IEooc_Applications2_Exercise1: A basic circular economy scenario for buildings

Objective: Understand the legal CE definitions and indicator frameworks. Work with salient CE indicators and develop a simple CE scenario with material stocks and flows. Interpret the CE as part of the energy service cascade.

Task 1. Pick a country or region of your choice and check if the government has issued a circular economy plan or legislation! If yes, continue, if no, repeat with another country!

What (legal) definition of the CE is promoted in this document, what are the main CE goals, sectors, products, and materials targeted and the concrete policy targets and indicators proposed? Is there any statement on the relation between the CE and sustainability or the SDGs? (2-3 pages, tables and figures where suitable)

Task 2. Check the country's steel production statistics (both recycling and from ore, the WorldSteel Association is the best source) and cement production (Wikipedia), and calculate the per capita values! Where in the energy service cascade are these products located? What do these production figures tell you?

Task 3. Check the country's residential and non-residential building stock (data are provided along with this exercise) and estimate the in-use stock of concrete and steel in those buildings (data on materials in buildings per m² are provided as well), both total and per capita values. Use the *standard building design* data for the material intensity in kg/m².

Task 4. Build a circular economy scenario for the construction and housing sector for this country with simple representations of the *narrow-slow-close* strategies! Consider four processes in your system definition: primary material production (from natural resources), building construction, building use, and building demolition and material recycling. Consider the relevant stocks and flows of building area, materials, and flows from/to the environment. Focus on three materials: concrete, steel, and construction wood.

For simplicity, assume a *steady state*, where the m² per capita is constant at a certain level over a long time, and where the annual inflow of new buildings is calculated as *inflow = stock/lifetime* (why?). Assume a building lifetime of 80 years for residential and 40 years for non-residential buildings.

For the narrow strategy, assume that the average per capita stock will decrease over time by 20%, both for residential and non-residential buildings, but not below 30 m²/capita (residential buildings) and 12 m²/capita (non-residential buildings). Assume also that future buildings will be built using the *light-weight and wood-intensive building design* option.

For the slow strategy, assume that the average building lifetime will increase to 100 years for residential and 50 years for non-residential buildings, so that the annual rate of new construction is lowered according to *inflow = stock/lifetime*.

For the close strategy, assume that improvements in the re-use and recycling of materials are possible as indicated in Table 1 below.

Table 1: Assumed current and future (close strategy) recycling rates of building material waste. Source: RECC model v2.5 database, https://www.industrialecology.uni-freiburg.de/odym-recc.

Material	Baseline recycling + reuse rate	Close strategy recycling + reuse rate
Steel	85%	95%
Concrete	0%	30%
Construction wood	15%	30%

For this scenario, calculate future material demand, the recycling/reuse of concrete, construction wood, and steel, and the resource and GHG emissions savings potential (data are provided on the *Env_impacts_ materials* sheet).

For the environmental impact of recycled material compared to material from virgin resources, assume the following: For steel, take the values provided for *steel, low alloyed, from ore, Europe* and *steel, low alloyed, from scrap, Europe*. For concrete from natural resources, take the values for *concrete, global*. For recycled concrete, cement from natural resources is still required to bind together the recycled crushed concrete. Therefore, take the same GHG and fossil fuel requirements as for *concrete, global*, and assume that the 'all materials' and 'metal ores' impacts of recycled concrete are zero, as these materials are sourced from construction waste. For structural construction wood from primary resources, take the data provided for *'wooden beam, Europe'*. For re-used wood, assume that it comes with no footprint, as the wooden building component is directly reused.

Task 5. Discuss your findings! What did you learn about potential for a circular economy in the energy service cascade? What are the potential sustainability implications of your circular economy scenario? Derive additional policy recommendations for a resource efficient circular economy in the country of your choice!

Industrial Ecology Open Online Course (IEooc)

Part III: Application

Applications part 2: Circular Economy

http://www.teaching.industrialecology.uni-freiburg.de/

Data: See IEooc_Application2_Exercise1_Data.xlsx

Additional Literature:

Kalt et al. (2019): „Conceptualizing energy services: A review of energy and well-being along the Energy Service Cascade“ https://doi.org/10.1016/j.erss.2019.02.026

https://www.blog.industrialecology.uni-freiburg.de/index.php/2023/06/01/how-will-a-sustainable-circular-economy-look-like/

Preparatory Exercises:

(1) IEooc_Methods1_Exercise1

(2) IEooc_Background1_Exercise1