

SUPPLEMENTAL DATA

Appendix A: Definitions

CBS Category	Definition
<i>Reuse</i>	Reuse involves retaining a material or component and using it again in a second system without breaking it down into raw materials. Reuse can include additional processes such as repair, refurbishment and remanufacturing to adapt the component to its new application.
<i>Recycling</i>	Recycling involves processing used materials into new products to prevent waste and reduce the consumption of fresh raw materials. Recycling can be divided into upcycling and downcycling, depending on whether the recycled material increases or decreases in value compared to the previous use case.
<i>DfD</i>	Design for disassembly is a strategic approach in building design aimed at facilitating easy disassembly through reversible connections. Based on that, it enables reuse or recycling of building components and materials at the end of their lifecycle.
<i>DfA</i>	Design for adaptation in the context of new building design refers to the approach of creating buildings that can evolve and accommodate different functions throughout their lifecycle with minimal waste generation. This concept emphasises the importance of flexibility, modularity and longevity.
<i>Longevity</i>	Longevity refers to the design and construction of buildings and components that are intended to last for an extended period, minimising the need for maintenance, replacement, and therefore reducing resource consumption over time.

Table S1: Definition of CBS categories used for the analysis.

Temporal term	Definition
<i>Estimated Service Life (ESL)</i>	Expected service life of a building or part of a building under specific in-use conditions, based on RSL but adjusted from reference in-use conditions. Used for all service life descriptions in this paper.
<i>Life Cycle (LC)</i>	Consecutive and interlinked stages in the life of the building, component or material, including a starting point and an end point
<i>Reference Service Life (RSL)</i>	Expected service life of a construction product, component, assembly or system under specified reference in-use conditions, as a basis for the ESL.
<i>Reference Study Period (RSP)</i>	The temporal system boundary in the assessment and divisor for using normalisation in reporting.
<i>Temporal considerations</i>	Any aspects and information described in relation to the time dimension in the LCA framework. Examples are temporal assumptions, the temporal representativeness.
<i>Temporal assumption</i>	All modelling assumptions influencing the temporal dimension of a study, e.g. RSP, ESL, number of life cycles, allocation, etc.
<i>Temporal resolution</i>	Describes the time granularity when temporal differentiation is carried out. A higher resolution can be achieved through dynamic modelling.
<i>Temporal scope</i>	Defines any type of period that is considered in an LCA study. EN15978 defines the RSP as temporal scope, but it can also be based on life cycle stages, life cycles or ESL of the product system.
<i>Temporal distribution</i>	How processes and impacts are distributed over time, including their duration, frequency, and quantitative magnitude across the relevant time period.
<i>Temporal position (Timing)</i>	The point or period in time at which a process or impact occurs, expressed relative to a defined time frame (e.g. RSP) or in absolute calendar time.
<i>Temporal representativeness</i>	Qualitative or quantitative assessment of data, processes or methods in relation to how appropriate their information fits with their temporal scope. The temporal representativeness of building LCA can be improved through prospective scenario data.

Table S2: Definition of terms connected to the temporal dimension of LCA.
Based on: EN15978:2026 and Beloin-Saint-Pierre *et al.* (2020)

Appendix B: Included studies

ID	Authors	Year	Country	Main study object	Study type	LCA level	CBS	Perspective	Cases
S01	Abu-Ghaida et al.	2025	BE	Single-family zero-energy building designed for disassembly	methodology development	building	DfD	downstream	1
S02	Agustí-Juan et al.	2019	CH	Prefabricated building elements	comparative case	component	Material Efficiency	downstream	2
S03	Andersen et al.	2020	DK	Reused and recycled components	comparative case	component	Reuse; Recycling	upstream	5
S04	Androsevic et al.	2019	BA	Low-waste external wall system	comparative case	component	DfD	downstream	1
S05	Brambilla et al.	2019	UK	Demountable steel-concrete floor system	comparative case	building	DfD	downstream	1
S06	Brütting et al.	2019	CH	Reused structural truss	integrated LCA	component	Reuse	upstream	1
S07	Buyle et al.	2019a	BE	Demountable internal wall assembly	comparative case	component	DfD	downstream	0
S08	Buyle et al.	2019b	BE	Demountable internal wall assembly	comparative case	component	DfD	downstream	1
S09	Cascione et al.	2022	UK	Circular biobased wall panels	comparative case	component	DfD	downstream	1
S10	Colangelo et al.	2020	IT	Concrete with recycled aggregates	material LCA	material	Recycling	upstream	2
S11	Cuenca-Moyano et al.	2019	ES	Masonry mortar with recycled aggregates	material LCA	material	Recycling	upstream	2
S12	Eberhardt et al.	2019a	DK	Concrete column designed for disassembly	comparative case	component	DfD	downstream	1
S13	Eberhardt et al.	2019b	DK	Office building designed for disassembly	methodology development	building	DfD	downstream	1
S14	Eberhardt et al.	2021	DK	Building structure with different circular strategies	methodology development	component	DfD; Material efficiency; DfA	combined	3
S15	Eberhardt et al.	2019c	DK	Building components designed for disassembly and recyclability	comparative case	component	DfD; Recyclability	downstream	3
S16	Eliard et al.	2026	BE	Circular office building designed for disassembly	comparative case	building	DfD	downstream	1
S17	Gobetti et al.	2025	IT	Mortar with recycled steel-slag	material LCA	material	Recycling	upstream	1
S18	Joensuu et al.	2022	FI	Building designed for disassembly	methodology development	building	DfD	downstream	1
S19	Kakkos et al.	2020	CH	Circular building unit (UMAR) in building	comparative case	building	DfD	downstream	1
S20	Kakkos et al.	2019	CH	Circular UMAR building unit	comparative case	component; building	DfD	downstream	1
S21	Kiesel et al.	2024	CH	Reused structural steel column	integrated LCA	component	Reuse	upstream	1

ID	Authors	Year	Country	Main study object	Study type	LCA level	CBS	Perspective	Cases
S22	Kitayama et al.	2024	UK	Reusable lightweight exterior infill wall	comparative case	building	DfD	downstream	1
S23	López-García et al.	2021	ES	Ceramic brick with Olive Pomace	material LCA	material	Recycling	upstream	1
S24	Lozano-Miralles et al.	2018	ES	Clay brick with recycled organic waste	material LCA	material	Recycling	upstream	1
S25	Marconi et al.	2020	IT	Insulation panel with recycled leather scraps	material LCA	material	Recycling	upstream	1
S26	Mostert et al.	2021	DE	Recycled concrete	material LCA	material; building	Recycling	upstream	3
S27	Mostert et al.	2020	DE	Recycled concrete	material LCA	material	Recycling	upstream	1
S28	Niu et al.	2021	FI	Reusable timber building	integrated LCA	building	DfD	downstream	1
S29	Peceño et al.	2021	ES	Seashell-based fireproofing material	integrated LCA	material	Recycling	upstream	1
S30	Pešta et al.	2020	CZ	Masonry with recycled aggregates	comparative case	component	Recycling; DfD	combined	2
S31	Quintana-Gallardo et al.	2021	ES	Waste rice-straw facade panel	integrated LCA	material	Recycling	upstream	1
S32	F. Rasmussen et al.	2019	DK	Upcycle and DfD building	comparative case	building	Reuse; DfD	combined	2
S33	F. N. Rasmussen et al.	2020	DK	Different circular buildings (miniCO2 houses)	comparative case	building	Reuse; DfD; Longevity	combined	4
S34	Salmio & Huuhka	2026	FI	Reused Bricks	material LCA	material	Reuse	upstream	1
S35	Schneider-Marin et al.	2025	NO	DfD building	methodology development	building; material	DfD	downstream	1
S36	Simões et al.	2021	PT	Precast concrete	integrated LCA	material	Recycling	upstream	1
S37	Trubina et al.	2024	CZ	Demountable facade	comparative case	component	DfD	downstream	1
S38	Uceda-Rodríguez et al.	2022	ES	Recycled lightweight aggregate	material LCA	material	Recycling	upstream	1
S39	van Stijn et al.	2021	NL	Different circular kitchen alternatives	methodology development	component	Reuse; DfA	combined	2
S40	van Stijn et al.	2020	NL	Different circular kitchen alternatives	integrated LCA	component	Reuse; Longevity; DfA	combined	3
S41	Vares et al.	2020	FI	Reuse of steel structure in industrial building	comparative case	building	Reuse	upstream	1
S42	Vasuks et al.	2025	LV	Recycled CLT	material LCA	material	Recycling	upstream	1

Table S3: Details of the studies examined.

References for the above-mentioned studies

- Abu-Ghaida, H., Hollberg, A., Ritzen, M., Wöhler, A., & Lizin, S. (2025). Assessing the environmental benefits of design for disassembly in buildings with a time-resolved prospective LCA approach. *International Journal of Life Cycle Assessment*, 30(9), 1913–1929. <https://doi.org/10.1007/S11367-025-02526-8>
- Agustí-Juan, I., Jipa, A., & Habert, G. (2019). Environmental assessment of multi-functional building elements constructed with digital fabrication techniques. *International Journal of Life Cycle Assessment*, 24(6), 1027–1039. <https://doi.org/10.1007/S11367-018-1563-4>
- Andersen, C. E., Kanafani, K., Zimmermann, R. K., Rasmussen, F. N., & Birgisdóttir, H. (2020). Comparison of GHG emissions from circular and conventional building components. *Buildings and Cities*, 1(1), 379–392. <https://doi.org/10.5334/BC.55>
- Androsevic, R., Brocato, M., Bijedic, D., & Rustempasic, N. (2019). Life Cycle Assessment as a Tool for Low Waste Building Systems, Case Study Building External Wall. *IOP Conference Series: Materials Science and Engineering*, 603(4), 042067. <https://doi.org/10.1088/1757-899X/603/4/042067>
- Brambilla, G., Lavagna, M., Vasdravellis, G., & Castiglioni, C. A. (2019). Environmental benefits arising from demountable steel-concrete composite floor systems in buildings. *Resources, Conservation and Recycling*, 141, 133–142. <https://doi.org/10.1016/J.RESCONREC.2018.10.014>
- Brütting, J., Desruelle, J., Senatore, G., & Fivet, C. (2019). Design of Truss Structures Through Reuse. *Structures*, 18, 128–137. <https://doi.org/10.1016/J.ISTRUC.2018.11.006>
- Buyle, M., Galle, W., Debacker, W., & Audenaert, A. (2019a). Consequential LCA of demountable and reusable internal wall assemblies: a case study in a Belgian context. *IOP Conference Series: Earth and Environmental Science*, 323(1), 012057. <https://doi.org/10.1088/1755-1315/323/1/012057>
- Buyle, M., Galle, W., Debacker, W., & Audenaert, A. (2019b). Sustainability assessment of circular building alternatives: Consequential LCA and LCC for internal wall assemblies as a case study in a Belgian context. *Journal of Cleaner Production*, 218, 141–156. <https://doi.org/10.1016/J.JCLEPRO.2019.01.306>
- Cascione, V., Roberts, M., Allen, S., Dams, B., Maskell, D., Shea, A., Walker, P., & Emmitt, S. (2022). Integration of life cycle assessments (LCA) in circular bio-based wall panel design. *Journal of Cleaner Production*, 344, 130938. <https://doi.org/10.1016/J.JCLEPRO.2022.130938>
- Colangelo, F., Navarro, T. G., Farina, I., & Petrillo, A. (2020). Comparative LCA of concrete with recycled aggregates: a circular economy mindset in Europe. *The International Journal of Life Cycle Assessment* 2020 25:9, 25(9), 1790–1804. <https://doi.org/10.1007/S11367-020-01798-6>
- Cuenca-Moyano, G. M., Martín-Morales, M., Bonoli, A., & Valverde-Palacios, I. (2019). Environmental assessment of masonry mortars made with natural and recycled aggregates. *The International Journal of Life Cycle Assessment*, 24(2), 191–210. <https://doi.org/10.1007/s11367-018-1518-9>
- Eberhardt, L., Birgisdóttir, H., & Birkved, M. (2019c). Comparing life cycle assessment modelling of linear vs. circular building components. *IOP Conference Series: Earth and Environmental Science*, 225(1). <https://doi.org/10.1088/1755-1315/225/1/012039>
- Eberhardt, L. C. M., Birgisdóttir, H., & Birkved, M. (2019a). Dynamic Benchmarking of Building Strategies for a Circular Economy. *IOP Conference Series: Earth and Environmental Science*, 323(1), 012027. <https://doi.org/10.1088/1755-1315/323/1/012027>
- Eberhardt, L. C. M., Birgisdóttir, H., & Birkved, M. (2019b). Life cycle assessment of a Danish office building designed for disassembly. *Building Research & Information*, 47(6), 666–680. <https://doi.org/10.1080/09613218.2018.1517458>
- Eberhardt, L. C. M., van Stijn, A., Kristensen Stranddorf, L., Birkved, M., & Birgisdóttir, H. (2021). Environmental design guidelines for circular building components: The case of the circular building structure. *Sustainability (Switzerland)*, 13(10). <https://doi.org/10.3390/SU13105621>

- Eliard, M., Bertini, A., Al-Obaidy, M., & Attia, S. (2026). Comparative life cycle and energy performance analysis of a circular office building in a temperate climate. *Low-Carbon Materials and Green Construction*, 4(1), 12. <https://doi.org/10.1007/s44242-026-00109-w>
- Gobetti, A., Cornacchia, G., Tomasoni, G., & Ramorino, G. (2025). The environmental benefits of industrial symbiosis: A case study on substituting sand with steel slag as filler in epoxy mortar. *Waste Management & Research: The Journal for a Sustainable Circular Economy*, 43(12), 2075–2091. <https://doi.org/10.1177/0734242X251350543>
- Joensuu, T., Leino, R., Heinonen, J., & Saari, A. (2022). Developing Buildings' Life Cycle Assessment in Circular Economy-Comparing methods for assessing carbon footprint of reusable components. *Sustainable Cities and Society*, 77, 103499. <https://doi.org/10.1016/J.SCS.2021.103499>
- Kakkos, E., Heisel, F., Hebel, D. E., & Hischier, R. (2019). Environmental assessment of the Urban Mining and Recycling (UMAR) unit by applying the LCA framework. *IOP Conference Series: Earth and Environmental Science*, 225(1), 012043. <https://doi.org/10.1088/1755-1315/225/1/012043>
- Kakkos, E., Heisel, F., Hebel, D. E., & Hischier, R. (2020). Towards Urban Mining—Estimating the Potential Environmental Benefits by Applying an Alternative Construction Practice. A Case Study from Switzerland. *Sustainability*, 12(12), 5041. <https://doi.org/10.3390/su12125041>
- Kiesel, A., Brandi, G., Schlatter, J., Gerber, A., & Langenberg, S. (2024). Structural Reuse of Decommissioned Ski Lift Steel Trusses for Load-Bearing Applications. *Architecture*, 4(4), 835–853. <https://doi.org/10.3390/architecture4040044>
- Kitayama, S., Iuorio, O., Josa, I., Borrión, A., & Black, L. (2024). Determining the carbon footprint reduction of reusing lightweight exterior infill walls: A case study of a school building in the United Kingdom. *Journal of Cleaner Production*, 469, 143061. <https://doi.org/10.1016/J.JCLEPRO.2024.143061>
- López-García, A. B., Cotes-Palomino, T., Uceda-Rodríguez, M., Moreno-Maroto, J. M., Cobo-Ceacero, C. J., Andreola, N. M. F., & Martínez-García, C. (2021). Application of Life Cycle Assessment in the Environmental Study of Sustainable Ceramic Bricks Made with 'alperujo' (Olive Pomace). *Applied Sciences*, 11(5), 2278. <https://doi.org/10.3390/app11052278>
- Lozano-Miralles, J. A., Hermoso-Orzáez, M. J., Martínez-García, C., & Rojas-Sola, J. I. (2018). Comparative Study on the Environmental Impact of Traditional Clay Bricks Mixed with Organic Waste Using Life Cycle Analysis. *Sustainability*, 10(8), 2917. <https://doi.org/10.3390/su10082917>
- Marconi, M., Barbanera, M., Calabrò, G., & Baffo, I. (2020). Reuse of leather scraps for insulation panels: Technical and environmental feasibility evaluation. *Procedia CIRP*, 90, 55–60. <https://doi.org/10.1016/j.procir.2020.01.053>
- Mostert, C., Sameer, H., Glanz, D., & Bringezu, S. (2020). Urban Mining for Sustainable Cities: Environmental Assessment of Recycled Concrete. *IOP Conference Series: Earth and Environmental Science*, 588(5), 052021. <https://doi.org/10.1088/1755-1315/588/5/052021>
- Mostert, C., Sameer, H., Glanz, D., & Bringezu, S. (2021). Climate and resource footprint assessment and visualization of recycled concrete for circular economy. *Resources, Conservation and Recycling*, 174, 105767. <https://doi.org/10.1016/J.RESCONREC.2021.105767>
- Niu, Y., Rasi, K., Hughes, M., Halme, M., & Fink, G. (2021). Prolonging life cycles of construction materials and combating climate change by cascading: The case of reusing timber in Finland. *Resources, Conservation and Recycling*, 170, 105555. <https://doi.org/10.1016/J.RESCONREC.2021.105555>
- Peceño, B., Alonso-Fariñas, B., Vilches, L. F., & Leiva, C. (2021). Study of seashell waste recycling in fireproofing material: Technical, environmental, and economic assessment. *Science of The Total Environment*, 790, 148102. <https://doi.org/10.1016/J.SCITOTENV.2021.148102>
- Pešta, J., Pavlů, T., Fořtová, K., & Kočí, V. (2020). Sustainable Masonry Made from Recycled Aggregates: LCA Case Study. *Sustainability*, 12(4), 1581. <https://doi.org/10.3390/su12041581>

- Quintana-Gallardo, A., Romero Clausell, J., Guillén-Guillamón, I., & Mendiguchia, F. A. (2021). Waste valorization of rice straw as a building material in Valencia and its implications for local and global ecosystems. *Journal of Cleaner Production*, 318, 128507. <https://doi.org/10.1016/J.JCLEPRO.2021.128507>
- Rasmussen, F., Birkved, M., & Birgisdóttir, H. (2019). Upcycling and Design for Disassembly – LCA of buildings employing circular design strategies. *IOP Conference Series: Earth and Environmental Science*, 225(1), 012040. <https://doi.org/10.1088/1755-1315/225/1/012040>
- Rasmussen, F. N., Birkved, M., & Birgisdóttir, H. (2020). Low- carbon design strategies for new residential buildings—lessons from architectural practice. *Architectural Engineering and Design Management*, 16(5), 374–390. https://doi.org/10.1080/17452007.2020.1747385/SUPPL_FILE/TAEM_A_1747385_SM7504.PDF
- Salmio, E., & Huuhka, S. (2026). Environmental impacts of reclaimed bricks: comparing different deconstruction methods. *Buildings & Cities*, 7(1), 323–340. <https://doi.org/10.5334/bc.651>
- Schneider-Marin, P., Chiusi, B., Thyholt, M., Rinholm, H., Resch, E., & Lausset, C. (2025). Greenhouse gas emissions of buildings designed for disassembly across multiple life cycles. *Building and Environment*, 282, 113247. <https://doi.org/10.1016/j.buildenv.2025.113247>
- Simões, F., Rios-Davila, F.-J., Paiva, H., Maljaee, H., Morais, M., & Ferreira, V. M. (2021). Sustainability Evaluation Using a Life Cycle and Circular Economy Approach in Precast Concrete with Waste Incorporation. *Applied Sciences*, 11(24), 11617. <https://doi.org/10.3390/app112411617>
- Trubina, N., Lupisek, A., Pesta, J., & Vlasata, B. (2024). Demountable structures: Evaluation of a circular design approach through life cycle assessment. *IOP Conference Series: Earth and Environmental Science*, 1402(1), 012040. <https://doi.org/10.1088/1755-1315/1402/1/012040>
- Uceda-Rodríguez, M., Moreno-Maroto, J. M., Cobo-Ceacero, C. J., López-García, A. B., Cotes-Palomino, T., & Martínez-García, C. (2022). Comparative Life Cycle Assessment of Lightweight Aggregates Made from Waste—Applying the Circular Economy. *Applied Sciences*, 12(4), 1917. <https://doi.org/10.3390/app12041917>
- van Stijn, A., Eberhardt, L. C. M., Wouterszoon Jansen, B., & Meijer, A. (2020). Design guidelines for circular building components based on LCA and MFA: The case of the Circular Kitchen. *IOP Conference Series: Earth and Environmental Science*, 588(4), 042045. <https://doi.org/10.1088/1755-1315/588/4/042045>
- van Stijn, A., Malabi Eberhardt, L. C., Wouterszoon Jansen, B., & Meijer, A. (2021). A Circular Economy Life Cycle Assessment (CE-LCA) model for building components. *Resources, Conservation and Recycling*, 174, 105683. <https://doi.org/10.1016/J.RESCONREC.2021.105683>
- Vares, S., Hradil, P., Sansom, M., & Ungureanu, V. (2020). Economic potential and environmental impacts of reused steel structures. *Structure and Infrastructure Engineering*, 16(4), 750–761. <https://doi.org/10.1080/15732479.2019.1662064>
- Vasuks, P., Vamza, I., Valtere, M., Bezrucko, T., & Blumberga, D. (2025). Recycled cross-laminated timber as a low environmental impact alternative to virgin material: Latvia case study. *Case Studies in Construction Materials*, 22, e04094. <https://doi.org/10.1016/J.CSCM.2024.E04094>

Appendix C: Temporal considerations

ID	Perspective	Scope	Modules EN15978	RSP type	RSP	LC	Replacements	Biogenic carbon	Temporal sensitivity	Result aggregation
S01	downstream	multiple life cycles	A1-A3, A4, B4, C2-C4, D	based on ESL	60	1	B4	mentioned	background data	resolved, modules
S02	downstream	full life cycle	A1-A3, A5, B4	based on ESL	60	1	B4	ND	ESL scenarios	aggregated
S03	upstream	multiple life cycles	A1-A3, C3-C4, D	ND	NA	1	ND	excluded	NA	resolved, modules
S04	downstream	full life cycle	A1-A3, A4, B4-B5, B6, C1-C4	ND	NA	1	ND	mentioned	NA	aggregated
S05	downstream	multiple life cycles	A1-A3, A4-A5, C1-C4, D	stated as RSP	100	2	ND	ND	ND	resolved, modules
S06	upstream	upfront impact	ND	ND	NA	NA	NA	ND	NA	aggregated (only A)
S07	downstream	full life cycle	A, B3-B5, C	stated as RSP	60	1	B4, B5	ND	background data	resolved, modules
S08	downstream	full life cycle	A, B3-B5, C	stated as RSP	60	1	B4, B5	excluded	refurbishment; background data	resolved, modules
S09	downstream	multiple life cycles	A1-A3, A4-A5, B3-B5, C1-C4, D	based on ESL	120/ 60	1/2	B4, B5	included	LC scenarios	resolved, modules
S10	upstream	upfront impact	ND	ND	NA	NA	NA	ND	NA	aggregated (only A)
S11	upstream	upfront impact	ND	ND	NA	NA	NA	ND	NA	aggregated (only A)
S12	downstream	multiple life cycles	ND	based on ESL	160	2	ND	ND	background data	resolved, other
S13	downstream	multiple life cycles	A1-A3, B4, C3-C4, D	based on ESL	50/8 0	2/3	B4	ND	LC scenarios	aggregated, allocation
S14	combined	multiple life cycles	ND	stated as RSP	200	1/3/4	unclear	excluded	LC sensitivity; ESL sensitivity	aggregated, allocation
S15	downstream	multiple life cycles	ND	based on ESL	30/5 0/16 0	2	ND	included	ND	resolved, other
S16	downstream	full life cycle	A1-A5, B4, B6, C3-C4	stated as RSP	50	1	B4, B5	included	ESL uncertainty; ESL sensitivity	resolved, modules
S17	upstream	upfront impact	ND	ND	NA	NA	NA	included	NA	aggregated (only A)
S18	downstream	multiple life cycles	A1-A5, B1-B6, C1-C4	stated as RSP	90/1 00	2/3	B4, B5	ND	ESL scenarios; LC scenarios	aggregated, allocation
S19	downstream	multiple life cycles	A1-A5, B4, B6, C3-C4, D	based on ESL	60	1	B4	ND	ND	resolved, modules
S20	downstream	multiple life cycles	A1-A3, A4-A5, B4, B6, C1-C4, D	based on ESL	60	1	B4	ND	ND	resolved, modules
S21	upstream	upfront impact	A1-A3	ND	NA	NA	NA	ND	NA	aggregated (only A)

ID	Perspective	Scope	Modules EN15978	RSP type	RSP	LC	Replacements	Biogenic carbon	Temporal sensitivity	Result aggregation
S22	downstream	full life cycle	A1-A3, A4, A5, C1-C4	stated as RSP	60	1	B4	ND	ESL scenarios	resolved, modules
S23	upstream	upfront impact	ND	not applied*	100*	NA	NA	ND	NA	aggregated (only A)
S24	upstream	upfront impact	ND	ND	NA	NA	NA	ND	NA	aggregated (only A)
S25	upstream	upfront impact	ND	ND	NA	NA	NA	ND	NA	aggregated (only A)
S26	upstream	upfront impact	C1-C3; A1-A3	ND	NA	NA	NA	ND	NA	aggregated (only A)
S27	upstream	upfront impact	C1-C3; A1-A3	ND	NA	NA	NA	ND	NA	aggregated (only A)
S28	downstream	multiple life cycles	ND	based on ESL	100	2	ND	included	ND	aggregated
S29	upstream	full life cycle	ND	ND	NA	1	ND	ND	ND	aggregated
S30	combined	multiple life cycles	ND	based on ESL	50/100	1/2	ND	included	ESL scenarios	aggregated
S31	upstream	upfront impact	A1-A3	ND	NA	NA	NA	ND	NA	aggregated (only A)
S32	combined	multiple life cycles	A1-A3, B4, C3-C4, D	stated as RSP	120	1	B4	included	ND	resolved, modules
S33	combined	full life cycle	A1-A3, B4, C3-C4	stated as RSP	120	1	B4, B5	included	ESL sensitivity	resolved, modules
S34	upstream	upfront impact	A1-A3	ND	NA	NA	NA	excluded	NA	aggregated (only A)
S35	downstream	multiple life cycles	A1-A5, B1, B4, C1-D	stated as RSP	60	3	B4	mentioned	ND	aggregated, allocation
S36	upstream	upfront impact	ND	ND	NA	NA	NA	ND	NA	aggregated (only A)
S37	downstream	multiple life cycles	A1-A3, A4-A5, B4, B5, C2-C4, D	stated as RSP	100	2	B4, B5	ND	ND	resolved, modules
S38	upstream	upfront impact	ND	ND	NA	NA	NA	ND	NA	aggregated (only A)
S39	combined	multiple life cycles	ND	stated as RSP	80	1/4/8	unclear	excluded	LC sensitivity; ESL sensitivity	aggregated, allocation
S40	combined	multiple life cycles	ND	stated as RSP	80	1/2/4/8	unclear	excluded	ND	aggregated, allocation
S41	upstream	multiple life cycles	A1-A3, A4-A5, B6, C1-C2, D	based on ESL	27	1	ND	ND	ND	resolved, modules
S42	upstream	upfront impact	ND	ND	NA	NA	NA	mentioned	NA	aggregated (only A)

Table S4: Details of the studies examined: temporal considerations.

Note: ND = not defined; NA = not applicable; * S23 states a 100 years RSP but does not further use it.

Appendix D: Emission reduction timing

[illegible]

ID	CBS Category	CBS Perspective	Circular system	Linear system	second. impacts	LCA level	GWP Results	Result format	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
S24_C01	Recycling	upstream	Organic waste recycling in bricks (BB15)	brick with red clay (BYRC)	NA	material	Figure 10	upfront only	R	R	R	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
S25_C01	Recycling	upstream	Recycling of leather scraps in insulation	polyurethane panels	yes	material	Figure 3	upfront only	R	R	R	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
S26_C01	Recycling	upstream	Recycled concrete XC1	BAU concrete (BAU1)	NA	material	Figure 4	upfront only	R	R	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
S26_C02	Recycling	upstream	Recycled concrete XC2	BAU concrete (BAU2)	NA	material	Figure 4	upfront only	I	I	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
S26_C03	Recycling	upstream	Recycled concrete building (45% made with RC)	BAU concrete	NA	building	Figure 6	upfront only	I	I	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
S27_C01	Recycling	upstream	Recycled concrete	BAU concrete	NA	material	Figure 6	upfront only	R	R	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
S28_C01	DfD	downstream	Future reuse of timber structure	"no cascading" scenario	NA	building	Figure 3	aggregated	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
S29_C01	Recycling	upstream	Recycled seashell waste as fireproofing material (60%)	Gypsum based fireproofing material (100G)	NA	material	Figure 6	aggregated	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
S30_C01	DfD	downstream	Reusable concrete block for masonry (Plan 3)	Plan 4 (non reusable, NA)	NA	component	Table 9	aggregated	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
S30_C02	Recycling	upstream	Recycled aggregate concrete in masonry (Plan 1 and 2)	Plan 3 (reusable, NA)	NA	component	Table 7	aggregated	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
S31_C01	Recycling	upstream	rice straw facade (recycling)	brick facade F1.1 (CEC)	low	material	Table 11	upfront only	R	R	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
S32_C01	Reuse	upstream	Upcycle building	Upcycle building – regular construction	yes	building	Table 4; Figure 2	modules	R	R	R	ND	ND	ND	ND	ND	R	ND	ND	ND	=	=	ND
S32_C02	DfD	downstream	DfD building	Upcycle building – regular construction	yes	building	Table 4; Figur 2	modules	I	I	I	ND	ND	ND	ND	ND	I	ND	ND	ND	R	R	NA
S33_C01	Reuse	upstream	Upcycle house	Reference House	yes	building	Figure 3	modules	R	R	R	ND	ND	ND	ND	ND	R	ND	ND	ND	I	I	ND
S33_C02	Longevity	downstream	Traditional Maintenance free house	Reference House	yes	building	Figure 3	modules	R	R	R	ND	ND	ND	ND	ND	R	ND	ND	ND	I	I	ND
S33_C03	Longevity	downstream	Innovative Maintenance free house	Reference House	yes	building	Figure 3	modules	R	R	R	ND	ND	ND	ND	ND	R	ND	ND	ND	I	I	ND
S33_C04	DfA	downstream	Adaptable house	Reference House	yes	building	Figure 3	modules	R	R	R	ND	ND	ND	ND	ND	I	R	ND	ND	R	R	ND

ID	CBS Category	CBS Perspective	Circular system	Linear system	second. impacts	LCA level	GWP Results	Result format	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
S34_C01	Reuse	upstream	Reclaimed bricks (two deconstruction techniques)	new brick	high	material	Figure 4	upfront only	R	R	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
S35_C01	DfD	downstream	DfD building (method)	"one life cycle" scenario	NA	building	Figure 8	aggregated	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
S36_C01	Recycling	upstream	Circular Precast Concrete	Linear precast concrete	NA	material	Figure 6; Table 7	upfront only	R	R	R	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
S37_C01	DfD	downstream	Demountable facade	conventional masonry system	NA	component	Figure 4; Table 4	modules	I	I	I	I	R	ND	ND	ND	I	I	ND	R	R	=	R
S38_C01	Recycling	upstream	Lightweight aggregates from waste (SY-2.5AHS)	Traditional Lightweight Aggregates (SY-0)	NA	material	Figure 6	upfront only	R	R	R	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
S39_C01	Reuse	upstream	Reclaim! kitchen	BAU kitchen	NA	component	Table 1	aggregated	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
S39_C02	DfA	downstream	Plug & Play kitchen	BAU kitchen	NA	component	Table 1	aggregated	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
S40_C01	Reuse	upstream	Reclaim! kitchen	BAU kitchen	NA	component	Table 1	aggregated	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
S40_C02	Longevity	downstream	Life+	BAU kitchen	NA	component	Table 1	aggregated	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
S40_C03	DfA	downstream	Plug & Play kitchen	BAU kitchen	NA	component	Table 1	aggregated	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
S41_C01	Reuse	upstream	Reused steel structure	New steel scenario (20% recycled content)	NA	building	Table 10; Figure 9	modules	R	R	R	I	I	ND	ND	ND	ND	ND	=	=	ND	ND	I
S42_C01	Recycling	upstream	recycled CLT	virgin CLT	NA	material	Table 2; Figure 6	upfront only	R	R	R	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table S5: Emission reduction timing.