Circular Economy Strategies for Adaptive Reuse of Cultural Heritage Buildings to Reduce Environmental Impacts


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Circular Economy (CE) (in general): aspirational and universal goal & suite of strategies for transitioning to a sustainable, and low-carbon economy based on slowing extraction and renewing resources

Cultural Heritage (CH) adaptive reuse aligns well with CE: embodied energy of old buildings; durability of old buildings (quality materials); building waste reduction; additional material demand-reduction (for new buildings); retrofit energy & efficiency measures reduce operational energy

Environmental indicators provide a non-monetary measure of environmental quality and human impact to:
- Define the state of environmental quality
- Set the baseline
- Monitor progress
Design: transformation is planned, designed and financed

- Evaluate options for transformation and adaptive reuse
- Implement material passports to facilitate reuse
- Communicate availability of a heritage site for adaptive reuse and/or rehabilitation
- Implement dismantling and disassembly and recovery rather than complete demolition
- Create new value chains from demolition wastes, e.g., gypsum to fertilizer, lumber to wood flooring
- Utilize materials for energy recovery when no alternative to landfill

Building Materials Sourcing: raw materials are extracted and sourced for project

- Reduce transport by choosing local sourcing
- Substitute fossil fuel intensive materials with bio-based materials
- Substitute new materials with used materials wherever possible

Build: construction, rehabilitation, adaptation

- Limit disturbance of trees, soils and habitat
- Increase or maintain green space
- Revive traditional construction techniques and materials
- Use abandoned or neglected cultural heritage sites
- Implement brownfield development through hazardous waste remediation and/or solid waste removal on site

Use & Operate: the space continuously meets the needs of residents/users

- Recover water and energy with modern and historical/cultural technology and design
- Implement, incentivise, and encourage users to achieve high rates of product reuse and recycling
- Strive to increase proportion of purchased and produced renewable energy whilst phasing out fossil fuels
- Implement ongoing energy efficiency strategy
- Implement use efficiency continuously
- Implement use arrangements that meet needs without individual ownership (i.e., shared office, laundry, conference spaces)

- Implement fee for service arrangements that reduce material inputs and incentivise longevity such as paying for light rather than electricity for lighting, copying services rather than copiers, flooring service rather than owning carpeting
- Promote and incorporate local and regional agriculture
- Ensure public access to greenspace and other spaces
- Create habitats for animals and insects
- Improve users quality of life
- Improve: land through pollutant remediation and/or increasing nutrients in soil
- Improve users low carbon mobility options
- Measure health impacts e.g., Indoor air quality
- Provide facilities for easy collection of recyclable materials and biomass for compost

Repurpose & Demolition: end of current use, used materials are extracted and disposed

- Smarter Building Use & Manufacture
- Expand Lifespan of Building and its Parts
- Useful Application of Materials
- Increasing Circularity
Imagine Buildings as Products that Deliver Shelter

- **Product Supply Chain Circularity Strategies** framework by Potting et al. (2017)
- **Cascading Material Use**
- **Prioritizes circular concepts and actions**
- **Higher Circularity = Less Materials & Energy**

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**Source:** Potting, J., Hekkert, M., Worrell, E., Hanemaaijer, A., 2017. Circular economy: measuring innovation in the product chain. PBL.
Imagining Buildings as Circular Products

• Product Supply Chain Circularity Strategies Framework

• Applied to Buildings
• Transform Linear to Circular

• Cascading Material Use
• Posits micro to macro transformation

Increasing Circularity

- Smarter Building Use & Manufacture
  - Refuse: No raw materials needed (R0)
  - Rethink: Sharing & multifunctional uses (R1)
  - Reduce: Cut raw materials (R2)

- Expand Lifespan of Building and its Parts
  - Reuse: Salvage material discarded by other consumers (R3)
  - Repair: Maintenance to extend lifespan (R4)
  - Refurbish: Modernization for reuse (R5)
  - Remanufacture: Use old product/parts in a new product with same purpose (R6)
  - Repurpose: Use components of old product for new purpose (R7)

- Useful Application of Materials
  - Recycle: Collect and process for reuse (R8)
  - Recover: Incinerate for heat energy (R9)
Building Life Cycle Phases as a Linear Product Supply Chain…

1. Design: transformation is planned, designed and financed

2. Building Materials Sourcing: raw materials are extracted and sourced for project

3. Build: construction, rehabilitation, adaptation

4. Use & Operate: the space continuously meets the needs of residents/users

5. Repurpose & Demolition: end of current use, used materials are extracted and disposed
Impact

- **46 cradle-to-cradle strategies**
- **Beyond linear supply chain cradle-to-gate perspective**

- Design considered as a critical separate phase (left out of many LCAs)
- Building Materials Sourcing considered as separate stage
- Embodied energy, impacts of occupancy stage and end-of-life of building included
- Project teams made up of all stakeholders at every stage of a building’s life cycle
- Straightforward and easily understood
Expected Impact

- Environmental Indicators and Strategies may be used for education and policy development
  - For example, public procurement including the level of environmental circularity that a building project achieves.

- Strategies can be practically applied for:
  1. Planning and evaluation at the start of project development
  2. An exploratory scoping exercise in combination with other participatory methods
  3. Post project review of environmental circularity

- Next step is testing with adaptive reuse of cultural heritage project teams
CIRCULAR MODELS LEVERAGING INVESTMENTS
IN CULTURAL HERITAGE ADAPTIVE REUSE

THANKS FOR YOUR ATTENTION!!!

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