Module 5 Lesson 4- The Circular Economy & Construction Waste

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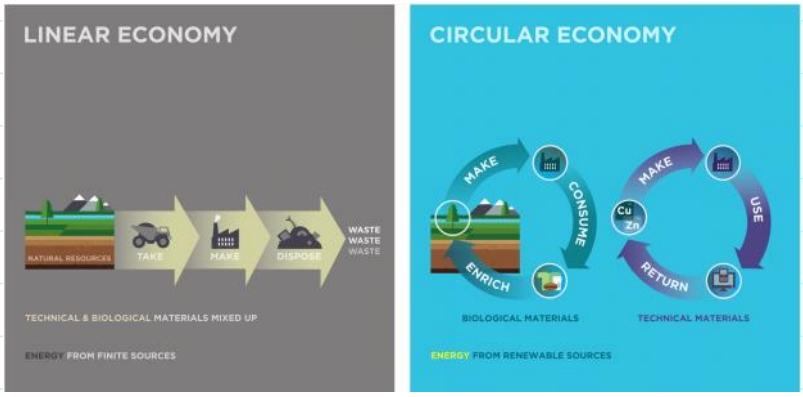
5.4.1 Circular Economy

- Suggests a focus on: eliminating waste (closing the loop)
  minimizing inputs
  adopting renewable energy
- challenges us to mimic biological cycles when we create technical cycles



Principle of Circular Economy in Cities

- Design-Out Waste & Pollution
  - reveal & design-out the negative, so-called "externalities" of economic activity that causes damage to human health and natural systems
  - externalities include GHG emission, traffic congestion, low-levels of exercise, etc.

- Keep products, components, and materials at their highest value and in use
  - designing for re-use, remanufacturing, recycling
  - favour inner loops to preserve more value, such as embedded energy and labour
  - maximize use of bio-based materials, extracting valuable bio-chemical feedstocks

- Regenerate natural systems
  - enhances natural capital by encouraging flows of nutrients within the system and creating conditions for regeneration

Opportunities to develop circularity in construction & real estate sector in Denmark

1) Industrialised production and 3D printing of building modules
2) Sharing and multi-purposing of buildings
3) Reuse and high-value recycling of components & materials

Barrier for:
① Inadequately defined legal frameworks, immature technology, custom & habit, capabilities & skills in industry
② " " " " , unintended consequences of existing regulations
③ Split incentives & lack of information across value chain, custom & habit, capabilities & skills

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- Vancouver hopes to be a zero-waste city by 2040

5.4.2 Recycling & Reusing Construction Waste

- The construction industry uses the most material world wide

- Recycled Aggregates
  - used for building foundations, concrete, and asphalt
  - additives must be included to ensure desired binding & structural performance

- Post-Tensioned Reinforcement
  - reduce need for "virgin" metal (i.e. steel)
  - result in lower CO_2 footprint and construction costs

- Brick Veneer
  - save transportation costs
  - create local jobs

- Concrete
  - mixture of cement, water, and coarse & fine aggregates
  - easy installation & locally available
  - widely used in large water and wastewater treatment plants, pipelines, & conduits due to low cost and flexibility

- Cement Production
  - accounts for 5% of global CO_2
  - emission-intensive
  - requires 4.7 million BTU (British Thermal Units) of energy
  - equivalent to 400 pounds of coal

- By-product CO_2
  - by-product of chemical reaction that converts $CaCO_3$ to both CaO and CO_2
  - released into atmosphere
  - an unnatural addition to earth's Carbon cycle

- CO_2 Reduction
  - can be made by replacing a portion of cement with other industrial waste products

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  - can be made by replacing a portion of cement with other industrial waste products
    - silica fume
    - metakaolin
    - slag
    - Fly ash

- Fly ash
  - Cost effective & environmentally friendly
  - reduces 80% of CO_2 emissions associated with cement manufacturing