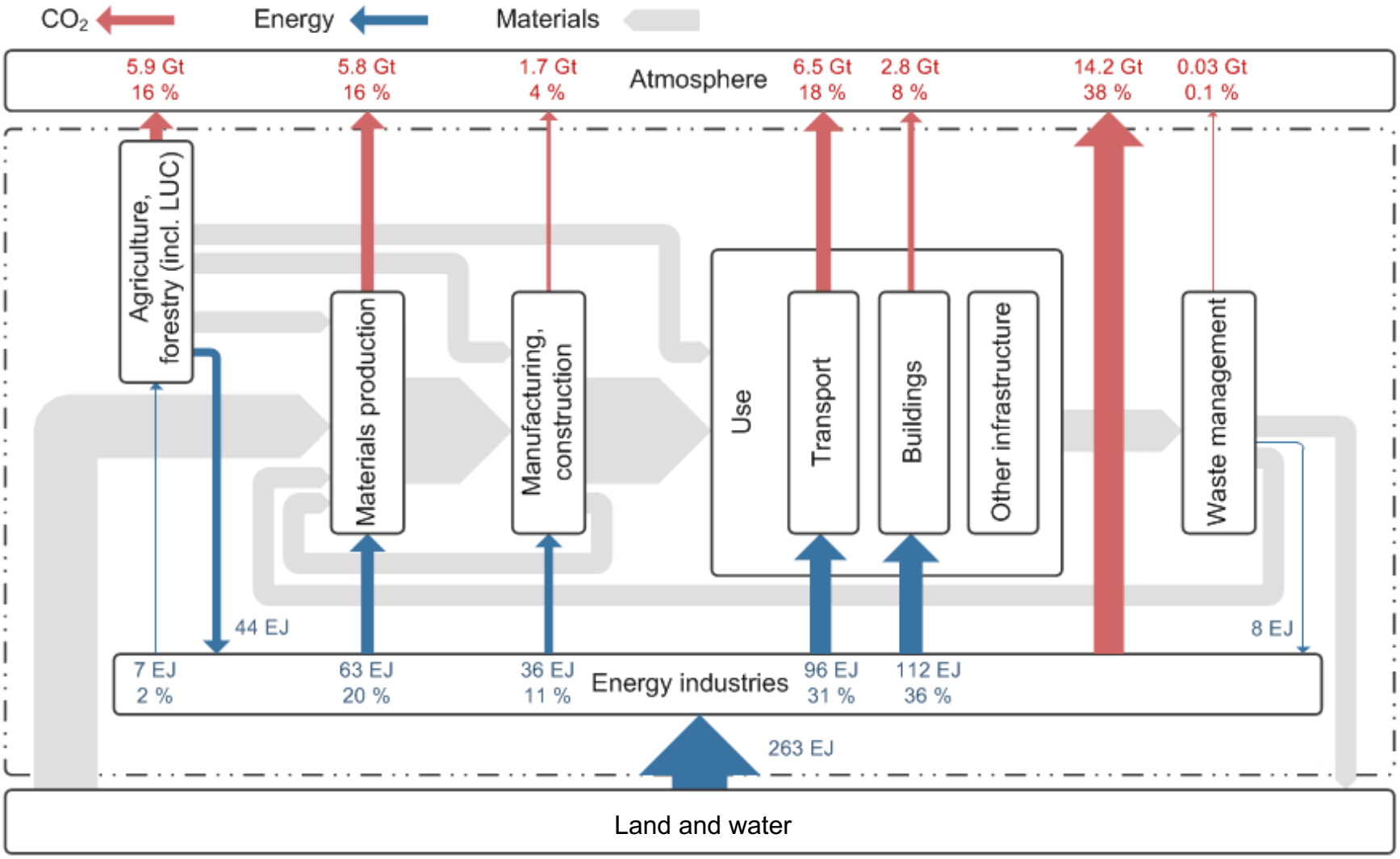
2. Globalization

→ Moves materials around the world

3. Sustainable development

→ Need for new infrastructures and changing global production and consumption patterns

Linkages between materials, energy, and emissions: socioeconomic metabolism

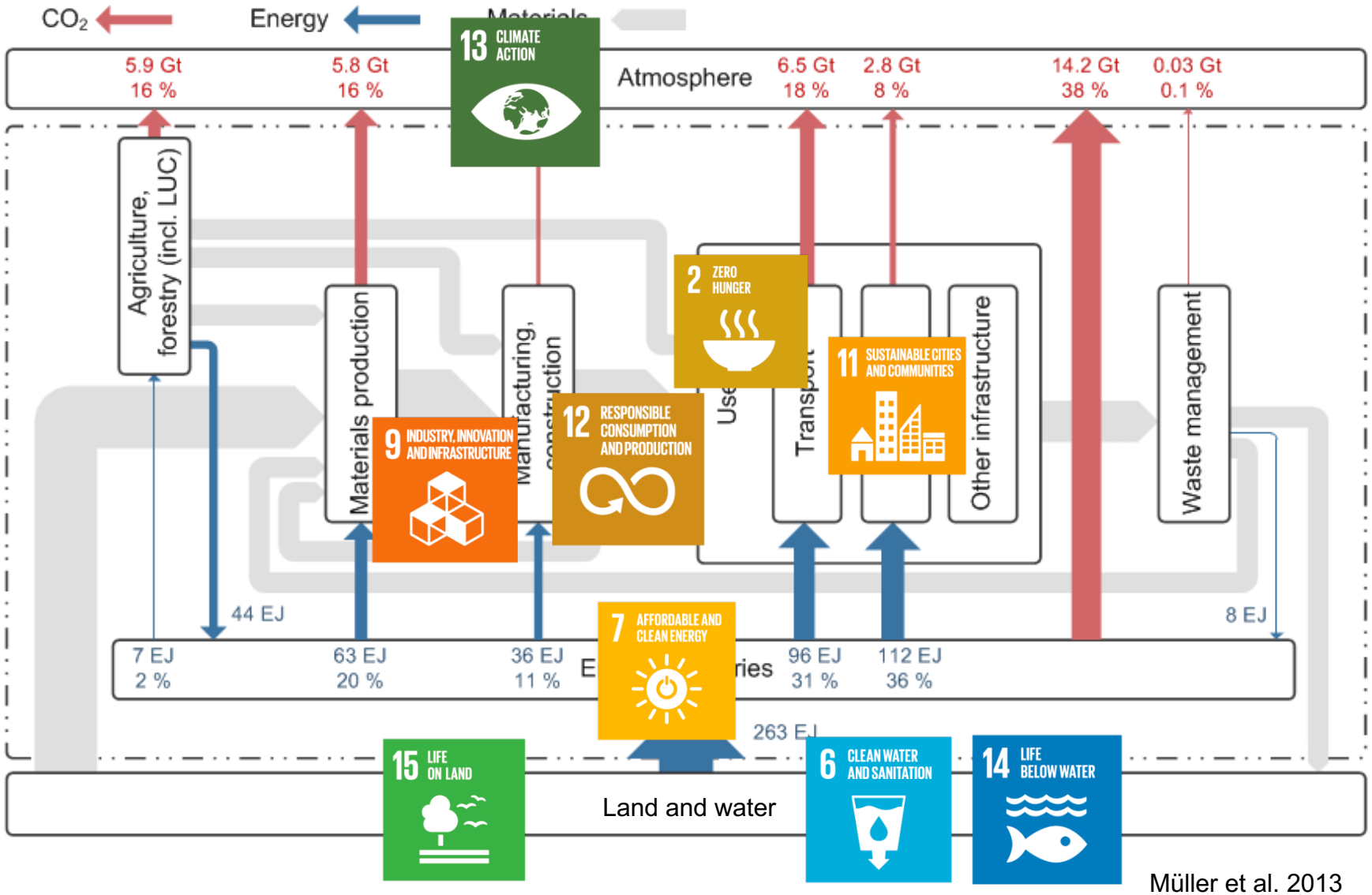


Müller et al. 2013

UN Sustainable Development Goals (SDGs) for 2030

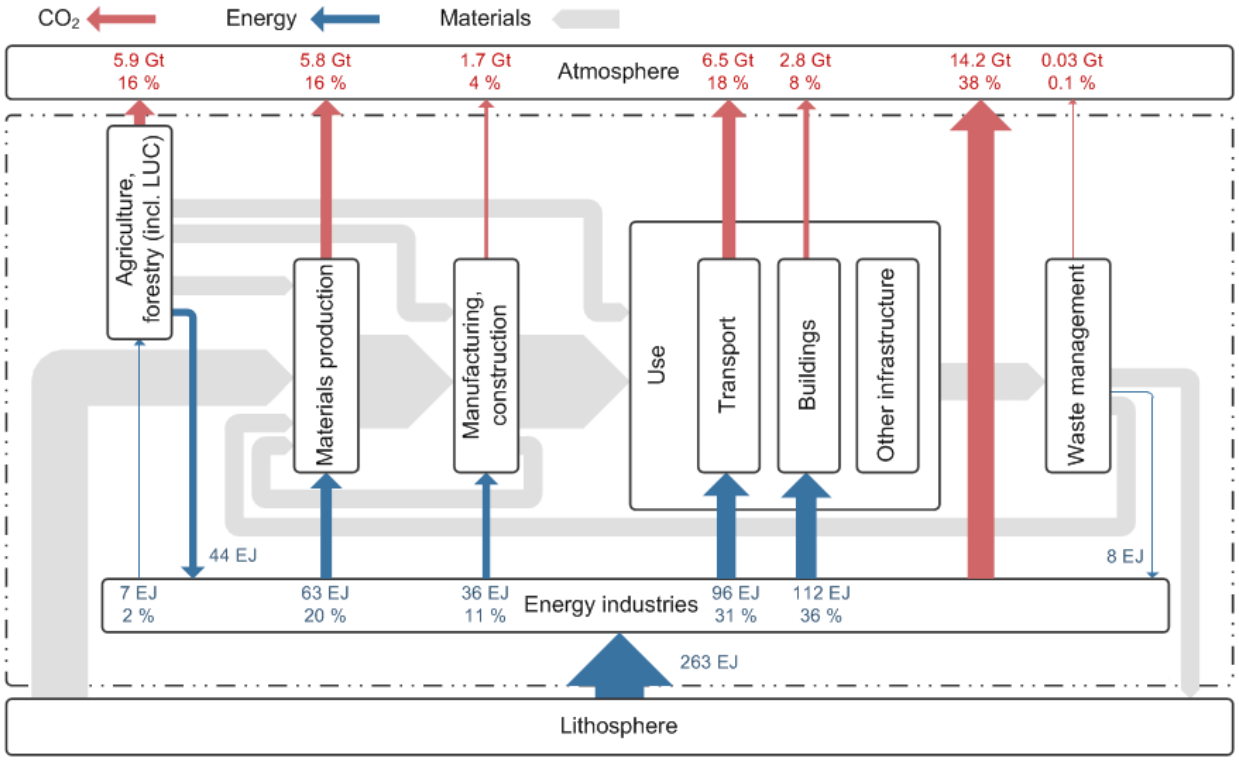
17 goals, 169 targets, 304 indicators

Socioeconomic metabolism and SDGs



Müller et al. 2013

Linkages between materials, energy, and emissions: socioeconomic metabolism

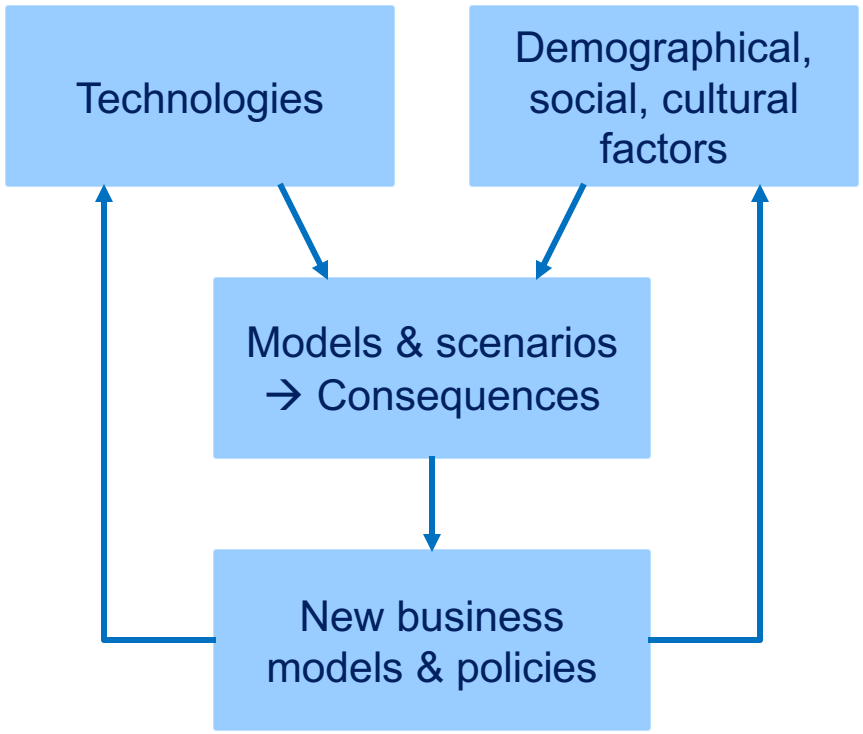


Data sources for 2008:
Emissions: EDGAR
Energy: IEA

Müller et al. 2013

1. The socioeconomic metabolism shapes the quality of our life (services provided by stocks in use and environment)
2. Current socioeconomic metabolism is not sustainable:
   - poverty / inequality (lack of access to essential services)
   - resource depletion, limited sinks for pollutants
3. Sustainable development requires transformation of socio-metabolic system
   → from design of processes/products to design of systems

Circular economy: need for learning labs



Circular economy strategies aim at controlling the material cycles.

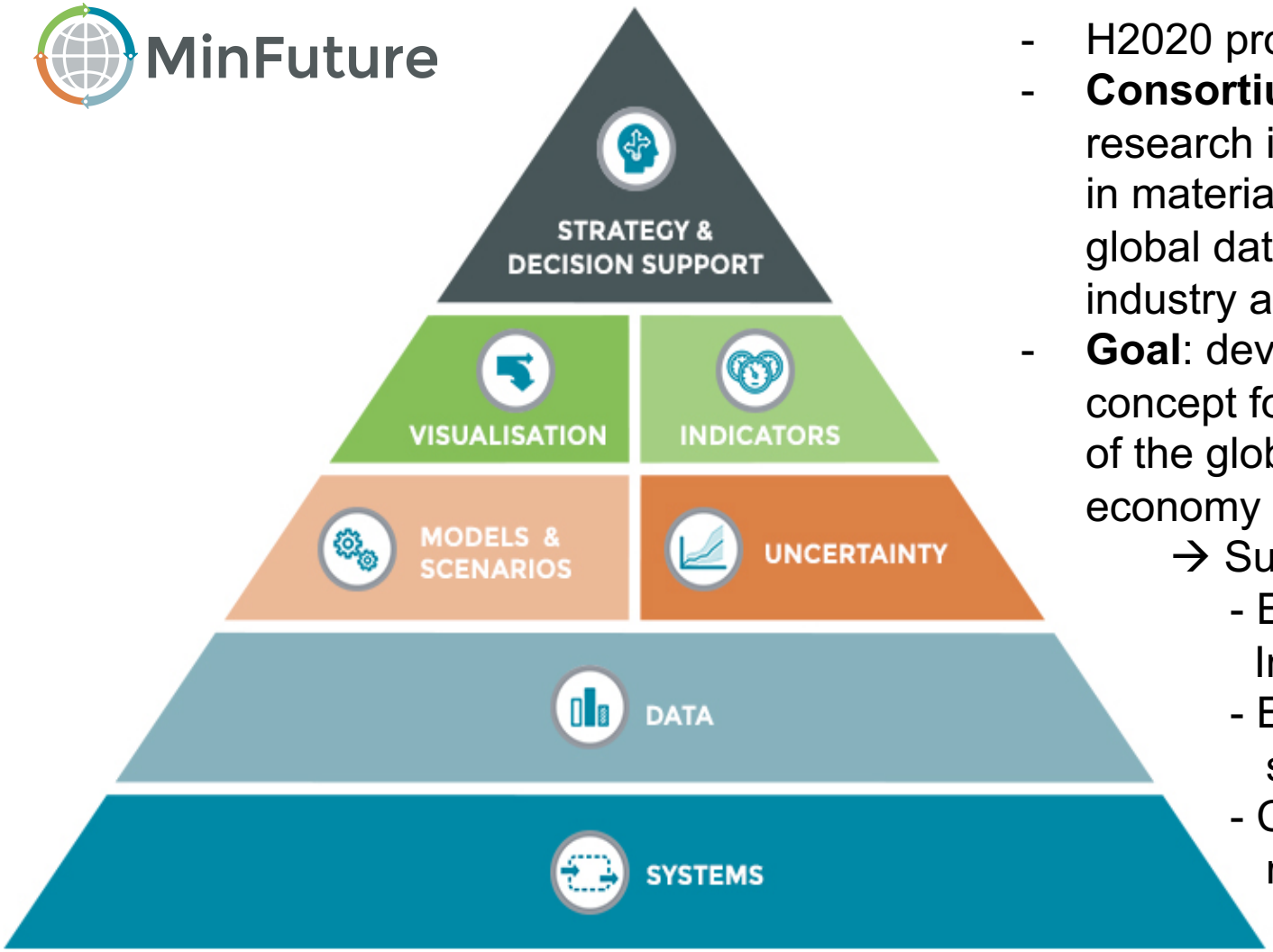
The material cycles are defined by technologies and other factors.

Scenarios with explicit assumptions about these drivers are used to analyze different futures.
→ learning

This will inform new business models and policies, which in turn affect technologies and social factors.

MinFuture project: Mapping the global physical economy

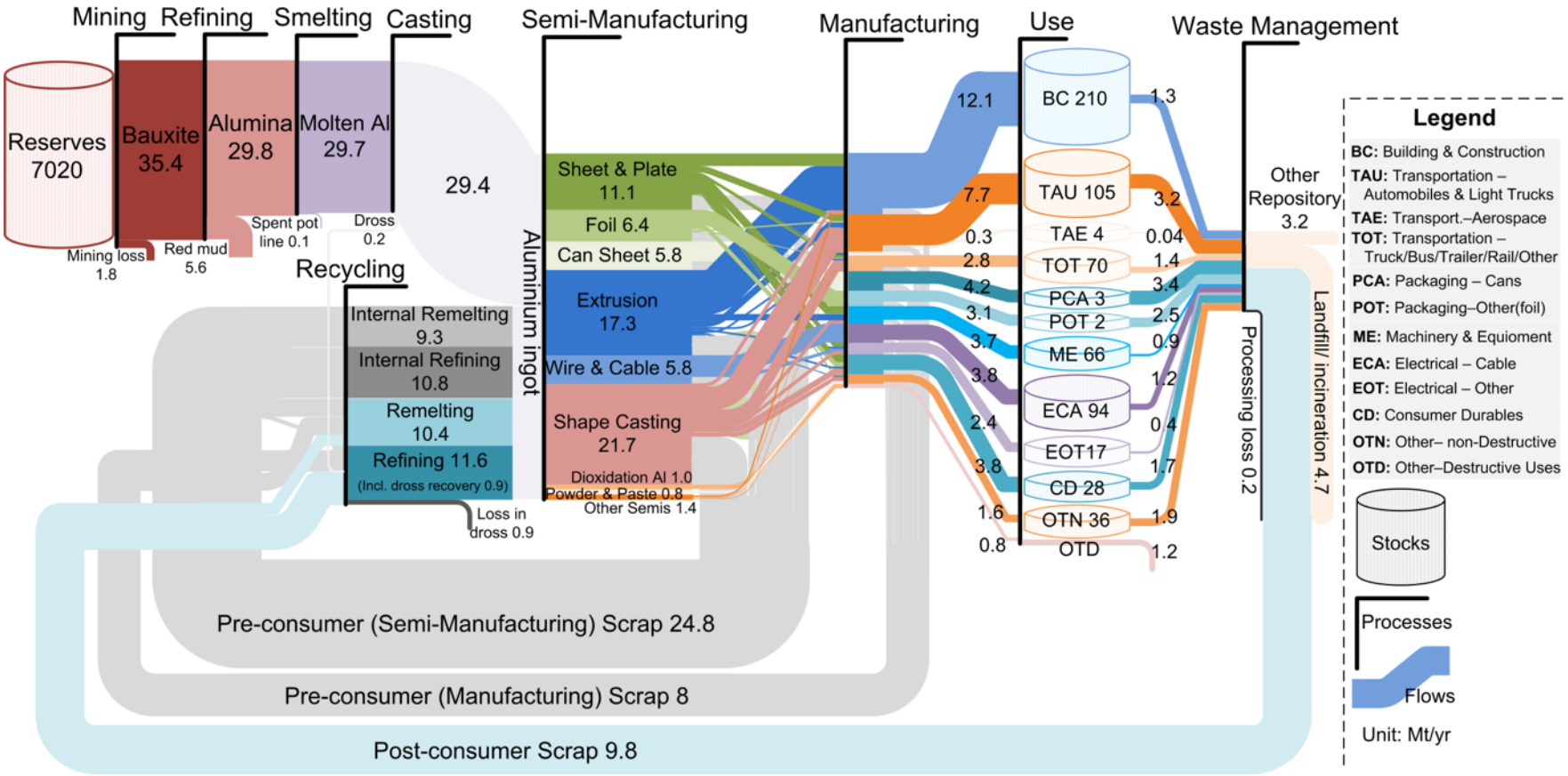
MinFuture



- H2020 project
- **Consortium**: leading global research institutes in material flow analysis, global data providers, and industry associations
- **Goal**: develop a proof-of-concept for the mapping of the global physical economy

  → Support
  - EU Raw Materials Initiative
  - EU Circular Economy strategy
  - Climate change mitigation

Global anthropogenic aluminium cycle in 2009



Source: Liu, Bangs, and Müller 2012: Nature Climate Change

Is recycling better than primary production?

- Energy use is about 10 times lower
- But: scrap is scarce (in-use stocks are growing)

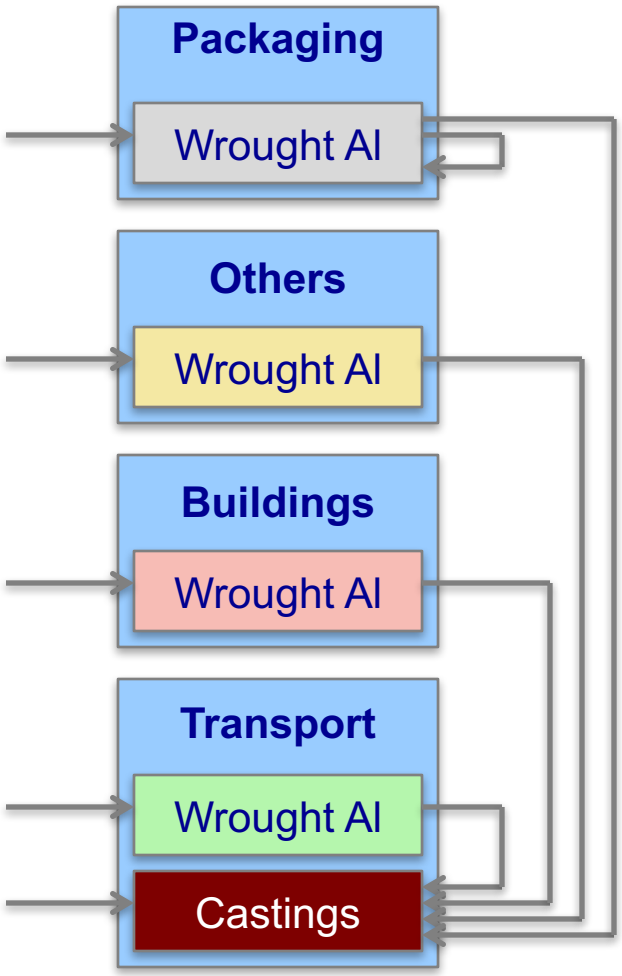
  the cycling of pre-consumer scrap leads to higher, not lower energy use

Historical development of the global trade-linked aluminium cycle

(ca. 70 million data records)

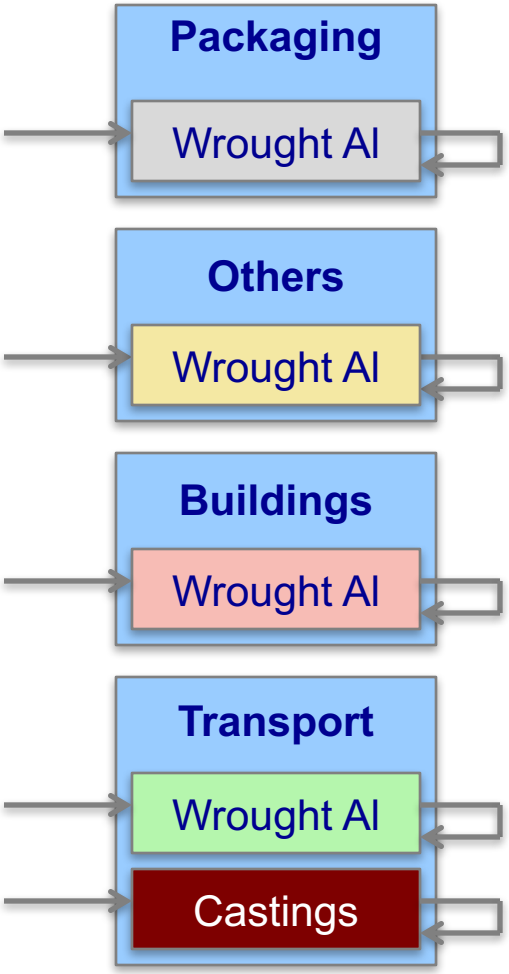
http://www.world-aluminium.org/statistics/massflow/

Today's aluminium recycling system: cascading use



- The bottom reservoir is formed by automotive secondary castings (mainly engine parts).
- **Today, the cascading system is economically and ecologically meaningful.**
  → It makes use of all the metals (aluminium, alloying elements, other elements)
  → This saves alloying elements for secondary casting
- **In the future, the same system with the same resources may become unsustainable.**
  → Increasing amounts of scrap
  → Limited capacity of engine parts to absorb this scrap
  → Scrap surplus in about a decade if cascading structure is maintained

Tomorrow's aluminium recycling system: Closed alloy cycles?



- A closing of alloy cycles would reduce the amount of scrap to be absorbed by automotive secondary castings.
  → Use scrap for a wider range of applications (sinks)

2012-2014: NTNU Simulation models anticipated a large global Al scrap surplus for business as usual

2015: Hydro acquired WMR Recycling GmbH, specialized in scrap sorting technology

2015: Automobile manufacturers started to accept the use of secondary scrap for the production of security-relevant components (e.g., wheel-to-wheel recycling)

Conclusions

1. The SDGs are not independent from each other, because they are linked through material flows.

2. Circularity of material flows can help reaching several SDGs, but there are also goal conflicts.
   → Circular economy should be regarded as a means, not an end.

3. To resolve goal conflicts in the transition towards a circular economy, we need
   - Maps
     → Research
   - Regional goals and priorities
     → Governance
   - Roads and pathways
     → Industry
   - People to use the paths
     → Citizens