

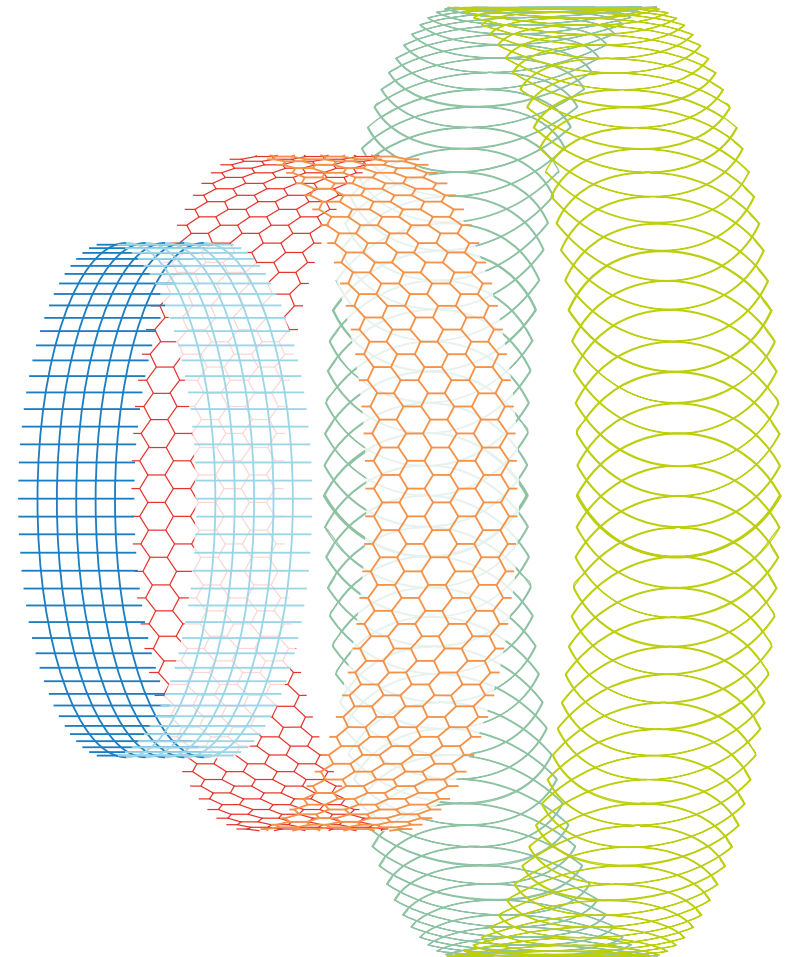


Building Prosperity

Unlocking the potential
of a nature-positive,
circular economy for Europe

This technical appendix details the quantitative modelling that supports the economic, social, and environmental benefits presented in Building Prosperity: Unlocking the potential of a nature-positive, circular economy.

Our analysis is built on ambitious yet achievable transformation targets for the built environment between 2025-2035. We have employed pragmatic yet nuanced assumptions for revenue calculations across the six nature-positive, circular strategies, carefully balancing optimism with feasibility. All data points and modelling parameters are based on reputable information sources, established industry benchmarks, and peer-reviewed research. This transparent methodology ensures the credibility of our findings while acknowledging the transformative scale of change required to realise the full potential of a nature-positive, circular built environment.



Six nature-positive, circular strategies can generate significant annual revenue distributed across the built environment value chain

Table 1 - Detailed breakdown of direct economic benefits across different strategies and value chain actors (EUR bn/year)

Ambitions		Modular and nature-focused Designers & Engineers	Material & component suppliers	Modular build & site remediation contractors	New building & site managers	Digital solution providers	Total new revenue pool
REVITALISE	Brownfield site redevelopment	5.58	0	7.2	30.24	1.29	46.0
	Conversion of vacant commercial buildings	3.2	15.2	22.7	13.8	1.65	54.9
MAXIMISE	Increase tree canopies	8.3	13.5	41.8	8.1	1.4	73.8
	Expand green-blue spaces	4.6	9.4	21.3	2.3	0.75	37.6
OPTIMISE	Material-efficient design	36.9	173.4	86.7	7.8	23.25	328.0
	Low-impact materials	0.0	35.3	0.0	0.0	0.0	35.3
		58.55	246.78	179.70	62.13	28.37	575.5

REVITALISE: Brownfield site redevelopment and the conversion of vacant commercial buildings

Assumptions and modelling approach

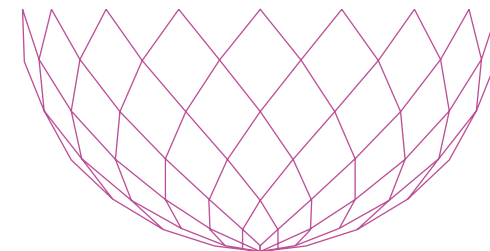
The economic benefits were modelled based on ambitious but achievable transformation targets over 2025-2035.

For brownfield site redevelopment, the modelling targets 4% of Europe's 3 million brownfield sites annually (12,000 sites × average site area 10,000 m² = 120 million m²/year). Benefits were modelled for designers and engineers by multiplying this annual development area by established industry rates: EUR 500,000 per site for master planning (yielding EUR 5.58 bn). For materials/remediation service providers the estimate was based on EUR 60/m² for remediation costs (EUR 7.2 bn). For asset managers, the revenue potential was based on a built area factor of 1.4, with buildings yielding a EUR 15/m²/month rental income (EUR 30.24 bn). Digital solution revenue is based on an increase from current digital investment of 1% of overall revenue to a cross-sector average of 3% (EUR 1.29 bn).

Total revenue pool = EUR 44.3 bn/year

For the conversion of vacant commercial buildings, the model identified a potential target area of 255 million m² of potential convertible space from across Europe's vacant office stock over the next 10 years (25 bn m² × 25% commercial × 51% office × 8% vacant). The annual target of 26 million m² generates value chain benefits through conversion costs of EUR 1,485/m², split 40/60 between materials (EUR 15.2 bn) and labour (EUR 22.7 bn). Design fees (8.5% of costs) contribute EUR 3.2 bn, while asset management revenue is based on an estimated EUR 5,397/m² property value which could generate 5% annual rental income (EUR 13.8 bn), plus 3% digital solutions revenue (EUR 1.65 bn).

Total revenue pool = EUR 56.6 bn/year



Summary tables

Table 2 - Scale and market context

Metric	Brownfield site redevelopment	Conversion of vacant commercial buildings
Market size	3 million brownfield sites	25 bn m ² real estate stock
Target segment	4% of available sites annually	8% of vacant office stock
Annual target	12,000 sites	1,020 sites
Annual area	120 million m ²	26 million m ²
Average site size	10,000 m ²	25,000 m ²
10-year target	1,680 million m ²	255 million m ²

Table 3 - Distribution across value chain and key assumptions

Value chain player	Brownfield site redevelopment		Conversion of vacant commercial buildings	
	Revenue potential/ year (EUR)	Key assumption	Revenue potential/ year (EUR)	Key assumption
Design/Engineering	5.58 bn	EUR 500,000/site planning fee	3.2 bn	8.5% of project costs
Design/Engineering	7.2 bn	EUR 60/m ² remediation cost	15.2 bn	EUR 1,485/m ² conversion cost × 40% materials
Construction	-	-	22.7 bn	EUR 1,485/m ² conversion cost × 40% labour
Asset management	30.24 bn	EUR 15/m ² /month rental	13.8 bn	EUR 5,397/m ² value, 5% of value = rental revenue
Digital solutions	1.29 bn	3% of revenue	1.65 bn	3% of revenue
Total revenue/year	44.3 bn		56.6 bn	

MAXIMIZE: Increase tree canopies and expand green-blue spaces

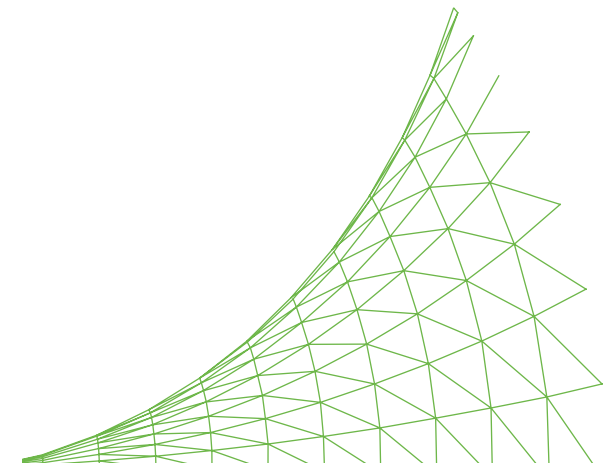
Assumptions and modelling approach

The economic benefits were modelled based on ambitious but achievable transformation targets over 2025-2035. The model calculates economic benefits of urban greening, targeting a total area of 8,474 km² across European cities, an area calculated to bring all EU cities to a minimum 45% green cover. The modelling approach divides interventions across the target area into two main types: increasing tree canopies on urban streets (80%) and expanded parks with trees and water features (20%).

For trees, the target area translates to an annual planting of 6.78 million trees (at 100 m² per tree) across 678 km². For the parks strategy, the target ambition is the development of 169 km² annually, with 50% tree coverage and an increase of 6.6% blue infrastructure. The economic benefits have been calculated using industry-derived figures including: EUR 1,434 per tree for materials, EUR 4,303 for planting, EUR 23.20/m² for ground preparation, and annual maintenance of EUR 9.40 per tree and EUR 1.10/m² for turf. Professional fees are estimated based on 15% project costs (design fees) and 2% of overall revenue (digital fees).

Total revenue pool 'trees' = EUR 73.1 bn/year

Total revenue pool 'parks' = EUR 38.35 bn/year



Summary tables

Table 4 - Scale and market context

Metric	Increase tree canopies	Urban parks
Market size	8,474 km ² potential urban green space	8,474 km ² potential urban green space
Target segment	80% of greening potential	20% of greening potential
Annual target	6.78 million trees	-
Annual area	678 km ²	169 km ²
Coverage density	1 tree per 100 m ²	50% tree cover, 6.6% blue infrastructure
10-year target	6,779 km ²	1,695 km ²

Table 5 - Distribution across value chain and key assumptions

Value chain player	Increase tree canopies		Urban parks	
	Revenue potential/year (EUR)	Key assumption	Revenue potential/year (EUR)	Key assumption
Design/Engineering	8.3 bn	15% of project costs	4.6 bn	15% of project costs
Materials/Remediation	13.5 bn	EUR 1,434/tree	9.4 bn	Trees, soil, turf, seeds, water infrastructure
Contracting	41.8 bn	EUR 4,303/tree + EUR 23.20/m ² groundwork	21.3 bn	EUR 4,303/tree + EUR 23.20/m ² groundwork + blue infrastructure EUR 1,315/m ²
Management	8.1 bn	EUR 9.40/tree maintenance	2.3 bn	Maintenance costs for turf, trees, and blue-green infrastructure
Digital solutions	1.4 bn	2% of revenue	0.75 bn	2% of revenue
Total revenue/year	73.1 bn		38.35 bn	

OPTIMISE: Material-efficient design and low-impact materials

Assumptions and modelling approach

The economic benefits were modelled based on transforming the European construction sector between 2025-2035 by applying a two-pronged strategy:

1 30% material reduction through:

- Bio-based material substitution (reduces concrete demand by 7.7%, as lighter weight buildings)
- Construction design efficiencies — primarily by a 75% shift to modular construction, saving 15% of materials
- A paradigm shift in newly built housing stock from single-family home (SFH) dominance (75%:25%) to a greater balance with multi-family homes (MFH) (45:55%) — reducing material consumption by 8-12%

2 Low-impact materials

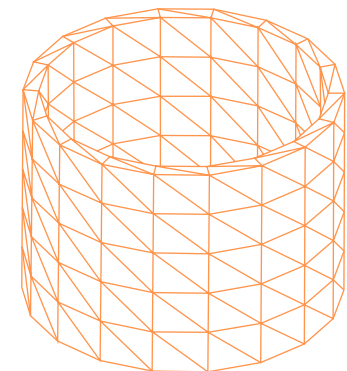
- 50% increase in timber use
- 35% green cement substitution
- 56% green steel substitution

For the material-efficient design strategy, the economic modelling focuses on a wide-scale shift to modular construction applied to the 1.57 million new residential units built annually (new build residential 3.5 per 1,000 population), split between single-family (45%, 705,600 units) and multi-family homes (55%, 143,733 buildings), as well as 53,532 'utility' buildings (residential, offices). Based on 75% modular adoption, economic benefits were estimated using industry rates: EUR 1,080/m² for modules and EUR 540/m² for on-site labour. Design fees average 8.5% of construction costs, equivalent to EUR 26,411 for single-family and EUR 126,772 for multi-family homes. Digital solutions revenue is based on 25% of the global construction software market.

Total revenue pool = EUR 328 bn/year

For low-impact materials, revenue potential is estimated using market prices for different materials: EUR 1,090/tonne for timber, EUR 150/tonne for green cement, and EUR 585-797/tonne for green steel.

Total revenue pool = EUR 35.3 bn/year



Summary tables

Table 6 - Scale and market context

Metric	Material-efficient design	Low-impact materials
Market size	Annual - 1.57 M new residential units and 53,532 utility buildings	
Target segment	75% modular adoption	50% increase in timber use 35% green cement substitution 56% green steel substitution
Annual target - Residential	705,600 SFH, 143,733 MFH	Buildings: 27.7 Mt green cement, 17.2 Mt green steel, 8.5 Mt of timber
Annual target - Utility (retail, office)	53,532 buildings	
Average unit size	SFH: 115 m ² , MFH: 552 m ² , Utility: 1,000 m ²	-
Total annual floor area	Residential: 161 Mm ² , Utility: 54 Mm ²	-

Table 7 - Distribution across value chain and key assumptions

Value chain player	Material-efficient design		Low-impact materials	
	Revenue potential/year (EUR)	Key assumption	Revenue potential/year (EUR)	Key assumption
Design/Engineering	36.9 bn	8.5% of project costs	-	-
Materials/Remediation	173.4 bn	EUR 1,080/m ² module costs	35.3 bn	EUR 1,090/tonne - CLT Price EUR 150/tonne - Green cement EUR 585/tonne - Green steel rebar EUR 797/tonne - Green steel other
Contracting	86.7 bn	EUR 540/m ² on-site labour costs modular	-	-
Building owners	7.8 bn	EUR 270/m ² residual value of modules	-	-
Digital solutions	23.3 bn	25% (EU market) of overall global construction software value add	-	-
Total revenue/year	328 bn		35.3 bn	

Wider economic benefits realised annually for businesses, municipalities, and citizens

Table 8 - Detailed breakdown of indirect economic benefits

Category	Impacts	Type of benefit	Annual benefits (EUR/year)
Vibrancy and footfall	Enhanced attractiveness of commercial zones increasing foot traffic to shops and businesses	Revenue	117 bn
Infrastructure	More resource-efficient infrastructure network construction	Avoided cost (infrastructure)	16 bn
Water and energy savings	Cooler, greener streets reducing energy and stormwater management costs	Avoided cost (infrastructure)	6 bn
Health through increased exposure to nature	Savings from reduced sick day leave	Avoided cost (public health)	8 bn
Productivity through reduction in heat island effect	Losses averted by reducing heat in some urban areas for office workers	Avoided cost (public health)	11 bn
Total revenue/year			158 bn

Indirect economic benefits

Assumptions and modelling approach

The indirect economic benefits modelling is based on three primary value pools:

Retail vibrancy and footfall

Benefits are calculated against a total EU retail turnover of EUR 4,076 bn. The model targets two segments: 10% of downtown retail areas through revitalisation strategies, and 9.1% of businesses through new tree-lined streets. Key assumptions include a 20% increase in footfall for revitalised areas and 10% higher spending in greened retail zones.

Infrastructure and resource savings

Analysis is based on data from Flanders region (EUR 380 million savings), extrapolated to the EU scale. The model assumes 60% of European urban areas have comparable characteristics to Flanders, which represents 1.5% of Europe's population. Resource savings includes:

- Energy: Based on 954 Mtoe¹ total EU consumption, focusing on the 23% used for building heating/cooling
- Drainage: Calculated from EUR 54 bn total EU wastewater charges, with impact on 9.1% of buildings near trees and 2.3% near parks

Health and productivity

Two primary components:

- Workplace health: modelled using German sick leave costs (EUR 118 bn) as baseline, adjusted for Germany's 29% share of EU GDP and 1.3 × higher sick leave rate
- Heat stress mitigation: Assessed against EUR 563 bn annual EU economic losses (worst case 2080 — reduced by 50% for 2030), targeting 35% of workforce in office environments, with benefits reaching 9.1% of buildings through trees and 2.3% through parks

¹ Mtoe – Mega tonnes of oil equivalent; 1 toe = 11630 kWh

Summary tables

Table 9 - Scale and market context for indirect benefits

Benefit category	Market size	Target segment	Key metrics/assumptions
Vibrancy and footfall	EUR 4,076 bn EU retail turnover	Revitalise: 10% of downtown retail areas Maximise: 9.1% of businesses impacted by new tree-lined streets	Revitalise: 20% increase in footfall Maximise: 10% willingness-to-spend increase when shopping
Infrastructure savings	EUR 380 million (Flanders savings)	Flanders region = 1.5% of the population of Europe 60% of urban areas in Europe	Derived from the Flanders region. Extrapolated to a share of EU by relative population size, assuming 60% of urban areas comparable to the Flanders region.
Energy savings	EU Total energy consumption 954 Mtoe	23% of EU energy use for heating/cooling buildings Energy cost = 0.2525 EUR/kWh	9.1% of building impacted, 5% reduction in energy
Water savings	EU Total waste water charges EUR 54 bn	9.1% buildings impacted by increase in tree-lined streets 2.3% buildings impacted by increase in parks	45% reduction in wastewater charges
Health through increased exposure to nature	Production losses due to sick leave to German economy – EUR 118 bn	GDP of Germany as a % of overall EU economy = 29% Factor German sick leave compared to rest of EU economy = 1.3	23% reduction in sick leave with a view of nature
Productivity through reduction in heat island effect	Annual economic loss in EU – 563 bn ²	9.1% buildings positively impacted – trees 2.3% buildings positively impacted – parks	35% of office workers

Nature, climate, and social benefits for all stakeholders

Key nature and climate benefits

Assumptions and modelling approach

The model quantifies two major non-economic impacts from circular and nature-positive strategies in European cities between 2025-2035:

Protected and created green space totals 16,000 km² through three mechanisms:

- Creating 8,474 km² of new urban green space (split between street trees and parks)
- Avoiding 6,720 km² of suburban sprawl through brownfield site redevelopment
- Preventing 1,020 km² of peripheral development through conversion of vacant commercial buildings.
The 4x multiplier for avoided sprawl reflects additional land savings from reduced infrastructure needs.

Carbon mitigation equivalent to 4.9% of EU emissions (133 Mt CO₂/year) via four mechanisms:

- Material efficiency in construction (92.8 Mt from green cement, steel, and reduced waste)
- Avoided transport emissions (23.2 Mt from 12 million fewer cars)
- Infrastructure savings (14.9 Mt from compact development)
- Direct carbon sequestration from new green space (2.1 Mt from trees and parks)

Table 10 - Detailed breakdown of key nature and climate benefits

Benefit category	Total	Equivalent
Protected and created green space	16,000 km ²	50% land area of Belgium
Carbon emissions reduction	133 Mt CO ₂ e	~5% total EU emissions

Acknowledgements



The Ellen MacArthur Foundation is an international charity that develops and promotes the circular economy in order to tackle some of the biggest challenges of our time, biodiversity loss, climate change, and waste and pollution. We work with our network of private and public sector decision makers, as well as academia, to build capacity, explore collaborative opportunities, and design and develop circular economy initiatives and solutions. Increasingly based on renewable energy, a circular economy is driven by design to eliminate waste, circulate products and materials, and regenerate nature, to create resilience and prosperity for business, the environment, and society.

Further information: www.ellenmacarthurfoundation.org

S Y S T E M I Q

Systemiq, the system-change company, was founded in 2016 to drive the achievement of the Sustainable Development Goals and the Paris Agreement, by transforming markets and business models in five key systems: nature and food, materials and circularity, energy, urban areas, and sustainable finance. A certified B Corp, Systemiq combines strategic advisory with high-impact, on-the-ground work, and partners with business, finance, policymakers, and civil society to deliver system change. In 2020, Systemiq and The Pew Charitable Trusts published *Breaking the Plastic Wave*: a comprehensive assessment of pathways towards stopping ocean plastic pollution, an evidence-based roadmap that shows how industry and governments can radically reduce ocean plastic pollution by 2040. Systemiq has offices in Brazil, France, Germany, Indonesia, the Netherlands, and the UK.

Further information: www.systemiq.earth

ARUP

Dedicated to sustainable development, Arup is a collective of 18,000 designers, advisors, and experts working across 140 countries. Founded to strive for humanity and excellence, Arup collaborates with clients and partners, using imagination, technology, and rigour to shape a better world. Arup is a longstanding knowledge partner to the Ellen MacArthur Foundation, working together over nearly a decade to enhance recognition of the circular economy in the built environment. In 2022, Arup and the Ellen MacArthur Foundation launched the Circular Buildings Toolkit, a practical tool designed to bring the circular economy into the mainstream for real estate players, helping asset owners, developers, and investors to future-proof assets as sustainability policies redraw the industry.

Further information: www.arup.com



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The ***Building Prosperity: Unlocking the potential of a nature-positive, circular economy report***
is available in: [English](#), [Español](#), and [Português](#).