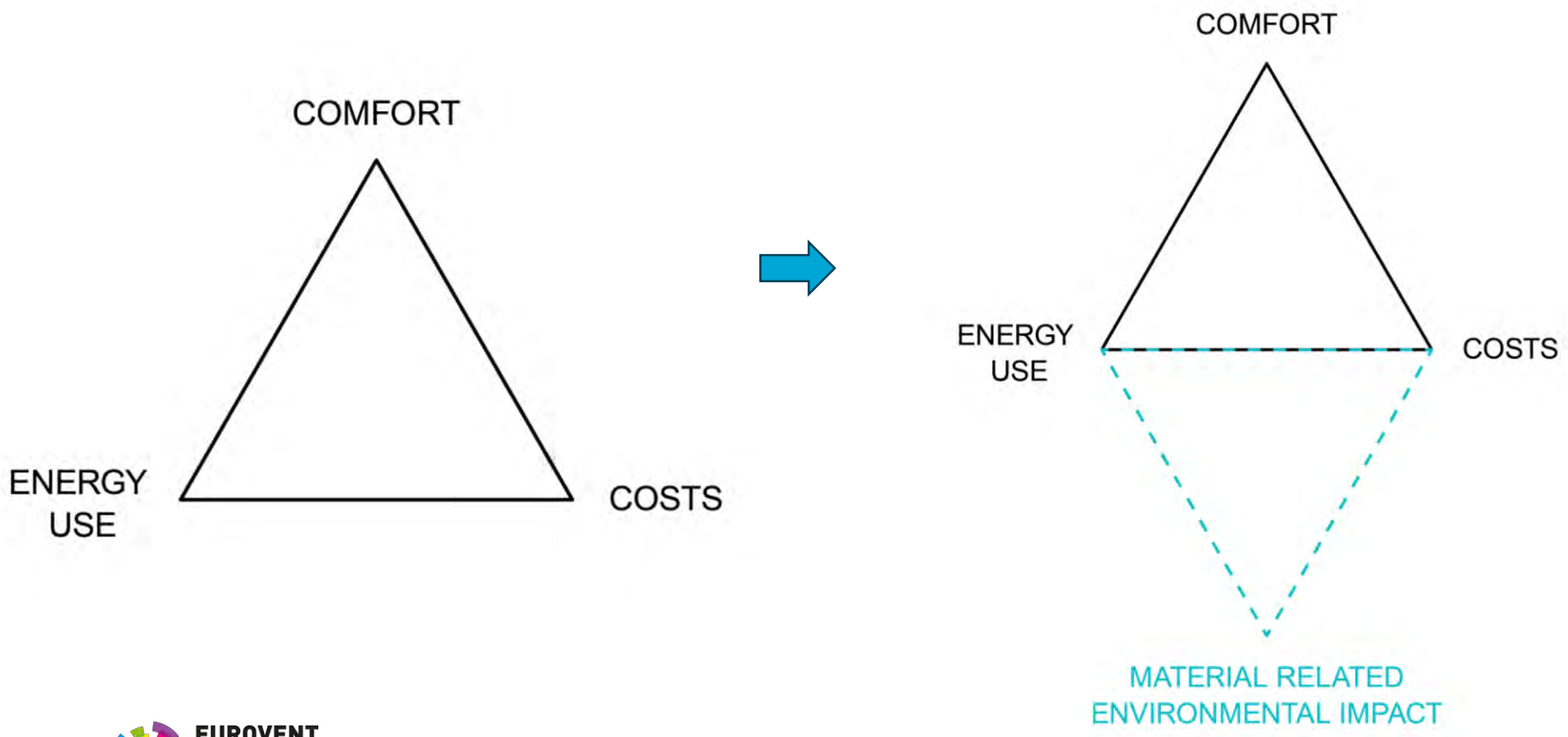
Circular building installations: Myth or reality?

Atze Boerstra
Professor Building Services Innovation
TU Delft

‘Standard’ vs ideal approach HVAC system design



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Take-Make-Waste approach still around….

(Photo's: Arjen Raue, bba binnenmilieu)

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Standard reaction to the idea of circular HVAC

- '*Sector is already very circular. No need for further actions / regulations.'*
- *'We use mostly recycled metals (e.g. in ventilation ducts), heat recovery nowadays is standard and fans for example are already ultra-energy efficient.'*

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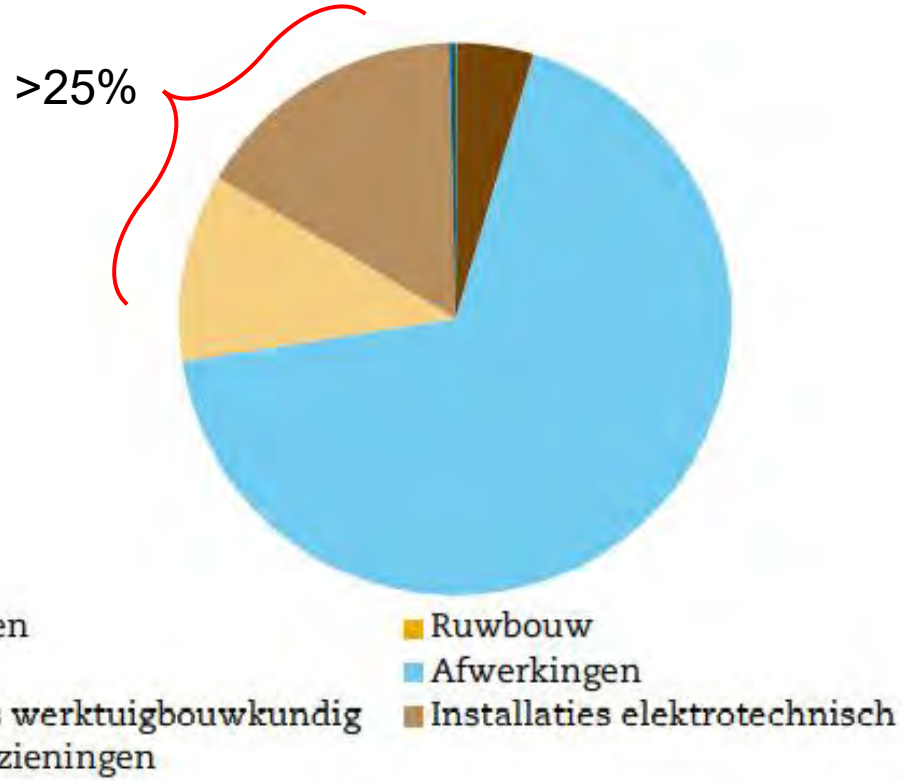
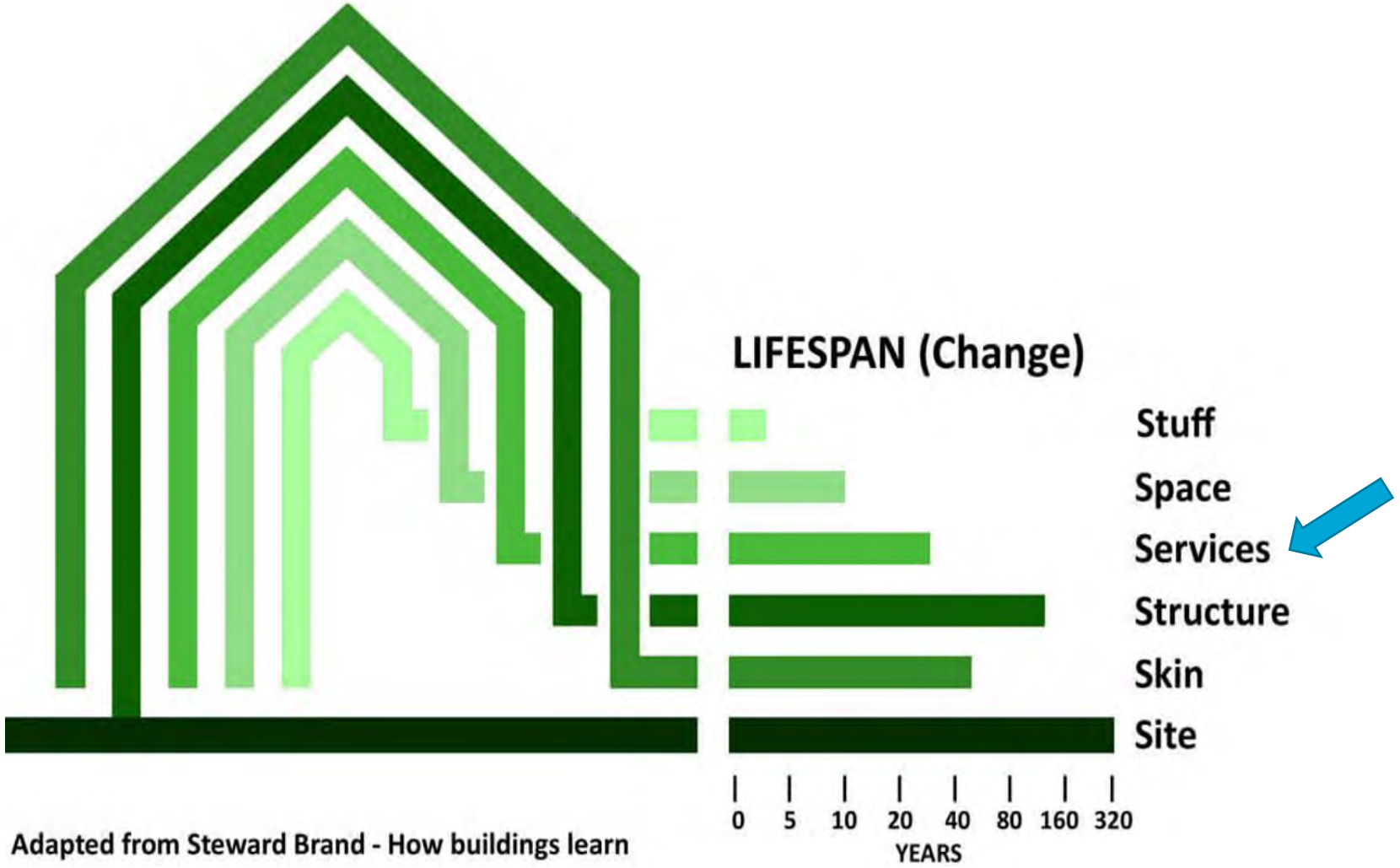
Relative environmental impact HVAC systems

- Relative environmental contribution of mechanical & electrical installations when renovating Dutch office buildings:



Source: Metabolic, 2020

Lifespan installations vs lifespan other components



Installations in the news (heat pump example)

'Calculated environment impact of heat pumps much higher than anticipated; difference partially due to 'forgotten' effects related to use of refrigerants and electronics for system controls'

NOS Nieuws Sport

NOS Nieuws • Dinsdag 21 februari 2023, 18:53 •
Aangepast dinsdag 21 februari 2023, 22:59

Materialen in warmtepomp schadelijker voor milieu dan gedacht

De milieubelasting van de materialen in een warmtepomp blijkt groter dan gedacht. Dat wordt duidelijk uit nieuwe berekeningen voor de Nationale Milieudatabase. Die tonen aan dat de milieubelasting van onder meer de productie en hergebruik van de materialen in een warmtepomp elf keer hoger ligt dan waar voorheen rekening mee werd gehouden, meldt de stichting achter de database, NMD.

De stichting brengt de milieueffecten van bouwproducten in kaart. De gegevens die tot nu toe werden gebruikt voor warmtepompen waren onvolledig. Onder meer de milieuschade van het koudemiddel (de vloeistof die in de pomp wordt gebruikt voor het transport van warmte), de elektronica en de levensduur van het apparaat werden niet meegenomen. Het gaat hierbij om een

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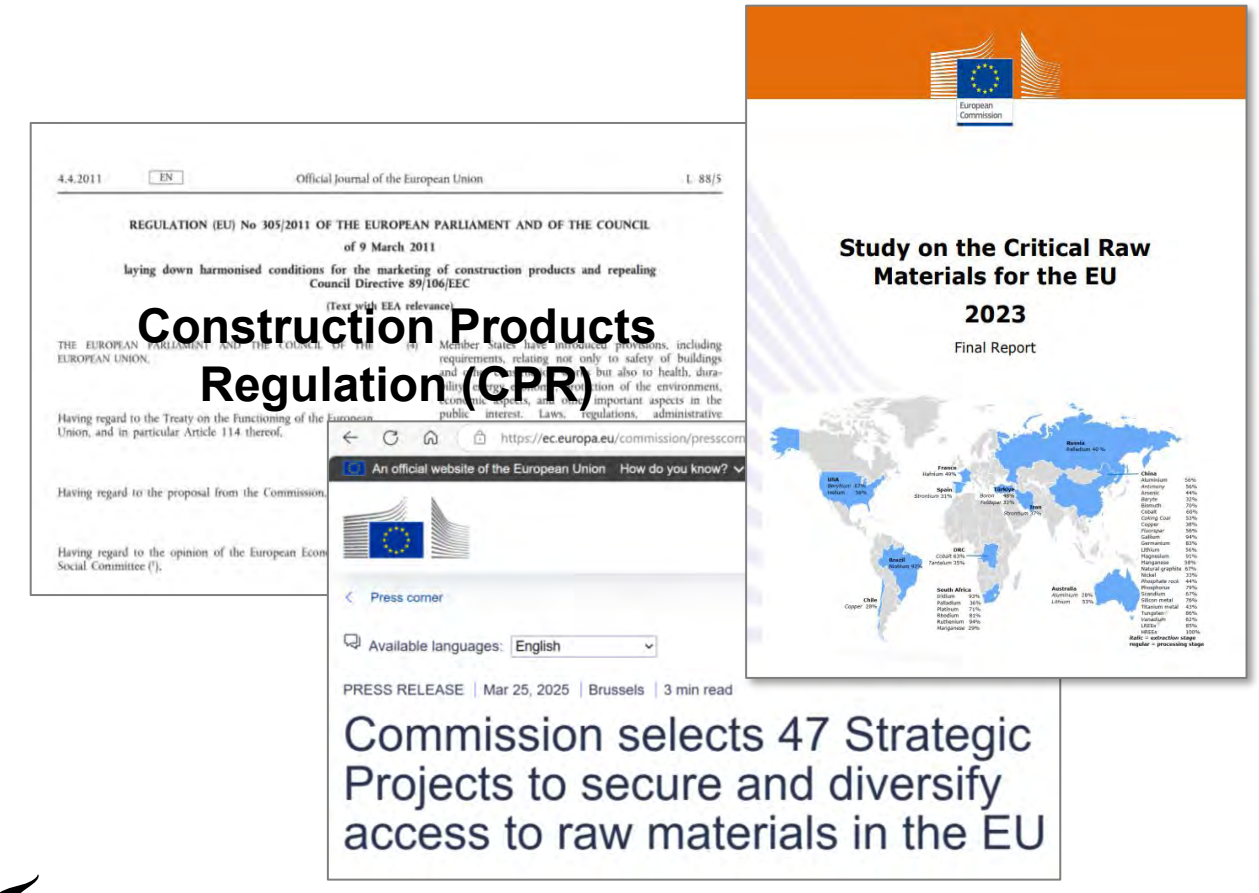
HVAC systems > relatively metal- & CRM-intensive



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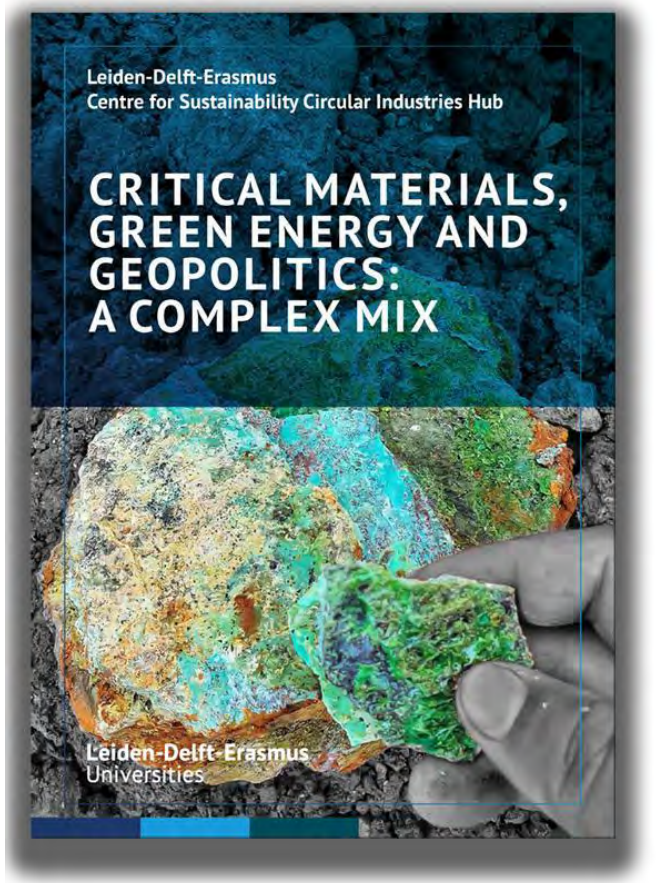
From fossil fuels to rear earth metals

- At the core of the present transition is a switch from fossil fuels to metals such as copper, lithium and rare earth metals.
- These metals are needed for producing the required wind turbines, solar panels, heat pumps, batteries etc.
- Making them critical materials for achieving the energy transition.
- Currently, the EU must import the bulk of these materials, making us very dependent on other countries...



For more information, read the TU Delft & et al. whitpaper: 'Critical materials, green energy and geopolitics; a complex mix.' Critical Materials_LDE White Paper_DEF20220627.pdf

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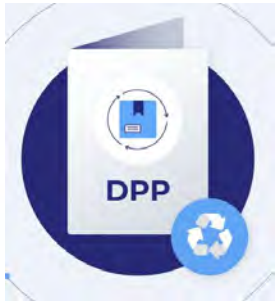
ESPR 2024:
Ecodesign for Sustainable Products Regulation

- This regulation supports the EU Green Deal and Circular Economy Action Plan.
- Art. 16 ESPR: *'New ecodesign requirements are meant to improve product durability, reliability, repairability, upgradability, reusability and recyclability, improve possibilities for the refurbishment and maintenance of products, ..., increase the energy and resource efficiency of products, with regard to the possibility of recovery of critical raw materials,…. while enabling remanufacturing and high-quality recycling and reducing carbon and environmental footprint.'*

For more information, see:
Ecodesign for Sustainable Products Regulation - European Commission



Solution is ‘no-installation buildings’?!

2226 Lustenau building, Austra (Baumschlager Eberle Architects)

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Some Dutch market-initiatives

Remanufacturing (e.g. circulation pumps)

Reconditioning (e.g. air handling units)

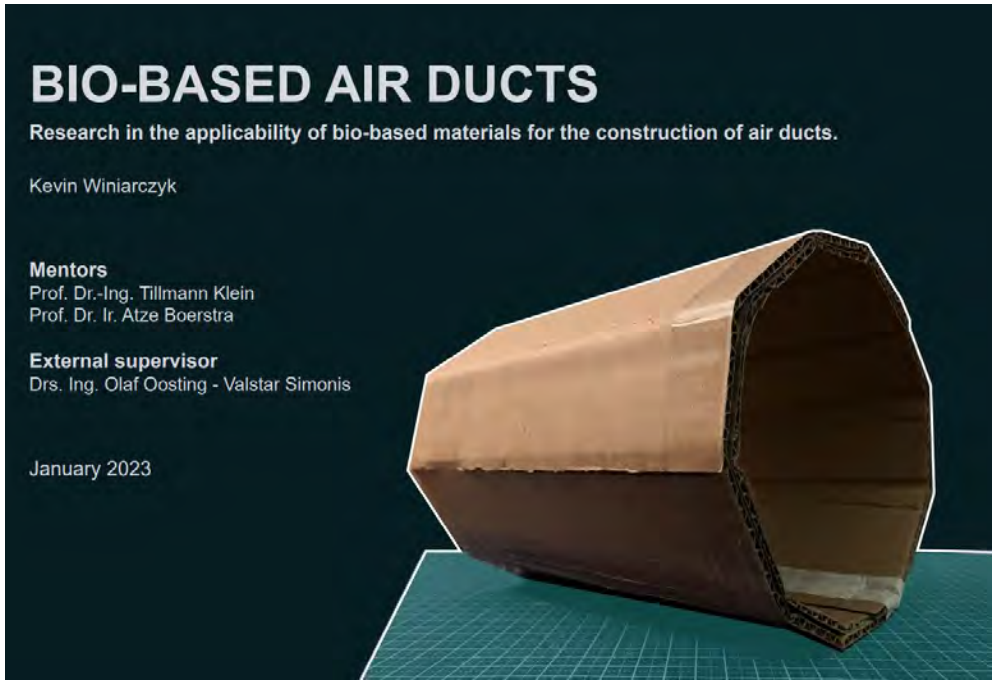
Source: www.circopump.nl & www.altena.com

Example project Dutch Government

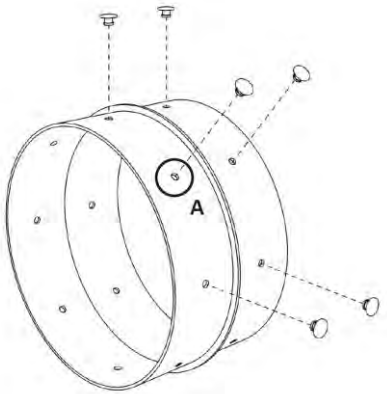
‘Kantoor vol Afval’ (KAVA) of Rijksvastgoedbedrijf (Dutch Governmental Buildings Agency @ airfield Valkenburg) with e.g. ‘2nd hand’ climate ceilings & ditto Air Handling Units from donor building

TU Delft graduation project 2022

(BK graduation project Kevin Winiarczyk; supervisors Tillmann, Olaf Oosting & yours truly)



Bio-Composite



Sheets of Tetra Pak - 95% bio-based Recycled plastic

Veneer

Source: : https://repository.tudelft.nl

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Example ‘rethink’ project TU Delft 2025

(BK graduation project of Wei Wei, supervisors Alessandra Luna Navarro & yours truly)

Couteract overheating problems in dwellings, schools and offices via indirect cooling with ceiling fans (as alternative for ‘airconditioning’); leads to factor 10 less impact

25 ˚ C + still air =

28 ˚ C + constant vertical airspeed of 0,8 m/s

(source: NEN-EN 16798-1, ASHRAE standard 55, Tanabe & Kimura, 1996)

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Roadmap circular climate installations
(Routekaart Circulaire Klimaatinstallaties)

Initiative of NL Government RVO / Thomas Wellink related to the National Program Circular Economy

Linked to 2,5 year / 2,5 Mio euro project ‘circular installations’ with involvement of e.g. TNO, TU Delft, Dutch Green Building Council, several NL companies, etc

Objectives:

25% ECI* reduction

50% lifespan extension

100% high-quality recycling

* ECI = Environmental Cost Indicator

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Not just a purely technical challenge

- Literature study Itanola et al., 2024
- Barriers encompass technical, economic, legislative, and organisational aspects.
- The analysis enabled the development of strategies that address design issues, business models, policy, product information, warranties, life cycle costing, digital technology, education, collaboration, and transparency.

Check for updates

Review Paper

BUILDING SERVICES ENGINEERING RESEARCH & TECHNOLOGY

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Closing the loop in building services: A systematic review of circular economy applications

Moses Itanola, Philip Griffiths and Ibrahim Motawa

Abstract

The substantial environmental impact of buildings has garnered significant attention. However, sustainability efforts often prioritise structural and envelope materials, overlooking building services - systems for ensuring occupants' safety and comfort. Given their complexity, rapid technological advancements, and substantial costs, these components necessitate a circular economy approach to optimise resource utilisation. This study conducts a systematic literature review to assess the current state of circular economy implementation in building services, identifying barriers, opportunities, key influencers, and potential strategies. Findings indicate that applying circular economy principles within building services remains nascent. Barriers encompass technical, economic, legislative, and organisational challenges. Conversely, numerous opportunities exist, alongside six key influential stakeholders. The analysis enabled the development of a framework to integrate existing principles and building blocks with identified essential strategies for advancing circular building services. The integrated strategies include design, business models, policy, product information, warranties, life cycle costing, digital technology, education, collaboration, and transparency. This study recognises various research gaps and highlights the need for further exploration to realise the full potential of circular economy in building services. Ultimately, a shift in mindset, coupled with new skills and holistic approaches, is required to drive progress in this domain.

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Take home messages & closing remarks

- It is high time to (also) address resource efficiency and material-related environmental impact, and to look beyond just energy, comfort and costs of HVAC systems and components.
- It is reality, not a myth; recent EU regulations (especially ESPR 2024) will enforce this
- Complex subject! Still a lot of challenges e.g. related to definitions, calculation methods, environmental data and materials
- Opportunity for early adopters like manufacturers / consultants that embrace C-HVAC
- Impact on industry will be considerable e.g. in terms of new business models, general logistics and organisation of (re)manufacturing processes

RIGHT THING TO DO

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